Texas A&M Transportation Institute

Dallas-Fort Worth (DFW), Houston-Galveston-Brazoria (HGB), and Bexar County 2015-Eight-Hour Ozone Nonattainment Area Reasonable Further Progress (RFP) On-Road Mobile Emissions Inventories

FINAL REPORT

Prepared for the Texas Commission on Environmental Quality (TCEQ)

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Texas A&M Transportation Institute

FINAL REPORT

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Abstract: The report focuses on developing on-road mobile emissions inventories for the Dallas-Fort Worth (DFW), Houston-Galveston-Brazoria (HGB), and Bexar County ozone nonattainment areas. The Texas A&M Transportation Institute (TTI) prepared this report for the Texas Commission on Environmental Quality (TCEQ) to support compliance with the 2015 eight-hour ozone standard. The inventories cover the Reasonable Further Progress (RFP) base year 2017, milestone year 2023, RFP milestone contingency year 2024, attainment year 2026, and attainment contingency year 2027. TTI

estimated summer weekday emissions of volatile organic compounds (VOC), nitrogen oxides (NOx), and other pollutants using the latest EPA MOVES (Motor Vehicle Emission Simulator) model and Texas data for vehicle miles traveled (VMT), speeds, and vehicle population to calculate on-road and off-network activity-related emissions. The report outlines the control strategies implemented, including pre-1990 fuel controls, post-1990 fuel standards, inspection and maintenance (I/M) programs, and Texas Low Emission Diesel (TxLED) with projections of emissions reductions through these measures.

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AADT	Annual Average Daily Traffic
AERR	Air Emissions Reporting Requirements
APU	Auxiliary Power Unit
ATR	Automatic Traffic Recorder
AVFT	Alternate Vehicle Fuel and Technology
BD	Biodiesel
BPR	Bureau of Public Roads
CAA	Clean Air Act
CDB	County Database
CFR	Code of Federal Regulations
CG	Conventional Gasoline
CNG	Compressed Natural Has
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COG	Council of Governments
DFW	Dallas-Fort Worth
DOW	Day of Week
E85	Ethanol
EI	Emissions Inventory
EIA	Energy Information Administration
EIS	Emission Inventory System
EPA	Environmental Protection Agency
FFS	Free-flow Speed
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FT	Fuel Type
GAD	Grant Activity Description
g/mi	Grams per mile
HGAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HPMS	Highway Performance Monitoring System
I/M	Inspection and Maintenance
LOS	Level of Service
MOVES	Motor Vehicle Emission Simulator
MPO	Metropolitan Planning Organization
MRS	MOVES Run Specification
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standard
NCTCOG	North Central Texas Commission of Governments

NEI	National EI
NH_3	Ammonia
NIPER	National Institute for Petroleum and Energy Research
NOx	Oxides of Nitrogen
ONI	Off-Network Idling
PM	Particulate Matter
$PM_{2.5}$	PM under 2.5 Micron
PM_{10}	PM under 10 Micron
QAPP	Quality Assurance Project Plans
RFG	Reformulated Gasoline
RFP	Reasonable Further Progress
SAN	San Antonio
SHEI	Source hour Extended Idling
SHI	Source Hour Idling
SHO	Source Hour Operating
SHP	Source Hour Parked
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SRF	Speed Reduction Factor
SUT	Source Use Type
TAZ	Transportation Analysis Zone
TCEQ	Texas Commission on Environmental Quality
TDM	Travel Demand Model
TEC	Total Energy Consumption
TOD	Time-of-Day
TTI	Texas A&M Transportation Institute
TxAER	Texas Air Emissions Repository
TxDOT	Texas Department of Transportation
TxDMV	Texas Department of Motor Vehicles
TxLED	Texas Low Emissions Diesel
ULSD	Ultra-Low Sulfur Diesel
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compounds
V/C	Volume-to-Capacity
XML	Extensible Markup Language

EXECUTIVE SUMMARY

The Texas Commission on Environmental Quality (TCEQ) sponsored work by the Texas A&M Transportation Institute (TTI) to develop and produce on-road emissions inventory (EI) data needed in support of the TCEQ's Dallas-Fort Worth (DFW), Houston-Galveston-Brazoria (HGB), and Bexar County 2015-eight-hour ozone nonattainment area reasonable further progress (RFP) state implementation plan (SIP) revision. The Clean Air Act (CAA) requires states to submit RFP plans that demonstrate progress in reducing emissions for areas that are not attaining the NAAQS within their jurisdictions. This work by TTI produced ozone season, summer weekday on-road mobile source RFP scenario emissions inventories, and individual control strategy reduction estimates needed for the DFW 9-county (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise Counties), HGB 6-county (Brazoria, Chambers, Fort Bend, Galveston, Harris, and Montgomery Counties), and Bexar County nonattainment area.

The RFP analysis requires five years - base, milestone, milestone contingency, attainment, and attainment contingency years (i.e., 2017, 2023, 2024, 2026, and 2027, respectively) - and includes the seventeen RFP inventory scenarios, as shown in Table 1.

Table 1. RFP Inventory Scenarios.

No.	RFP Inventory	Activity Input	Emissions Rates Input
1	2017 Base Year	2017 (Base Year)	Base Year
2	2023 Pre-1990 Control	2023 (Milestone Year)	Pre-1990 Controls Except Federal Motor Vehicle Control Program (FMVCP) (CS1)
3	2023 Partial Control Strategy		CS1+ current fuels (CS2)
4	2023 Partial Control Strategy		CS2 + I/M (CS3)
5	2023 Full Control Strategy		CS3 + Texas Low Emissions Diesel (TxLED) (CSC)
6	2024 Pre-1990 Control	2024 (Milestone Contingency Year)	CS1
7	2024 Partial Control Strategy		CS2
8	2024 Partial Control Strategy		CS3
9	2024 Full Control Strategy		CSC
10	2026 Pre-1990 Control	2026 (Attainment Year)	CS1
11	2026 Partial Control Strategy		CS2
12	2026 Partial Control Strategy		CS3
13	2026 Full Control Strategy		CSC
14	2027 Pre-1990 Control	2027	CS1
15	2027 Partial Control Strategy		CS2

No.	RFP Inventory	Activity Input	Emissions Rates Input
16	2027 Partial Control Strategy	(Attainment Contingency Year)	CS3
17	2027 Full Control Strategy		CSC

TTI produced inventory estimates of six gaseous pollutants - volatile organic compounds (VOC), carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), ammonia (NH_3), and carbon dioxide (CO_2) - and of particulate matter (PM) pollutants in both 2.5 and 10-micron size categories ($PM_{2.5}$ and PM_{10}). Individual control strategy reduction estimates of VOC and NO_X were also required.

A new methodology was used for incrementally modeling control programs, as needed for estimating the individual control strategy reductions. This new modeling method replaced the "Pre-1990 controls only" scenario with the "Pre-1990 controls except for full FMVCP" scenario due to limitations in the Motor Vehicle Emission Simulator version 4 (MOVES4) model[1]. Subsequent incremented control strategy scenarios focus on the impacts of post-1990 (current) gasoline and diesel fuel properties and the vehicle inspection and maintenance (I/M) program. With the growing significance of EVs in the on-road fleet, in addition to the predominant gasoline and diesel vehicles, electricity-powered vehicles are now explicitly included in the modeling of vehicle populations with their associated activity, which is new in Texas on-road emissions inventories for SIPs.

TTI used the latest, official version of the U.S. Environmental Protection Agency's (EPA) MOVES4 model, as required for SIP analyses, in combination with TTI's SIP-quality inventory development methodology for use with MOVES.[2] This is the detailed, disaggregate, travel demand model (TDM) link-based rates-per-activity inventory process. It produces MOVES-based emissions rate look-up tables for external emissions calculations performed at detailed, disaggregate, temporal, and spatial levels, using the latest (readily) available data, models, and procedures. The latest planning assumptions were used to assure that motor vehicle emissions budgets to be established by TCEQ in the SIP will be consistent with transportation conformity analysis requirements.

Hourly inventories were estimated by the MOVES source use type (SUT) and fuel type (FT) combinations (or vehicle type – see Table 2) and TDM roadway class. TDMs were post-processed to estimate hourly, directional, link (roadway segment)-level fleetwide

[1] Although TTI previously developed and used a method to approximate the post-1990 FMVCP effects, in lieu of the no-longer-available MOVES pre-1990 FMVCP feature, this prior approximation method is not recommended.
[2] EPA's latest January 2024 MOVES4.0.1 release was used in this analysis.

vehicle miles of travel (VMT) and operational speeds for use in combination with time-of-day VMT mix estimates (fractional VMT by vehicle type) for the roadway-based emissions calculations. Using estimates of vehicle operating hours, vehicle populations, truck hotelling activity, and other data, TTI estimated hourly off-network activity factors for the parked or idling (not on roads) vehicle-based emissions calculations. Off-network activity type factors are: off-network idling (ONI) hours: source-hours-parked (SHP); starts; and source hours extended idling (SHEI) and auxiliary power unit (APU) hours (emissions-producing components of combination long-haul truck hotelling hours). Particular off-network evaporative rates, in mass/SHP form, not directly available from MOVES, were produced by a post-processing method and compiled with other rates produced directly by MOVES to yield look-up tables of all rates in the appropriate activity terms, as needed in the external emissions calculations. The analysis used TTI's MOVES-based inventory development utilities recently updated for use with MOVES4.[3] EPA's *Technical Guidance*[4] is the primary technical reference for guidance.

Table 2 shows the vehicle SUT and FT combinations that are included in this work. Gasoline, diesel, and electricity were the predominant FTs that were estimated, with other alternative fuels, such as compressed natural gas (CNG) and ethanol (E85), treated as *de minimis*.

Table 2. MOVES SUT/FT (Vehicle Types)

SUT ID	SUT Description	SUT/FT Abbreviation
11	Motorcycle	MC_Gas
21	Passenger Car	PC_Gas, PC_Diesel, PC_Electricity
31	Passenger Truck	PT_Gas, PT_Diesel, PT_Electricity
32	Light Commercial Truck	LCT_Gas, LCT_Diesel, LCT_Electricity
41	Other Buses	OBus_Gas, OBus_Diesel, OBus_Electricity
42	Transit Bus	TBus_Gas, TBus_Diesel, TBus_Electricity
43	School Bus	SBus_Gas, SBus_Diesel, SBus_Electricity
51	Refuse Truck	RT_Gas, RT_Diesel, RT_Electricity
52	Single Unit Short-Haul Truck	SUShT_Gas, SUShT_Diesel, SUSht_Electricity

[3] TTI's MOVES2014a-compatible inventory estimation utilities are detailed in: *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide,* TTI, August 2016. Note that the TTI utilities have been updated for use with MOVES4, however, the main inventory process and procedures are consistent with TTI's MOVES2014a-based utilities, and its user guide is provided for reference until the TTI's MOVES4 utilities document is available. The MOVES4 utilities emission estimation process is similar to the MOVES2014a-based utilities.

[4] *MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, August 2023.

SUT ID	SUT Description	SUT/FT Abbreviation
53	Single Unit Long-Haul Truck	SULhT_Gas, SULhT_Diesel, SULhT_Electricity
54	Motor Home	MH_Gas, MH_Diesel, MH_Electricity
61	Combination Short-Haul Truck	CShT_Gas, CShT_Diesel, CShT_Electricity
62	Combination Long-Haul Truck	CLhT_Diesel, CLhT_Electricity

Table 3 through Table 12 summarize the inventory estimates and individual control strategy reduction estimates for the DFW 9-county, HGB 6-county, and Bexar County nonattainment areas, respectively. More detailed discussions are provided in the report on methodologies, the various model or inventory inputs and their development.

