

CHAPTER 7: EMISSION FACTORS/MOVES MODEL

7.1 Overview

This chapter discusses development of the regional motor vehicle emissions analysis for the North Central Texas nonattainment area, including all key assumptions used in the process. A regional emissions analysis must be conducted for multiple analysis years to satisfy the requirements of 40 Code of Federal Regulations Part 93.109 (40 CFR 93.109) of the conformity rule for ozone nonattainment areas. Specifically, the regional emissions analysis is used to conduct the emission budget test and to determine any contributions to emission reductions. The procedures for determining regional transportation-related emissions are described in 40 CFR Part 93.118 of the conformity rule. The following sections discuss the analysis years and a description of the modeling processes used to conduct the analysis.

7.2 Emissions Factor Estimation Model (MOVES 2014a)

According to 40 CFR Part 93.111 of the conformity rule, the conformity determination must be based on the latest emission estimation model available. The Environmental Protection Agency (EPA) released the new Motor Vehicle Emission Simulator (MOVES) model in March of 2010. EPA released subsequent updates to the model as MOVES2010a in September 2010, MOVES2010b in April 2012, MOVES2014 in July 2014, an update to MOVES2014 in October 2014, MOVES2014a in November 2015, with an update in December 2016. EPA considers MOVES2014a as an enhancement to the MOVES2014 model, not as a new emissions model. In order to comply with the conformity rule, the applicable model for this conformity analysis was chosen to be MOVES2014a.

As outlined in the Pre-analysis Consensus Plan, included in Appendix 12.12, the Interagency Consultation Partners approved the use of MOVES2014a to develop 2018, 2020, 2028, 2037, and 2045 vehicle emission factors. Emission factors are one component to determine volatile organic compounds (VOC) and nitrogen oxides (NO_x) emissions from the region's on-road vehicles. MOVES2014a input parameters are listed below in Exhibits 7.2-1 through 7.2-6 with the appropriate data source and/or methodology applied. Information listed applies to all counties and analysis years unless otherwise specified. Referenced files identifying specific local data and MOVES2014a technical reports are included in Appendix 12.13. MOVES2014a input databases utilizing these parameters and data for each county are included in Appendix 12.14.

Exhibit 7.2-1: MOVES Model Details and Model Parameter Selections

Command	Function/Description	Input Parameter Values	Description
MOVES Model Version	Identifies the Model Version to be utilized for the analysis.	MOVES2014a	MOVES was released in November 2016 and last updated in December 2017.
Calendar Year	Identifies calendar year for which emissions factors are to be calculated. (Required to run model).	2018, 2020, 2028, 2037, 2045	Attainment Demonstration Years and Plan Forecast Years
Evaluation Month	Provides option of calculating emissions factors for each month of the calendar year.	7	Representing summer ozone season

Exhibit 7.2-2: MOVES2014a Input Parameters and Source

Input Parameter Name	Description	Source
Source Type Population	Input the number of vehicles in the geographic area which is to be modeled for each vehicle. Texas A&M Transportation Institute's (TTI) MOVES population Build module is used to convert MOVES2014a based Texas Department of Motor Vehicles (TxDMV) registration data for each county into 13 MOVES vehicle Source Use Types.	2014 TxDMV registration data.
Source Type Age Distribution	Input that provides the distribution of vehicle counts by age for each calendar year and vehicle type. TxDMV registration data is used to estimate the age distribution of vehicle types up to 30 years. The distribution of age fractions should sum up to 1.0 for all vehicle types for each analysis year.	2014 TxDMV registration data. MOVES default used for buses.
Vehicle Type VMT	County specific vehicle miles of travel (VMT) is distributed to six Highway Performance Monitoring System 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. The sum of speed distribution to all speed bins for each road type, vehicle type, and time/day type would be 1.0.	Travel Model Output.
Road Type Distribution (VMT Fractions)	Input County Specific VMT by road type. VMT fraction is 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.
Meteorology	County specific data on temperature, humidity, and barometric pressure.	Regional data from the Texas Commission on Environmental Quality (TCEQ); see Appendix 12.14. See Exhibit 7.2-3 for 10-county average hourly data.
I/M Coverage	Input Inspection and Maintenance Program (I/M) coverage record for each combination of pollutants, process, county, fuel type, regulatory class and model year are specified using this input.	See Exhibit 7.2-4.
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 MOVES input where local data unavailable. See Exhibit 7.2-5.
Fuel Formulation	Input county specific fuel properties in the MOVES database.	TCEQ, EPA Fuel Surveys and default MOVES input where local data unavailable.
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.	2014 TxDMV registration data. MOVES default used for light duty vehicles and buses. 12 County regional data applied for heavy-duty vehicles.

