APPENDIX 12

DALLAS-FORT WORTH MOTOR VEHICLE EMISSIONS SIMULATOR 3 (MOVES3)-BASED REASONABLE FURTHER PROGRESS ON-ROAD EMISSIONS INVENTORIES AND CONTROL STRATEGIES REDUCTIONS FOR ANALYSIS YEARS 2017, 2023, AND 2024

Dallas-Fort Worth and Houston-Galveston-Brazoria Moderate Areas Reasonable Further Progress State Implementation Plan Revision for the 2015 Eight-Hour Ozone National Ambient Air Quality Standard

Project Number 2022-023-SIP-NR

ABSTRACT

TITLE:	Dallas-Fort Worth Motor Vehicle Emissions Simulator 3 (MOVES3)-Based Reasonable Further Progress On-Road Emissions Inventories and Control Strategies Reductions for Analysis Years 2017, 2023, and 2024
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NUMBER OF PAGES:	37
ABSTRACT:	The Texas Commission on Environmental Quality (TCEQ) is planning an update to the Dallas-Fort Worth Reasonable Further Progress State Implementation Plan (DFW RFP SIP), which will require analysis from a base year of 2017 to an attainment year of 2023 to demonstrate continued progress toward attainment of the United States Environmental Protection Agency's (EPA) 2015 8-hour ozone standard for the DFW 9-county nonattainment area, including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise counties. The DFW RFP on-road mobile

source emissions inventories shall be developed using the EPA's MOVES3 model as directed by the TCEQ Project Manager and shall use latest planning assumptions to assure motor vehicle emissions budgets set by the SIP revision will be consistent with transportation conformity analysis requirements. To complete the DFW RFP SIP analysis, the North Central Texas Council of Governments (NCTCOG) will assist TCEQ by developing DFW RFP on-road mobile source emissions inventories for a base year, attainment year, and attainment contingency year, as well as individual control measure reduction estimates and contingency measure control reduction estimates.

ACKNOWLEDGEMENTS

The North Central Texas Council of Governments would like to thank the following individuals for their invaluable assistance in preparing this report.

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GLOSSARY OF ABBREVIATIONS

ABY	Adjusted Base Year
ASM	Acceleration Simulation Mode
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
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
LED	Low Emission Diesel
MPA	Metropolitan Planning Area
MPO	Metropolitan Planning Organization
MOVES3	Motor Vehicle Emissions Simulator 3
NAAQS	National Ambient Air Quality Standards
NCT	North Central Texas
NCTCOG	North Central Texas Council of Governments
NH_3	Ammonia
NHB	Non-Home Based
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
NPMRDS	National Performance Management Research Data Set
NSWD	Non-Summer Week Day
O_3	Ozone
OBD	On-Board Diagnostic Systems
Pb	Lead
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter 2.5 Microns
PM_{10}	Particulate Matter 10 Microns
ppb	parts per billion
RFG	Reformulated Gasoline
RFP	Reasonable Further Progress
RPM	Revolutions Per Minute
SHI	Source Hours Idling
SHP	Source Hours Parked
SHO	Source Hours Operating
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SUT	Source Use Types
TAFT	Transportation Analytical Forecasting Tool
TCEQ	Texas Commission on Environmental Quality
TOD	Time-of-Day
TSZ	Traffic Survey Zone
TTI	Texas Transportation Institute
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emissions Diesel
VDF	Volume Delay Function
VHT	Vehicle Hours of Travel
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compounds

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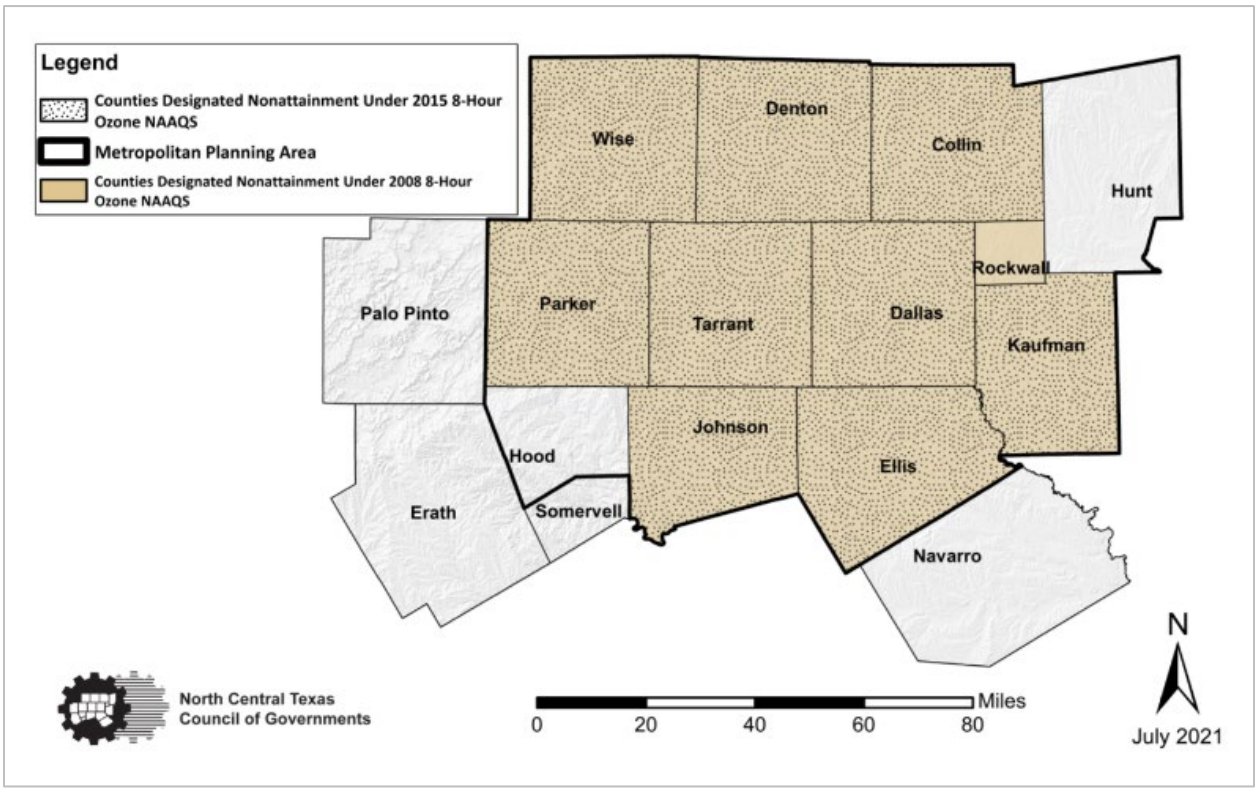
CHAPTER 1: INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) is planning an update to the Dallas-Fort Worth Reasonable Further Progress State Implementation Plan (DFW RFP SIP), which will require analysis from a base year of 2017 to an attainment year of 2023 to demonstrate continued progress toward attainment of the United States Environmental Protection Agency's (EPA) 2015 8-hour ozone standard for the DFW 9-county nonattainment area including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise counties. The DFW RFP on-road mobile source emissions inventories shall be developed using the EPA's MOVES3 model as directed by the TCEQ Project Manager and shall use latest planning assumptions to assure motor vehicle emissions budgets set by the SIP revision will be consistent with transportation conformity analysis requirements. To complete the DFW RFP SIP analysis, the North Central Texas Council of Governments (NCTCOG) will assist TCEQ by developing DFW RFP on-road mobile source emissions inventories for a base year, milestone years, milestone contingency years, attainment year, and attainment contingency year, as well as individual control measure reduction estimates and contingency measure control reduction estimates.