Table 3. DFW 8-County Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_X	SO_2	NH_3	CO_2	$PM_{2.5}$	PM_{10}
Base Year[1]	2017	187,053,987	38.01	51.49	898.21	132.81	1.15	13.21	109,268.43	5.13	14.74
CS1[2]	2023	249,154,132	34.62	58.46	1,990.02	127.59	74.33	13.45	130,424.28	30.23	46.88
	2024	254,259,402	33.79	56.50	1,951.42	119.84	74.74	13.36	131,490.87	27.19	44.35
	2026	267,544,974	33.76	51.40	1,854.80	106.89	75.42	13.15	133,126.91	23.53	41.09
	2027	271,676,989	32.32	50.40	1,829.56	101.66	76.33	13.30	135,383.22	22.71	41.48
CS2[3]	2023	249,154,132	34.62	49.98	1,037.20	104.27	0.75	13.45	131,501.27	4.21	18.58
	2024	254,259,402	33.79	47.78	1,006.39	97.28	0.59	13.36	132,578.35	4.11	19.27
	2026	267,544,974	33.76	44.26	954.91	88.61	0.60	13.15	134,230.01	3.93	19.78
	2027	271,676,989	32.32	43.72	942.60	85.02	0.61	13.30	136,508.52	4.01	21.15
CS3[4]	2023	249,154,132	34.62	44.39	888.44	101.54	0.75	13.45	131,501.27	4.21	18.58
	2024	254,259,402	33.79	42.29	861.29	95.04	0.59	13.36	132,578.35	4.11	19.27
	2026	267,544,974	33.76	38.69	813.91	86.77	0.60	13.15	134,230.01	3.93	19.78
	2027	271,676,989	32.32	38.09	803.27	83.33	0.61	13.30	136,508.53	4.01	21.15
CSC[5]	2023	249,154,132	34.62	44.39	888.44	101.39	0.75	13.45	131,501.27	4.21	18.58
	2024	254,259,402	33.79	42.29	861.29	94.93	0.59	13.36	132,578.35	4.11	19.27
	2026	267,544,974	33.76	38.69	813.91	86.71	0.60	13.15	134,230.01	3.93	19.78
	2027	271,676,989	32.32	38.09	803.27	83.28	0.61	13.30	136,508.53	4.01	21.15

[1] Base year inventory: 2017 activity inputs and 2017 control strategy emissions rates.
[2] CS1 Pre-1990 Controls Except for Full FMVCP: All pre-1990 controls except FMVCP is current as of each year. (i.e., pre-1990 gasoline and diesel)
[3] CS2 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., Full FMVCP, Tier 3 gasoline and diesel).
[4] CS3 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., Full FMVCP, Tier 3 gasoline, and I/M).
[5] CSC Full control strategy: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., post-1990 FMVCP, Tier 3 gasoline, I/M programs, and TxLED). For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column.

Table 4. DFW Wise County Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_X	SO_2	NH_3	CO_2	$PM_{2.5}$	PM_{10}
Base Year[1]	2017	2,731,814	47.59	0.89	16.01	2.71	0.02	0.19	1,591.71	0.08	0.18
CS1[2]	2023	4,116,989	43.41	0.96	31.71	2.72	1.41	0.22	2,173.18	0.64	0.86
	2024	4,200,962	43.19	0.91	30.84	2.51	1.41	0.21	2,175.58	0.55	0.77
	2026	4,325,219	42.50	0.80	28.85	2.19	1.41	0.21	2,168.26	0.46	0.68
	2027	4,427,303	42.22	0.78	28.29	2.04	1.41	0.21	2,183.44	0.43	0.65
CS2[3]	2023	4,116,989	43.41	0.83	17.95	2.34	0.02	0.22	2,189.39	0.07	0.24
	2024	4,200,962	43.19	0.77	16.10	2.10	0.01	0.21	2,191.80	0.06	0.24
	2026	4,325,219	42.50	0.69	15.00	1.87	0.01	0.21	2,184.43	0.06	0.25
	2027	4,427,303	42.22	0.68	14.70	1.75	0.01	0.21	2,199.75	0.06	0.25
CSC[5]	2023	4,116,989	43.41	0.83	17.95	2.34	0.02	0.22	2,189.39	0.07	0.24
	2024	4,200,962	43.19	0.77	16.10	2.10	0.01	0.21	2,191.80	0.06	0.24
	2026	4,325,219	42.50	0.69	15.00	1.87	0.01	0.21	2,184.43	0.06	0.25
	2027	4,427,303	42.22	0.68	14.70	1.75	0.01	0.21	2,199.75	0.06	0.25

[1] Base year inventory: 2017 activity inputs and 2017 control strategy emissions rates.

[2] CS1 Pre-1990 Controls Except for Full FMVCP: All pre-1990 controls except FMVCP is current as of each year. (i.e., pre-1990 gasoline and diesel)

[3] CS2 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., Full FMVCP, Tier 3 gasoline and diesel).

[5] CSC Full control strategy: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., post-1990 FMVCP, Tier 3 gasoline, I/M programs, and TxLED). For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column.

Table 5. DFW 8-County Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC					NO_X				
		2017	2023	2024	2026	2027	2017	2023	2024	2026	2027
Inventory	Pre-90 Control Except for Full FMVCP	-	58.46	56.50	51.40	50.40	-	127.59	119.84	106.89	101.66
	Control Strategy	51.49	44.39	42.29	38.69	38.09	132.81	101.39	94.93	86.71	83.28
Reductions	Total	-	14.07	14.21	12.71	12.31	-	26.20	24.91	20.18	18.39
	Tier 3 Fuels and ULSD	-	8.48	8.72	7.14	6.68	-	23.32	22.56	18.28	16.64
	I/M	-	5.59	5.49	5.57	5.63	-	2.73	2.24	1.83	1.69
	TxLED	-	0.00	0.00	0.00	0.00	-	0.14	0.11	0.07	0.05

Note: Reductions are step by step from CS1 to CSC. Columns may not total due to rounding.

Table 6. DFW Wise County Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC					NO_X				
		2017	2023	2024	2026	2027	2017	2023	2024	2026	2027
Inventory	Pre-90 Control Except for Full FMVCP	-	0.96	0.91	0.80	0.78	-	2.72	2.51	2.19	2.04
	Control Strategy	0.89	0.83	0.77	0.69	0.68	2.71	2.34	2.10	1.87	1.75
Reductions	Total	-	0.13	0.14	0.11	0.10	-	0.38	0.42	0.32	0.29
	Tier 3 Fuels and ULSD	-	0.13	0.14	0.11	0.10	-	0.38	0.41	0.32	0.29
	TxLED	-	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00

Note: Reductions are step by step from CS1 to CSC. Columns may not total due to rounding.

Table 7. HGB 5-County Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_X	SO_2	NH_3	CO_2	$PM_{2.5}$	PM_{10}
Base Year[1]	2017	162,845,613	41.55	44.41	769.85	114.80	0.97	11.01	93,507.70	4.48	11.92
CS1[2]	2023	185,251,036	41.12	42.08	1,411.29	90.53	53.83	9.27	92,647.02	22.78	32.91
	2024	188,410,967	41.00	40.24	1,363.72	83.75	53.73	9.09	92,312.84	20.32	30.41
	2026	194,916,277	40.99	36.18	1,269.45	73.30	53.51	8.79	91,905.66	17.30	27.41
	2027	199,265,426	40.81	35.25	1,237.24	68.74	53.71	8.78	92,358.41	16.25	26.53
CS2[3]	2023	185,251,036	41.12	36.10	732.51	73.80	0.53	9.27	93,401.75	2.79	11.17
	2024	188,410,967	41.00	34.22	706.16	67.89	0.41	9.09	93,063.75	2.66	11.21
	2026	194,916,277	40.99	31.22	656.53	60.63	0.41	8.79	92,652.73	2.48	11.29
	2027	199,265,426	40.81	30.64	640.16	57.16	0.41	8.78	93,109.60	2.42	11.49
CS3[4]	2023	185,251,036	41.12	31.97	627.35	71.81	0.53	9.27	93,401.75	2.79	11.17
	2024	188,410,967	41.00	30.18	604.34	66.24	0.41	9.09	93,063.75	2.66	11.21
	2026	194,916,277	40.99	27.20	559.90	59.31	0.41	8.79	92,652.73	2.48	11.29
	2027	199,265,426	40.81	26.58	545.90	55.94	0.41	8.78	93,109.60	2.42	11.49
CSC[5]	2023	185,251,036	41.12	31.97	627.35	71.69	0.53	9.27	93,401.75	2.79	11.17
	2024	188,410,967	41.00	30.18	604.34	66.16	0.41	9.09	93,063.75	2.66	11.21
	2026	194,916,277	40.99	27.20	559.90	59.26	0.41	8.79	92,652.73	2.48	11.29
	2027	199,265,426	40.81	26.58	545.90	55.90	0.41	8.78	93,109.60	2.42	11.49

[1] Base year inventory: 2017 activity inputs and 2017 control strategy emissions rates.
[2] CS1 Pre-1990 Controls Except for Full FMVCP: All pre-1990 controls except FMVCP are current as of each year. (i.e., pre-1990 gasoline and diesel)
[3] CS2 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline).
[4] CS3 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, and I/M). For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column.
[5] CSC Full control strategy: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, I/M programs, and TxLED).

Table 8. HGB Chambers County Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_X	SO_2	NH_3	CO_2	$PM_{2.5}$	PM_{10}
Base Year[1]	2017	2,909,668	56.93	0.51	11.91	2.83	0.02	0.17	1,791.91	0.09	0.17
CS1[2]	2023	3,347,382	56.52	0.40	17.88	1.90	1.40	0.15	1,818.96	0.54	0.66
	2024	3,392,744	56.51	0.38	17.13	1.72	1.39	0.15	1,806.83	0.47	0.58
	2026	3,485,303	56.57	0.33	15.63	1.45	1.38	0.15	1,788.84	0.38	0.49
	2027	3,538,328	56.56	0.31	15.01	1.32	1.37	0.15	1,782.72	0.35	0.46
CS2[3]	2023	3,347,382	56.52	0.33	9.63	1.69	0.01	0.15	1,830.34	0.05	0.13
	2024	3,392,744	56.51	0.31	9.21	1.52	0.01	0.15	1,818.09	0.04	0.12
	2026	3,485,303	56.57	0.27	8.41	1.30	0.01	0.15	1,799.97	0.04	0.12
	2027	3,538,328	56.56	0.26	8.09	1.19	0.01	0.15	1,793.83	0.03	0.12
CSC[5]	2023	3,347,382	56.52	0.33	9.63	1.69	0.01	0.15	1,830.34	0.05	0.13
	2024	3,392,744	56.51	0.31	9.21	1.52	0.01	0.15	1,818.09	0.04	0.12
	2026	3,485,303	56.57	0.27	8.41	1.29	0.01	0.15	1,799.97	0.04	0.12
	2027	3,538,328	56.56	0.26	8.09	1.19	0.01	0.15	1,793.83	0.03	0.12

[1] Base year inventory: 2017 activity inputs and 2017 control strategy emissions rates.

[2] CS1 Pre-1990 Controls Except for Full FMVCP: All pre-1990 controls except FMVCP are current as of each year. (i.e., pre-1990 gasoline and diesel)

[3] CS2 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline).

[4] CS3 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, and I/M). For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column.

[5] CSC Full control strategy: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, I/M programs, and TxLED).

Table 9. HGB 5-County Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC					NO_X				
		2017	2023	2024	2026	2027	2017	2023	2024	2026	2027
Inventory	Pre-90 Control Except for Full FMVCP	-	42.08	40.24	36.18	35.25	-	90.53	83.75	73.30	68.74
	Control Strategy	44.41	31.97	30.18	27.20	26.58	114.80	71.69	66.16	59.26	55.90
Reductions	Total	-	10.11	10.05	8.98	8.67	-	18.84	17.60	14.04	12.84
	Tier 3 Fuels and ULSD	-	5.97	6.02	4.96	4.61	-	16.73	15.87	12.66	11.57
	I/M	-	4.14	4.03	4.02	4.05	-	1.98	1.64	1.33	1.23
	TxLED	-	0.00	0.00	0.00	0.00	-	0.12	0.09	0.05	0.04

Note: Reductions are step by step from CS1 to CSC. Columns may not total due to rounding.

Table 10. HGB Chambers County Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC					NO_X				
		2017	2023	2024	2026	2027	2017	2023	2024	2026	2027
Inventory	Pre-90 Control Except for Full FMVCP	-	0.40	0.38	0.33	0.31	-	1.90	1.72	1.45	1.32
	Control Strategy	0.51	0.33	0.31	0.27	0.26	2.83	1.69	1.52	1.29	1.19
Reductions	Total	-	0.07	0.07	0.06	0.05	-	0.21	0.20	0.16	0.13
	Tier 3 Fuels and ULSD	-	0.07	0.07	0.06	0.05	-	0.21	0.20	0.15	0.13
	TxLED	-	0.00	0.00	0.00	0.00	-	0.00	0.00	0.01	0.00

Note: Reductions are step by step from CS1 to CSC. Columns may not total due to rounding.