Exhibit 7.2-3: 2012 10-County Average Hourly Meteorological Data²³

Hours	Temperature	Relative Humidity
12:00 a.m.	80.02	65.12
1:00 a.m.	78.83	67.72
2:00 a.m.	77.83	70.23
3:00 a.m.	76.91	72.39
4:00 a.m.	76.02	74.71
5:00 a.m.	75.25	76.73
6:00 a.m.	74.63	78.75
7:00 a.m.	75.51	77.59
8:00 a.m.	78.38	71.59
9:00 a.m.	81.63	64.07
10:00 a.m.	84.68	57.19
11:00 a.m.	87.47	51.07
12:00 p.m.	89.76	46.37
1:00 p.m.	91.51	42.56
2:00 p.m.	92.60	39.96
3:00 p.m.	93.35	38.73
4:00 p.m.	93.51	38.26
5:00 p.m.	93.09	38.66
6:00 p.m.	92.03	40.13
7:00 p.m.	89.96	43.29
8:00 p.m.	86.83	49.33
9:00 p.m.	84.31	54.49
10:00 p.m.	82.65	58.42
11:00 p.m.	81.24	62.19

²³ Data provided by the TCEQ based on combined data from LEADS, NWS, and U.S. Air Force. County-specific data located in Appendix 12.14

Exhibit 7.2-4: MOVES2014a I/M Descriptive Inputs for Subject Counties

2018					
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data ²⁴					
I/M Program ID	20	21	23	24	Differentiates I/M programs
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	Identifies the pollutant and vehicle process
Source Use Type	21, 31, 32	21, 31, 32	21, 31, 32	21, 31, 32	Identifies the vehicle type
Begin Model Year	1996	1994	1994	1996	Model year I/M Program begins
End Model Year	2016	1995	1995	2016	Model year I/M Program ends
Inspection Frequency	1	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	ASM ²⁵ 2525/5015 Phase-in Cut points	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Identifies test type
Test Standards ID	51	23	41	45	Identifies test with MOVES2014a database test standards IDs
I/M Compliance	93.12% for source type 21, 91.26% for source type 31 and 85.67% for source type 32 ²⁶				Expected compliance (%)

²⁴ Wise County does not have an I/M program

²⁵ ASM – Acceleration Simulation Mode

²⁶ <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NN9L.txt>

Exhibit 7.2-4: MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2020 (Year based on EPA nonattainment classification under 2015 ozone NAAQS)			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	Differentiates I/M programs
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	Identifies the pollutant and vehicle process
Source Use Type	21, 31, 32	21, 31, 32	Identifies the vehicle type
Begin Model Year	1996	1996	Model year I/M Program begins
End Model Year	2018	2018	Model year I/M Program ends
Inspection Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Identifies test type
Test Standards ID	51	45	Identifies test with MOVES2014a database test standards IDs
I/M Compliance	93.12% for source type 21, 91.26% for source type 31 and 85.67% for source type 32		Expected compliance (%)

Exhibit 7.2-4: MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2028			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	Differentiates I/M programs
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	Identifies the pollutant and vehicle process
Source Use Type	21, 31, 32	21, 31, 32	Identifies the vehicle type
Begin Model Year	2004	2004	Model year I/M Program begins
End Model Year	2026	2026	Model year I/M Program ends
Inspection Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Identifies test type
Test Standards ID	51	45	Identifies test with MOVES2014a database test standards IDs
I/M Compliance	93.12% for source type 21, 91.26% for source type 31 and 85.67% for source type 32		Expected compliance (%)