Exhibit 1.1: Dallas-Fort Worth Nonattainment Area Map



This report documents the methodology and results of the RFP emissions inventories. Chapter 1 outlines the background, purpose and scope, and modeling approach; and provides a summary of the 9-county estimated emissions totals, activity, and control reduction 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 reflect regional conditions more accurately. Seasonal and hourly adjustment factors were applied to produce 2017, 2023, and 2024 analysis year vehicle activity and report vehicle activity in hourly periods. Consistent with previous emissions 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 procedures used to develop the vehicle population off-network activity estimates.

Chapter 4 documents the parameters and inputs used to develop on-road mobile source emission factors by utilizing the US EPA's Motor Vehicle Emission Simulator version 3 (MOVES3) model. Regionally specific calculations, procedures, MOVES3 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 5 documents the 9-county nonattainment area vehicle emission calculation procedure and estimates.

Chapter 6 summarizes emissions of all pollutants by county and analysis years.

List of Appendices

The Appendices contain supplemental information, including a table containing all pollutants calculated, and electronic data supporting the DFW RFP Emissions Inventory. An electronic data submittal description document was also included.

Appendix A: MOVES3 Runspecs (MRS) and Input Database Files
Appendix B: County and Scenario Input and Output Files
Appendix C: Summary Files (Tab Files)
Appendix D: SCC and XML Files

Background

The Clean Air Act Amendments (CAAA) of 1990 requires the EPA to set National Ambient Air Quality Standards (NAAQS) 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, sulfur dioxide, nitrogen dioxide, and lead.

With the signing of the CAAA into law, the four counties of Collin, Dallas, Denton, and Tarrant in the DFW area were designated as nonattainment under the 1-Hour Ozone NAAQS. 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 1-Hour Ozone NAAQS, the EPA determined this standard was insufficient to protect human health. As a result, the EPA developed the 1997 8-Hour Ozone NAAQS, <85 parts per billions (ppb), to place greater emphasis on prolonged exposure to pollutants. In April 2004, the 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 Ozone NAAQS, with an effective designation date of June 15, 2004. The nine-county nonattainment area 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 area was classified as "serious" with the new attainment date of June 2013.

On July 20, 2012, the DFW area was reclassified as "moderate" nonattainment for the 2008 8-Hour Ozone NAAQS (≤75 ppb), Wise County was added as the tenth nonattainment county. On December 23, 2014, a District of Columbia Circuit ruled against the EPA, establishing July 20, 2018 as the attainment date for moderate nonattainment areas, which is exactly six years from the official date of designation. This change required the 2015-2017 design value to determine moderate nonattainment area's attainment status. In addition, these areas had to model a 2017 future year under the 75 ppb standard.

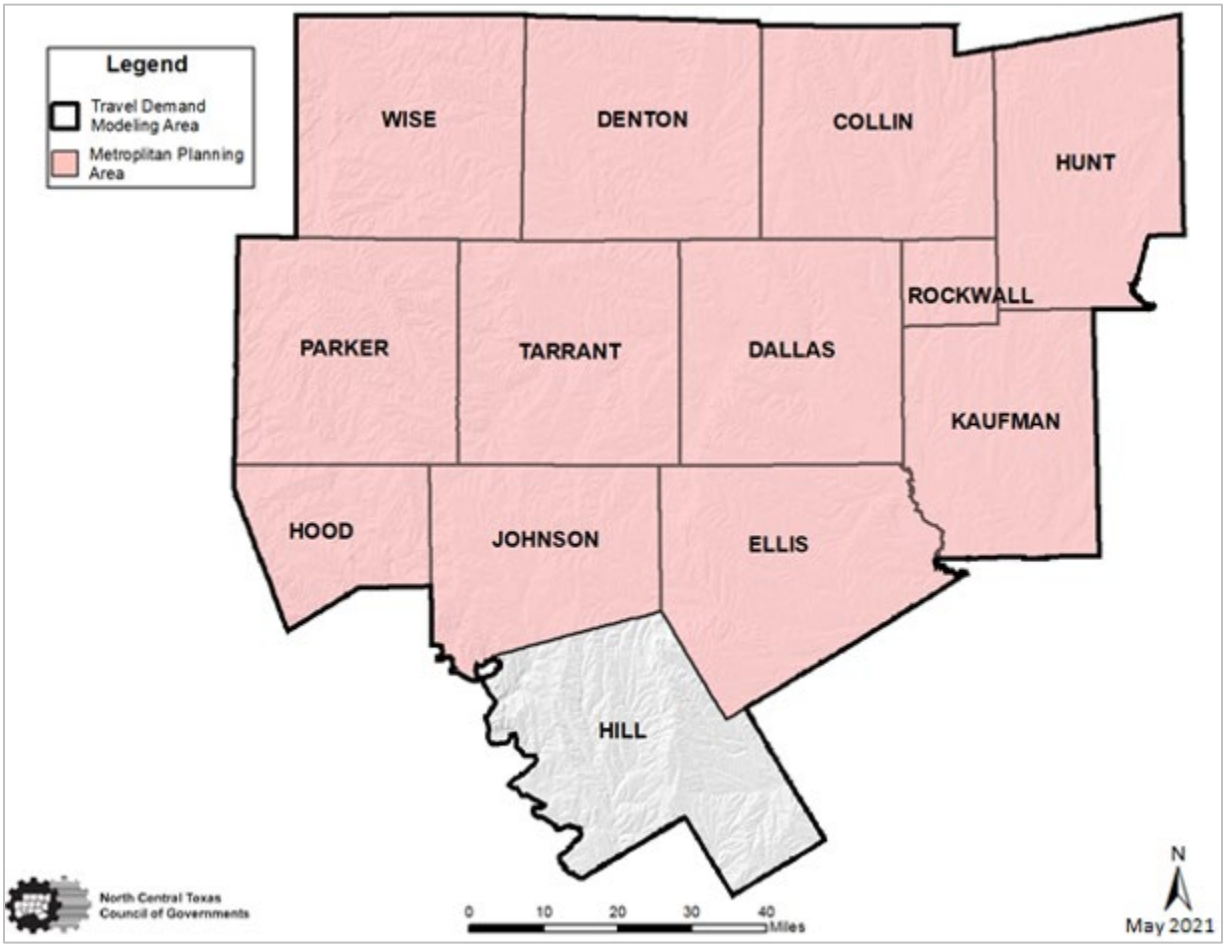
TCEQ, the State's environmental agency, is required under the CAAA to submit SIP revisions documenting the emission of ozone precursors are declining at rates to achieve the NAAQS. The SIP is an air quality plan containing a collection of regulations and measures to reduce emissions from stationary, area, mobile (on-road and non-road) sources, and demonstrate attainment of the air quality standards. The section of the SIP that outlines the plan to achieve these emissions reductions is subsequently defined as the "Reasonable Further Progress" plan.

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 was contracted by TCEQ to develop on-road mobile source emission inventories for the region consistent with the EPA's requirements for demonstrating RFP. NCTCOG applies a four-step travel demand model process using TransCAD software to forecast regional vehicle activity and utilizes the EPA's MOVES3 with a post-processing application to estimate regional mobile source emissions.

Modeling Approach

The Transportation Analytical Forecasting Tool (TAFT) is utilized to estimate VMT and emissions for the 2017, 2023, and 2024 analysis years for summer weekday. TAFT'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 TAFT modeling domain is shown in Exhibit 1.2.