Table 11. Bexar County Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_X	SO_2	NH_3	CO_2	$PM_{2.5}$	PM_{10}
Base Year[1]	2017	47,288,348	29.10	17.80	330.79	38.47	0.35	3.70	30,073.86	1.55	5.03
CS1[2]	2023	53,914,308	25.94	15.36	521.35	31.20	16.37	3.30	31,492.39	6.96	11.92
	2024	54,354,204	25.94	14.51	498.93	28.92	16.18	3.20	31,075.23	6.19	11.12
	2026	55,843,828	26.13	12.66	459.48	25.24	15.88	3.05	30,574.00	5.31	10.22
	2027	56,898,249	25.95	12.27	447.17	23.59	15.93	3.04	30,725.53	5.05	10.05
CS2[3]	2023	53,914,308	25.94	13.20	289.24	26.24	0.25	3.30	31,768.39	1.19	5.65
	2024	54,354,204	25.94	12.19	276.42	23.85	0.14	3.20	31,347.17	1.14	5.63
	2026	55,843,828	26.13	10.85	254.29	21.32	0.14	3.05	30,841.85	1.08	5.61
	2027	56,898,249	25.95	10.62	247.61	20.04	0.14	3.04	30,994.95	1.06	5.72
CS3[4]	2027	56,898,249	25.95	9.28	210.41	19.62	0.14	3.04	30,994.95	1.06	5.72
CSC[5]	2023	53,914,308	25.94	13.20	289.24	26.21	0.25	3.30	31,768.39	1.19	5.65
	2024	54,354,204	25.94	12.19	276.42	23.83	0.14	3.20	31,347.17	1.14	5.63
	2026	55,843,828	26.13	10.85	254.29	21.31	0.14	3.05	30,841.85	1.08	5.61
	2027	56,898,249	25.95	9.28	210.41	19.61	0.14	3.04	30,994.95	1.06	5.72

[1] Base year inventory: 2017 activity inputs and 2017 control strategy emissions rates.

[2] CS1 Pre-1990 Controls Except for Full FMVCP: All pre-1990 controls except FMVCP are current as of each year. (i.e., pre-1990 gasoline and diesel)

[3] CS2 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline).

[4] CS3 Incremental control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, and I/M). For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column. The vehicle I/M program is to be implemented in Bexar County by November 7, 2026, the first ozone season after implementation is likely to occur in the next year. The first year to model the I/M program in Bexar County is recommended as 2027.

[5] CSC Full control strategy: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., full FMVCP, Tier 3 gasoline, I/M programs, and TxLED).

Table 12. Bexar County Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC					NO_X				
		2017	2023	2024	2026	2027	2017	2023	2024	2026	2027
Inventory	Pre-90 Control Except for Full FMVCP	-	15.36	14.51	12.66	12.27	-	31.20	28.92	25.24	23.59
	Control Strategy	17.80	13.20	12.19	10.85	9.28	38.47	26.21	23.83	21.31	19.61
Reductions	Total	-	2.16	2.32	1.81	3.00	-	4.99	5.09	3.94	3.98
	Tier 3 Fuels and ULSD	-	2.16	2.32	1.81	1.65	-	4.96	5.07	3.92	3.54
	I/M	-	0.00	0.00	0.00	1.34	-	0.00	0.00	0.00	0.42
	TxLED	-	0.00	0.00	0.00	0.00	-	0.03	0.02	0.01	0.01

Note: Reductions are step by step from CS1 to CSC. Columns may not total due to rounding.

1 INTRODUCTION

The TCEQ works with local planning districts, the Texas Department of Transportation (TxDOT), and the TTI to provide on-road mobile source emissions inventories of air pollutants. The TxDOT typically funds transportation conformity determinations required under 40 Code of Federal Regulations (CFR) Part 93. The TCEQ funds mobile source EI work in support of Federal CAA requirements, such as supporting the attainment of the National Ambient Air Quality Standard (NAAQS) and the study and control of hazardous air pollutants, including those from motor vehicles and/or motor vehicle fuels (as mandated under FCAA sections 202 and 211).

The TCEQ is planning to update the SIP, which will require an RFP analysis from the base year to an attainment year, as determined in the final implementation rule, to demonstrate continued progress toward the attainment of EPA's 2015 eight-hour ozone standard. RFP emissions inventories must be developed for the DFW 9-county, the HGB 6-county, and the Bexar County nonattainment area. These RFP emissions inventories were developed using the latest MOVES model and the latest planning assumptions to assure that motor vehicle emissions budgets to be set by the SIP revision will be consistent with transportation conformity emissions analysis requirements.

1.1 PURPOSE AND OBJECTIVE

The purpose of this work was to develop on-road mobile emissions inventories necessary to support the DFW 9-county, the HGB 6-county, and the Bexar County RFP SIP revision for the 2015 eight-hour ozone NAAQS. Specifically, TTI developed on-road mobile link-based emissions inventories for the DFW 9-county, HGB 6-county, and Bexar County ozone nonattainment areas for analysis years 2017, 2023, 2024, 2026, and 2027.

To complete the DFW 9-county, the HGB 6-county, and the Bexar County RFP SIP analysis, RFP emissions inventories were required for a base year (2017), a milestone year (2023), a milestone contingency year (2024), an attainment year (2026), and an attainment contingency year (2027), as well as individual control measure reduction estimates, and contingency measure control reduction estimates.

TTI accomplished this work in two main parts:

- Development of On-Road Mobile Source RFP Emissions Inventories for the DFW 9-county, the HGB 6-county, and the Bexar County Ozone Nonattainment Areas,

- Quantification of Individual On-Road Mobile Source RFP Control Reductions for the DFW 9-county, the HGB 6-county, and the Bexar County Ozone Nonattainment Area Emissions Inventories.

The requirements and objectives for each of these parts are outlined in Sections 1.1.2 and 1.1.3.

1.1.1 Report Organization

The remainder of this report is divided into the sections described below.

- Section 2.0 presents an overview of the county-level, TDM link-based emission inventory development process and describes its key components. A description of the additional emissions modeling for attainment and contingency years performed to estimate emissions reductions by individual control strategy is also included.
- Section 3.0 describes the procedure for estimating the DFW 9-county, HGB 6-county, and Bexar County on-road EI for both on-network and off-network activity.
- Section 4.0 provides an overview of the estimation of the emission rates process and provides descriptions of the preparation of the MOVES run specification files, the county input database files, modeling run procedures, and post-run processing activities.
- Section 5.0 describes the on-network and off-network emissions calculations and the information and format of the emission output files.
- Section 6.0 completes the narrative with a discussion of quality assurance and quality control.
- The list of references is followed by the set of appendices to complete the report.

TTI provided all pertinent data relating to project activities in specified electronic formats (i.e., supporting electronic document files) along with this report. TTI maintains a record of all electronic files developed or used in conjunction with the completion of this project.

1.1.2 Development of On-Road Mobile Source RFP Emissions Inventories for the Three Ozone Nonattainment Areas

For this part of the work, TTI developed link-based on-road mobile emissions estimates for the DFW 9-county, HGB 6-county, and Bexar County ozone nonattainment areas for the 2017 RFP base year and the four RFP analysis years: 2023, 2024, 2025, and 2027. One base year inventory was required and up to five control scenario inventories were needed for each RFP analysis year, depending on the county.

The various post-1990 fuels programs and I/M programs, as they were modeled by analysis year and county, are outlined in Table 13. Note that beginning with the 2024 analysis year, the RFG coverage was expanded (by adding five DFW area counties) to include all 16 counties in the three areas except for Bexar County. All counties require I/M except for three until 2027, when I/M coverage is to be expanded to include Bexar County,[5] with Chambers and Wise as the only non-I/M counties in 2027.

Table 13. Gasoline Programs, Diesel Programs, and I/M Program Requirements by 2015 Ozone NAAQS Nonattainment County and Analysis Year

<table>
<tr><th>Analysis Year</th><th>Tier 3 TxLRVPG[1]</th><th>Tier 3 RFG[2]</th><th>I/M</th><th>TxLED/ULSD[3]</th></tr>
<tr><td>2017 (base year)</td><td rowspan="2">Bexar, Ellis, Johnson, Kaufman, Parker, Wise</td><td rowspan="2">Brazoria, Chambers, Collin, Dallas, Denton, Fort Bend, Galveston, Harris, Montgomery, Tarrant</td><td rowspan="4">All counties except Bexar, Chambers, Wise</td><td rowspan="5">All 16 counties</td></tr>
<tr><td>2023</td></tr>
<tr><td>2024</td><td rowspan="3">Bexar</td><td rowspan="3">All 16 counties, except Bexar</td></tr>
<tr><td>2026</td></tr>
<tr><td>2027</td><td>All counties except Chambers, Wise</td></tr>
</table>

[1] TxLRVPG: East Texas Regional Low Ried Vapor Pressure (RVP) Gasoline
[2] RFG: Reformulated Gasoline
[3] Ultra Low Sulfur Diesel

For the 2017 RFP base year, the following emissions inventories were required:

i. An RFP base year EI. The base year inventory is an actual historical year inventory for the analysis year,

[5] Since the vehicle I/M program is to be implemented in Bexar County by November 7, 2026, the first ozone season after implementation is likely to occur in the next year. It follows that for Bexar County ozone season EI modeling purposes, the first year to model the I/M program is 2027.

For the 2023 milestone year, the 2024 milestone contingency year, the 2026 attainment year, and the 2027 attainmet contingency yeat, the following emissions inventories were required:

i. An RFP EI with pre-1990 controls with current FMVCP EIs (i.e., pre-1990 fuels, no I/M program, but with full FMVCP),

ii. An RFP EI with post-1990 individual control strategies excluding I/M program and TxLED,

iii. An RFP EI with post-1990 control strategies, including I/M program but excluding TxLED (for non-I/M counties, this step was skipped)[6],

iv. An RFP EI with post-1990 individual control strategies including I/M program (if applicable) and TxLED.

The RFP inventories with activity and emissions rate components were previously listed in Table 1.

For the emissions inventories to be consistent with EPA EI development guidance[7], the TTI used the most recent activity information, based upon current travel demand modeling, and the most recent version of the EPA's on-road emissions model to complete this work. TTI produced the RFP EI using methods agreed upon in consultation with the TCEQ Project Manager, which was part of an earlier deliverable of this project (subtask 3.1, delivered April 14, 2024). TTI ensured the methods were consistent with the EPA's applicable RFP guidance[8] and that individual control reduction calculations were consistent with the capabilities of MOVES.

TTI also adhered to the following requirements using methods, data, and procedures as detailed in the later sections:

- Used the most recent version of the EPA's MOVES model (MOVES4.0.1), as specified by the TCEQ Project Manager, as the emissions factor model for developing emissions inventories for this work.

[6] For Bexar County, I/M program was modeled for the 2027 RFP attainment contingency year but skipped for all previous analysis years.
[7] More information on the EI development guidance can be found here: https://www.epa.gov/air-emissions-inventories/air-emissions-inventory-guidance-documents.
[8] More information is available here: https://www.epa.gov/ground-level-ozone-pollution/reasonable-further-progress-attainment-demonstration-and-related.

- The geographic scopes of the emissions inventories are the DFW 9-county nonattainment area, the HGB 6-county nonattainment area, and the Bexar County nonattainment area.
- The emissions inventories include the following criteria pollutants and ozone precursors: VOC, CO, NO_X, SO_2, NH_3, CO_2, $PM_{2.5}$, and PM_{10}.
- Used summer work weekday as the day type for the emissions inventories. Adjusted average annual daily activity levels to account for both seasonal differences for summer months (June, July, and August; months 6, 7, and 8, respectively) and for weekday (Monday through Friday).
- Used 2017 climate inputs. Used seasonal hourly temperature and relative humidity, 24-hour barometric pressure averages, and other data, as agreed upon and provided by the TCEQ.
- Used the most current vehicle miles traveled (VMT) mixes. The VMT mixes were consistent with the EPA MOVES source use types and three of the five MOVES FTs, gasoline, diesel, and electricity, with CNG and E85 assumed *de minimis*.
- Used county-level registration data as input for locality-specific age distributions. The latest available registration data (2018 and 2021 end-of-year; 2018 for 2017 base year and 2021 for all future year) were used for the historical year (as no actual registration data for the historical year was available), and for the future analysis years.
- A link-based, time-of-day emissions analysis methodology was used for all three nonattainment areas. TTI used travel demand model network link-based VMT for the DFW 9-county, the HGB 6-county, and the Bexar County nonattainment areas reflecting summer work weekday traffic activity.
- Used 2017 and most recently available data for the off-network activity development. Developed 2017 and future year off-network activity inputs based on the current Texas on-road EI development processes[9].
- Used MOVES individual fuel parameter inputs consistent with CFR Title 40 – Protection of the Environment, Part 80 – Regulation of Fuels and Fuel Additives, Section 27 – Controls and Prohibitions on Gasoline Volatility (40 CFR § 80.27), as appropriate for RFP control scenarios.