Exhibit 7.2-4: MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2037			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	Differentiates I/M programs
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	Identifies the pollutant and vehicle process
Source Use Type	21, 31, 32	21, 31, 32	Identifies the vehicle type
Begin Model Year	2013	2013	Model year I/M Program begins
End Model Year	2035	2035	Model year I/M Program ends
Inspection Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Identifies test type
Test Standards ID	51	45	Identifies test with MOVES2014a database test standards IDs
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 86.6% for source use type 32		Expected compliance (%)

Exhibit 7.2-4: MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2045			
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data			
I/M Program ID	20	24	Differentiates I/M programs
Pollutant Process ID	101, 102, 201, 202, 301, 302	112	Identifies the pollutant and vehicle process
Source Use Type	21, 31, 32	21, 31, 32	Identifies the vehicle type
Begin Model Year	2021	2021	Model year I/M Program begins
End Model Year	2043	2043	Model year I/M Program ends
Inspection Frequency	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Evaporative Gas Cap and OBD Check	Identifies test type
Test Standards ID	51	45	Identifies test with MOVES2014a database test standards IDs
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 86.6% for source use type 32		Expected compliance (%)

Exhibit 7.2-5: MOVES2014a Fuel Supply

Fuel Formulation ID	Market Share	Market Share CV ²⁷
18724/18734	1	0
30011	1	0

²⁷ Coefficient of Variation

EXHIBIT 7.2-6: MOVES2014a Fuel Properties

Fuel Type	Gasoline ²⁸		Diesel ²⁹
County Group	Core ³⁰	Perimeter ³¹	All Counties ³²
Fuel Formulation ID	18724	18734	30011
Fuel Subtype ID	12	12	20
RVP	7.00	7.80	0.00
Sulfur Level	10.00	10.00	11.00
ETOH Volume	9.67	9.66	0.00
MTBE Volume	0.00	0.00	0.00
ETBE Volume	0.00	0.00	0.00
TAME Volume	0.00	0.00	0.00
Aromatic Content	14.74	25.35	0.00
Olefin Content	10.74	8.33	0.00
Benzene Content	0.46	0.61	0.00
e200	49.21	49.45	0.00
e300	85.13	82.68	0.00
Vol to Wt Percent Oxy	0.3653	0.3653	N/A
BioDieselEster Volume	0.00	0.00	N/A
Cetane Index	0.00	0.00	N/A
PAH Content	0.00	0.00	N/A
T50	202.52	203.73	0.00
T90	325.77	327.68	0.00

²⁸ TTI produced these fuel formulation estimates using local summer 2017 fuel survey sample data (TCEQ survey by ERG for non-RFG counties and EPA Texas RFG survey data). The overall average fuel properties for each region 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 gasoline relative sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058).

²⁹ TTI produced diesel average sulfur estimates using the summer 2014 TCEQ fuel survey diesel sample data by aggregating and averaging sulfur content values for Texas Low-Emission Diesel (TxLED) counties.

³⁰ EPA Texas RFG survey data, sulfur level set to Tire 3 Rule regulated value.

³¹ RVP modified to the TCEQ low RVP regulated value of 7.8 for 95 east Texas counties, and no RVP buffer for ethanol applied because the one pound waiver is only for counties with a federally regulated RVP level, sulfur level set to Tire 3 Rule regulated value.

³² Future year diesel fuel parameters are the MOVES defaults modified to reflect consistency with the federal low sulfur diesel rule, fuel survey data, and diesel fuel properties used in SIP emission inventory development.

7.2.1 Vehicle Registration Distribution

Vehicle age distributions are calculated from TxDMV vehicle registration data. July 2014 data sets are utilized for light- and heavy-duty vehicle classes. MOVES 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 County-to-County Worker Flow data from the 2000 Census. Exhibit 7.2.1-1 identifies percentages applied for this weighted adjustment. The 12-county summed heavy-duty vehicle data is used for developing the heavy-duty registration portion for heavy-duty vehicles.