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



Several components of the model were updated as part of this model development. These include improvements to the mode-choice model; vehicle ownership model; external stations; volume-delay-function; transit assignment; and traffic assignment convergence criteria, which are discussed in Chapter 2. Emissions are quantified by grouping control strategy scenarios as a model run. Exhibit 1.3 describes the control strategy scenarios modeled for all the analysis years.

Exhibit 1.3: Emissions Inventory Scenarios Modeled

Reasonable Further Progress Scenarios	Input Files
Adjusted Base Year[2]	ABY
Pre-1990 Federal Motor Vehicle Control Program (FMVCP)	PR90
FMVCP Tier 1 FMVCP Tier 2 FMVCP – Heavy-Duty 2007	FMVCP
Fuel Controls (FC)[3]	FC
Expanded Inspection & Maintenance (I/M)	IM
Texas Low-Emission Diesel[4]	TxLED

[1]In the table above, each scenario contains the control strategies of all previous scenarios.
[2]Base year (2011) VMT is used for all analysis years.
[3]Includes fuel controls (reformulated gasoline and ultra-low-sulfur diesel)
[4]I/M emission factors will be used to estimate TxLED emission benefits.

Final RFP on-road emission estimates by pollutant for summer weekday for each analysis year are shown in Exhibits 1.4 through 1.6. Exhibits 1.7 through 1.9 show the emissions reductions resulting from the application of each control scenario. These emission estimates and reductions are provided for the 9-county 2015 8-hour ozone nonattainment area. The CAAA 182(b)(1) requires moderate areas newly designated as nonattainment to show, within a three-year period, a 15 percent emissions reduction in volatile organic compounds (VOC), not NO_X from the baseline year. Appendix B contains the detailed emissions by county, pollutant, and by time-of-day for all NCT counties modeled.

VMT for summer weekday for each analysis year are shown in Exhibit 1.10. Appendix C contains the summarized VMT estimates by analysis year for all NCT counties modeled.

Exhibit 1.4: On-Road Emissions for the DFW 9-County Nonattainment Area[1]

Summer Season, Midweek On-Road Emissions (tons/day)			
Nitrogen Oxides			
	2017	**2023**	**2024**
ABY	N/A	1220.52	1220.52
PR90	1222.87	1333.33	1354.90
FMVCP	171.12	96.45	89.47
FC	134.48	74.39	69.25
IM	127.75	72.31	67.41
TxLED	123.95	69.82	65.04
Volatile Organic Compounds			
	2017	**2023**	**2024**
ABY	N/A	685.63	685.63
PR90	688.16	753.54	767.03
FMVCP	74.77	50.63	48.62
FC	61.76	42.23	40.46
IM	55.94	37.73	36.00
TxLED	55.94	37.73	36.00

[1] Each scenario contains the control strategies of all previous scenarios

Exhibit 1.5: On-Road Emissions for Wise County[2]

Summer Season, Midweek On-Road Emissions (tons/day)			
Nitrogen Oxides			
	2017	**2023**	**2024**
ABY	N/A	24.83	24.83
PR90	24.94	27.85	28.48
FMVCP	4.15	2.56	2.41
FC	3.60	2.22	2.10
IM	3.60	2.22	2.10
TxLED	3.47	2.13	2.01
Volatile Organic Compounds			
	2017	**2023**	**2024**
ABY	N/A	9.31	9.31
PR90	9.35	10.47	10.72
FMVCP	1.11	0.73	0.70
FC	0.95	0.61	0.59
IM	0.95	0.61	0.59
TxLED	0.95	0.61	0.59

[2] Each scenario contains the control strategies of all previous scenarios

Exhibit 1.6: On-Road Emissions for the DFW 8-County Nonattainment Area[3]

Summer Season, Midweek On-Road Emissions (tons/day)			
Nitrogen Oxides			
	2017	**2023**	**2024**
ABY	N/A	1195.68	1195.68
PR90	1197.93	1305.48	1326.41
FMVCP	166.97	93.89	87.05
Fuel Controls	130.88	72.18	67.15
I/M	124.14	70.09	65.31
TxLED	120.48	67.69	63.02
Volatile Organic Compounds			
	2017	**2023**	**2024**
ABY	N/A	676.32	676.32
PR90	678.81	743.07	756.31
FMVCP	73.66	49.91	47.92
Fuel Controls	60.80	41.62	39.87
I/M	54.99	37.11	35.41
TxLED	54.99	37.11	35.41

[3] Each scenario contains the control strategies of all previous scenarios

Exhibit 1.7: Control Strategy Emission Reductions for the DFW 9-County Nonattainment Area[4]

Summer Season, Midweek On-Road Emission Reductions (tons/day) Nitrogen Oxides				
		2017	2023	2024
Inventory	PR90	1222.87	1333.33	1354.90
	Control Strategies	123.95	69.82	65.04
Reductions	FMVCP	1051.74	1236.88	1265.43
	FC	36.64	22.06	20.21
	IM	6.74	2.09	1.84
	TxLED	3.79	2.49	2.37
	Total	1098.92	1263.51	1289.86
Volatile Organic Compounds				
		2017	2023	2024
Inventory	PR90	688.16	753.54	767.03
	Control Strategies	55.94	37.73	36.00
Reductions	FMVCP	613.39	702.90	718.40
	FC	13.02	8.40	8.17
	IM	5.82	4.51	4.46
	TxLED	0.00	0.00	0.00
	Total	632.22	715.81	731.03

[4] The sum of 'Reductions' in each analysis year may be slightly less than or more than the total due to rounding

Exhibit 1.8: Control Strategy Emission Reductions for Wise County[5]

Summer Season, Midweek On-Road Emission Reductions (tons/day)				
Nitrogen Oxides				
		2017	**2023**	**2024**
Inventory	**PR90**	24.94	27.85	28.48
	Control Strategies	3.47	2.13	2.01
Reductions	**FMVCP**	20.79	25.29	26.07
	FC	0.55	0.34	0.32
	IM	0.00	0.00	0.00
	TxLED	0.13	0.09	0.09
	Total	21.47	25.72	26.47
Volatile Organic Compounds				
		2017	**2023**	**2024**
Inventory	**PR90**	9.35	10.47	10.72
	Control Strategies	0.95	0.61	0.59
Reductions	**FMVCP**	8.24	9.74	10.02
	FC	0.16	0.12	0.11
	IM	0.00	0.00	0.00
	TxLED	0.00	0.00	0.00
	Total	8.40	9.86	10.14

[5] The sum of 'Reductions' in each analysis year may be slightly less than or more than the total due to rounding

Exhibit 1.9: Control Strategy Emission Reductions for the 8-County Nonattainment Area[6]

Summer Season, Midweek On-Road Emission Reductions (tons/day)				
Nitrogen Oxides				
		2017	**2023**	**2024**
Inventory	**PR90**	1197.93	1305.48	1326.41
	Control Strategies	120.48	67.69	63.02
Reductions	**FMVCP**	1030.95	1211.59	1239.36
	FC	36.09	21.72	19.90
	IM	6.74	2.09	1.84
	TxLED	3.66	2.40	2.29
	Total	1077.44	1237.79	1263.39
Volatile Organic Compounds				
		2017	**2023**	**2024**
Inventory	**PR90**	678.81	743.07	756.31
	Control Strategies	54.99	37.11	35.41
Reductions	**FMVCP**	605.15	693.16	708.38
	FC	12.86	8.29	8.05
	IM	5.82	4.51	4.46
	TxLED	0.00	0.00	0.00
	Total	623.82	705.95	720.90

[6] The sum of 'Reductions' in each analysis year may be slightly less than or more than the total due to rounding

