On-Road Mobile Source Redesignation and Maintenance Emissions Inventories for the Dallas-Fort Worth Counties in Either the Four-County Area (DFW4) and/or Nine-County Area (DFW9) Previously Designated as Nonattainment for the One-Hour and/or the 1997 8-Hour Ozone National Ambient Air Quality Standard

October 2018

North Central Texas
Council of Governments

What is NCTCOG?

The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts, and special districts which was established in January 1966 to assist local governments in **planning** for common needs, **cooperating** for mutual benefit, and **coordinating** for sound regional development.

It serves a 16-county metropolitan region centered around the two urban centers of Dallas and Fort Worth. Currently the Council has **236 members**, including 16 counties, 168 cities, 24 independent school districts, and 28 special districts. The area of the region is approximately **12,800 square miles**, which is larger than nine states, and the population of the region is about **7 million** which is larger than 38 states.

NCTCOG's structure is relatively simple; each member government appoints a voting representative from the governing body. These voting representatives make up the **General Assembly** which annually elects a 17-member Executive Board. The **Executive Board** is supported by policy development, technical advisory, and study committees, as well as a professional staff of 350.

NCTCOG's offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags Over Texas).

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NCTCOG's Department of Transportation

Since 1974 NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation for the Dallas-Fort Worth area. NCTCOG's Department of Transportation is responsible for the regional planning process for all modes of transportation. The department provides technical support and staff assistance to the Regional Transportation Council and its technical committees, which compose the MPO policy-making structure. In addition, the department provides technical assistance to the local governments of North Central Texas in planning, coordinating, and implementing transportation decisions.

Prepared in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.

On-Road Mobile Source Redesignation and Maintenance Emissions Inventories for the Dallas-Fort Worth Counties in Either the Four-County Area (DFW4) and/or Nine-County Area (DFW9) Previously Designated as Nonattainment for the One-Hour and/or the 1997 8-Hour Ozone National Ambient Air Quality Standard

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ABSTRACT

TITLE:	On-Road Mobile Source Redesignation and Maintenance Emissions Inventories for the Dallas-Fort Worth Counties in Either the Four-County Area (DFW4) and/or the Nine-County Area (DFW9) Previously Designated as Nonattainment for the One-Hour and/or the 1997 8-Hour Ozone National Ambient Air Quality Standard
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ABSTRACT:	The North Central Texas Council of Governments conducted on-road emissions inventories to support the Texas Commission on Environmental Quality in development of the Dallas-Fort Worth Redesignation and Maintenance State Implementation Plan revisions for the One-Hour and the 1997 8-Hour Ozone National Ambient Air Quality Standards. Four counties were previously designated as nonattainment for the one-hour ozone standard: Collin, Dallas, Denton and Tarrant; and nine counties previously designated as nonattainment for the 1997 eight-hour ozone

standard: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant. This report documents the on-road mobile methodologies applied and estimated emission results for analysis years 2014, 2020, 2026, and 2032. The estimated emissions are reported for oxides of nitrogen, volatile organic compounds, carbon monoxide, carbon dioxide, sulfur dioxide, ammonia, particulate matter with aerodynamic diameters equal to or less than 2.5 microns, and particulate matter with aerodynamic diameters equal to or less than 10 microns.

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GLOSSARY OF ABBREVIATIONS

ASWT	-	Average School Season Weekday
ATR	-	Automatic Traffic Recorder
CAAA	-	Clean Air Act Amendments
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
DFW	-	Dallas-Fort Worth
DFX	-	Dallas-Fort Worth Travel Model for the Expanded Area
DV	-	Design Value
EPA	-	Environmental Protection Agency
GISDK	-	Geographic Information System Developer Kit
HBW	-	Home-Based Work
HNW	-	Home-Based Non-Work
HOV	-	High Occupancy Vehicle
HPMS	-	Highway Performance Monitoring System
I/M	-	Inspection & Maintenance Program
MPA	-	Metropolitan Planning Area
MPO	-	Metropolitan Planning Organization
MOVES2014a	-	Motor Vehicle Emissions Simulator 2014a
NAAQS	-	National Ambient Air Quality Standards
NCT	-	North Central Texas
NCTCOG	-	North Central Texas Council of Governments
NHB	-	Non-Home Based
NH_3	-	Ammonia
NO_X	-	Oxides of Nitrogen
PM	-	Particulate Matter
$PM_{2.5}$	-	Particulate Matter 2.5 Microns
PM_{10}	-	Particulate Matter 10 Microns
ppb	-	parts per billion
RDM	-	Redesignation and Maintenance
SIP	-	State Implementation Plan
SO_2	-	Sulfur Dioxide
SUT	-	Source Use Types
TCEQ	-	Texas Commission on Environmental Quality
TOD	-	Time-of-Day
TSZ	-	Traffic Survey Zone
TTI	-	Texas A&M Transportation Institute
TxDMV	-	Texas Department of Motor Vehicles
TxDOT	-	Texas Department of Transportation
TxLED	-	Texas Low Emissions Diesel
VHT	-	Vehicle Hours of Travel
VMT	-	Vehicle Miles of Travel
VDF	-	Volume Delay Function
VOC	-	Volatile Organic Compounds

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TABLE OF EXHIBITS

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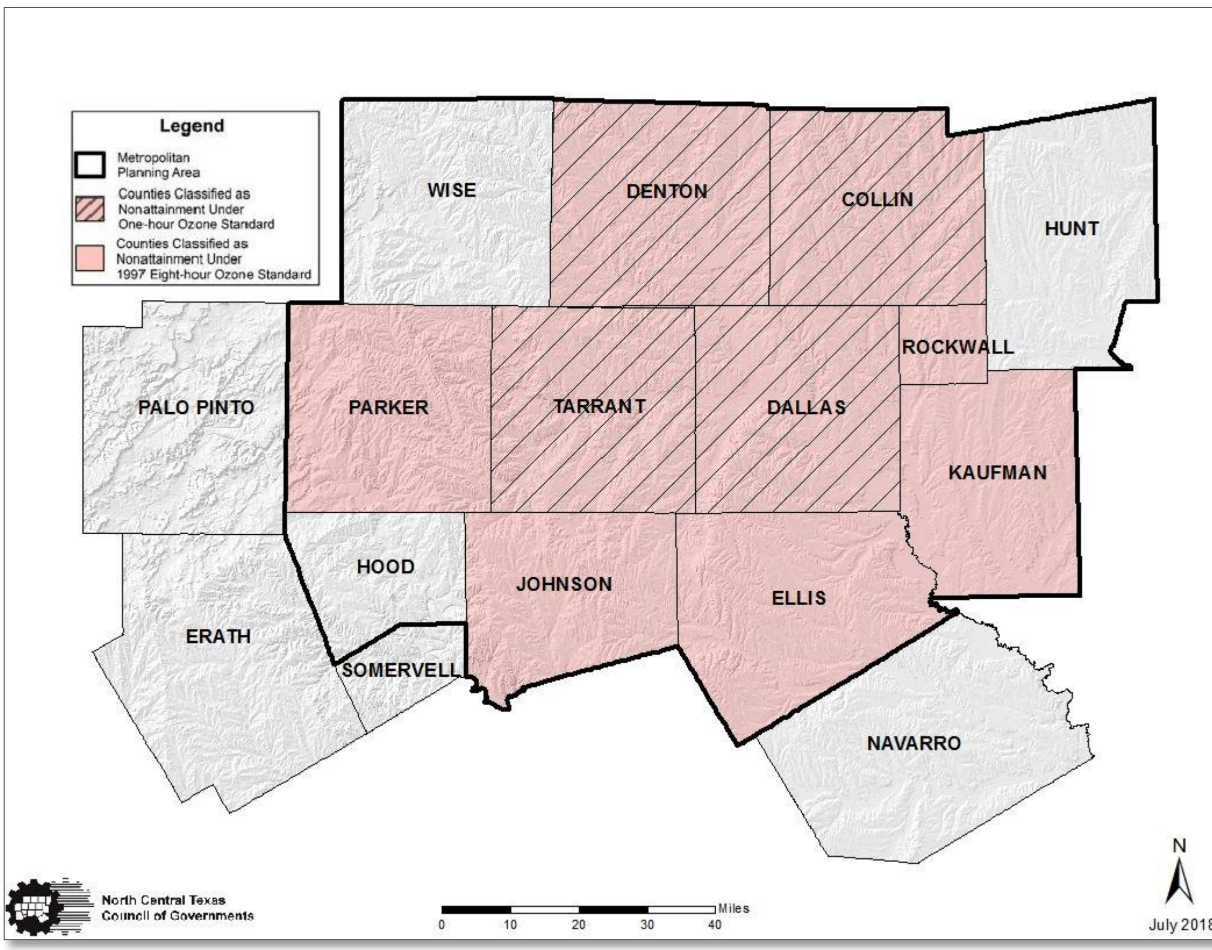
CHAPTER 1: INTRODUCTION

The North Central Texas Council of Governments (NCTCOG) developed on-road emissions inventories to support the Texas Commission on Environmental Quality's (TCEQ) Redesignation Request and Maintenance Plan State Implementation Plan (SIP) revisions for the One-Hour and the 1997 8-Hour Ozone National Ambient Air Quality Standards (NAAQS). These inventories cover the Dallas-Fort Worth (DFW) four-county nonattainment area for the one-hour standard (Collin, Dallas, Denton, and Tarrant) as well as the nine-county nonattainment area for the 1997 8-hour ozone standard (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant) as shown in Exhibit 1.1. This analysis years include 2014, 2020, 2026, and 2032. Pollutants being evaluated are oxides of nitrogen, volatile organic compounds, carbon monoxide, carbon dioxide, sulfur dioxide, ammonia, particulate matter with aerodynamic diameters equal to or less than 2.5 microns, and particulate matter with aerodynamic diameters equal to or less than 10 microns.

Exhibit 1.1: Dallas-Fort Worth Nonattainment Area Map



This report documents the methodology and results of the Redesignation and Maintenance (RDM) emissions inventories. Chapter 1 outlines the background, purpose, the modeling approach; and provides a summary of the four-county and nine-county estimated emissions totals and activity summaries.