[9] For more information, refer to TTI's (2024) *Protocols for the Development of Emission Inventory Modeling Parameters and Calculation of Local Values for Texas* report (PGA: 582-23-43429-012).

- Used the TCEQ fuel property survey data, including Reid vapor pressure (RVP), to develop model inputs where appropriate. The TCEQ provided the 2017 Summer Fuel Field Study Final Report and associated electronic files, while the latest 2023 Summer Fuel Field Study was conducted by TTI. Use of EPA's 2017 (for base year 2017) and 2020 (for milestone year 2023 onwards) surveys for RFG.
- Modeled the effects of all the federal motor vehicle control programs as appropriate for RFP control scenarios.
- Modeled either federally regulated gasoline and diesel sulfur levels or latest available fuel survey data for RFP control scenarios.
- Used control program parameters, including RVP and other fuel settings, as well as the I/M and TxLED programs, based upon the emission inventory type as defined by the RFP analysis control scenarios.

TTI provided data products to TCEQ in one electronic data submittal, described in Appendix B.

1.1.3 Quantification of Individual On-Road Mobile Source RFP Control Reductions for the Three Ozone Nonattainment Area Emissions Inventories

To complete this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the 2023, 2024, 2026, and 2027 RFP analysis years, for the DFW 9-county, HGB 6-county, and Bexar County areas. TTI estimated total control strategy reductions and individual control reductions using a MOVES-based methodology submitted to and approved by the TCEQ Project Manager as part of subtask 3.1 of this project. TTI ensured the methods were consistent with the standard Texas on-road mobile source control strategy quantification methods and the EPA's RFP guidance[10]. Unlike previous RFP analyses, the post-1990 FMVCP individual control reductions were not estimated because MOVES4 is only capable of modeling full FVMCP effects for each year.

For the three nonattainment area RFP control reduction estimates to be consistent with their requirements for RFP EI analysis listed in the previous section, the methodology for estimating individual control reductions required the development of a set of full link-

[10] EPA (1995). Reasonable Further Progress, Attainment Demonstration, and related Requirements for Ozone Nonattainment Areas Meeting the Ozone National Ambient Air Quality Standards. Available at: https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19950510_seitz_rfp_attainment_demos.pdf.

based emissions inventories for up to five control scenarios for each RFP analysis year. These inventories were prepared in accordance with the guidelines outlined in Section 1.1.1, as further detailed in subsequent sections. Individual control reductions were determined by directly subtracting one inventory from another. For instance, subtracting the EI with current fuel properties from the inventory with pre-1990 gasoline and diesel properties results in the emission reductions attributed to post-1990 improvements in gasoline and diesel fuel. Full details are provided in later sections.

2 OVERVIEW OF METHODOLOGY

The detailed TDM link-based, rates-per-activity inventory methodology was used to produce MOVES-based, on-road vehicle, historical and future case inventories by county. The inventories are composed of emissions estimates based on vehicle activity on the roadway network and off of the roadway network. For the roadway-based component of the analysis, emission rates look-up tables (e.g., grams per mile [g/mi]) produced using MOVES were combined externally with each TDM network link (or roadway segment) VMT estimate to calculate the roadway-based inventories. The off-network activity factors were estimated for the off-network emission calculations using estimates of vehicle operating hours, vehicle type populations, combination long-haul truck hotelling, and other data. TTI developed and maintains a series of computer utilities/procedures used to calculate and summarize detailed on-road mobile source, emissions inventories in various formats, such as those used in this analysis. Appendix A (electronic only) describes these applications.

The emission inventory estimation process requires the development of the following major inventory components. All are inputs to the emissions calculation utility, except vehicle populations, which are an intermediate input needed for calculating estimates of particular off-network activity factors.

- On-road fleet link VMT and average speeds.
- VMT mix
- Vehicle population and off-network activity factors.
- MOVES-based emission rates
- Inventory calculations

2.1 ON-ROAD FLEET LINK-VMT AND SPEEDS

TTI used data sets extracted from the latest, time-of-day, directional, regional travel models, seasonal day-type adjustments, Highway Performance Monitoring System (HPMS) VMT-consistency adjustments, and hourly allocation factors to estimate the hourly, directional, link-VMT and associated average fleet speed inputs to the inventory calculations. The seasonal period, day type, and hourly distributions used were based on factors developed with TxDOT automatic traffic recorder (ATR) data from the project nonattainment area. The HPMS consistency factor was applied to total model link-level VMT for all county areas.

When the TDM analysis years are different from the inventory analysis years, intermediate year factors are developed using the bounding TDM data and applied to the nearest TDM analysis year network to estimate the inventory analysis year link VMT. Intermediate year factors were needed for this analysis. The hourly average operational fleet speeds are estimated corresponding to the link VMT estimates using the speed model (i.e., Bureau of Public Roads [BPR] link speed model for estimating operational speeds on links in Bexar County, the Houston Speed Model for estimating operational speeds on each link of the Houston/Galveston TDM, while the DFW speed for each link were provided in the North Central Texas Commission of Governments' [NCTCOG's] 2023 report) within the TDMs.

2.2 Vehicle Population and Off-Network Vehicle Activity Factor Estimates

The non-roadway-based onroad mobile source inventory estimates (e.g., from vehicle starts, parked vehicle evaporative processes, hotelling activity, off-network idling) were calculated as the product of the amount of the associated activity factor and the pollutant mass per unit of the activity factor. To estimate the ONI hours, SHP, and vehicle starts activity factors, vehicle population estimates were needed. Hours of ONI for each hour of the day were estimated from the source hours operating (SHO) and total source hours idling (SHI) that occurred on the network. Hotelling activity factor estimates (composed largely of the emissions-producing SHEI and diesel APU hours) were based on county-specific actual estimates.[11] Vehicle starts were based on MOVES rates runs used in developing the inventories and local vehicle population estimates.

2.2.1 Vehicle Type Populations

TTI based the vehicle population estimates on vehicle registration data, vehicle population factors, developed from the VMT mix, for re-categorizing registration aggregations, and, additionally, for future years, VMT growth estimates. For a historical year, the vehicle population estimates are based solely on mid-year TxDOT (or Texas Department of Motor Vehicles [TxDMV]) county registration data, if available for that year, 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, mid-year or end-year if mid-year is unavailable) registrations, grown to a future value (growth as a function of base and future VMT),

[11] 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 in 2017.

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.

2.2.2 ONI Hours

ONI is not related to combination truck hotelling activity in extended idling mode. ONI is an idling activity that occurs 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 off network [roadTypeID = 1] and avgspeedbinID =0) with the corresponding hours of ONI.

TTI estimates ONI hours of 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 idling while operating on roads versus not on roads).

2.2.3 SHP

The SHP was estimated as a function of total hours (hours a vehicle exists) minus its hours operating on roads (SHO) and minus its ONI hours. For a historical year, the vehicle type SHP estimates are based on VMT mix, link VMT and speeds, and 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 hour.

2.2.4 Starts

Engine starts were based on MOVES rates runs used in developing the inventories and local vehicle population estimates. The MOVES default starts per day per vehicle, starts hour fractions, and the average of June through August starts-month-adjust inputs to MOVES were used, in combination with local vehicle age distributions, to produce the MOVES "starts per vehicle" output for estimating vehicle starts. MOVES weekday starts per vehicle were used. The starts were calculated as the product of starts/vehicle/hour from MOVES, and the county vehicle type population estimates. This was performed by the hour.

2.2.5 SHEI and APU Hours

The SHEI and APU hours are the sole emissions producing activity factors derived from the four operating mode components of hotelling hours. SHEI and APU hours were estimated for each hour using the local hourly hotelling hours estimates, combination long-haul truck travel fractions by model year (calculated from local age distributions and moves default relative mileage accumulation rates), and MOVES default hotelling activity distributions for each model year (Table 28). The hotelling activity factors in total comprise the time (hours) spent in the four hotelling operating modes. In the latest MOVES vernacular these hotelling modes are:

- Extended idling (of main engine – applicable to SHEI) (opmodeID 200).
- Hotelling diesel auxilliary power unit (applicable to APU hours) (opmodeID 201).
- Hotelling shore power (plug-in) (opmodeID 203).
- Hotelling battery or all engines/accessories off (opmodeID 204).

2.3 VMT Mix

The VMT mix designates the vehicle types (as shown previously in Table 2) included in the analysis and specifies the fraction of on-road fleet VMT attributable to each vehicle type by time of day, by day type, and by MOVES road type.

TTI developed and improved the VMT mix procedure to produce the four-period, time-of-day estimates[12] of vehicle type VMT allocations by MOVES road type and by day type, for use with the DFW, HGB, and San Antonio (SAN) District. The main data sources used include recent, 2013 to 2022 TxDOT vehicle classification counts, year-end 2021 TxDOT/ TxDMV registration data, Freight Analysis Framework data, Vehicle Inventory and Use Survey data, and MOVES default data. For this study, two VMT mixes were utilized: 2015 and 2025. The former incorporated MOVES default EV information whereas the latter incorporated the latest available county-level EV information. The

[12] TTI (July 2024). Subtask 5.3 Maintain, Update and Enhance Traffic Activity Estimation and Forecasting Methods. TxDOT-TTI Interagency Contract 27476.

2015 VMT mix was used for 2017 base year whereas the 2025 VMT mix was used for all future years.

2.4 MOVES-Based Emissions Rates

TTI produced the emission rates look-up table inputs to the TTI's inventory calculation utility in three basic steps. The first step was to set up and execute the MOVES emissions rate mode runs. Next step was to perform the initial post-processing, which calculates rates in the form needed that are not directly available from MOVES, and combines all the needed rates in tables for the emissions calculations. The third step is to apply emission rate adjustments to an emission rate database table if necessary.

Local input parameters were developed and used to produce rates reflective of the local scenario conditions (e.g., weather, fleet characteristics, and fuel properties). MOVES county scale, rates mode modeling scenarios produced rates for the MOVES weekday day type by pollutant, process, speed (for roadway-based processes), hour, road type, and average SUT/FT consistent with the local VMT mix which defines the vehicle type sources, as shown in Table 2. The first post-processing step produced the mass-per-SHP off-network evaporative rates not available from MOVES. The next, rates adjustment post-processing step, depending on the county and control scenario, applied TxLED NOx adjustment factors to incorporate the impacts of TxLED fuel.

County-level, MOVES weekday hourly emissions factors were developed for four RFP control scenarios: 1) CS1 – is pre-1990 controls except full FMVCP, 2) CS2 – is the same as CS1 except updated with current fuel parameters as of each year, and 3) CS3 – is the same as CS2 except adding in the I/M program parameters current for each year, for I/M counties. Emission rates for these first three scenarios were produced running MOVES. CSC, the fourth and final control scenario, incorporated TxLED effects on diesel vehicle NOx emission rates, via the post-processing step – this is the full "current controls" scenario. Actual, local, activity estimates for the DFW 9-county, the HGB 6-county, and the Bexar County nonattainment areas were then externally combined with the associated emission rates in the inventory calculations process, as needed to produce the inventories for each particular RFP scenario as needed for the individual control measure emissions reductions estimation procedure.

2.5 Inventory Calculations

Summer weekday analysis year inventories for the 2017 RFP base year, each future year (2023, 2024, 2026, and 2027) RFP control scenario (pre-90 controls with full FMVCP and current controls), and each future year "incremental control" scenario were calculated for 9 counties in the DFW nonattainment area, 6 counties in the HGB nonattainment area, and Bexar County. The major inputs were:

- TxDOT district-level, weekday, time-of-day, VMT mix by MOVES road type;
- county, hourly on-road fleet link VMT and speed estimates for each analysis year summer weekday;
- county, hourly, off-network activity factor estimates by vehicle type for each activity scenario (i.e., 2017, 2023, 2024, 2026, and 2027 summer weekday) of ONI hours, SHP, starts, SHEI, and APU hours; and
- county-level look-up tables of hourly MOVES seasonal weekday rates by road type, speed bin, vehicle type (SUT/FT), and process.