Exhibit 1.10: Vehicle Miles of Travel for the DFW 9-County Nonattainment Area

Summer Season, Midweek Vehicle Miles of Travel (miles/day)			
	2017	**2023**	**2024**
ABY	N/A	212,145,874	212,145,874
PR90	212,145,874	231,521,648	235,106,886
FMVCP	212,145,874	231,521,648	235,106,886
FC	212,145,874	231,521,648	235,106,886
IM	212,145,874	231,521,648	235,106,886
TxLED	212,145,874	231,521,648	235,106,886

Exhibit 1.11: Vehicle Miles of Travel for Wise County

Summer Season, Midweek Vehicle Miles of Travel (miles/day)			
	2017	**2023**	**2024**
ABY	N/A	3,534,821	3,534,821
PR90	3,534,821	3,950,145	4,036,827
FMVCP	3,534,821	3,950,145	4,036,827
FC	3,534,821	3,950,145	4,036,827
IM	3,534,821	3,950,145	4,036,827
TxLED	3,534,821	3,950,145	4,036,827

Exhibit 1.12: Vehicle Miles of Travel for the 8-County Nonattainment Area

Summer Season, Midweek Vehicle Miles of Travel (miles/day)			
	2017	**2023**	**2024**
ABY	N/A	208,611,053	208,611,053
PR90	208,611,053	227,571,503	231,070,059
FMVCP	208,611,053	227,571,503	231,070,059
FC	208,611,053	227,571,503	231,070,059
IM	208,611,053	227,571,503	231,070,059
TxLED	208,611,053	227,571,503	231,070,059

CHAPTER 2: 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 Transportation Analytical Forecasting Tool (TAFT) 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 TAFT using a link-based methodology for each time period.

Transportation Analytical Forecasting Tool

The source of VMT estimates for the Reasonable Further Progress (RFP) Emission Inventories for the nonattainment counties is the network-based TAFT executed by the North Central Texas Council of Governments (NCTCOG) Transportation Department in the TransCAD environment. TransCAD is a Geographic Information System-based commercial travel demand software package for transportation planning. TAFT 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 TAFT is based on a multi-step sequential process designed to model travel behavior and predict travel demand at regional, sub-area, or corridor levels. These steps are Trip Generation, Trip Distribution, Mode Choice, and Roadway Assignment.

The roadway network developed for the RFP Emissions Inventories contains over 40,000 unique segments constructed to replicate the transportation system of the coverage area. For this RFP inventory, the transportation network was developed for the years 2017, 2023, and 2024. 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 End 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, rail, and managed lanes.

Household trip purposes in the TAFT are defined in one of three 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. TAFT also includes non-household trips, which cover commercial trips in the region. These trips are included in the model in three vehicle classes of auto, medium trucks, and heavy trucks. Trips that are not originated and ended entirely in the region are categorized as external trips in the same three vehicle classes as commercial vehicle trips. Finally, passenger trips to commercial airports are also included as a separate trip purpose in the regional travel model.

The model process begins with an estimate of the socio-economic variables for each zone. The data is organized by transportation analysis zone (TAZ), the smallest zone size available in the TAFT. There are 5,352 TAZs in the model (5,303 internal zones plus 47 externals). The data for each TAZ includes zone centroid; number of households; population; basic, retail, and service employment, and land area. This level of detail is retained in all 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 TAFT 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 Microsoft Visual Basic programming language.

Trip Generation Model

The Trip Generation Model is a computer program written in GISDK script language by NCTCOG staff. 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 2017, 2023, and 2024 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.

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.

Exhibit 2.1: Socio-Economic Demographic Summary

DFW 12-County Metropolitan Planning Area			
Analysis Year	**2017**	**2023**	**2024**
Population	7,285,760	8,057,240	8,182,757
Number of Households	2,597,520	2,870,206	2,914,504
Employment Types			
Basic	1,139,298	1,170,847	1,172,679
Retail	447,811	499,473	507,953
Service	3,113,174	3,433,264	3,484,980
Total Employment	4,700,283	5,103,584	5,165,612

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Trip Distribution Model

The Trip Distribution Model creates the trip interaction among TAZs using production and attraction person trips estimated in the Trip Generation step. 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. Trip Distribution uses auto travel time as the representation of impedance for traveling between zone pairs. The network travel times are the results of the Traffic Assignment step, and therefore, the feedback loop is designed in TAFT for internal consistency.

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 multinomial logic formulation for all the trip

purposes. The commercial vehicle trips and external trips are estimated as vehicle trips and do not require a modal split. 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 a.m. – 8:59 a.m. Morning Peak, 3:00 p.m. – 6:29 p.m. 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 TAFT 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 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 TAFT 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 functions were originally calibrated based on more than 8,000 traffic counts collected in 2004. These functions were later adjusted based on National Performance

Management Research Data Set (NPMRDS) and 2014 time-of-day traffic counts collected at about 20,000 observations. NPMRDS contains travel time data by 5-minute interval.

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 contains speeds by county for each hour of the day. The resulting congested TAFT county speeds, weighted by VMT, are listed in Exhibit 2.2.

Exhibit 2.2: Average Congested Speeds (miles/hour)

County	2017	2023	2024
Collin	34.48	34.00	33.89
Dallas	33.60	33.18	33.07
Denton	36.44	35.67	35.41
Ellis	46.79	46.14	45.85
Johnson	42.21	41.57	41.40
Kaufman	47.51	45.86	45.48
Parker	43.43	43.31	43.22
Tarrant	36.21	35.48	35.26
Wise	45.14	44.25	44.01

Local Street VMT

The roadway network of the TAFT 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 TAFT non-summer weekday (NSWD) activity to summer (June, July, and August) weekday activity. Automatic Traffic Recorder (ATR) data, collected by the Texas Department of Transportation (TxDOT), is used to calculate the necessary conversions. ATR data averaged over five years (2015-2019) was used to convert NSWD activity to summer.

Seasonal and Daily Adjustments

ATR data is organized into five day types: Sunday, Monday, Midweek (Tuesday, Wednesday, and Thursday), Friday, and Saturday. To adjust the representative average school season weekday (ASWT) data from the TAFT 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 midweek (Tuesday-Thursday) adjustments by area type for TAFT counties are listed in Exhibit 2.3.

Exhibit 2.3: Seasonal/Daily Adjustment Factors

	County Type	Midweek
2017, 2023 & 2024 TAFT Counties (ASWT to Summer)	Core (Dallas/Tarrant)	1.008
	Rural (Collin/Denton)	0.978
	Perimeter (Other Counties)	1.041

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 TAFT 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 TAFT 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.

Model VMT Adjustments (HPMS vs. TAFT)

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 the Environmental Protection Agency's (EPA) guidance for emission inventory development.

NCTCOG performed a validation on the TAFT model in 2014 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 TAFT model validation which is based on 2010 demographics. Exhibit 2.5 shows the calculation performed to develop the new HPMS adjustment factor, 0.9889, based on a comparison of 2014 VMT for HPMS and TAFT.

Exhibit 2.5: 2014 DFW and HPMS VMT Analysis

Model VMT Adjustment Factor	
	2014 VMT
HPMS (ASWT)[1]	178,714,289
TAFT (ASWT)	180,721,839
HPMS/TAFT Ratio	**0.9889**

[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. 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 RFP VMT estimates are located in Exhibit 2.6 for all counties in the nonattainment area. VMT is summarized by 2017, 2023, and 2024 model years for each county. Appendix B contains the VMT by county for each hour for all counties.