Chapter 2 documents the procedures used to develop regional vehicle activity estimates in terms of vehicle miles of travel (VMT) and average vehicle speed. These procedures include development of adjustment factors to more accurately reflect regional conditions. Seasonal and hourly adjustment factors were applied to produce 2014, 2020, 2026, and 2032 analysis year vehicle activity and report vehicle activity in hourly periods. Consistent with previous emission inventory practices, a comparison was made between travel demand model VMT estimates and appropriate Highway Performance Monitoring System (HPMS) VMT to develop HPMS adjustment factors. Also, a nonrecurring congestion adjustment was applied to account for vehicle emissions due to traffic accidents not captured in the standard four-step travel modeling process.

Chapter 3 documents the parameters and inputs used to develop on-road mobile source emission factors by utilizing the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator version 2014a (MOVES2014a) model (released December2015, updated November 2016). Regionally specific calculations, procedures, MOVES2014a emission factors, and adjustments are provided to better reflect regional vehicle emissions emitted. The calculations and procedures include source use type age distribution, fuel engine fractions, vehicle registration, hourly VMT, and trip length distribution. Also accounted for are low emission diesel oxides of nitrogen (NO_X) adjustments and VMT mix.

Chapter 4 documents the four-county and nine-county nonattainment area vehicle emission calculation procedure and estimates.

Chapter 5 summarizes emissions of all pollutants by county and analysis year.

The Appendices contain supplemental information, including a table containing all pollutants calculated, and electronic data supporting the DFW RDM emissions inventories.

Appendix A: MOVES2014a External Files

Appendix B: MOVES2014a Inputs and Output Database Files

Appendix C: MOVES2014a Emission Factor Files

Appendix D: County Emission Estimates (Tab-delimited Format)

Appendix E: Inventory Summary Files (Tab-delimited Format)

Appendix F: SCC and XML Files

Appendix G: Project Quality Control Report and Travel Model Validation Report

Appendix H: Supplement Files (MOVES RunSpecs and MYSQL Script)

Appendix I: Electronic Data Submittal Description

Background

The Clean Air Act Amendments (CAAA) of 1990 requires the EPA to set National Ambient Air Quality Standards for widespread pollutants considered harmful to public health and the environment. The EPA set NAAQS for six of the principal pollutants: ozone, particulate matter (PM), carbon monoxide (CO), sulfur dioxide, NO_X, and lead.

With the signing of the CAAA into law, the four counties of Collin, Dallas, Denton, and Tarrant County in the DFW region were designated as nonattainment under the one-hour NAAQS for the pollutant ozone. The law also requires the EPA to periodically review the NAAQS to ensure they provide adequate health and environmental protection and to update these standards as necessary. Upon completion of a scientific review of the one-hour NAAQS, EPA determined the One-Hour NAAQS was insufficient to protect human health. As a result, the EPA developed the 1997 8-Hour NAAQS, <85 parts per billions (ppb), to place greater emphasis on prolonged exposure to pollutants.

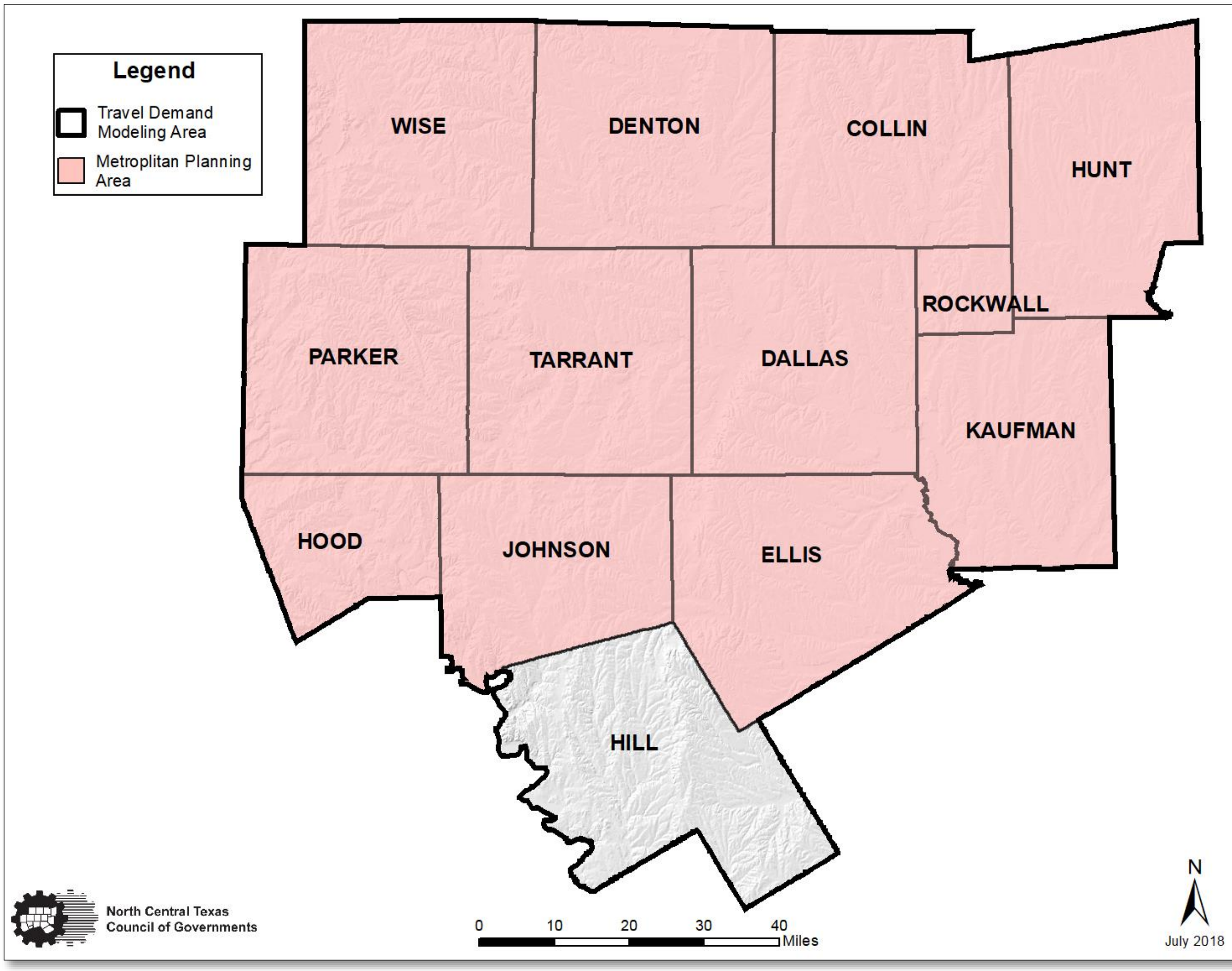
In April 2004, EPA announced Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties comprise the new DFW nine-county nonattainment area for the pollutant ozone under the 1997 8-Hour NAAQS, with an effective designation date of June 15, 2004. The nine-county nonattainment region received a “Moderate” ozone classification with an attainment date of June 15, 2010. As a result of not reaching attainment by June 2010, the DFW region was classified as “Serious” with an attainment date of June 2013.

On-road mobile is a key component of the SIP, as a SIP places emission limits on on-road mobile sources. These on-road mobile emission limits are termed motor vehicle emission budgets and have a direct impact on transportation planning. NCTCOG serves as the Metropolitan Planning Organization for transportation in the DFW area and working with the TCEQ developed on-road mobile source emission inventories for the region consistent with the EPA’s requirements for demonstrating maintenance. NCTCOG applies a four-step travel demand model process using TransCAD software to forecast regional vehicle activity and utilizes EPA’s MOVES2014a with a post-processing application to estimate regional mobile source emissions.

Modeling Approach

The DFW Travel Model for the Expanded Area (DFX) is utilized to estimate VMT and emissions for the 2014, 2020, 2026, and 2032 analysis years. DFX’s modeling domain includes Collin, Dallas, Denton, Ellis, Hill, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. Hill County is not part of the North Central Texas (NCT) Metropolitan Planning Area (MPA) boundary; however, to capture travel from outside areas, Hill County is included in the modeling domain. The NCT 12-county MPA and the 13-county DFX modeling domain is shown in Exhibit 1.2.

Exhibit 1.2: Dallas-Fort Worth Travel Demand Modeling Domain Map



Final RDM VMT and on-road emission estimates by pollutant for summer weekday for each analysis year are shown in Exhibits 1.3 and 1.4. These emission estimates and reductions are provided for the four- and nine-county area previously designated as nonattainment for the One-Hour and 1997 8-Hour ozone NAAQS. Appendix D contains the detailed emissions by county by pollutant and time-of-day for all NCT counties modeled.

Exhibit 1.3: On-Road Emissions for the DFW Four-County Modeling Domain

Four-County Total Summer Season, Weekday VMT (miles) and On-Road Emissions (tons per day)				
	2014	**2020**	**2026**	**2032**
VMT	172,642,333	195,993,904	222,033,288	241,248,455
NO_X	148.44	70.06	44.51	32.17
VOC	69.69	44.66	34.81	25.46
CO	972.96	806.52	655.20	469.52
CO_2	91,109.70	93,494.28	89,474.32	86,039.24
SO_2	1.45	0.61	0.58	0.57
NH_3	5.36	4.62	4.97	5.28
$PM_{2.5}$[1]	5.28	3.50	2.84	2.69
PM_{10}[1]	12.55	11.64	11.92	12.99

Exhibit 1.4: On-Road Emissions for the DFW Nine-County Modeling Domain

Nine-County Total Summer Season, Weekday VMT (miles) and On-Road Emissions (tons per day)				
	2014	**2020**	**2026**	**2032**
VMT	200,226,432	228,458,526	260,603,106	286,192,643
NO_X	184.33	89.68	57.97	42.94
VOC	80.47	51.62	40.17	29.51
CO	1,122.53	929.91	758.85	549.11
CO_2	107,219.33	111,030.09	107,611.25	105,059.99
SO_2	1.68	0.75	0.72	0.72
NH_3	6.24	5.41	5.87	6.30
$PM_{2.5}$[1]	6.47	4.22	3.40	3.23
PM_{10}[1]	14.69	13.47	13.80	15.19

[1]Includes Brakewear and Tirewear

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CHAPTER 2: ROADWAY NETWORK VEHICLE ACTIVITY ESTIMATION PROCEDURES

This chapter discusses the methodology used in estimating the vehicle activity measures influencing air quality in the North Central Texas area. These measures include: vehicle miles of travel (VMT) and average speed. The current Dallas-Fort Worth Travel Model for the Expanded Area (DFX) covers the 12-county Metropolitan Planning Area (MPA) of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties, plus Hill County. The VMT and speeds were estimated with the DFX using a link-based methodology for each time period.