Exhibit 7.2.1-1: County-to-County Worker Flow

County of Employment										
Resident County	Collin	Dallas	Denton	Ellis	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
Collin	65.38%	10.25%	5.08%	0.28%	0.20%	0.97%	0.05%	7.63%	0.87%	0.00%
Dallas	19.09%	65.97%	10.19%	10.73%	1.32%	15.83%	0.98%	23.65%	7.69%	0.69%
Denton	11.45%	7.85%	75.56%	0.37%	0.17%	0.66%	0.94%	0.58%	3.30%	3.12%
Ellis	0.16%	1.79%	0.17%	79.39%	1.43%	0.74%	0.10%	0.00%	0.55%	0.21%
Hood	0.03%	0.06%	0.05%	0.10%	2.27%	0.00%	2.39%	0.00%	0.53%	0.37%
Hunt	0.76%	0.42%	0.13%	0.12%	0.00%	4.37%	0.03%	9.42%	0.03%	0.00%
Johnson	0.05%	0.32%	0.32%	3.46%	76.23%	0.00%	1.45%	0.16%	3.21%	0.69%
Kaufman	0.29%	1.57%	0.14%	0.74%	0.02%	72.64%	0.00%	3.59%	0.11%	0.02%
Parker	0.02%	0.14%	0.09%	0.06%	0.52%	0.02%	77.41%	0.00%	2.57%	5.86%
Rockwall	0.68%	1.23%	0.14%	0.12%	0.06%	3.70%	0.00%	53.95%	0.06%	0.13%
Tarrant	2.02%	10.29%	7.36%	4.63%	17.47%	1.06%	14.11%	1.02%	80.26%	10.75%
Wise	0.07%	0.11%	0.76%	0.01%	0.31%	0.02%	2.55%	0.00%	0.82%	78.15%

Source: American Community Survey for the five-year period between 2006 and 2010.

7.3 Adjustments to Emission Factors

Adjustments are applied to emission factors as a post-process step. The Low Emission Diesel (LED) NO_x Adjustment is applied to the emission factors. VMT mix is applied simultaneously with the emission calculation.

7.3.1 Low Emission Diesel NO_x Adjustment

NO_x emission factors for diesel vehicle classes are adjusted by adjustment factors developed by NCTCOG using the spreadsheet TCEQ provided, to apply the Texas Low Emission Diesel (TxLED) Program. Exhibit 7.3.1-1 lists the appropriate adjustment for each vehicle class.

Exhibit 7.3.1-1: TxLED NO_x Adjustments

Vehicle Classification	2018	2020	2028	2037	2045
Passenger Car	0.95008	0.95081	0.95163	0.95200	0.95200
Passenger Truck	0.94980	0.95014	0.95130	0.95200	0.95200
Light Commercial Truck	0.94693	0.94806	0.95021	0.95200	0.95200
Intercity Bus	0.94296	0.94387	0.94817	0.95200	0.95200
Transit Bus	0.94317	0.94407	0.94891	0.95200	0.95200
School Bus	0.94314	0.94393	0.94862	0.95200	0.95200
Refuse Truck	0.94628	0.94738	0.95154	0.95200	0.95200
Single Unit Short-Haul Truck	0.95120	0.95154	0.95198	0.95200	0.95200
Single Unit Long-Haul Truck	0.95131	0.95156	0.95196	0.95200	0.95200
Motor Home	0.94579	0.94675	0.95040	0.95200	0.95200
Combination Short-Haul Truck	0.94913	0.94985	0.95177	0.95200	0.95200
Combination Long-Haul Truck	0.94739	0.94821	0.95130	0.95200	0.95200