Exhibit 2.6: Vehicle Miles of Travel[7]

DFW Nonattainment Area			
County	**2017**	**2023**	**2024**
Collin	25,999,041	28,670,816	29,202,408
Dallas	84,654,176	90,707,613	91,652,443
Denton	20,277,564	22,481,069	22,932,330
Ellis	7,351,291	8,353,667	8,562,673
Johnson	4,988,178	5,583,181	5,719,868
Kaufman	6,288,552	7,258,835	7,448,955
Parker	5,217,801	5,698,419	5,792,452
Tarrant	53,834,450	58,817,903	59,758,931
Wise	3,534,821	3,950,145	4,036,827
Total	212,145,874	231,521,648	235,106,886

[7] The sum of county VMTs in each analysis year may be slightly less than or more than the total due to rounding

CHAPTER 3 ESTIMATION OF OFF-NETWORK ACTIVITY

The non-roadway-based inventory estimates (e.g., from vehicle starts, parked vehicle evaporative processes, non-roadway-based vehicle idling, hotelling activity) were calculated as the product of the amount of associated activity and the mass per unit of activity. To estimate the source hours parked (SHP) and vehicle starts activity, vehicle population estimates were needed. Hotelling activity estimates (composed largely of the emissions-producing source hours extended idling [SHEI] and diesel auxiliary power unit [APU] hours) were based on county-specific actual estimates.[8]

MOVES3 UTL (utilities) and the methodology provided by the Texas A&M Transportation Institute (TTI) is used to calculate the vehicle population and off-network activity estimates.

Vehicle Type Populations

TTI based the vehicle population estimates on vehicle registration data, vehicle population factors developed from the VMT mix, and additionally for future years, VMT growth estimates. For a historical year, the vehicle population estimates are based on mid-year TxDOT (or TxDMV) county registrations data, if available, and regional, all roads-weekday VMT mix-based vehicle type population factors for the analysis year. For future years, vehicle type populations were estimated as a function of base (e.g., latest available, if available, mid-year) registrations, grown to a future value (growth as a function of base and future VMT), and all roads-weekday VMT mix-based vehicle type population factors for the analysis year. This same procedure may be used to back-cast vehicle populations for earlier years for which vehicle registrations are unavailable.

ONI Hours

ONI hours (new with MOVES3) are not related to combination truck hotelling activity. These are idling activities that occur while a vehicle is idling in a parking lot, drive-through, driveway, while waiting to pick up passengers, or loading/unloading cargo. ONI applies to all MOVES source types. Emissions are calculated by multiplying the emission rates (exhaust running emissions for MOVES roadType ID “1”, or “off-network”) with the corresponding hours of ONI. TTI estimates ONI activity consistent with the MOVES methodology. This is accomplished in general using a formula that calculates ONI as a function of MOVES default relationships on total idling and total operating hours, derived from telematics data, in combination with local roadway network activity estimates (VMT and speeds), and MOVES default road idling fractions (proportions of vehicle idling while operating on roads).

[8] Base estimates of hotelling hours used in this analysis are 2017 winter weekday estimates, developed by TTI during the truck idling study that produced county 24-hour hotelling estimate totals for all Texas counties, sponsored by TCEQ starting in 2017.

SHP

The SHP was estimated as a function of total hours (hours a vehicle exists) minus its hours operating on roads (source hours operating [SHO]) and minus ONI hours. For a historical year, the vehicle type SHP estimates are based on VMT mix, link VMT and speeds, and the vehicle population estimates. The VMT mix is applied to the link VMT to produce vehicle-type-specific VMT estimates. Link VMT is divided by the associated speed to produce SHO estimates, which are aggregated by vehicle type and subtracted from associated source hours resulting in SHP estimates. For a future year, the vehicle type SHP was estimated in the same manner as for historical years, except using the future year link VMT and speeds, VMT mix, and vehicle population estimates. This was performed by county and hour.

Starts

Engine starts were based on the MOVES national default starts per vehicle, and the local, county vehicle type population estimates. MOVES default weekday and weekend day starts per vehicle were used. Weekday results were used for Weekday and Friday scenarios and weekend day starts were used for Saturday and Sunday scenarios. The starts were calculated as the product of starts/vehicle from MOVES, and the county vehicle type population estimates. This was performed by county and hour.

SHI and APU Hours

The SHI and APU hours, two of four activity components comprising the diesel combination long-haul truck hotelling hours, were estimated for each county activity scenario using TTI's current procedure and base and activity estimates from TCEQ's 2017 truck idling study. NCTCOG used the winter weekday, 24-hour, 2017 base county level hotelling estimates from the truck idling study in combination with county scaling factors estimated from the base year and the analysis year link VMT and VMT mixes to produce the 2019 and 2023, county, hourly hotelling activity estimates. Hotelling hourly factors (estimated by inverting hourly VHT factors) were then applied to allocate the 24-hour hotelling hours estimates for each county to each hour of the day. Estimated SHEI and APU hours fractions of hotelling hours based on an updated hotelling activity distribution from the truck idling study (which is the same as the MOVES3 default) were used to separate SHEI and APU hours activity from total hotelling hours, for each county and hour.

CHAPTER 4: EMISSION FACTOR ESTIMATION PROCEDURE

MOVES3 and Input Parameters

The Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator version 33 (MOVES3) is used to develop vehicle emission factors to conduct the Reasonable Further Progress (RFP) emission inventory for the Dallas-Fort Worth (DFW) 9-county ozone nonattainment area for analysis years 2017, 2023, and 2024. The emission factors are one component in the equation to determine vehicle emissions emitted from the region's on-road vehicles. MOVES3 parameters used to develop emissions inventory 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 and MOVES3 input files utilizing these parameters and data for each county are included in Appendix A.

Exhibit 4.1: MOVES3 Modeled Pollutants

Command	Input Parameter Values and Molecular Formulas	Description
Pollutant	VOC, CO, NO_X, CO_2, SO_2, NH_3, $PM_{2.5}$, and PM_{10},	Volatile Organic Compounds (VOC), Carbon Monoxide (CO), Nitrogen Oxides (NO_X), 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: MOVES3 External Conditions

Command	Input Parameter Values	Description
Calendar Year	2017, 2023, and 2024	RFP analysis years
Altitude	1	Low altitude; EPA default
Evaluation Month	7	Representing Summer
Minimum/Maximum Temperature	N/A	See Hourly Temperatures
Hourly Temperatures	Average Summer (June, July and August)	2017 County specific, provided by the Texas Commission on Environmental Quality (TCEQ)
Relative Humidity	Average Summer (June, July and August)	2017 County specific, provided by TCEQ
Barometric Pressure	Average Summer (June, July and August)	2017 County specific, provided by TCEQ

Exhibit 4.3: MOVES3 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. Texas A&M Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert MOVES3 based Texas Department of Motor Vehicles (TxDMV) registration data for each county into 13 MOVES3 SUT population.	TxDMV registration data
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.	TxDMV registration data MOVES3 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

Exhibit 4.3: MOVES3 Input Parameters (continued)

Input Parameter	Description	Source
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 MOVES3 input where local data unavailable
Meteorology	Regional average summer data on temperature and humidity.	2017 data provided by TCEQ
Fuel Formulation	Input county specific fuel properties in the MOVES3 database.	TCEQ, EPA Fuel Surveys, and default MOVES3 input where local data unavailable
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.	State I/M Program data provided by 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.	TxDMV registration data MOVES3 default used for light duty vehicles and buses