Dallas-Fort Worth Expanded Travel Model

The source of VMT estimates for the Redesignation and Maintenance (RDM) Emissions Inventories for the four and nine nonattainment counties is the network-based DFX executed by the North Central Texas Council of Governments (NCTCOG) Transportation Department in the TransCAD environment. TransCAD is a Geographic Information System (GIS)-based commercial travel demand software package for transportation planning. DFX supports federally required regional transportation planning efforts for the Dallas-Fort Worth (DFW) area. Since 1974, NCTCOG has served as the Metropolitan Planning Organization (MPO) for the DFW area. The Transportation Department provides technical support and staff assistance to the Regional Transportation Council and its technical committees that comprise the MPO policy-making structure.

Multimodal Transportation Analysis Process

The forecasting technique of the DFX is based on a four-step sequential process designed to model travel behavior and predict travel demand at regional, sub-area, or corridor levels. These four steps are: Trip Generation, Trip Distribution, Mode Choice, and Roadway Assignment. The roadway network developed for the RDM Emissions Inventories contains over 30,000 unique segments constructed to replicate the transportation system of the coverage area. For these inventories, the transportation network was developed for the years 2014, 2020, 2026, and 2032. Each facility link in the network has the following attributes:

- Network Node Numbers (defining the beginning and end of each link)
- Number of Operational Lanes in the AM PM Peak and Off-Peak Periods
- Functional Classification
- Divided/Undivided Roadway Code
- Type of Traffic Control At Each of the Link
- Traffic Direction (One- or Two-Way)
- Length of Link
- Estimated Loaded Speeds In Each Period
- Speed Limit
- Traffic Survey Zone
- Tolls
- Area Type
- Free-Flow Speeds
- Hourly Capacities
- Truck Exclusion Code
- Length of Link

Every roadway segment in the network falls in one of the functional classes of centroid connectors, freeways, principal arterials, minor arterials, collectors, ramps, frontage roads, and high occupancy vehicle (HOV) lanes.

Trip purposes in the DFX are defined in one of four ways: home-based work (HBW), which includes trips from home to work or work to home; home-based non-work (HNW), which includes non-work trips beginning or ending at home; non-home based (NHB), which includes trips where home is neither the origin nor the destination; and other trips that include all truck trips as well as all external-internal, internal-external, and external-external vehicle trips.

The model process begins with an estimate of the socio-economic variables for each zone. The data is organized by traffic survey zone (TSZ), the smallest zone size available in the DFX. There are 5,386 TSZs in the model (5,303 internal zones plus 83 externals). The data for each TSZ includes: zone centroid; median household income; number of households; population; basic, retail, and service employment; and land area. This level of detail retained in all four modeling steps.

The Trip Generation Model generates the number of weekday person trips sent to and received from each zone. The Trip Distribution Model determines the trip interaction between each zone and the rest of the zones in the MPA. The Mode Choice Model divides the person trips into two categories of transit and automobile trips. The Assignment Model loads the auto demand onto the roadway network, and the transit passenger trips onto the transit network, commonly referred to as the four-step transportation modeling process. The DFX model application is written by NCTCOG staff in the TransCAD script language known as the Geographic Information System Developer Kit (GISDK), and integrated with a user interface developed in visual basic programming language.

Trip Generation Model

The Trip Generation Model generates the number of weekday person trips sent to and received from each zone. The Trip Generation Model converts the population and employment data into person trip ends and outputs the total number of trips produced by and attracted to each zone by trip purpose. The 2014, 2020, 2026, and 2032 population and employment forecasts were generated with the Disaggregate Residential Allocation Model/Employment Allocation Model using travel times from the Roadway and Transit Assignment Steps consistent with current planning practice. The data can be seen in Exhibit 2.1. The cross-classified trip production model is stratified by income quartile and household size. The allocation of TSZ households into the four income quartiles and six household size categories is based on distribution curves developed from the United States Census Population data. The cross-classified trip attraction model is stratified by area type, employment type (basic, retail, and service), and, for the case of the HBW trip purpose, income quartile. Area type designations are a function of the population and employment density of a zone.

Exhibit 2.1: Socio-Economic Demographic Summary

DFW Nine-County Nonattainment Area				
	2014	**2020**	**2026**	**2032**
Population	6,652,501	7,455,630	8,186,880	9,099,708
Number of Households	2,379,322	2,653,817	2,909,381	3,205,783
Employment Types				
Basic	1,029,233	1,120,790	1,135,412	1,207,307
Retail	411,263	461,678	509,542	569,379
Service	2,877,296	3,221,192	3,526,109	3,963,879
Total Employment	4,317,792	4,803,660	5,171,063	5,740,565

The Trip Generation Model allows the user to input trip rates and trip generation units associated with special generators such as regional shopping malls, hospitals, and colleges/universities. At the end of the generation process, HBW trips are balanced to the estimated trip attractions. All other purposes are balanced to the estimated trip productions in that zone. Because of the uniqueness of the NHB trips, zonal productions for NHB trips are later set equal to the attractions in a given zone.

The regional trip productions and attractions are balanced for each trip purpose. The total trip attractions are balanced to the estimated trip productions in that zone for all other trip purposes.

Trip Distribution Model

The Trip Distribution Model creates the production-attraction person trip tables for each of the 5,386 model zones. The Trip Distribution Model uses the person trips produced by and attracted to each zone generated in the Trip Generation Model, plus zone-to-zone minimum travel time information from the roadway network to estimate the number of person trips between each pair of zones for each trip purpose. All estimates of roadway travel times include a representation of the time needed for locating a parking space, paying for parking, and walking from the car to the final destination. Estimates of these terminal times were derived from NCTCOG's 1994 Workplace Survey and 1996 Household Travel Survey. NCTCOG is in the process of updating the trip distribution model component based on 2009 household survey data. The model uses a gamma-based gravity formulation technique to estimate the zone-to-zone interchange of trips. Iterations of the gravity model are required to ensure that the estimated number of zonal trips received equals the projected number of trip attractions generated by the Trip Generation Model.

Mode Choice Model

The Mode Choice Model determines the mode of travel and auto occupancy. Using the information regarding trip maker characteristics (e.g., income and auto ownership), roadway and transit system characteristics (e.g., in-vehicle time and out-of-vehicle time), and travel costs (e.g., auto operating costs, parking costs, and transit fare), the model splits the trips among all applicable modes of travel. The model uses a nested logic formulation for all the trip purposes. The "other" trips are assumed to be vehicle trips with one occupant and are not processed by the Mode Choice Model. The trip purposes of HBW, HNW, and NHB have nine choice sets: drive alone, two occupant shared ride, three + occupancy shared ride, walk access to bus service, auto access to bus service, walk access to rail service, auto access to rail service, walk access to bus and rail service with transfer, and auto access to bus and rail service with transfer.

Roadway Assignment

The Roadway Assignment Model consists of simultaneous user equilibrium origin-destination assignments of drive alone, shared-ride, and truck vehicle classes for three separate time-of-day periods (6:30 am to 8:59am Morning Peak, 3:00 pm to 6:29 pm Evening Peak, and the 18-hour Off-Peak). The drive alone vehicle class is kept separate from the shared-ride vehicle class so that HOV assignments can be performed as an integral part of an equilibrium assignment. Trucks are kept separate from the other vehicle classes so that the modeled truck volumes on all links can be tracked, and a separate value-of-time can be defined for them. A generalized cost path building technique is embedded within the model, in which the iterative calculation of zone-to-zone impedances are based on weighting factors applied to the capacity-restrained travel time, the distance (representing fuel cost), and tolls. As is standard with all User Equilibrium procedures, the TransCAD program uses an iterative process to achieve a convergent solution in which no travelers can improve their path by shifting routes. Since the results of the three time-of-day assignments can be combined to obtain total weekday modeled volumes, validation checks can be performed with either time-of-day or weekday observed traffic counts.

Speed Estimation Procedure

The link speed in the DFX is estimated by dividing the length of the link by its loaded travel time. The loaded travel time is the sum of the free-flow travel time, traffic congestion delay, and the delay caused by the traffic control devices (e.g., stop signs, yield signs, and signals). These three elements of the loaded travel time are all functions of the link volume to capacity ratio. These functions are programmed in the volume delay function (VDF) that is an essential input to the traffic assignment step. The result of the traffic assignment step is the final time-period-specific average loaded speeds for each of the 30,000 plus links in the roadway network. The VMT and vehicle hours of travel (VHT) for different time periods is included in the output as well to obtain an overall average speed (VMT/VHT) for any desired length of time.

The free-flow (uncongested) speed is defined as the speed limit. Free-flow speeds are an important link attribute since they are the base for calculating the congested (loaded) speeds in the Traffic Assignment step.

The VDF in the DFX uses a conical congestion delay form defined for each link functional classification, a non-linear delay curve based on the Webster's uniform delay formulation at signalized intersections, and a linear delay curve for the stop and yield controlled approaches.

The volume-delay curves were calibrated based on the available 2004 daily link traffic counts at more than 8,000 locations (collected by the Texas Department of Transportation [TxDOT]), and the travel time runs along freeway and arterial corridors (performed by several consultants as part of other projects). The time-of-day link counts were not available for the calibration of the model in each time period.

Finally, all of the delay elements are added to the uncongested travel time (based on the free-flow speeds) to produce the total loaded travel time on each roadway segment. Appendix E contains speeds by county for each hour of the day. The resulting congested DFX county speeds are listed in Exhibit 2.3.