Source: Texas Commission on Environmental Quality and NCTCOG

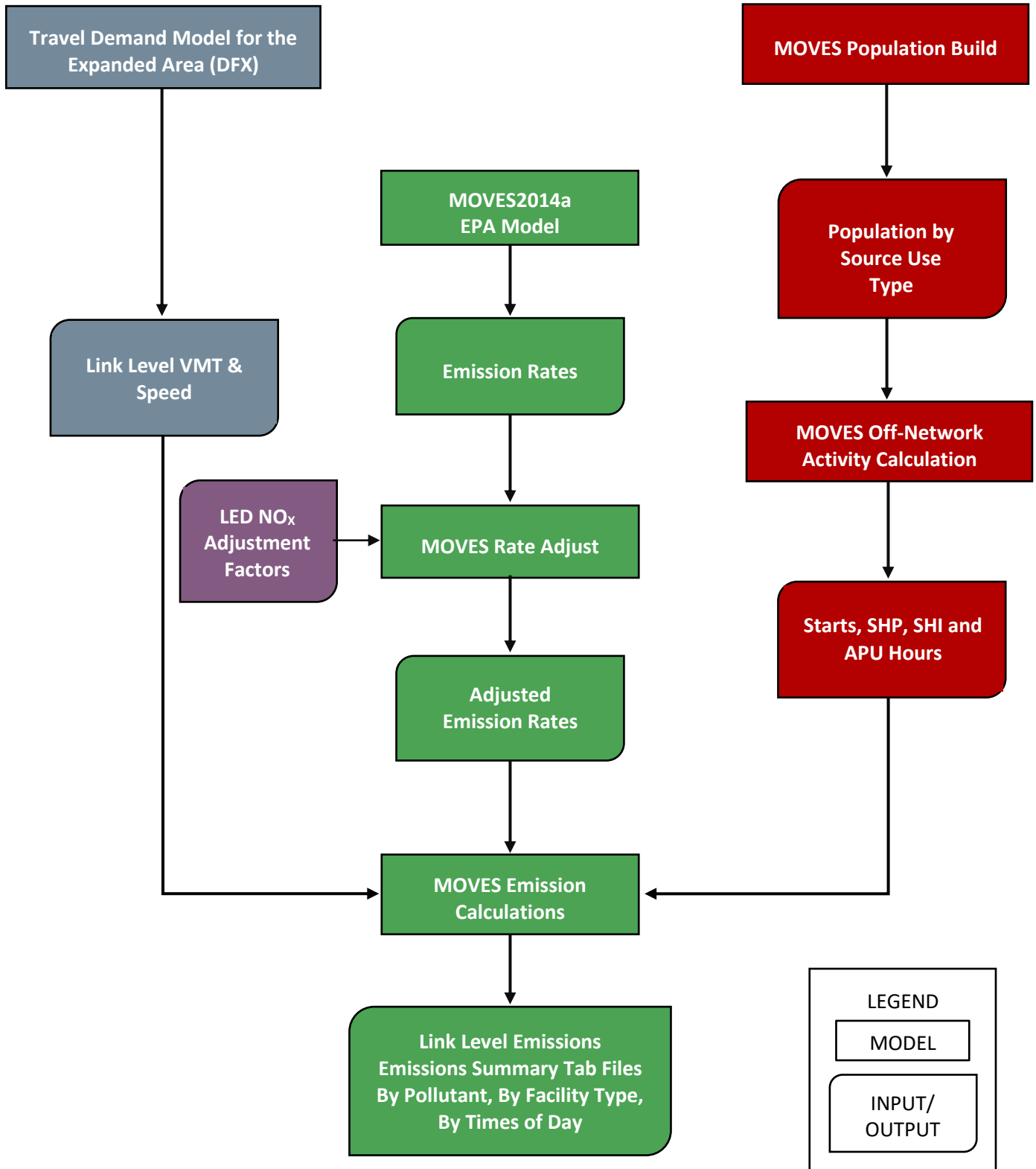
7.3.2 Vehicle Miles of Travel Mix (or Fractions)

VMT mix is applied to the emission factors in a post-process methodology using the EmisCalc software utility of the MOVESUTL developed by TTI. The VMT mix enables the assignment of emission factors by vehicle type to VMT in order to calculate emissions on a specified roadway facility or functional class. VMT mix is estimated for four MOVES roadway types, Rural Restricted (rural freeways), Rural Unrestricted (rural arterials and collectors), Urban Restricted (urban freeways) and Urban Unrestricted (urban arterials and collectors) for daily time periods for each of the modeling counties. Each county's roadway sections are classified as rural or urban by the vehicle activity behavior and the demographics of the counties. The VMT mix methodology utilizes data, assumptions, and procedures from the Texas Department of Transportation, TTI, and the Dallas-Fort Worth Travel Model for the Expanded Area model. Once all adjustments are accounted for, final emission factors can be developed. Appendix 12.16 includes MOVES2014a emission factors for all counties in the nonattainment area.

7.4 Modeled Emission Estimation

Modeled emission estimates are calculated using "TTI emission inventory estimation utilities using moves: movesutl", developed by TTI for MOVES. This utility combines vehicle activity and emissions factors to create emission estimates at the link level. Exhibit 7.4-1 outlines the emission calculation modeling process.

Exhibit 7.4-1: MOVES2014a Emission Modeling Process



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