Exhibit 4.4 MOVES3 I/M Descriptive Inputs for Subject Counties

2017					
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data[9]					
I/M Program ID	20	21	23	24	MOVES3
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	MOVES3
Source Use Type	21, 31, 32	21, 31, 32	21, 31, 32	21, 31, 32	MOVES3
Begin Model Year	1996	1993	1993	1996	Annual testing; program specifications[10]
End Model Year	2015	1995	1995	2015	Annual testing; program specifications
Inspect Frequency	1	1	1	1	Annual testing; program specifications[11]
Test Standards Description	Exhaust OBD[12] Check	ASM[13] 2525/ 5015 Phase-in Cut points	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications[14]
Test Standards ID	51	23	41	45	MOVES3
I/M Compliance[15]	94.79% for source use type 21, 91.12% for source use type 31 and 71.34% for source use type 32				Expected compliance (%) - MOVES3 Default

[9] Wise County does not have an I/M Program
[10] Inputs provided by the TCEQ
[11] Inputs provided by the TCEQ
[12] On-board Diagnostic
[13] Acceleration Simulation Mode
[14] Inputs provided by the TCEQ
[15] https://www.epa.gov/sites/production/files/2020-11/documents/420b20052.pdf

Exhibit 4.4. MOVES3 I/M Descriptive Inputs for Subject Counties (continued)

2023			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	MOVES3
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	MOVES3
Source Use Type	21, 31, 32	21, 31, 32	MOVES3
Begin Model Year	1999	1999	Annual testing; program specifications
End Model Year	2021	2021	Annual testing; program specifications
Inspect Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	45	MOVES3
I/M Compliance	94.00% for source use type 21, 90.35% for source use type 31 and 70.74% for source use type 32		Expected compliance (%) - MOVES3 Default

Exhibit 4.4. MOVES3 I/M Descriptive Inputs for Subject Counties (continued)

2024			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	MOVES3
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	MOVES3
Source Use Type	21, 31, 32	21, 31, 32	MOVES3
Begin Model Year	2000	2000	Annual testing; program specifications
End Model Year	2022	2022	Annual testing; program specifications
Inspect Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	45	MOVES3
I/M Compliance	94.00% for source use type 21, 90.35% for source use type 31 and 70.74% for source use type 32		Expected compliance (%) - MOVES3 Default

Exhibit 4.5. Fuel Formulations

Year	Pre-1990 Controls			2017		
Fuel Type	Gasoline		Diesel	Gasoline		Diesel
Counties	Core	Perimeter	All	Core	Perimeter	All
fuelformulationID	10001	10002	32500	17714	17702	31706
fuelsubtypeID	10	10	20	12	12	21
RVP	7.8	9	\N	7.00	7.54	\N
sulfurLevel	429.96	429.96	2500	22.11	21.28	6.37
ETOHVolume	0	0	\N	9.67	9.66	\N
MTBEVolume	0	0	\N	0	0	\N
ETBEVolume	0	0	\N	0	0	\N
TAMEVolume	0	0	\N	0	0	\N
aromaticContent	26.4	26.4	\N	14.74	25.35	\N
olefinContent	11.9	11.9	\N	10.74	8.33	\N
benzeneContent	1.64	1.64	\N	0.46	0.76	\N
e200	46.04	50	\N	49.21	49.45	\N
e300	81.43	83	\N	85.13	82.68	\N
VolToWtPercentOxy	0	0	\N	0.3653	0.3653	\N
BioDieselEsterVolume	\N	\N	0	\N	\N	4.68
CetaneIndex	\N	\N	\N	\N	\N	\N
PAHContent	\N	\N	\N	\N	\N	\N
T50	207.9	199.82	\N	202.52	203.73	\N
T90	336.54	329.41	\N	325.77	327.68	\N

Exhibit 4.5. Fuel Formulations (Continued)

Year	2021 and Future Years (2023 and 2024)		
Fuel Type	**Gasoline**		**Diesel**
Counties	**Core**	**Perimeter**	**All**
fuelformulationID	14714	14702	30600
fuelsubtypeID	12	12	21
RVP	7.09	7.80	\N
sulfurLevel	10.00	10.00	6
ETOHVolume	9.56	9.56	\N
MTBEVolume	0	0	\N
ETBEVolume	0	0	\N
TAMEVolume	0	0	\N
aromaticContent	16.96	22.22	\N
olefinContent	10.13	8.69	\N
benzeneContent	0.37	0.99	\N
e200	47.00	49.64	\N
e300	84.95	84.60	\N
VolToWtPercentOxy	0.3653	0.3653	\N
BioDieselEsterVolume	\N	\N	4.86
CetaneIndex	\N	\N	\N
PAHContent	\N	\N	\N
T50	210.35	202.53	\N
T90	325.30	319.75	\N

Source: TTI

Notes: Pre-1990 control fuel formulations are consistent with TCEQ's most recent DFW RFP emissions analysis. The 7.8 psi RVP limit formulation (not available in MOVES3) is from MOVES2014b. The diesel formulation (ID 32500) is based on NIPER U.S. refiner survey summaries which placed average sulfur content for the typical No. 2 diesel, within the post-1979/pre-1993 regulation period, in the 2500-3000 ppm range. Fuel subtype IDs 10 and 20 are non-oxygenated conventional gasoline and conventional diesel, respectively.

TTI based the RFG formulations on EPA's RFG compliance surveys for summer, available yearly. RFG properties are actual averages (calculated as composites of averages by fuel grade using sales fractions based on Texas RFG sales volume data from the EIA). The RFG properties for 2021+ (future years) are based on the latest available 2020 survey, except for sulfur, which is set to the expected future level (MOVES3 default, consistent with the Tier 3 standard). Fuel subtype ID 12 is 10% ethanol volume blended in gasoline (E10).

The diesel sulfur levels for the historical years are statewide averages developed from TCEQ's summer fuel surveys for each of the survey years (2011, 2017, 2020). The 2017 sulfur content estimate is used for 2018, since no 2018 Texas diesel survey was readily available. Diesel sulfur for future years is set to the MOVES3 default expected future value, which is close to the actual, relatively stable, statewide averages observed in the last four TCEQ fuel surveys (2011, 2014, 2017, 2020). The biodiesel ester volume percent estimates are based on EIA transportation sector biodiesel and diesel consumption estimates for Texas, by year, using latest available data (2018) for 2018 and later years. Fuel subtype ID 21 is biodiesel (BD), in Texas, ULSD currently estimated with a blend of about 5% by volume biodiesel ester

Area Specific Calculations and Procedures

SourceUse Type Distribution

Sourceuse Source use type age distributions are calculated from TxDMV vehicle registration data. End-of-year data sets of 2018 utilized for light- and heavy-duty vehicle classes. MOVES3 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 Census Transportation Planning Products Program (CTPP) 2012 - 2016. 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 4.6: County-to-County Worker Flow[16]