Exhibit 2.2: Average Congested Speeds

County	2014	2020	2026	2032
Collin	35.93	35.22	34.81	33.26
Dallas	36.11	35.73	36.01	34.83
Denton	37.67	37.01	37.00	35.99
Ellis	46.75	46.47	45.22	42.57
Johnson	42.37	41.52	40.54	38.60
Kaufman	47.29	45.32	42.90	40.04
Parker	44.44	43.74	43.26	42.06
Rockwall	41.50	40.17	41.84	40.06
Tarrant	37.72	37.16	37.02	35.38

Local Street VMT

The roadway network of the DFX does not contain the details of local (residential) streets. However, a VMT estimate is possible based on data provided by the travel model. Local street VMT is calculated for each county by multiplying the number of intrazonal trips by the intrazonal trip length and then adding the VMT from the zone centroid connectors. The temporal distribution is assumed to be the same as for non-local streets.

Adjustments

Seasonal, Daily, and Hourly Adjustments

The vehicle activity data used for this analysis is representative of the summer season. This section outlines the process used to convert the DFX average school season weekday (ASWT) activity to summer (June, July, and August) weekday activity. The school season includes February, April, May, September, and October months and the weekday is Tuesday, Wednesday, and Thursday. Automatic Traffic Recorder (ATR) data, collected by TxDOT, is used to calculate the necessary conversions. ATR data, averaged over five years (2012-2016), was used to convert ASWT activity to summer.

Seasonal and Daily Adjustments

ATR data is organized into five day types: Sunday, Monday, weekday (Tuesday, Wednesday, and Thursday), Friday, and Saturday. To adjust the representative ASWT data from the DFX to summer weekday, an ASWT to summer ATR conversion ratio is calculated. The summer portion of the ratio includes traffic volumes recorded between June and August. Seasonal weekday (Tuesday-Thursday) adjustments by area type for DFX counties are listed in Exhibit 2.3.

Exhibit 2.3: Seasonal/Daily Adjustment Factors

	County Type	Midweek
2014, 2020, 2026, and 2032 DFX Counties (ASWT to Summer)	Core (Dallas/Tarrant)	1.010
	Rural (Collin/Denton)	0.998
	Perimeter (Other Counties)	1.054

Hourly Adjustments

Daily volumes recorded for midweek, described above, are aggregated by hour to determine the percent of daily traffic occurring during each hour, representing hourly vehicle activity estimates. The DFX county midweek is further detailed by utilizing a time period volume for aggregation, as opposed to the daily volumes provided for the other day types. These time periods correspond to the time periods utilized in the DFX where AM Peak is 6:30 a.m. to 8:59 a.m., PM Peak is 3:00 p.m. to 6:29 p.m., and Off-Peak represents all other hours of the day (12:00 a.m. to 6:29 a.m., 9:00 a.m. to 2:59 p.m., and 6:30 p.m. to 11:59 p.m.). Periods split by mid-hour times utilize an equal division of traffic recorded during the hour. Exhibit 2.4 shows the hourly adjustments for the nine counties modeled, for the summer season.

Exhibit 2.4: Hourly Adjustments

Collin	Dallas	Denton	Ellis	Johnson	Kaufman	Parker	Rockwall	Tarrant
0.853%	0.894%	0.818%	1.055%	1.026%	1.053%	1.049%	0.814%	0.891%
0.557%	0.585%	0.533%	0.808%	0.786%	0.807%	0.803%	0.530%	0.583%
0.502%	0.531%	0.471%	0.741%	0.720%	0.739%	0.736%	0.467%	0.529%
0.548%	0.585%	0.505%	0.880%	0.856%	0.878%	0.874%	0.499%	0.582%
0.982%	1.051%	0.901%	1.375%	1.337%	1.372%	1.366%	0.889%	1.045%
2.628%	2.803%	2.432%	2.746%	2.670%	2.741%	2.729%	2.404%	2.787%
5.834%	5.880%	5.539%	5.110%	5.088%	5.220%	5.104%	5.531%	5.865%
8.019%	7.730%	7.727%	7.435%	7.542%	7.735%	7.458%	7.765%	7.730%
7.221%	6.867%	7.149%	6.721%	6.818%	6.992%	6.742%	7.210%	6.878%
4.915%	4.972%	5.041%	5.189%	5.046%	5.179%	5.156%	5.069%	4.972%
4.536%	4.592%	4.647%	5.354%	5.206%	5.343%	5.320%	4.671%	4.593%
4.733%	4.774%	4.882%	5.490%	5.339%	5.479%	5.456%	4.913%	4.776%
4.997%	5.024%	5.182%	5.619%	5.464%	5.608%	5.583%	5.220%	5.028%
5.141%	5.176%	5.319%	5.811%	5.651%	5.800%	5.775%	5.356%	5.180%
5.510%	5.580%	5.639%	6.132%	5.963%	6.120%	6.094%	5.668%	5.581%
6.764%	6.766%	6.543%	6.249%	6.639%	6.094%	6.340%	6.435%	6.762%
7.580%	7.569%	7.364%	6.794%	7.218%	6.625%	6.892%	7.248%	7.566%
7.873%	7.792%	7.802%	6.981%	7.417%	6.807%	7.082%	7.705%	7.800%
6.415%	6.329%	6.635%	5.565%	5.655%	5.492%	5.586%	6.637%	6.344%
4.490%	4.458%	4.761%	4.253%	4.136%	4.245%	4.226%	4.812%	4.468%
3.440%	3.434%	3.612%	3.389%	3.295%	3.382%	3.367%	3.645%	3.440%
2.882%	2.910%	2.964%	2.724%	2.649%	2.719%	2.707%	2.982%	2.911%
2.159%	2.218%	2.154%	2.058%	2.002%	2.054%	2.045%	2.156%	2.215%
1.421%	1.480%	1.380%	1.519%	1.477%	1.516%	1.510%	1.375%	1.475%
100.000%	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%

Source: NCTCOG

Model VMT Adjustments (HPMS vs. DFX)
Consistent with previous emission inventory practices, the DFW MPO used TxDOT's Highway Performance Monitoring System (HPMS) data to adjust modeled VMT to reflect the HPMS data for consistent reporting across the State. This adjustment is based on EPA's guidance for emission inventory development.

NCTCOG performed a validation on the DFX model in order to meet the transportation conformity requirements per the *Code of Federal Regulation*s, which states, "Network-based travel models must be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination" (40CFR §93.122(b)(1)(i). NCTCOG incorporated the updated DFX model validation which is based on 2010 demographics. Exhibit 2.5 shows the calculation performed to develop the new HPMS adjustment factor, 0.9703, based on a comparison of 2010 VMT for HPMS and DFX.

Exhibit 2.5: 2010 DFW and HPMS VMT Analysis

Model VMT Adjustment Factor	
	2010 VMT
HPMS (ASWT)[1]	165,292,084
DFX (ASWT)	170,346,118
HPMS/DFX Ratio	0.9703

[1]Annual Average Daily Traffic to ASWT conversion factor applied.

Nonrecurring Congestion
According to a paper published in the January 1987 Institute of Transportation Engineers Journal by Jeffrey A. Lindley entitled Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions, congestion due to traffic incidents accounts for twice as much as congestion from bottleneck situations. Congestion due to incidents, or nonrecurring congestion, causes emissions not represented in the VMT-based calculations of the base emissions. In order to include these effects, the delay caused by nonrecurring congestion is added to the freeway travel times and congestion delay due to bottlenecks to obtain an increased freeway travel time, which translates into reduced speed on freeway facilities. Reducing the freeway speeds increases volatile organic compounds (VOC) and oxides of nitrogen (NO_X) emissions by 4.9 percent, resulting in a factor of 1.049 for freeway VOC and NO_X emissions in urban and rural counties. This is thought to be a conservative estimate of increased emissions due to nonrecurring congestion. Arterial street emissions are not significantly affected by incidents because alternate routes on the arterial system are generally available. Therefore, this factor is not applied to non-freeway type facilities.

VMT Estimates
The VMT estimates are located in Exhibit 2.6 for all counties in the nonattainment area. VMT is summarized by 2014, 2020, 2026, and 2032 analysis years for each county. Appendix E contains the VMT by county for each hour for all counties.

Exhibit 2.6: Vehicle Miles of Travel (Miles/Day)

COUNTY	2014	2020	2026	2032
Collin	23,994,655	28,457,773	33,496,142	37,776,570
Dallas	78,058,778	87,026,509	95,833,486	102,570,416
Denton	19,038,154	22,626,922	26,470,711	28,510,024
Ellis	7,392,742	8,792,173	10,481,553	12,398,263
Johnson	5,513,616	6,364,886	7,572,835	8,924,618
Kaufman	6,443,864	7,673,897	9,240,933	10,748,412
Parker	5,667,179	6,631,870	7,641,103	8,654,865
Rockwall	2,566,698	3,001,796	3,633,394	4,218,030
Tarrant	51,550,746	57,882,700	66,232,949	72,391,445
Four-County Total	172,642,333	195,993,904	222,033,288	241,248,455
Nine-County Total	200,226,432	228,458,526	260,603,106	286,192,643

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CHAPTER 3: ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates, county-level analysis years 2014, 2020, 2026, and 2032 weekday estimates of the source hours parked (SHP), starts, source hours idling (SHI), and auxiliary power units (APU) hours are required by hour and vehicle (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the analysis year county-level vehicle population. Appendix A contains the vehicle population and hourly SHP, starts, SHI, and APU hours.

NCTCOG parameter spreadsheet is used to convert Motor Vehicle Emissions Simulator version 2014a (MOVES2014a) based Texas Department of Motor Vehicles registration data for each county into 13 MOVES2014a source use type (SUT) population (or vehicle population). The county-level SHP, starts, SHI, and APU hours of off- network activity were developed using the "OffNetActCalc" utility and methodology provided by TTI.

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of SHP by hour and vehicle type for each activity scenario. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type SHO. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The Source Hours Operating (SHO) was calculated using the link vehicle miles of travel (VMT) and speeds and the VMT mixes by MOVES road-type category. Appendix A includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for all analysis years.

Vehicle Type Total Available Hours

The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours for each activity scenario was set equal to the vehicle type vehicle population for the analysis year.

Vehicle Type VHT

To calculate the VHT (or SHO) for a given link, the VMT was allocated to each vehicle type using the Texas Department of Transportation district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type VHT. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process. This SHO calculation was performed for each link in a given hour, aggregating the VHT to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of starts by hour and vehicle type for each activity scenario. For each activity scenario, the vehicle type hourly default starts per vehicle were multiplied by the activity scenario county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix A includes the 24-hour summaries of the county-level vehicle type starts by hour for each analysis year.