For the VMT-based calculations, county-to-TxDOT district, TDM road type/area type-to-MOVES road type, and hour-of-day to time-of-day period designations were used to match the appropriate VMT mixes with the link VMT. The VMT mixes by MOVES road type were multiplied by the link fleet VMT to distribute each link's VMT to the different vehicle types. Emission rates for each link's average speed were interpolated (refer to the Utilities) from the appropriate set of look-up table rates and corresponding index speeds (i.e., the average bin speeds of 2.5, 5.0, 10.0, 15.0, … 75.0 mph) bounding the link's average speed. For link speeds below or above the minimum and maximum average bin speeds of 2.5 and 75 mph, the rates for those bounding speeds were used. The estimated vehicle type and MOVES road type link-speed-specific rates for each process were then multiplied by the associated VMT to produce the link-based emissions estimates. This process was performed for each hour, for each RFP inventory scenario and individual control measure inventory scenario

For the off-network calculations, which are county level, the vehicle type, county-level rates were multiplied by the associated county total activity factor estimate (starts, ONI hours, SHP, SHEI, APU hours), as determined by the pollutant process. This process was performed for each hour, for each RFP inventory scenario and individual control measure inventory scenario.

The on-road mobile inventory utilities produce tab-delimited summary output files and optionally a set of 24 link-emissions files for gridded emissions analyses (not included for this analysis). The standard on-road tab-delimited output file includes hourly and 24-hour activity and emissions results summarized by vehicle type and road type. The extensible markup language (XML) format output feature produces 24-hour activity and emissions data in a form (aggregated and coded) consistent with the EPA's latest 2020 National EI (NEI) inventory, as needed for uploading specified inventory data to TCEQ's Texas Air Emissions Repository (TexAER).

Appendix B contains more information on the output definitions and specifications, including the inventory data formatted for compatibility with TexAER.

2.6 Individual Control Strategy Emissions Reductions Estimation

The milestone, milestone contingency, attainment, and attainment contingency year EI sets (CS1, CS2, CS3, and CSC) developed as described in Sections 2.4 and 2.5 were used to calculate the individidual control strategy emissions reductions in general by subracting one inventory from another. This was performed for each nonattainment area relatively simply as follows.

The emissions inventories by control scenario for this RFP analysis are defined as:

- "CS1" = Pre-1990 control scenario with full FMVCP;
- "CS2" = CS1 + current state and federal fuels;
- "CS3" = CS2 +I/M programs; and
- "CSC" = CS3 + TxLED fuels (i.e., full control strategy scenario).

For each future year and nonattainment area, control strategy emissions reductions (total and by individual strategy) were estimated by subtracting the emissions of one inventory from another. This was done sequentially, as follows:

- CS1 – CSC = total post-1990 emissions reductions from current gasoline and diesel standards, I/M, TxLED;
- CS1 – CS2 = emissions reductions from current gasoline and diesel standards;
- CS3 – CS2 = emissions reductions from I/M programs; and
- CSC – CS3 = emissions reductions from the TxLED program.

3 ESTIMATION OF ACTIVITY AND VEHICLE MIX

To estimate on-road EI for the three nonattainment areas, both on-network and off-network activity are required. The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDMs. To estimate the off-network (or parked vehicle) emissions using the mass per activity factor emissions rates, county-level estimates of the ONI hours, SHP, starts, SHEI, and APU hours are required by hour and vehicle type for each activity scenario (SHEI and APU hours are for diesel combination long-haul trucks only). This section leads off with the VMT mix which specifies the vehicle types in the analysis, is needed in calculations of particular off-network activity factors, and in apportioning fleetwide VMT by vehicle type.

3.1 DEVELOPMENT OF VEHICLE TYPE VMT MIX

VMT mix is a major input to the MOVES link-based emissions estimation process. It is an estimate of the fraction of on-road fleet VMT attributable to each SUT by FT and is used to subdivide the total VMT estimates on each link into VMT by vehicle type. The VMT mix is also used to split vehicle population aggregations into the inventory vehicle types, which were needed in estimating some of the off-network activity factor inputs. The VMT estimates by vehicle type are combined with the appropriate emissions factors in the link-emissions calculations.

Since proportions of travel by vehicle type can significantly vary by TOD, affecting emissions totals, the TTI VMT mix procedure develops VMT mix by time period. Time period VMT mix (by MOVES roadway type and vehicle type) consists of four time periods: morning rush hour (AM peak), mid-day, evening rush hour (PM peak), and overnight.

TxDOT district-level, time period, and Weekday (average Monday through Friday) VMT mix (for gasoline-, diesel-, and electricity-powered vehicles) is estimated by the four MOVES road type categories using the methodology characterizing VMT by vehicle type for a region (or district).[13] To accommodate MOVES4 changes, the procedure has been updated to meet MOVES4 requirements. Figure 1 shows the simplified process flow chart of the SUT VMT mix procedure prior to subdivision of the estimated SUT proportions by FT.

[13] TTI (2024). *Fiscal Year (FY) 2024 MOVES4 Source Use Type and FT Vehicle Miles Traveled (VMT) Distribution Update for Conformity Analysis. TxDOT-TTI Interagency Contract 27476.*

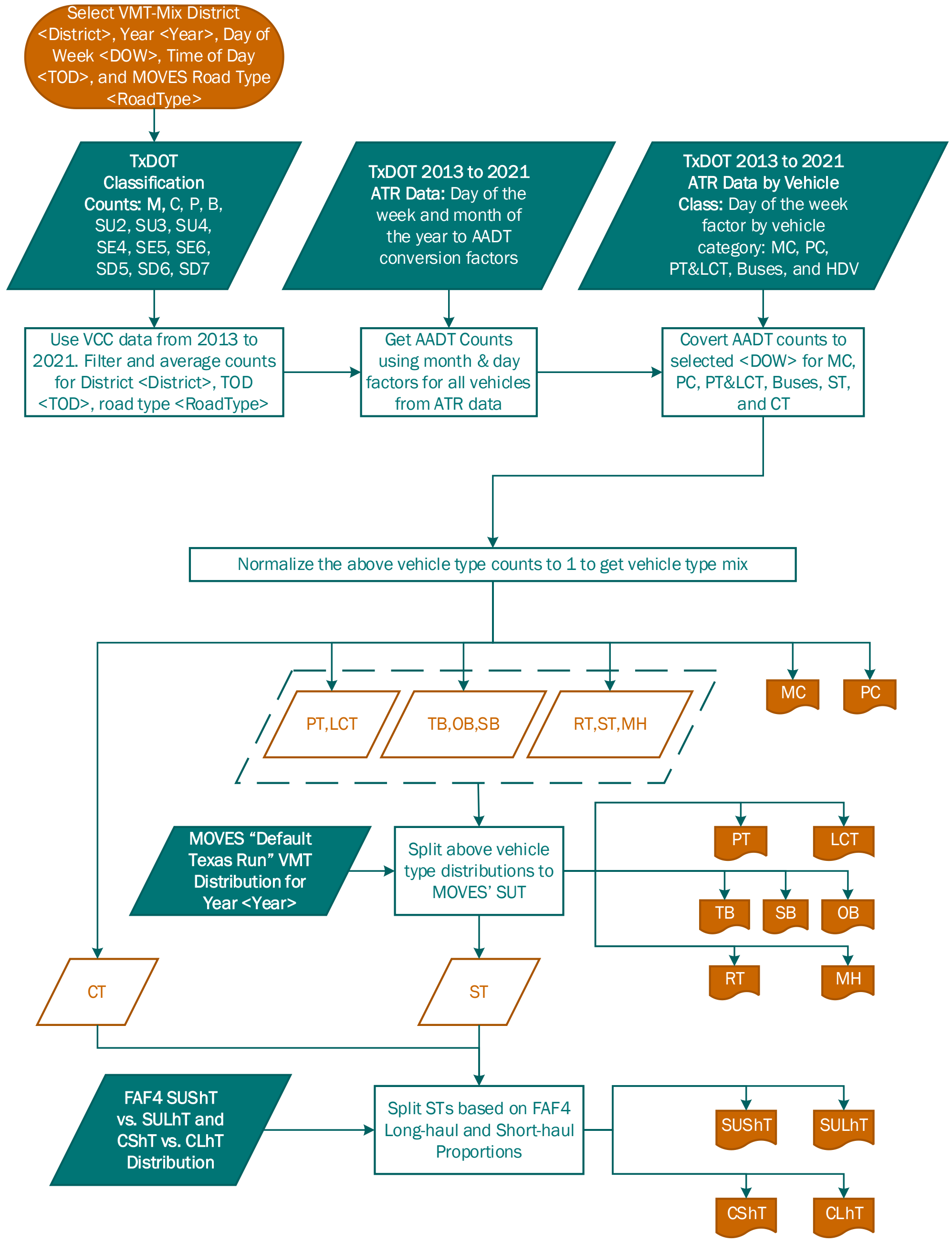

Figure 1. Simplified Overview of the VMT Mix Process Prior to Subdivision by FT.

The modified procedure characterizes VMT by vehicle type for a region or district as described below:

1. Develop county-level customized Alternate Vehicle Fuel and Technology (AVFT) table using TxDMV Registration Data and *DFW Clean Cities* online database[14] for MOVES4.

[14] DFW Clean Cities online database: https://www.dfwcleancities.org/.

2. Conduct MOVES county-level inventory runs using customized AVFT and default values. Aggregate the VMT by SUT and FT at the district level.
3. TxDOT Classification Counts – Data files of standard TxDOT classification data assembled and used for determining the in-use road fleet mix.
4. TxDOT ATR Data – Data files of TxDOT ATR data assembled and used to allocate VMT by season and day of the week.
5. Day of Week (DOW) Factors by Urban Area/TxDOT District – Seasonal day-of-week factors from TxDOT ATR data used to allocate VMT by season and day-of-week by urban area/TxDOT district.
6. Convert TxDOT Classification Counts into MOVES SUT:

- Split vehicle classes 1 (motorcycles [M]) and 2 (passenger vehicles [C]) count into motorcycle and passenger cars directly based on their vehicle classification counts.
- Split vehicle class 3 (two-axle, four-tire single-unit trucks [P]) counts into passenger trucks and light commercial trucks using district-level VMT distribution by the corresponding SUTs.
- Split vehicle class 4 (buses [B]) counts into other buses, transit buses, and school buses using district-level VMT by the corresponding SUTs.
- Split vehicle classes 5 (six-tire, two-axle single-unit vehicles [SU2]), 6 (three-axle single-unit vehicles [SU3]), and 7 (four or more axle single-unit vehicles [SU4]) into single-unit trucks, combination trucks, mobile homes, and refuse trucks using MOVES4 district-level VMT by the corresponding SUTs.
- Split vehicle classes 8 (three or four-axle single-trailer vehicles [SE4]), 9 (five- axle single-trailer vehicles [SE5]), 10 (six or more axle single-trailer vehicles [SE6]), 11 (five or less axle multi-trailer vehicles [SD5]), 12 (six axle multi-trailer vehicles [SD6]), and 13 (seven or more axle multi-trailer vehicles [SD7]) into combination short-haul trucks and combination long-haul trucks and split single-unit trucks into single-unit short-haul trucks and single-unit long-haul trucks using assignment results from registration data.

7. Estimate fractions of FTs for each MOVES SUT using its district-level VMT by FTs and apply the FT fractions to each SUT.

- To account for Texas-specific EV population, the 2021 vehicle registration data was utilized to develop an EV adjustment factor at the county-level by comparing the actual EV count to MOVES4 default. This adjustment factor was applied to the market share of electricity passenger cars, passenger trucks, and light commercial truck of all model years in the *samplevehiclepopulation* table. Then, the market share of all other FTs but gasoline, diesel, and electricity in the *samplevehiclepopulation* table were set to zero. The sum of the normalized fractions is set at 1.

8. Produce VMT mix – Output file of MOVES SUTs and FTs by region, analysis year, day type, and time period.

TxDOT district-level Weekday (as well as Friday, Saturday, and Sunday) VMT mix by MOVES road-type category are produced based on recent multi-year vehicle classification counts and appropriate end-of-year TxDOT vehicle registration data. Using the same data sets and a similar procedure, aggregate (i.e., all road-type categories), TxDOT district-level weekday vehicle type VMT mixes (used in the vehicle population estimation) are also produced. To ensure general applicability and consistency across all study areas, all VMT mixes are developed in five-year increments beginning with the year 2005 and applied to the analysis years based on Table 14.