	County of Employment											
Resident County	**Collin**	**Dallas**	**Denton**	**Ellis**	**Hood**	**Hunt**	**Johnson**	**Kaufman**	**Parker**	**Rockwall**	**Tarrant**	**Wise**
Collin	55.22%	6.48%	13.29%	0.95%	0.67%	7.41%	0.23%	3.70%	0.21%	9.23%	0.93%	0.54%
Dallas	37.87%	82.64%	32.35%	36.93%	3.17%	17.36%	5.50%	47.96%	3.45%	49.85%	16.77%	5.52%
Denton	3.90%	2.18%	44.30%	0.62%	0.32%	0.62%	0.40%	0.84%	1.10%	0.39%	2.26%	9.26%
Ellis	0.05%	0.49%	0.04%	51.18%	0.02%	0.03%	2.50%	1.14%	0.06%	0.11%	0.30%	0.11%
Hood	0.00%	0.01%	0.01%	0.07%	65.80%	0.00%	0.93%	0.00%	1.98%	0.19%	0.12%	0.02%
Hunt	0.39%	0.10%	0.02%	0.10%	0.53%	61.57%	0.17%	1.02%	0.00%	5.35%	0.01%	0.00%
Johnson	0.03%	0.05%	0.06%	0.67%	3.62%	0.19%	45.79%	0.06%	0.98%	0.05%	0.81%	0.11%
Kaufman	0.03%	0.36%	0.02%	0.32%	0.00%	2.79%	0.00%	40.42%	0.01%	2.13%	0.03%	0.00%
Parker	0.02%	0.02%	0.06%	0.05%	4.89%	0.11%	0.58%	0.01%	45.90%	0.00%	0.60%	2.38%
Rockwall	0.47%	0.76%	0.04%	0.13%	0.00%	9.18%	0.00%	3.12%	0.00%	31.39%	0.02%	0.13%
Tarrant	2.02%	6.88%	9.55%	8.85%	20.89%	0.73%	43.79%	1.73%	44.87%	1.31%	77.86%	27.01%
Wise	0.01%	0.01%	0.25%	0.13%	0.08%	0.00%	0.11%	0.00%	1.45%	0.00%	0.28%	54.94%

Source: Census Transportation Planning Products Program (CTPP) 2012 - 2016

[16] The sum of each county maybe less than or more than 100% due to rounding.

Fuel Engine Fractions

Diesel fractions for heavy-duty vehicle categories utilized 12-county summed yearly registration data for modeling all the analysis years. End-of-year 2018 registration data is used for modeling all analysis years. Light-duty and bus categories utilize MOVES3 default values. All diesel fraction files, included in Appendix A, list specific data used for this analysis.

MOVES3 Emission Factors

MOVES3 emission factors for all the control scenarios 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.

TxLED NOx Adjustment

NO_X emission factors for diesel vehicle classes are adjusted to apply the federal low emission diesel program. Exhibit 4.7 lists the appropriate adjustment for each vehicle class.

Exhibit 4.7: TxLED NO_x Adjustments

Source Use Type	Adjustment Factors		
	2017	2023	2024
Passenger Car	0.9491	0.9514	0.9516
Passenger Truck	0.9459	0.9489	0.9494
Light Commercial Truck	0.9455	0.9485	0.9490
Intercity Bus	0.9450	0.9481	0.9486
Transit Bus	0.9493	0.9508	0.9510
School Bus	0.9466	0.9494	0.9497
Refuse Truck	0.9463	0.9495	0.9500
Single Unit Short-Haul Truck	0.9508	0.9518	0.9519
Single Unit Long-Haul Truck	0.9509	0.9516	0.9517
Motor Home	0.9447	0.9467	0.9474
Combination Short-Haul Truck	0.9500	0.9513	0.9515
Combination Long-Haul Truck	0.9482	0.9507	0.9510

Source: TCEQ

Vehicle Miles of Travel Mix (or Fractions)

The VMT mix designates the vehicle types included in the analysis. It specifies the fraction of on-road fleet VMT attributable to each vehicle type by day type (i.e., average weekday) and MOVES road type.

The TTI provided the VMT mixes. TTI estimated the VMT mix based on TTI's 24-hour average VMT mix method, expanded to produce the four-period, time-of-day estimates.[17] The procedure sets Texas vehicle registration category aggregations for MOVES source use type (SUT) categories to be used in the VMT mix estimates and for developing other fleet parameter inputs needed in the process (e.g., vehicle age distributions). The VMT mix procedure produced a set of four-period, time-of-day average vehicle type VMT allocations by MOVES road type and by day type, estimated for each TxDOT district for use with each county for each year analyzed. The data sources used were recent 2009 to 2018 TxDOT vehicle classification counts, year-end 2018 TxDOT/Texas Department of Motor Vehicles (TxDMV) registration data and MOVES default data.

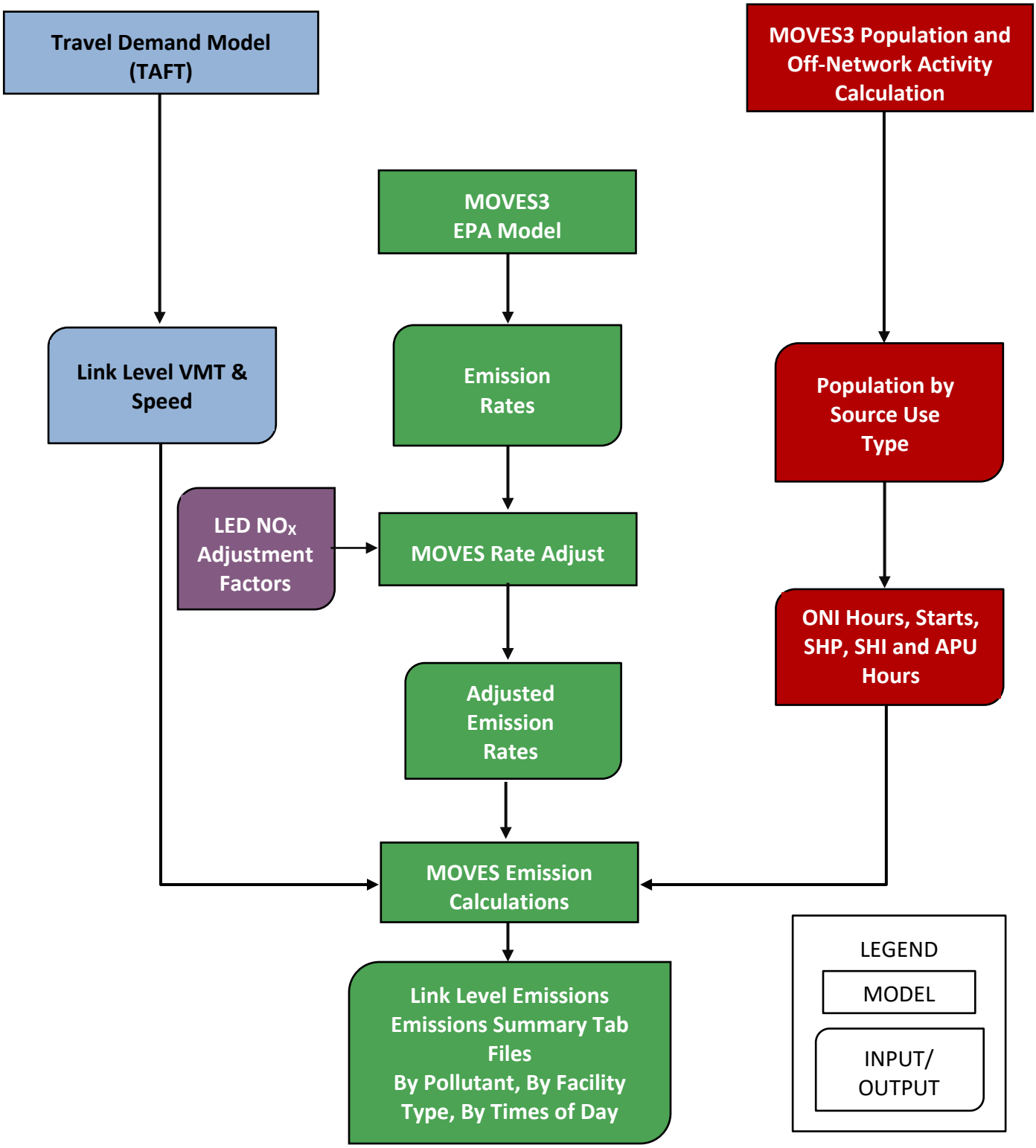
[17] MOVES Source Use Type and VMT Mix for Conformity Analysis, TTI, August 2017

CHAPTER 5: EMISSION CALCULATION PROCEDURE

Emissions estimates are calculated using *"TTI emissions inventory estimation utilities using moves: MOVES3 UTL",* developed by the Texas A&M Transportation Institute. This software combines vehicle activity and emission factors to create emission estimates.