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For the activity scenario day type of Weekday, the MOVES national default weekday starts per vehicle were used.

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) emissions-producing hotelling activities (i.e., truck main engine idling and diesel APU use). During hotelling, the truck's main engine is assumed to be in idling mode or its diesel auxiliary power unit is in use, or it is using electric power or no power. For each activity scenario, hotelling hours were first estimated followed by estimation of the SHI and diesel APU hours components of hotelling hours. The discussion and associated procedures are only applicable to CLhT_Diesel vehicles.

The hotelling activity estimates were based on information from a TCEQ extended idling study, which produced 2017 winter weekday extended idling estimates for each Texas county. Hotelling scaling factors (by activity scenario) were applied to the base 2017 winter weekday hotelling values from the study to estimate the 24-hour hotelling. Hotelling hourly factors were then applied to allocate the 24-hour hotelling to each hour of the day. To ensure valid hourly hotelling values were used in the emissions estimation, the hourly hotelling hours were compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. This procedure was performed for each activity scenario. Appendix A incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each analysis year.

Hotelling Scaling Factors

To estimate the analysis year county-level 24-hour hotelling activity, county-level hoteling scaling factors were developed using the county-level 2017 winter weekday link-level VMT and speeds, the VMT mix (by MOVES road type), the county-level analysis year weekday link-level VMT and speeds, and the VMT mix (by MOVES road type). The 2017 winter weekday link-level VMT and speeds were developed similarly to the 2014 summer weekday link-level VMT and speed data. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process. For the base, weekday, vehicle type VMT mix, the 2017 VMT mix was used.

For each link in the 2017 winter weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2017 winter weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24-hour 2017 winter weekday VMT. Using a similar allocation process, the activity scenario CLhT_Diesel hourly and 24-hour VMT were calculated using the activity scenario link-level VMT and speeds and the inventory vehicle type VMT mix. The county-level 24-hour hoteling scaling factors by activity scenario were calculated by dividing the activity scenario CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2017 winter weekday VMT.

Hotelling Hourly Factors

Hotelling hourly factors for each activity scenario were used to allocate county-level, 24-hour, hotelling hours to each hour of the day. These hotelling hourly factors were calculated as the inverse of the activity scenario hourly VHT fractions. The hourly VHT fractions were first calculated using the hourly VHT from the SHP estimation process (VHT = SHO). The inverses of these hourly VHT fractions were calculated and then normalized across all hours to produce the county-level, hotelling hours hourly distribution. This procedure was performed for each analysis year.

Hotelling by Hour Estimation

The initial activity scenario hotelling by hour was calculated by multiplying the 24-hour 2017 winter weekday hotelling hours by the activity scenario hotelling scaling factor and by the activity scenario hotelling hourly factors. A comparison was then made between hourly hotelling and hourly SHP for the scenario. For each hour where the activity scenario initial hotelling hours were greater than the SHP, the final hotelling hours estimate was set equal to the SHP, otherwise the initial hotelling hours estimate was set as the final value. All calculations (scaling factors, hotelling hourly factors, and hotelling by hour calculations) were performed by county for each analysis year.

SHI and APU Hours Estimation
The hourly, county-level, hotelling estimates for each activity scenario were then factored to produce the SHI and APU hours activity components using aggregate extended idle mode and aggregate APU mode fractions. For each hour, the activity scenario hotelling hours was multiplied by the SHI fraction to calculate the hourly SHI and by the APU fraction to calculate the hourly APU hours.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the updated MOVES hotelling distributions.[2] The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions. (The sum of the resulting SHI and APU fractions, when subtracted from 1.0, leaves the portion of hotelling hours in which trucks were using electric power or using no power.)

[2] Population and Activity of On-road Vehicles in MOVES201X (page 87 of unpublished report), https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=328870

CHAPTER 4: EMISSION FACTOR ESTIMATION PROCEDURE

Mobile Model and Input Parameters

The Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator version 2014a (MOVES2014a), is used to develop the 2014, 2020, 2026, and 2032 vehicle emission factors for this analysis. The emission factors are one component in the equation to determine vehicle emissions emitted from the region's on-road vehicles. MOVES2014a parameters used to develop these emissions inventories are listed in Exhibits 4.1 through 4.5 with the appropriate data source and/or methodology applied. Information listed applies to all counties unless otherwise specified. Referenced files identifying specific local data are included in Appendix A. MOVES2014a input files utilizing these parameters and data for each county are included in Appendix B.

Exhibit 4.1: MOVES2014a Modeled Pollutants

Command	Input Parameter Values and Molecular Formulas	Description
Pollutant	NO_X, VOC, CO, CO_2, SO_2, NH_3, $PM_{2.5}$ and PM_{10}	Oxides of Nitrogen (NO_X), Volatile Organic Compounds (VOC), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), ammonia (NH_3), Particulate Matter with aerodynamic diameters equal to or less than 2.5 microns ($PM_{2.5}$), and Particulate Matter with aerodynamic diameters equal to or less than 10 microns (PM_{10}).

Exhibit 4.2: MOVES2014a External Conditions

Command	Input Parameter Values	Description
Calendar Year	2014, 2020, 2026, and 2032	Redesignation and Maintenance analysis years
Evaluation Month	7	Summer
Minimum/Maximum Temperature	N/A	See Hourly Temperatures
Hourly Temperatures	Average Summer (June, July and August)	2014 TxDOT district level hourly temperatures, provided by the Texas Commission on Environmental Quality (TCEQ)
Relative Humidity	Average Summer (June, July and August)	2014 TxDOT district level hourly relative humidity, provided by TCEQ
Barometric Pressure	Average Summer (June, July and August)	2014 TxDOT district level barometric pressure values, provided by TCEQ

Exhibit 4.3: MOVES2014a Input Parameters

Input Parameter	Description	Source
Source Type Population	Input number of vehicles in geographic area to be modeled for each vehicle, and apply the appropriate growth factors for each analysis year. NCTCOG parameter spreadsheet is used to convert MOVES2014a based Texas Department of Motor Vehicles (TxDMV) registration data for each county into 13 MOVES2014a SUT population.	July 2014 TxDMV registration data (most recent mid-year data available)
Source Type Age Distribution	Input provides distribution of vehicle counts by age for each calendar year and vehicle type. TxDMV registration data used to estimate age distribution of vehicle types up to 30 years. Distribution of Age fractions should sum up to 1.0 for all vehicle types for each analysis year.	July 2014 TxDMV registration data (most recent mid-year data available) MOVES2014a default used for buses
Vehicle Type Vehicle Miles of Travel	County specific vehicle miles of travel (VMT) distributed to six highway performance monitoring system (HPMS) Vehicle types.	Travel Model Output
Average Speed Distribution	Input average speed data specific to vehicle type, road type, and time of day/type of day into 16 speed bins. Sum of speed distribution to all speed bins for each road type, vehicle type, and time/day type is 1.0.	Travel Model Output
Road Type Distribution (VMT Fractions)	Input county specific VMT by road type. VMT fraction distributed between the road type and must sum to 1.0 for each source type.	Travel Model Output
Ramp Fraction	Input county specific fraction of ramp driving time on rural and urban restricted roadway type.	Travel Model Output
Fuel Supply	Input to assign existing fuels to counties, months, and years, and to assign the associated market share for each fuel.	TCEQ, EPA Fuel Surveys and default MOVES2014a input where local data unavailable
Meteorology	Regional average summer data on temperature and humidity.	Local data from TCEQ
Fuel Formulation	Input county specific fuel properties in the MOVES2014a database.	TCEQ, EPA Fuel Surveys, and default MOVES2014a input where local data unavailable

Exhibit 4.3: MOVES2014 Input Parameters (continued)

Input Parameter	Description	Source
Inspection and Maintenance Coverage	Input inspection and maintenance (I/M) coverage record for each combination of pollutants, process, county, fuel type, regulatory class and model year are specified using this input.	Local data from TCEQ
Fuel Engine Fraction / Diesel Fraction (AVFT)	Input fuel engine fractions (i.e. Gasoline vs. Diesel Engines types in the vehicle population) for all vehicle types.	July 2014 TxDMV registratiowintern data (most recent mid-year data available) MOVES2014a default used for light-duty vehicles and buses

Exhibit 4.4: 2014 TxDOT District Level Hourly Temperatures (^{0}F)

Collin	Dallas	Denton	Ellis	Johnson	Kaufman	Parker	Rockwall	Tarrant
78.29	78.29	78.29	78.29	79.04	78.29	79.04	78.29	79.04
77.36	77.36	77.36	77.36	77.99	77.36	77.99	77.36	77.99
76.52	76.52	76.52	76.52	76.97	76.52	76.97	76.52	76.97
75.76	75.76	75.76	75.76	76.06	75.76	76.06	75.76	76.06
75.07	75.07	75.07	75.07	75.36	75.07	75.36	75.07	75.36
74.45	74.45	74.45	74.45	74.55	74.45	74.55	74.45	74.55
73.93	73.93	73.93	73.93	73.93	73.93	73.93	73.93	73.93
75.01	75.01	75.01	75.01	74.62	75.01	74.62	75.01	74.62
77.53	77.53	77.53	77.53	77.27	77.53	77.27	77.53	77.27
80.31	80.31	80.31	80.31	80.20	80.31	80.20	80.31	80.20
82.74	82.74	82.74	82.74	82.69	82.74	82.69	82.74	82.69
85.15	85.15	85.15	85.15	85.31	85.15	85.31	85.15	85.31
87.12	87.12	87.12	87.12	87.43	87.12	87.43	87.12	87.43
88.77	88.77	88.77	88.77	88.97	88.77	88.97	88.77	88.97
89.85	89.85	89.85	89.85	90.27	89.85	90.27	89.85	90.27
90.39	90.39	90.39	90.39	91.09	90.39	91.09	90.39	91.09
90.54	90.54	90.54	90.54	91.26	90.54	91.26	90.54	91.26
90.09	90.09	90.09	90.09	91.06	90.09	91.06	90.09	91.06
89.02	89.02	89.02	89.02	90.04	89.02	90.04	89.02	90.04
86.82	86.82	86.82	86.82	88.28	86.82	88.28	86.82	88.28
84.28	84.28	84.28	84.28	85.37	84.28	85.37	84.28	85.37
81.83	81.83	81.83	81.83	83.06	81.83	83.06	81.83	83.06
80.48	80.48	80.48	80.48	81.62	80.48	81.62	80.48	81.62
79.31	79.31	79.31	79.31	80.25	79.31	80.25	79.31	80.25