Table 14. VMT Mix Year/Analysis Year Correlations.

VMT Mix Year	Analysis Years
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032
2035	2033 through 2037

3.2 Vehicle Miles of Travel

The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDMs. This analysis also required that VMT be adjusted for HPMS consistency and to reflect estimated levels characteristic of a typical activity scenario. The EI utilities (see Appendix A), the latest available data sets from TDMs (2017, 2019, 2023, 2024, 2026, and 2027 for DFW; 2017, 2018, 2023, 2027, and 2030 for

HGB; and 2017, 2020, 2025, and 2035 for SAN), and post-processing factors developed from several other data sources, were used to produce this hourly VMT by direction.

A summary of the total vehicle hour traveled (VHT) and VMT for each scenario and analysis year is shown in Table 15 (DFW), Table 16 (HGB), and Table 17 (Bexar). More detailed breakdown of the hourly and 24-hour VMT and VHT by road type were provided electronically to TCEQ (see Appendix B for electronic data descriptions).

Table 15. Summary of the DFW 9-County 24-hour VHT and VMT for each scenario and analysis year.

Scenario	Year	VHT	VMT	VMT/VHT
CS1	2023	7,291,686	253,271,121	34.73
	2024	7,622,476	258,460,364	33.91
	2026	8,027,565	271,870,193	33.87
	2027	8,510,491	276,104,292	32.44
CS2	2023	7,291,686	253,271,121	34.73
	2024	7,622,476	258,460,364	33.91
	2026	8,027,565	271,870,193	33.87
	2027	8,510,491	276,104,292	32.44
CS3	2023	7,196,837	249,154,132	34.62
	2024	7,525,210	254,259,402	33.79
	2026	7,925,791	267,544,974	33.76
	2027	8,405,633	271,676,989	32.32
CSC	2017	4,920,830	187,053,987	38.01
	2023	7,196,837	249,154,132	34.62
	2024	7,525,210	254,259,402	33.79
	2026	7,925,791	267,544,974	33.76
	2027	8,510,491	276,104,292	32.44

Table 16. Summary of the HGB 6-County 24-hour VHT and VMT for each scenario and analysis year.

Scenario	Year	VHT	VMT	VMT/VHT
CS1	2023	4,564,086	188,598,418	41.32
	2024	4,655,481	191,803,711	41.20
	2026	4,817,153	198,401,580	41.19
	2027	4,945,199	202,803,754	41.01
CS2	2023	4,564,086	188,598,418	41.32
	2024	4,655,481	191,803,711	41.20

Scenario	Year	VHT	VMT	VMT/VHT
	2026	4,817,153	198,401,580	41.19
	2027	4,945,199	202,803,754	41.01
CS3	2023	4,504,859	185,251,036	41.12
	2024	4,595,438	188,410,967	41.00
	2026	4,755,548	194,916,277	40.99
	2027	4,882,642	199,265,426	40.81
CSC	2017	3,970,250	165,755,281	41.75
	2023	4,564,086	188,598,418	41.32
	2024	4,655,481	191,803,711	41.20
	2026	4,817,153	198,401,580	41.19
	2027	4,945,199	202,803,754	41.01

Table 17. Summary of the Bexar County 24-hour VHT and VMT for each scenario and analysis year.

Scenario	Year	VHT	VMT	VMT/VHT
CS1	2023	2,078,328	53,914,308	25.94
	2024	2,095,694	54,354,204	25.94
	2026	2,137,271	55,843,828	26.13
	2027	2,192,971	56,898,249	25.95
CS2	2023	2,078,328	53,914,308	25.94
	2024	2,095,694	54,354,204	25.94
	2026	2,137,271	55,843,828	26.13
	2027	2,192,971	56,898,249	25.95
CS3	2027	2,192,971	56,898,249	25.95
CSC	2017	1,624,767	47,288,348	29.10
	2023	2,078,328	53,914,308	25.94
	2024	2,095,694	54,354,204	25.94
	2026	2,137,271	55,843,828	26.13
	2027	2,192,971	56,898,249	25.95

3.2.1 Data Sources

The latest available link trips data, and zonal radii data sets extracted from the latest available TDMs (2017, 2019, 2023, 2024, 2026, and 2027 for DFW, 2017, 2018, 2023, 2027, and 2030 for HGB, and 2017, 2020, 2025, and 2035 for SAN) were used to estimate the directional link VMT and speeds by hour. Since intrazonal VMT are not accounted for in the TDMs, the intrazonal VMT was estimated using the TDM's trip matrix and zonal radii data sets.

Several other data sources were used to adjust the VMT for HPMS consistency and to estimate the summer weekday VMT. The first data source is HPMS VMT estimates, which are based on traffic count data collected according to a statistical sampling procedure specified by the Federal Highway Administration (FHWA) designed to estimate VMT. The county total HPMS Annual Average Daily Traffic (AADT) VMT was used to ensure the travel model VMT was consistent with the HPMS VMT estimates. (EPA and FHWA have endorsed HPMS as the appropriate source of VMT and require that VMT used to construct on-road mobile source emissions estimates be consistent with that reported through HPMS.)

The second data source is ATR vehicle counts, which are collected by TxDOT at selected locations throughout Texas on a continuous basis. These vehicle counts are available by season, month, and day types, as well as on an annual average daily basis (i.e., AADT). The counts are very well suited for making seasonal, day-of-week, and time-of-day comparisons (e.g., seasonal adjustment and hourly allocation factors), even though there may be relatively few ATR data collection locations in any given area.

Multiple years (2013 through 2022) of data from the ATR stations were grouped for this analysis at different aggregation levels, depending upon the purpose. This data source was used to produce the day-type-specific adjustment factor, in which the data from the ATR stations within the DFW area TxDOT districts (Dallas and Fort Worth), HGB area TxDOT districts (Houston and Beaumont), and the SAN TxDOT district were used with the DFW, the HGB, and the SAN TDM areas, respectively. This data source was also used to produce the time-of-day (hourly) allocation factors, in which the data from the ATR stations within each nonattainment area were combined.

3.2.2 VMT Adjustments

For each activity scenario, the TDM VMT was adjusted for HPMS consistency and for seasonality and day-type (i.e., summer weekday). For the 2017 activity scenario, which by definition is a historical year (i.e., HPMS VMT data exists for this year), county-level VMT control totals were used to develop VMT adjustment factors. For the remaining activity scenario years (2023, 2024, 2026, and 2027), which are considered future years (i.e., HPMS VMT data did not exist for these years[15]), a regional HPMS factor and seasonal weekday factors were used. For the analysis years without TDMs (i.e., 2024 and 2027 HGB, 2023, 2024, 2026, and 2027 SAN), TTI also produced intermediate year growth factors using the bounding TDMs (i.e., 2023 and 2026 HGB, 2026 and 2030 HGB, 2020 and 2025 SAN, 2025 and 2035 SAN) and applied these factors to nearest TDM network link data to produce TDM network link VMT for the analysis years originally without TDMs. Hourly travel factors were also applied to distribute this adjusted VMT over each hour of the day.

3.2.2.1 Historical Year Activity Scenarios – VMT Control Totals and VMT Adjustments

To estimate the HPMS-consistent summer weekday VMT for the 2017 historical base year scenarios, county-level 2017 summer weekday VMT control totals were used to develop county-level VMT adjustment factors. The VMT control totals are comprised of two key components: the analysis year county-level HPMS AADT VMT and the AADT-to-summer weekday adjustment factors.

The AADT-to-summer weekday adjustment factors were developed using aggregated ATR data for the years 2013 through 2022. This factor was calculated by dividing the average day-of-week count for June through August by the AADT traffic count. Table 18 shows the three nonattainment areas' AADT-to-summer weekday factors used in developing the VMT control totals.

Table 18. AADT-to-Summer Weekday Factor for Control Total Development.

Area	TxDOT District	Adjustment Factor[1]
DFW	Dallas	1.071796
	Fort Worth	1.078469
	Paris	1.052559
HGB	Beaumont	1.042417
	Houston	1.054301
SAN	San Antonio	1.058777

[1] Converts AADT to average summer weekday (June through August, Monday through Friday).

The VMT control total for each county in the three nonattainment areas were then produced by multiplying the 2017 analysis year HPMS AADT VMT for the county by their

[15] TxDOT typically update their official roadway inventory annual report in October of the following year. I.e., the 2022 report was released on October 17, 2023, and the 2021 report was release on October 26, 2022.

summer weekday adjustment factor. To develop the county-level VMT adjustment factor, the county's 2017 summer weekday control total was divided by the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from the 2017 analysis year TDM. For each link in the TDM, the volume was multiplied by the corresponding VMT adjustment factor (based on the county where the link is located). The adjusted link volumes were then multiplied by the associated link lengths to produce the analysis year link-level HPMS consistent, 2017 summer weekday VMT estimates. This same adjustment was applied to the intrazonal VMT.

3.2.2.2Future Year Activity Scenarios – HPMS Adjustment Factor

For the future year activity scenarios, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from each future year TDM for HPMS consistency. The HPMS adjustment factors used in this analysis were based on the DFW's 2019, HGB's 2016, and SAN's 2020 TDM validations. The validation year HPMS adjustment factor was calculated by dividing the TDM validation year HPMS VMT (first adjusted to average non-summer weekday traffic [ANSWT] form using the ANSWT/AADT ATR count ratio) by validation year total model VMT (See Table 19 for the HGB and SAN HPMS adjusment factors). The NCTCOG provided the DFW HPMS adjustment factor (0.9889) to TTI through email; the DFW model validation year was 2019.

Table 19. HPMS Adjustment Factor.

Area	Model Validation Year	HPMS AADT VMT	AADT-to-ANSWT Factor	HPMS-Based ANSWT VMT	TDM VMT	HPMS Factor
HGB[1,2]	2016	165,009,090	1.06178	175,203,352	186,710,076	0.9384
SAN[3, 4]	2020	52,940,988	1.040896	55,106,088	66,910,614	0.8236

[1] TDM area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties.
[2] Applied to all future years and areas in the HGB region TDM.
[3] TDM area includes Bexar, Comal, Guadalupe, Kendall and Wilson Counties.
[4] Applied to all future years and areas in the SAN region TDM.

3.2.2.3 Future Year Activity Scenarios – Seasonal Adjustment Factors

For the future year activity scenarios, seasonal adjustment factors were used to adjust the TDM and estimated intrazonal VMT to summer weekday VMT. The seasonal adjustment factors were developed for the DFW TDM area (12 counties), HGB TDM area (8 counties), and SAN TDM area (5 counties) TDM areas using TDM area-based aggregated ATR data for the years 2013 through 2022. These factors were calculated by dividing the average day-of-week (weekday) count for June through August by the ANSWT traffic count. Table 20 shows the seasonal adjustment factor for each of the three nonattainment areas.

Table 20. ANSWT-to-Summer Weekday Factor for Future Year Activity Scenarios.

TDM Area	Adjustment Factor[1]
DFW	1.034267
HGB	0.993966
SAN	1.016464

[1] Converts ANSWT to average summer weekday (June through August, Monday through Friday).

3.2.2.4 Future Year Activity Scenarios – Intermediate Year Adjustment Factors

For TDMs that do not exist for future analysis year scenarios, intermediate year adjustment factors were used to estimate future analysis year VMT from an existing TDM (usually closest TDM year to the emissions analysis year). These adjustment factors were developed using the bounding year TDMs and applied to the TDMs designated for the analysis years missing TDMs. The intermediate year adjustment factors were based on the annually compounded growth rates between bounding year TDMs, as shown in Table 21.

Table 21. Annually Compounded Growth Rates (Intermediate Year Adjustment Factors).

Area	Lower Bounding TDM Year	Upper Bounding TDM Year	Lower Bounding TDM VMT[1]	Upper Bounding TDM VMT[1]	Growth Rate
DFW[2]	-	-	-	-	-
HGB	2023	2026	208,821,153	219,762,738	1.0172
	2026	2030	219,762,738	239,878,185	1.0221
Bexar County	2020	2025	55,307,951	57,542,223	1.0080
	2025	2035	57,542,223	69,396,511	1.0189

[1] VMT is unadjusted TDM VMT plus intrazonal VMT.
[2] No growth rates needed for DFW.