Exhibit 5.1 outlines the emission calculation modeling process that is used to calculate the emissions estimates for the DFW ozone nonattainment area. Different procedures were applied for DFW Travel Demand Model counties outlined in the following sections.

Exhibit 5.1: MOVES3 Emission Modeling Process



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

Vehicle Miles of Travel Estimates

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

Speed Estimates

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

Emission Estimates

The final county emission estimates for each analysis year and control scenarios are summarized in Exhibit 6.1.[18] Additional modeled pollutants not shown in this section are available in Appendices B and C.

Appendix B contains the detailed emissions for all counties by analysis year, control scenarios TOD.

Appendix C contains the summarized emissions for all counties by analysis year, control scenarios TOD.

[18] The sum of each county emission estimates maybe slightly less than or more than the total due to rounding

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area

Oxides of Nitrogen Emissions (tons/day) Summer Season, Midweek			
Adjusted Base Year			
County	**2017**	**2023**	**2024**
Collin	N/A	136.38	136.38
Dallas	N/A	469.02	469.02
Denton	N/A	113.92	113.92
Ellis	N/A	49.24	49.24
Johnson	N/A	33.61	33.61
Kaufman	N/A	41.85	41.85
Parker	N/A	36.69	36.69
Tarrant	N/A	314.96	314.96
Wise	N/A	24.83	24.83
Total	N/A	1220.52	1220.52
Pre-90 Controls			
County	**2017**	**2023**	**2024**
Collin	89.27	98.25	100.16
Dallas	274.98	296.58	300.66
Denton	69.15	76.72	78.42
Ellis	19.33	21.80	22.36
Johnson	15.36	17.16	17.56
Kaufman	15.56	18.04	18.54
Parker	14.87	16.22	16.51
Tarrant	180.29	198.30	202.09
Wise	9.35	10.47	10.72
Total	688.16	753.54	767.03

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area (continued)

Nitrogen Oxides Emissions (tons/day) Summer Season, Midweek			
FMVCP			
County	**2017**	**2023**	**2024**
Collin	17.35	9.59	8.88
Dallas	63.78	34.36	31.50
Denton	15.31	8.71	8.12
Ellis	7.64	4.48	4.19
Johnson	5.42	3.30	3.12
Kaufman	6.63	4.00	3.77
Parker	6.04	3.68	3.45
Tarrant	44.81	25.78	24.03
Wise	4.15	2.56	2.41
Total	171.12	96.45	89.47
Fuel Controls			
County	**2017**	**2023**	**2024**
Collin	13.04	6.97	6.48
Dallas	48.90	25.57	23.48
Denton	11.79	6.55	6.13
Ellis	6.44	3.71	3.49
Johnson	4.61	2.79	2.65
Kaufman	5.63	3.37	3.18
Parker	5.21	3.17	2.99
Tarrant	35.27	20.04	18.76
Wise	3.60	2.22	2.10
Total	134.48	74.39	69.25

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area (continued)

Nitrogen Oxides Emissions (tons/day) Summer Season, Midweek			
Inspection/Maintenance			
County	**2017**	**2023**	**2024**
Collin	12.26	6.72	6.25
Dallas	46.13	24.75	22.76
Denton	11.15	6.34	5.95
Ellis	6.19	3.64	3.42
Johnson	4.44	2.73	2.60
Kaufman	5.43	3.31	3.12
Parker	5.04	3.12	2.94
Tarrant	33.50	19.48	18.27
Wise	3.60	2.22	2.10
Total	127.75	72.31	67.41
TxLED			
County	**2017**	**2023**	**2024**
Collin	11.94	6.51	6.05
Dallas	44.87	23.95	22.00
Denton	10.83	6.13	5.75
Ellis	5.97	3.50	3.29
Johnson	4.29	2.63	2.50
Kaufman	5.24	3.18	3.00
Parker	4.86	2.99	2.82
Tarrant	32.49	18.80	17.62
Wise	3.47	2.13	2.01
Total	123.95	69.82	65.04

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day) Summer Season, Midweek			
Adjusted Base Year			
County	**2017**	**2023**	**2024**
Collin	N/A	88.94	88.94
Dallas	N/A	273.85	273.85
Denton	N/A	68.90	68.90
Ellis	N/A	19.30	19.30
Johnson	N/A	15.33	15.33
Kaufman	N/A	15.53	15.53
Parker	N/A	14.81	14.81
Tarrant	N/A	179.67	179.67
Wise	N/A	9.31	9.31
Total	N/A	685.63	685.63
Pre-90 Controls			
County	**2017**	**2023**	**2024**
Collin	89.27	98.25	100.16
Dallas	274.98	296.58	300.66
Denton	69.15	76.72	78.42
Ellis	19.33	21.80	22.36
Johnson	15.36	17.16	17.56
Kaufman	15.56	18.04	18.54
Parker	14.87	16.22	16.51
Tarrant	180.29	198.30	202.09
Wise	9.35	10.47	10.72
Total	688.16	753.54	767.03

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day) Summer Season, Midweek			
FMVCP			
County	**2017**	**2023**	**2024**
Collin	9.19	6.36	6.11
Dallas	29.14	19.33	18.51
Denton	7.54	5.28	5.09
Ellis	2.30	1.56	1.51
Johnson	1.89	1.30	1.25
Kaufman	1.81	1.22	1.18
Parker	1.79	1.19	1.15
Tarrant	20.02	13.67	13.12
Wise	1.11	0.73	0.70
Total	74.77	50.63	48.62
Fuel Controls			
County	**2017**	**2023**	**2024**
Collin	7.53	5.29	5.07
Dallas	23.60	15.90	15.20
Denton	6.29	4.45	4.28
Ellis	1.98	1.31	1.26
Johnson	1.66	1.12	1.07
Kaufman	1.54	1.01	0.97
Parker	1.56	1.02	0.98
Tarrant	16.65	11.52	11.03
Wise	0.95	0.61	0.59
Total	61.76	42.23	40.46

Exhibit 6.1: Final Emission Estimates for the 9-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day) Summer Season, Midweek			
Inspection/Maintenance			
County	**2017**	**2023**	**2024**
Collin	6.78	4.68	4.48
Dallas	21.34	14.19	13.51
Denton	5.67	3.95	3.79
Ellis	1.80	1.18	1.13
Johnson	1.52	1.01	0.96
Kaufman	1.41	0.92	0.88
Parker	1.43	0.92	0.88
Tarrant	15.05	10.25	9.78
Wise	0.95	0.61	0.59
Total	55.94	37.73	36.00
TxLED			
County	**2017**	**2023**	**2024**
Collin	6.78	4.68	4.48
Dallas	21.34	14.19	13.51
Denton	5.67	3.95	3.79
Ellis	1.80	1.18	1.13
Johnson	1.52	1.01	0.96
Kaufman	1.41	0.92	0.88
Parker	1.43	0.92	0.88
Tarrant	15.05	10.25	9.78
Wise	0.95	0.61	0.59
Total	55.94	37.73	36.00