Exhibit 4.5: 2014 TxDOT District Level Hourly Relative Humidity Values

Collin	Dallas	Denton	Ellis	Johnson	Kaufman	Parker	Rockwall	Tarrant
72.28	72.28	72.28	72.28	66.96	72.28	66.96	72.28	66.96
74.59	74.59	74.59	74.59	69.69	74.59	69.69	74.59	69.69
76.58	76.58	76.58	76.58	72.36	76.58	72.36	76.58	72.36
78.72	78.72	78.72	78.72	74.84	78.72	74.84	78.72	74.84
80.38	80.38	80.38	80.38	76.80	80.38	76.80	80.38	76.80
82.05	82.05	82.05	82.05	78.79	82.05	78.79	82.05	78.79
83.34	83.34	83.34	83.34	80.46	83.34	80.46	83.34	80.46
81.77	81.77	81.77	81.77	79.55	81.77	79.55	81.77	79.55
76.01	76.01	76.01	76.01	74.01	76.01	74.01	76.01	74.01
69.22	69.22	69.22	69.22	67.33	69.22	67.33	69.22	67.33
63.26	63.26	63.26	63.26	61.59	63.26	61.59	63.26	61.59
57.65	57.65	57.65	57.65	55.88	57.65	55.88	57.65	55.88
53.31	53.31	53.31	53.31	51.28	53.31	51.28	53.31	51.28
49.74	49.74	49.74	49.74	47.97	49.74	47.97	49.74	47.97
47.38	47.38	47.38	47.38	45.22	47.38	45.22	47.38	45.22
46.04	46.04	46.04	46.04	43.44	46.04	43.44	46.04	43.44
45.46	45.46	45.46	45.46	42.75	45.46	42.75	45.46	42.75
45.95	45.95	45.95	45.95	42.45	45.95	42.45	45.95	42.45
47.67	47.67	47.67	47.67	43.85	47.67	43.85	47.67	43.85
51.78	51.78	51.78	51.78	46.82	51.78	46.82	51.78	46.82
56.94	56.94	56.94	56.94	52.19	56.94	52.19	56.94	52.19
62.92	62.92	62.92	62.92	57.23	62.92	57.23	62.92	57.23
66.54	66.54	66.54	66.54	60.70	66.54	60.70	66.54	60.70
69.70	69.70	69.70	69.70	63.98	69.70	63.98	69.70	63.98

Exhibit 4.6: 2014 TxDOT District Level Barometric Pressure Values

County	Barometric Pressure
Collin	29.95
Dallas	29.95
Denton	29.95
Ellis	29.95
Hood	29.93
Hunt	29.94
Johnson	29.93
Kaufman	29.95
Parker	29.93
Rockwall	29.95
Tarrant	29.93
Wise	29.93

Exhibit 4.7: MOVES2014a I/M Descriptive Inputs for Subject Counties

2014						
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data						
I/M Program ID	20	21	22	23	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	MOVES2014a
Source Use Type	21, 31, 32	21, 31, 32	52, 54	21, 31, 32	21, 31, 32	MOVES2014a
Begin Model Year	1996	1990	1990	1990	1996	Annual testing; program specifications[3]
End Model Year	2012	1995	2012	1995	2012	Annual testing; program specifications
Inspection Frequency	1	1	1	1	1	Annual testing; program specifications[4]
Test Standards Description	Exhaust OBD[5] Check	ASM[6] 2525/ 5015 Phase-in Cut points	Two-mode, 2500 RPM[7]/Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications[8]
Test Standards ID	51	23	12	41	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32[9]					MOVES2014a

[3] Inputs provided by the TCEQ
[4] Inputs provided by the TCEQ
[5] On-board Diagnostic
[6] Acceleration Simulation Mode
[7] Revolutions Per Minute
[8] Inputs provided by the TCEQ
[9] http://www.epa.gov/otaq/models/moves/documents/420b15007.pdf

2020				
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data				
I/M Program ID	20	22	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	MOVES2014a
Source Use Type	21, 31, 32	52, 54	21, 31, 32	MOVES2014a
Begin Model Year	1996	1996	1996	Annual testing; program specifications
End Model Year	2018	2018	2018	Annual testing; program specifications
Inspect Frequency	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	12	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32			Expected compliance (%) - MOVES2014a Default

2026				
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data				
I/M Program ID	20	22	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	MOVES2014a
Source Use Type	21, 31, 32	52, 54	21, 31, 32	MOVES2014a
Begin Model Year	2002	2002	2002	Annual testing; program specifications
End Model Year	2024	2024	2024	Annual testing; program specifications
Inspect Frequency	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	12	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32			Expected compliance (%) - MOVES2014a Default

2032				
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data				
I/M Program ID	20	22	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	MOVES2014a
Source Use Type	21, 31, 32	52, 54	21, 31, 32	MOVES2014a
Begin Model Year	2008	2008	2008	Annual testing; program specifications
End Model Year	2030	2030	2030	Annual testing; program specifications
Inspect Frequency	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	12	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32			Expected compliance (%) - MOVES2014a Default

Exhibit 4.8: MOVES2014a Fuel Properties

	2014			2020, 2026, 2032		
Counties	**Core**	**Perimeter**	**All**	**Core**	**Perimeter**	**All**
Fuel Type	**Gasoline**		**Diesel**	**Gasoline**		**Diesel**
Fuel Formulation ID	10704	10702	30002	18724	18734	30011
Fuel Subtype ID	12	12	20	12	12	20
RVP	7.10	7.52	0	7.00	7.80	0
Sulfur Level	28.47	30.84	6.18	10.00	10.00	11.00
Ethanol Volume	9.70	9.76	0	9.67	9.66	0
MTBE Volume	0	0	0	0	0	0
ETBE Volume	0	0	0	0	0	0
TAME Volume	0	0	0	0	0	0
Aromatic Content	14.42	22.65	0	14.74	25.35	0
Olefin Content	13.36	11.75	0	10.74	8.33	0
Benzene Content	0.44	0.55	0	0.46	0.61	0
e200	49.00	49.82	0	49.21	49.45	0
e300	84.30	83.70	0	85.13	82.68	0
Vol To Wt Percent Oxy	0.3653	0.3653	0	0.3653	0.3653	0
BioDiesel Ester Volume	0	0	0	0	0	0
Cetane Index	0	0	0	0	0	0
PAH Content	0	0	0	0	0	0
T50	203.60	203.22	0	202.52	203.73	0
T90	329.78	322.54	0	325.77	327.68	0

Notes: **2014** gasoline: TTI produced the RFG fuel formulation estimates using local 2014 fuel survey sample data (EPA Texas RFG survey data), except for RVP, which is the MOVES default (RVP is not available in the EPA RFG data). RFG properties were calculated using the standard procedure of aggregating and averaging by fuel grade (regular [RU], mid-grade [MU], and premium [PU]), and combining them into the final overall averages using latest available statewide sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058). Diesel sulfur: TTI produced diesel average sulfur estimates using the summer 2014 TCEQ fuel survey diesel sample data by aggregating and averaging sulfur content values for TxLED counties.
2018 and later (future) gasoline: formulations are based on latest local survey data (TTI used Texas summer gasoline data from EPA DFW RFG compliance surveys and TCEQ/ERG statewide surveys from 2017), except for RFG, average sulfur level was set to the expected future year value (i.e., MOVES default [Tier 3 annual average standard]); and for conventional gasoline the regulated properties RVP, sulfur level, and benzene content were replaced with expected future year values (i.e., the appropriate MOVES defaults). Diesel sulfur: set to the expected Texas future year value (conservative level based on local data and also within the ULSD annual average standard).

Area Specific Calculations and Procedures

SourceUse Type Distribution

Sourceuse type age distributions are calculated from the TxDMV vehicle registration data. July data sets of 2014 (most recent mid-year data available) utilized for light- and heavy-duty vehicle classes. MOVES2014a default values are used for bus categories. Light-duty registration data for Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties are weighted for commute patterns with the County-to-County Worker Flow data from the 2013 five-year American Community Survey. Exhibit 4.6 identifies the percentages applied for this weighted adjustment. The TTI methodology is applied to the heavy-duty vehicle data for developing registration for all heavy-duty vehicles. These files are included in Appendix A

Exhibit 4.9: County-to-County Worker Flow[10]

Resident County	County of Employment											
	Collin	Dallas	Denton	Ellis	Hood	Hunt	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
Collin	65.4%	10.2%	5.1%	0.3%	0.1%	4.2%	0.2%	1.0%	0.0%	7.6%	0.9%	0.0%
Dallas	19.1%	66.0%	10.2%	10.7%	0.9%	3.9%	1.3%	15.8%	1.0%	23.6%	7.7%	0.7%
Denton	11.5%	7.9%	75.6%	0.4%	0.3%	0.0%	0.2%	0.7%	0.9%	0.6%	3.3%	3.1%
Ellis	0.2%	1.8%	0.2%	79.4%	0.2%	0.1%	1.4%	0.7%	0.1%	0.0%	0.6%	0.2%
Hood	0.0%	0.1%	0.0%	0.1%	84.0%	0.0%	2.3%	0.0%	2.4%	0.0%	0.5%	0.4%
Hunt	0.8%	0.4%	0.1%	0.1%	0.0%	84.3%	0.0%	4.4%	0.0%	9.4%	0.0%	0.0%
Johnson	0.0%	0.3%	0.3%	3.5%	3.2%	0.0%	76.2%	0.0%	1.4%	0.2%	3.2%	0.7%
Kaufman	0.3%	1.6%	0.1%	0.7%	0.1%	1.2%	0.0%	72.6%	0.0%	3.6%	0.1%	0.0%
Parker	0.0%	0.1%	0.1%	0.1%	4.3%	0.0%	0.5%	0.0%	77.4%	0.0%	2.6%	5.9%
Rockwall	0.7%	1.2%	0.1%	0.1%	0.5%	5.6%	0.1%	3.7%	0.0%	53.9%	0.1%	0.1%
Tarrant	2.0%	10.3%	7.4%	4.6%	6.2%	0.4%	17.5%	1.1%	14.1%	1.0%	80.3%	10.7%
Wise	0.1%	0.1%	0.8%	0.0%	0.2%	0.2%	0.3%	0.0%	2.5%	0.0%	0.8%	78.2%

Source: 2013 5-year American Community Survey.