3.2.3 Future Year Activity Scenarios – VMT Summary

For each future year activity scenario (i.e., 2023, 2024, 2026, and 2027 summer weekday), the final HPMS VMT is comprised of two parts: the link-level VMT and the estimated intrazonal VMT. The volume for each link was multiplied by the HPMS factor, intermediate year adjustment factor (if necessary) the seasonal adjustment factor, and the link's respective length based on TDM on that analysis year or the closet available historical year TDM (if there is no analysis year TDM) (i.e., 2019 for DFW, 2018 for HGB, and 2020 for Bexar County) to estimate the link-level VMT (hourly factors were applied to distribute the resulting VMT over each hour of the day, discussed in a later section). This set of adjustment factors (as well as the hourly factors mentioned previously) were also applied to the estimated intrazonal VMT. Table 22 shows the TDM and summer weekday VMT summaries.

Table 22. 2017, 2023, 2024, 2026, and 2027 VMT Summary.

Year	VMT	DFW	HGB	Bexar County
2017	TDM[1]	223,194,176	191,428,583	51,084,007
	Weekday[2]	196,769,163	170,636,069	47,288,348
2023	TDM[1]	257,775,736	208,821,153	56,605,628
	Weekday[2]	263,649,578	194,769,383	53,914,308
2024	TDM[1]	263,014,484	212,398,159	57,067,505
	Weekday[2]	269,007,700	198,105,690	54,354,204
2026	TDM[1]	263,014,484	219,762,738	58,622,006
	Weekday[2]	282,993,928	204,974,595	55,843,828
2027	TDM[1]	280,822,862	224,620,239	59,728,919
	Weekday[2]	287,221,870	209,505,334	56,898,249

[1] Includes intrazonal VMT.
[2] The DFW and HGB weekday VMTs here represent the entire TDM area, and not just for the 9-county and 6-county areas.

3.2.4 Hourly Travel Factors

Hourly travel factors were used to distribute the TDM and intrazonal VMT to each hour of the day. These hourly travel factors were developed using multi-year (2013 through 2022) aggregated ATR station data for each region. To maintain VMT proportions within each of the four assignment time periods, the hourly fractions were normalized within each time period to produce the time period hourly travel factors. Each factor (i.e., 24, or one for each hour of the day) was then multiplied by the link volume (in addition to the other VMT adjustment factors). These adjusted link volumes were then multiplied by their respective link lengths to estimate the link level, summer weekday VMT estimates for each activity scenario year. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 23 (DFW), Table 24 (HGB), and Table 25 (SAN) show the summer weekday time period hourly travel factors derived using counties contained in each TDM (TDM area)

Table 23. DFW 12-County TDM Area Summer Weekday Time Period Half Hourly Travel Factors.

Assignment	Hour	Half-hour Factor	Time Period Half Hour Factor
AM Peak	6:30 a.m. to 7:00 a.m.	0.027234	0.180469
	7:00 a.m. to 7:30 a.m.	0.032464	0.215123
	7:30 a.m. to 8:00 a.m.	0.032464	0.215123
	8:00 a.m. to 8:30 a.m.	0.029373	0.194643
	8:30 a.m. to 9:00 a.m.	0.029373	0.194643
PM Peak	3:00 p.m. to 3:30 p.m.	0.032402	0.137362
	3:30 p.m. to 4:00 p.m.	0.032402	0.137362
	4:00 p.m. to 4:30 p.m.	0.034774	0.147415
	4:30 p.m. to 5:00 p.m.	0.034774	0.147415
	5:00 p.m. to 5:30 p.m.	0.035505	0.150516
	5:30 p.m. to 6:00 p.m.	0.035505	0.150516
	6:00 p.m. to 6:30 p.m.	0.030527	0.129413
Overnight	12:00 a.m. to 12:30 a.m.	0.005209	0.008494
	12:30 a.m. to 1:00 a.m.	0.005209	0.008494
	1:00 a.m. to 1:30 a.m.	0.003513	0.005728
	1:30 a.m. to 2:00 a.m.	0.003513	0.005728
	2:00 a.m. to 2:30 a.m.	0.003133	0.005109
	2:30 a.m. to 3:00 a.m.	0.003133	0.005109
	3:00 a.m. to 3:30 a.m.	0.0035	0.005708
	3:30 a.m. to 4:00 a.m.	0.0035	0.005708
	4:00 a.m. to 4:30 a.m.	0.00629	0.010258
	4:30 a.m. to 5:00 a.m.	0.00629	0.010258
	5:00 a.m. to 5:30 a.m.	0.015648	0.025518
	5:30 a.m. to 6:00 a.m.	0.015648	0.025518
	6:30 a.m. to 7:00 a.m.	0.027234	0.044413
	9:00 a.m. to 9:30 a.m.	0.025716	0.041937
	9:30 a.m. to 10:00 a.m.	0.025716	0.041937
	10:00 a.m. to 10:30 a.m.	0.024997	0.040765
	10:30 a.m. to 11:00 a.m.	0.024997	0.040765
	11:00 a.m. to 11:30 a.m.	0.025782	0.042045
	11:30 a.m. to 12:00 p.m.	0.025782	0.042045
	12:00 p.m. to 12:30 p.m.	0.027162	0.044295
	12:30 p.m. to 13:00 p.m.	0.027162	0.044295
	13:00 p.m. to 13:30 p.m.	0.027941	0.045566
	13:30 p.m. to 14:00 p.m.	0.027941	0.045566

Assignment	Hour	Half-hour Factor	Time Period Half Hour Factor
	14:00 p.m. to 14:30 p.m.	0.029662	0.048371
	14:30 p.m. to 15:00 p.m.	0.029662	0.048371
	6:30 p.m. to 7:00 p.m.	0.030527	0.049783
	7:00 p.m. to 7:30 p.m.	0.023619	0.038517
	7:30 p.m. to 8:00 p.m.	0.023619	0.038517
	8:00 p.m. to 8:30 p.m.	0.018704	0.030502
	8:30 p.m. to 9:00 p.m.	0.018704	0.030502
	9:00 p.m. to 9:30 p.m.	0.015762	0.025704
	9:30 p.m. to 10:00 p.m.	0.015762	0.025704
	10:00 p.m. to 10:30 p.m.	0.012341	0.020125
	10:30 p.m. to 11:00 p.m.	0.012341	0.020125
	11:00 p.m. to 11:30 p.m.	0.008745	0.014261
	11:30 p.m. to 12:00 a.m.	0.008745	0.014261

[1] Used in the VMT calculation process. Half hour factor is used for the DFW TDM as it includes certain TOD periods that span half-hour intervals.

Table 24. HGB 8-County TDM Area Summer Weekday Time Period Hourly Travel Factors.

Assignment	Hour	Base factor	Time Period Factor[1]
AM Peak	6:00 a.m. to 7:00 a.m.	0.061036	0.33422
	7:00 a.m. to 8:00 a.m.	0.064849	0.3551
	8:00 a.m. to 9:00 a.m.	0.056737	0.31068
Mid-Day	9:00 a.m. to 10:00 a.m.	0.051163	0.159548
	10:00 a.m. to 11:00 a.m.	0.050106	0.156252
	11:00 a.m. to 12:00 p.m.	0.052103	0.162479
	12:00 p.m. to 1:00 p.m.	0.054269	0.169234
	1:00 p.m. to 2:00 p.m.	0.055052	0.171675
	2:00 p.m. to 3:00 p.m.	0.057982	0.180812
PM Peak	3:00 p.m. to 4:00 p.m.	0.063397	0.24206
	4:00 p.m. to 5:00 p.m.	0.068096	0.260002
	5:00 p.m. to 6:00 p.m.	0.070337	0.268558
	6:00 p.m. to 7:00 p.m.	0.060076	0.22938
Overnight	7:00 p.m. to 8:00 p.m.	0.047264	0.201297
	8:00 p.m. to 9:00 p.m.	0.036536	0.155607
	9:00 p.m. to 10:00 p.m.	0.030712	0.130802
	10:00 p.m. to 11:00 p.m.	0.023867	0.10165
	11:00 p.m. to 12:00 a.m.	0.016195	0.068974
	12:00 a.m. to 1:00 a.m.	0.009113	0.038812

Assignment	Hour	Base factor	Time Period Factor[1]
	1:00 a.m. to 2:00 a.m.	0.006064	0.025827
	2:00 a.m. to 3:00 a.m.	0.0056	0.02385
	3:00 a.m. to 4:00 a.m.	0.006553	0.027909
	4:00 a.m. to 5:00 a.m.	0.014161	0.060312
	5:00 a.m. to 6:00 a.m.	0.038732	0.16496

[1] Used in the VMT calculation process.

Table 25. SAN 5-County TDM Area Summer Weekday Time Period Hourly Travel Factors.

Assignment	Hour	Base factor	Time Period Factor[1]
AM Peak	6:00 a.m. to 7:00 a.m.	0.050926	0.299558
	7:00 a.m. to 8:00 a.m.	0.063234	0.371956
	8:00 a.m. to 9:00 a.m.	0.055844	0.328486
Mid-Day	9:00 a.m. to 10:00 a.m.	0.0491	0.153061
	10:00 a.m. to 11:00 a.m.	0.049047	0.152895
	11:00 a.m. to 12:00 p.m.	0.052075	0.162335
	12:00 p.m. to 1:00 p.m.	0.055125	0.171842
	1:00 p.m. to 2:00 p.m.	0.05629	0.175474
	2:00 p.m. to 3:00 p.m.	0.059151	0.184393
PM Peak	3:00 p.m. to 4:00 p.m.	0.066541	0.237236
	4:00 p.m. to 5:00 p.m.	0.072363	0.257993
	5:00 p.m. to 6:00 p.m.	0.077492	0.27628
	6:00 p.m. to 7:00 p.m.	0.064088	0.228491
Overnight	7:00 p.m. to 8:00 p.m.	0.047416	0.207307
	8:00 p.m. to 9:00 p.m.	0.038374	0.167774
	9:00 p.m. to 10:00 p.m.	0.032551	0.142316
	10:00 p.m. to 11:00 p.m.	0.024627	0.107671
	11:00 p.m. to 12:00 a.m.	0.017061	0.074592
	12:00 a.m. to 1:00 a.m.	0.010204	0.044613
	1:00 a.m. to 2:00 a.m.	0.007001	0.030609
	2:00 a.m. to 3:00 a.m.	0.00615	0.026888
	3:00 a.m. to 4:00 a.m.	0.006791	0.029691
	4:00 a.m. to 5:00 a.m.	0.011092	0.048495
	5:00 a.m. to 6:00 a.m.	0.027457	0.120044

[1] Used in the VMT calculation process.

3.2.5 Estimation of Link Speeds

3.2.5.1 Bureau of Public Roads Speed Link Speed Model

To estimate link operational (congested) speeds for SAN, the speed model built into the SAN TDM is used. The BPR speed model is formulated as a polynomial function with respect to the ratio of traffic volume to capacity. The BPR speed model was used to estimate the hourly, directional, congested speed for each link, except for the TDM centroid connectors and added intrazonal links. The speeds of centroid connectors are the model free-flow speed (FFS). The speeds of intrazonal links are calculated as the average speeds of all centroid connectors in the same transportation analysis zone (TAZ). The congested speed was calculated using the following formula:

$$Congested\ Speed\ = \frac{LEN}{(FFT * \left(1 + \alpha \times \left(\frac{V}{C}\right)^{\beta}\right))/60}$$

Where

LEN is the length of the link,

FFT is the directional link free-flow travel time (in minutes),

V is the directional link traffic flow,

C is the directional link capacity,

α and β are model parameters.

To calculate the hourly, directional, congested speed:

i. the link length and directional link free-flow speeds in the travel model were directly used as the FFS,

ii. the directional hourly link flow *V* was estimated by distributing the Time-Of-Day (TOD) link flow among each hour in the TOD using corresponding normalized hourly factors for the TOD (see Table 23),

iii. the directional hourly link capacity *C* was estimated by evenly distributing the TOD capacity among each hour within the TOD, and

iv. the model parameters α and β associated with each link in the travel model were directly used.

3.2.5.2 Houston Speed Model

The operational speeds for each link, excluding centroid connectors and the special intrazonal links, were calculated using the Houston speed model. The Houston speed model calculates these speeds using the travel model speed, speed factors (consisting of a free-flow speed factor and level of service [LOS] E speed factor) and a volume-to-capacity (V/C) ratio-based speed reduction factor (SRF) for each link.