[10] The sum of each county may be less than or more than 100% due to rounding

Fuel Engine Fractions
Diesel fractions for heavy-duty vehicle categories utilized 12-county summed yearly July 2014 registration data for modeling 2014, 2020, 2026, and 2032 analysis years. Light-duty and bus categories utilize MOVES2014a default values. All diesel fraction files, included in Appendix A, list specific data used for this analysis.

MOVES2014a Emission Factors
MOVES2014a emission factors for all the analysis years are reported in Appendix C.

Adjustments
Adjustments are applied to the emission factors in a post-process step. Texas Low Emission Diesel (TxLED) NO_X Adjustment is applied to the emission factors. VMT Mix adjustment is applied simultaneously with the emission calculation procedure discussed in Chapter 5.

TxLED NOx Adjustment
NO_X emission factors for diesel vehicle classes are adjusted to apply the Texas low emission diesel program. TxLED adjustments were applied to the diesel vehicle NO_x emissions rates for all nine counties. NCTCOG produced these average diesel SUT NO_x adjustments using 4.8 percent and 6.2 percent reductions for 2002 and later, and 2001 and earlier model years, respectively.[11] The extracted and adjusted rate tables were placed in databases for subsequent input to the on-road mobile source emissions calculator.[12] Exhibit 4.7 lists the appropriate adjustment for each vehicle class.

Exhibit 4.10: TxLED NOx Adjustments

Source Use Type	Adjustment Factors			
	2014	2020	2026	2032
Passenger Car	0.9440	0.9508	0.9517	0.9520
Passenger Truck	0.9473	0.9501	0.9506	0.9520
Light Commercial Truck	0.9438	0.9481	0.9500	0.9520
Intercity Bus	0.9420	0.9439	0.9466	0.9520
Transit Bus	0.9422	0.9441	0.9472	0.9520
School Bus	0.9423	0.9439	0.9469	0.9520
Refuse Truck	0.9446	0.9474	0.9508	0.9520
Single Unit Short-Haul Truck	0.9497	0.9515	0.9519	0.9520
Single Unit Long-Haul Truck	0.9501	0.9516	0.9519	0.9520
Motor Home	0.9444	0.9467	0.9492	0.9520
Combination Short-Haul Truck	0.9472	0.9498	0.9515	0.9520
Combination Long-Haul Truck	0.9449	0.9482	0.9508	0.9520

Source: NCTCOG

[11] Reductions as detailed in the EPA Office of Transportation and Air Quality Memorandum, RE: Texas Low Emission Diesel [LED] Fuel Benefits, September 27, 2001.
[12] The TxLED counties list may be found at: http://www.tceq.texas.gov/airquality/mobilesource/txled/txled-affected-counties. For full details on the TCEQ TxLED factor development procedure, see "mvs14-statewide-txled-analysis-06-12-17-18.zip" found at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/.

Sourceusetype Population

TxDMV registration data was used for developing sourceusetype (SUT) population for the DFW area. July 2014 registration data is used for developing 2014, 2020, 2026, and 2032 analysis years SUT population. For years 2020, 2026, and 2032, VMT growth factors were used to forecast SUT population. These growth factors were calculated by dividing the nine-county future year VMT (2020, 2026, and 2032) by the nine-county 2014 VMT. The growth factors are: 1.1410 for 2020, 1.3015 for 2026, and 1.4293 for 2032. Exhibit 4.8 summarizes the SUT for all analysis years. All SUT population files are included in Appendix A.

Exhibit 4.11: SUT Population for the DFW Four-County and Nine-County Nonattainment Areas

	2014	2020	2026	2032
Collin	620,219	707,671	807,243	886,512
Dallas	1,767,804	2,017,070	2,300,877	2,526,804
Denton	502,994	573,919	654,670	718,953
Ellis	125,961	143,718	163,942	180,040
Johnson	124,422	141,965	161,940	177,842
Kaufman	81,716	93,239	106,354	116,797
Parker	100,730	114,932	131,109	143,980
Rockwall	66,230	75,570	86,202	94,664
Tarrant	1,377,954	1,572,243	1,793,461	1,969,562
Four-County Total	4,268,971	4,870,903	5,556,251	6,101,831
Nine-County Total	4,768,030	5,440,327	6,205,798	6,815,154

Vehicle Miles of Travel Mix (or Fractions)

VMT Mix is applied to the emission factors in a post-process methodology. The VMT mix enables assignment of emission factors by vehicle type to a total volume to calculate emissions on a link or functional class. VMT mix is estimated for rural and urban freeways, and arterials for three time periods.

Vehicle counts reported in the latest available Texas Department of Transportation (TxDOT) Vehicle Classification Report (2016) provide a base for the distribution of vehicles by type and functional class for the freeway, arterial, and collector VMT Mixes. The number of vehicles in each of the 12 axle-based categories are combined into intermediate groups, and then disaggregated into MOVES2014a SUT by applying appropriate TxDMV registration data and/or MOVES2014a defaults. Exhibit 4.9 outlines this process. For each functional class, the values are aggregated across the total vehicles to determine the fraction of vehicles from each class. Motorcycles are allocated as 0.1 percent for each functional class, subtracted from the Light-Duty Gasoline Vehicles category.

This "temporary" VMT mix calculation is then redistributed using local truck and non-truck splits identified by the DFX model. This process is performed for each of the three functional classes and three time periods, where AM peak is 6:30 am to 8:59 am, PM peak is 3:00 pm to 6:29 pm, and Off-Peak represents all other hours of the day. Motorcycles, light-duty vehicles, and two-axle light-duty trucks are classified as non-trucks. Trucks and heavy-duty vehicles with three axles or more, to include buses, are defined as truck

Exhibit 4.12: Vehicle Classification Process

Axle-Based Vehicle Classifications		Intermediate Groups/HPMSVtypeID[13]		Detailed Groups	
C	**Passenger Vehicles**	PV	Light-Duty Vehicles (25)	Passenger Car	Passenger Gasoline Vehicle
					Passenger Diesel Vehicle
					Motorcycle (MC)[14]
P	**2 Axle, 4 Tire Single Unit**			Passenger Truck	Passenger Gasoline Truck
					Passenger Gasoline Truck
				Light Commercial Truck	Light Commercial Gasoline Truck
					Light Commercial Gasoline Truck
B	**Buses**	Bus	Buses (40)	School Bus	Gasoline School Bus*
					Diesel School Bus*
				Transit Bus	Gasoline Transit Bus*
					Diesel Transit Bus*
				Diesel Intercity Bus*	
SU2	**2 Axle, 6 Tire Single Unit**	Heavy-Duty Trucks	Single Unit Heavy-Duty Vehicles (50)	Single Unit Short-haul Truck	Single Unit Short-haul Gasoline Truck*
SU3	**3 Axle, Singe Unit**				Single Unit Short-haul Diesel Truck*
SU4	**4+ Axle, Single Unit**			Single Unit Long-haul Truck	Single Unit Long-haul Gasoline Truck*
SE4	**3 or 4 Axle, Single Trailer**				Single Unit Long-haul Diesel Truck*
SE5	**5 Axle, Single Trailer**	Heavy-Duty Trucks	Combination Heavy-Duty Vehicles (60)	Combination Short-haul Truck	Combination Short-haul Gasoline Truck*
SE4	**3 or 4 Axle, Single Trailer**				
SD5	**5 Axle, Multi Trailer**				Combination Short-haul Diesel Truck*
SD6	**6 Axle, Multi Trailer**			Combination Long-haul Diesel Truck*	
SD7	**7+ Axle, Multi Trailer**				

*Categories calculated using MOVES2014a defaults

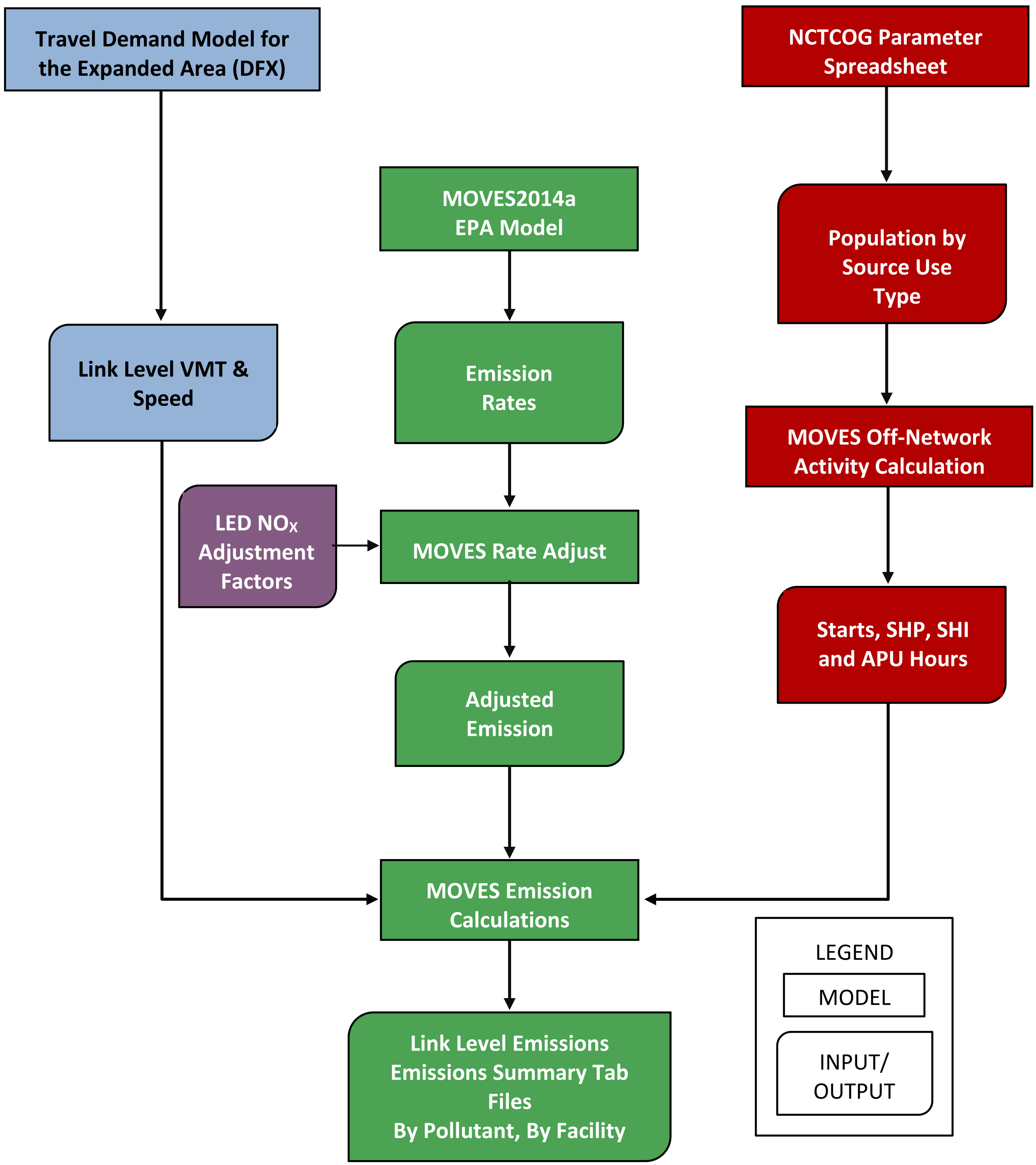
[13] HPMS – Highway Performance Monitoring System
[14] Motorcycles are allocated as 0.1 percent for each functional class, subtracted from the light-duty vehicles.

CHAPTER 5: EMISSION CALCULATION PROCEDURE

Emissions estimates are calculated using *"TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL"* an on-road emissions inventory development utility developed by the Texas A&M Transportation Institute (TTI). This software combines vehicle activity and emission factors to create emission estimates.

Exhibit 5 outlines the emission calculation modeling process that is used to calculate the emissions estimates for the Dallas-Fort Worth ozone nonattainment area. Rate per Distance, Rate per Vehicle, and Rate per Profile are applied for DFW Expanded Travel Demand Model (DFX) counties outlined in the following sections.

Exhibit 5: MOVES2014a Emission Modeling Process



CHAPTER 6: SUMMARY OF VEHICLE MILES OF TRAVEL, SPEED, AND EMISSIONS

Vehicle Miles of Travel Estimates

Appendix E contains the summarized VMT estimates by the analysis year and time-of-day (TOD) for the counties.

Speed Estimates

Appendix E contains the summarized speeds by the analysis year and TOD for the counties.

Emission Estimates

The final county emission estimates for each analysis year are summarized in Exhibit 6.2. Additional modeled pollutants not shown in this section are available in Appendices D and E.

Appendix D contains the detailed emissions for all counties by pollutant, analysis year, and TOD.

Appendix E contains the summarized emissions for all counties by pollutant, analysis year, and TOD.

Exhibit 6.1: VMT by County

COUNTY	2014	2020	2026	2032
Collin	23,994,655	28,457,773	33,496,142	37,776,570
Dallas	78,058,778	87,026,509	95,833,486	102,570,416
Denton	19,038,154	22,626,922	26,470,711	28,510,024
Ellis	7,392,742	8,792,173	10,481,553	12,398,263
Johnson	5,513,616	6,364,886	7,572,835	8,924,618
Kaufman	6,443,864	7,673,897	9,240,933	10,748,412
Parker	5,667,179	6,631,870	7,641,103	8,654,865
Rockwall	2,566,698	3,001,796	3,633,394	4,218,030
Tarrant	51,550,746	57,882,700	66,232,949	72,391,445
Four-County Total	172,642,333	195,993,904	222,033,288	241,248,455
Nine-County Total	200,226,432	228,458,526	260,603,106	286,192,643

Exhibit 6.2: Final Emission Estimates by County

Oxides of Nitrogen (NO_X) (tons/day)				
County	2014	2020	2026	2032
Collin	19.02	9.17	5.98	4.45
Dallas	68.03	32.01	19.99	14.40
Denton	17.12	8.27	5.44	4.01
Ellis	10.49	5.65	3.84	3.14
Johnson	6.33	3.12	1.99	1.52
Kaufman	8.10	4.21	2.85	2.24
Parker	7.97	5.00	3.61	2.95
Rockwall	3.00	1.64	1.17	0.92
Tarrant	44.27	20.61	13.10	9.31
Four-County Total	148.44	70.06	44.51	32.17
Nine-County Total	184.33	89.68	57.97	42.94

Exhibit 6.2: Final Emission Estimates by County (continued)

Volatile Organic Compounds (VOC) (tons/day)				
County	2014	2020	2026	2032
Collin	9.08	5.99	4.73	3.51
Dallas	31.12	19.51	15.06	11.00
Denton	7.57	4.97	3.91	2.86
Ellis	2.86	1.82	1.40	1.06
Johnson	2.38	1.53	1.17	0.86
Kaufman	2.13	1.32	1.01	0.77
Parker	2.19	1.49	1.15	0.88
Rockwall	1.22	0.80	0.63	0.48
Tarrant	21.92	14.19	11.11	8.09
Four-County Total	69.69	44.66	34.81	25.46
Nine-County Total	80.47	51.62	40.17	29.51

Carbon Monoxide (CO) (tons/day)				
County	2014	2020	2026	2032
Collin	122.62	104.97	86.75	63.48
Dallas	451.48	370.20	295.30	209.73
Denton	97.11	81.90	67.09	47.83
Ellis	39.14	33.45	28.26	22.03
Johnson	31.29	25.15	21.17	16.36
Kaufman	32.16	27.08	23.19	17.62
Parker	32.48	25.83	21.03	16.01
Rockwall	14.50	11.88	10.00	7.57
Tarrant	301.75	249.45	206.06	148.48
Four-County Total	972.96	806.52	655.20	469.52
Nine-County Total	1,122.53	929.91	758.85	549.11

Exhibit 6.2: Final Emission Estimates by County (continued)

Carbon Dioxide (CO_2) (tons/day)				
County	2014	2020	2026	2032
Collin	12,531.22	13,345.49	13,229.11	13,254.10
Dallas	41,396.18	42,021.03	39,189.86	37,104.81
Denton	10,202.54	10,779.75	10,623.03	10,206.79
Ellis	4,520.09	5,037.84	5,272.75	5,637.77
Johnson	3,092.77	3,285.61	3,376.60	3,536.53
Kaufman	3,677.77	4,018.02	4,215.81	4,396.10
Parker	3,419.61	3,706.65	3,764.79	3,907.62
Rockwall	1,399.39	1,487.69	1,506.98	1,542.73
Tarrant	26,979.76	27,348.01	26,432.32	25,473.54
Four-County Total	91,109.70	93,494.28	89,474.32	86,039.24
Nine-County Total	107,219.33	111,030.09	107,611.25	105,059.99

Sulfur Dioxide (SO_2) (tons/day)				
County	2014	2020	2026	2032
Collin	0.20	0.09	0.09	0.09
Dallas	0.66	0.27	0.25	0.24
Denton	0.16	0.07	0.07	0.07
Ellis	0.06	0.03	0.03	0.04
Johnson	0.05	0.02	0.02	0.02
Kaufman	0.05	0.03	0.03	0.03
Parker	0.05	0.05	0.05	0.05
Rockwall	0.02	0.01	0.01	0.01
Tarrant	0.43	0.18	0.17	0.17
Four-County Total	1.45	0.61	0.58	0.57
Nine-County Total	1.68	0.75	0.72	0.72

Exhibit 6.2: Final Emission Estimates by County (continued)

Ammonia (NH_3) (tons/day)				
County	2014	2020	2026	2032
Collin	0.71	0.66	0.74	0.82
Dallas	2.49	2.08	2.16	2.26
Denton	0.57	0.52	0.59	0.62
Ellis	0.24	0.22	0.25	0.29
Johnson	0.17	0.15	0.17	0.20
Kaufman	0.21	0.19	0.22	0.24
Parker	0.18	0.16	0.18	0.20
Rockwall	0.08	0.07	0.08	0.09
Tarrant	1.59	1.36	1.48	1.58
Four-County Total	5.36	4.62	4.97	5.28
Nine-County Total	6.24	5.41	5.87	6.30

Particulate Matter less than 2.5 ($PM_{2.5}$) (tons/day)[15]				
County	2014	2020	2026	2032
Collin	0.69	0.48	0.41	0.41
Dallas	2.44	1.60	1.27	1.18
Denton	0.61	0.40	0.32	0.30
Ellis	0.36	0.21	0.16	0.15
Johnson	0.21	0.13	0.11	0.11
Kaufman	0.26	0.16	0.13	0.12
Parker	0.27	0.16	0.11	0.11
Rockwall	0.09	0.06	0.05	0.05
Tarrant	1.54	1.02	0.84	0.80
Four-County Total	5.28	3.50	2.84	2.69
Nine-County Total	6.47	4.22	3.40	3.23

[15] Includes Brakewear and Tirewear

Exhibit 6.2: Final Emission Estimates by County (continued)

Particulate Matter less than 10 (PM_{10}) (tons/day)[16]				
County	**2014**	**2020**	**2026**	**2032**
Collin	1.71	1.69	1.83	2.09
Dallas	5.82	5.31	5.26	5.62
Denton	1.39	1.30	1.36	1.46
Ellis	0.61	0.50	0.50	0.60
Johnson	0.42	0.37	0.39	0.46
Kaufman	0.46	0.40	0.44	0.52
Parker	0.47	0.39	0.38	0.43
Rockwall	0.18	0.17	0.17	0.19
Tarrant	3.63	3.34	3.47	3.82
Four-County Total	12.55	11.64	11.92	12.99
Nine-County Total	14.69	13.47	13.80	15.19

[16] Includes Brakewear and Tirewear