The speed factors were used to convert the link-level travel model (input) speed to a free-flow speed and a LOS E speed (i.e., application of these factors results in two speeds). The free-flow speed factors (grouped by functional class and area type) were calculated by dividing the distance-weighted free-flow speed by the distance-weighted input speed for each functional class/area type combination. The distance-weighted free-flow speeds were calculated using output from the detailed speed model used by the Houston-Galveston Area Council (HGAC) in the travel model development process (as provided by HGAC) with link volumes set to 0 (i.e., V/C = 0). The LOS E speed factors were calculated in a similar manner (distance-weighted LOS E speed divided by distance-weighted input speed) using the detailed speed model output with link volumes set equal to capacity (i.e., V/C = 1).

The link-specific V/C ratio is calculated as the time period (hourly) volume divided by the time period capacity. The V/C ratio is expressed as:

$$v/c\ ratio = V_h/C_h$$

Where:

> V_h = the hourly link volume (travel model × HPMS factor × seasonal adjustment factor × hourly time period factor; Weekend profile factor is included for Saturday and Sunday, not applicable for this analysis); and
>
> C_h = the hourly link capacity (travel model capacity × hourly capacity factor). Appendix E shows the hourly capacity factors.

After the V/C ratio was calculated, the link-specific SRF was determined using the V/C ratio, the link-specific SRF area type, the link-specific SRF functional class, and the SRFs. The SRFs are for V/C ratios of 0 to 1 in 0.05 increments (i.e., 0, 0.05, 0.10, ... , 0.95, 1.0). Appendix E shows these SRFs. The link-specific SRF was calculated using linear interpolation. For V/C ratios greater than 1.0, a SRF is not required.

The speed model (for V/C ratios from 0.00 to 1.00) is expressed as:

$$S_{v/c} = S_{0.0} - SRF_{v/c} \times (S_{0.0} - S_{1.0})$$

Where:

$S_{v/c}$ = estimated directional speed for the forecast V/C ratio on the link in the given direction;

$S_{0.0}$ = estimated free-flow speed for the V/C ratio equal to 0.0;

$S_{1.0}$ = estimated LOS E speed for the V/C ratio equal to 1.0; and

$SRF_{v/c}$ = SRF for the V/C ratio on the link. The V/C ratio can be 0.0 to 1.0.

For V/C ratios greater than 1.0 and less than 1.5, the following speed model extension was used:

$$S_{v/c} = S_{1.0} \times (\frac{1.15}{1 + (v/c)^4})$$

Where:

$S_{v/c}$ = estimated directional speed for the forecast V/C ratio on the link in the given direction;

$S_{1.0}$ = estimated LOS E speed for the V/C ratio equal to 1.0; and

v/c = the forecast v/c ratio on the link. The V/C ratio can be 1.0 to 1.5.

For V/C ratios greater than 1.5, the speed was calculated using the previous speed model extension, except the V/C ratio was set to 1.5.

These speed models were applied to all functional classes excluding the centroid connector and intrazonal functional classes. For these functional classes, capacity data were not used. The centroid connector travel model input speeds were used as the centroid connector operational speed estimates. Operational speeds for the intrazonal functional class were estimated by zone as the average of the zone's centroid connector speeds.

3.2.5.3 DFW Speed Model from NCTCOG's AQ report

For DFW RFP, the operational speeds for each link, excluding centroid connectors and the special intrazonal links, were calculated using the DFW speed model provided in its AQ report[16]. The DFW speed model calculates these speeds using the free-flow travel

[16] https://www.nctcog.org/getmedia/fcbb560e-798b-47a0-8baa-ccbe285dbfed/2023-Conformity_Document_Final_Updated.pdf

speed, delay factors (consisting of delay constants and non recurring factors), and a V/C ratio.

The congested speed was calculated using the following formula:

$$Congested\ Speed\ = \frac{60*LEN}{(FFT+(unitDelay*Len)*(1+NonRecFactor))},$$

$$unitDelay = \min\,(delay, CConst),$$

$$delay = AConst * \exp\,(BConst * V/C),$$

Where

LEN is the length of the link,

FFT is the directional link free-flow travel time (in minutes),

V is the directional link traffic flow,

C is the directional link capacity,

$AConst$, $BConst$, $CConst$, and $NonRecFactor$ are model parameters whose values depend on link functional class.

3.2.6 Estimation of link-level VMT

The directional hourly link-level VMT is calculated as follows

$$VMT_h = V_h * LEN$$

Where V_h is the hourly directional link flow (after applying VMT adjustment factors),

LEN is the length of the link.

The DFW TDM includes specific TOD periods that span half-hour intervals, such as the AM peak period from 6:30 to 9:00 AM. To compute the directional hourly link-level VMT, the VMT for each half-hour interval is first calculated. These half-hour VMT values are then aggregated to obtain the directional hourly link-level VMT. For instance, the VMT from 6:00 to 7:00 AM is determined by combining the VMT from the 6:00-6:30 and 6:30-7:00 intervals.

3.3 Estimation of Off-Network Activity

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates (i.e., mass per ONI hour, mass per SHP, mass per start, and mass per

SHEI), county-level estimates of the ONI hours, SHP, starts, SHEI, and APU hours are required by hour and vehicle type for each activity scenario (SHEI 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. Summaries of the vehicle population and 24-hour ONI hours, SHP, starts, SHEI, and APU hours off-network activity factors are included as Appendix E. Hourly ONI hours, SHP, starts, SHEI, and APU hours activity estimates are included with the detailed inventory data provided (see inventory data file descriptions in Appendix B).

The county-level vehicle population estimates were developed using the VehPopulationBuild utility. The county-level ONI hours, SHP, starts, SHEI, and APU hours of off-network activity were developed using the OffNetActCalc utility. Appendix A contains a description of the utilities.

3.3.1 Estimation of Vehicle Population

Vehicle population estimates are needed to estimate the SHP and starts off-network activity factors. The vehicle population estimates (included as Appendix E) were produced for each county in the three nonattainment areas for each activity scenario year. The vehicle population estimates are a function of vehicle registration data (TxDMV registration data sets), population scaling factors (where applicable), and vehicle type VMT mix.

For estimating vehicle populations, a historical activity scenario year is defined as any year where actual TxDMV registration data and HPMS VMT data (used in developing population scaling factors) exist. Therefore, the 2017 activity scenario year was considered a historical year and the vehicle population estimates were based on the 2018 TxDMV registration data and scaling factor estimated between 2017 and 2018 HPMS VMT. Since the HPMS VMT data were not available for 2023, 2024, 2026, and 2027, these analyses were considered future activity scenario years. For the future activity scenario years, the vehicle population estimates were based on the most recent year (2021) TxDMV registration data set and the activity scenario year population scaling factors.

The VMT mix used to estimate the vehicle population is the aggregate (i.e., all road-type categories) TxDOT district-level weekday VMT mix. The development of the VMT mix is described in more detail in Chapter 3.1.

3.3.1.1Historical Years Vehicle Population Estimates

The county-level vehicle population estimates for the base year (2017) were calculated using the inventory year, county-level, registration data (end-year 2018 [for 2017 base year] and 2021 [for all future years] TxDMV vehicle registrations county totals) with VMT-based back scaling and the assigned aggregate VMT mix (see Table 14 and Appendix D). These historical year county-level vehicle population scaling factors were calculated as the ratio of the county-level summer weekday VMT for the activity scenario year (2017) to the county-level summer weekday VMT for the year of the most recent (2021) TxDMV registration data (i.e., vehicle population decreases/increases linearly with VMT). Historical years' VMT mix was applied to historical years. The vehicle population estimation process assumes that all of the non-long-haul SUT category populations for a county are represented in the county vehicle registration data. This process also estimates the long-haul category populations as an expansion of the county registrations. There are four main steps in the vehicle population estimation process: registration data category aggregation, calculation of the vehicle type population factors, estimation of the county-level vehicle population by vehicle type, and scaling the vehicle population from vehicle registration to the analysis years.

The first step in the vehicle estimation process is the registration data category aggregation. For the county, the inventory year vehicle registrations were aggregated into five categories. Table 26 shows these five categories.

Table 26. Registration Data Categories.

Registration Data Category	Vehicle Registration Aggregation
1	Motorcycles
2	Passenger Cars (PC)
3	Trucks <= 8.5 K gross vehicle weight rating (GVWR) (pounds)
4	Trucks > 8.5 and <= 19.5 K GVWR
5	Trucks > 19.5 K GVWR

The second step is calculating the vehicle type population factors. Using the assigned aggregate VMT mix, population factors were calculated for each vehicle type. For the non-long-haul SUT categories, the population factors were calculated by dividing the vehicle type VMT mix fraction for each vehicle type by the summed total of the VMT mix fractions in their associated vehicle registration data category. For example, the LCT_Diesel population factor using the VMT mix is LCT_Diesel/(PT_Gas + PT_Diesel + LCT_Gas + LCT_Diesel). For the long-haul SUTs, the vehicle type population factors were calculated by taking the ratio of the long-haul and short-haul VMT mix values. For example, the SULhT_Gas population factor using SUT mix fractions is SULhT_Gas/SUShT_Gas. Table 27 shows the vehicle registration aggregations and their associated MOVES SUT/FTs (vehicle types).

Table 27. TxDMV Vehicle Registration Aggregations and Associated Vehicle Types for Estimating Vehicle Populations.

Vehicle Registration[1] Aggregation	Associated Vehicle Type[2]
Motorcycles	MC_Gas
Passenger Cars (PC)	PC_Gas; PC_Diesel; PC_Electricity
Trucks <= 8.5 K GVWR (pounds)	PT_Gas; PT_Diesel; PT_Electricity LCT_Gas; LCT_Diesel; LCT_Electricity
Trucks > 8.5 and <= 19.5 K GVWR	RT_Gas; RT_Diesel; RT_Electricity SUShT_Gas; SUShT_Diesel; SUShT_Electricity MH_Gas; MH_Diesel; MH_Electricity Obus_Gas; Obus_Diesel; Obus_Electricity TBus_Gas; TBus_Diesel; TBus_Electricity SBus_Gas; SBus_Diesel; SBus_Electricity
Trucks > 19.5 K GVWR	CShT_Gas; CShT_Diesel; CShT_Electricity
NA[1]	SULhT_Gas; SULhT_Diesel; SULhT_Electricity CLhT_Gas; CLhT_Diesel; CShT_Electricity

[1] The four long-haul SUT/FT populations are estimated using a long-haul-to-short-haul weekday SUT VMT mix ratio applied to the short-haul SUT population estimate.
[2] The end-year TxDMV county registrations data extracts were used (i.e., the three data set consisting of: 1 - light-duty cars, trucks, and motorcycles; 2 - heavy-duty diesel trucks; and 3 - heavy-duty gasoline trucks) for estimating the vehicle populations.

The third step is the estimation of the county-level vehicle type population. The non-long-haul vehicle type populations were estimated by applying their vehicle type population factors to the aggregated registrations of the appropriate registration data category. For the CLhT_Gas type, the vehicle population was set to 0. For the remaining three long-haul SUT/FTs (SULhT_Gas, SULhT_Diesel, and CLhT_Diesel), the vehicle populations were calculated as the product of the corresponding short-haul category vehicle population and the associated long-haul population factor (e.g., SULhT_Gas vehicle population = SUShT_Gas vehicle population x [SULhT_Gas SUT mix fraction/ SUShT_Gas SUT mix fraction]).

3.3.1.2Future Years Vehicle Population Estimates

The process for estimating the county-level population estimates for the future years is very similar to the historical vehicle population. The most recent (2021) county-level TxDMV registration data sets for which HPMS data exists were used. The county-level base 2021 vehicle total population estimates were calculated using the 2021 registration data sets. Future year county-level vehicle population scaling factors were used to scale the county-level base 2021 vehicle population estimates to the activity scenario year. These future year county-level vehicle population scaling factors were calculated as the ratio of the county-level summer weekday VMT for the activity scenario year to the county-level summer weekday VMT for the year of the most recent (2021) TxDMV registration data (i.e., vehicle population increases linearly with VMT). With the assigned aggregate VMT mix for future years and the 2021 registration data sets, the future year source type and FT based vehicle populations were calculated.

3.3.2 Estimation of ONI Hours

One of the activity measures needed to estimate the off-network emissions is the new activity type with MOVES3, which was inherited in MOVES4, from off-network idling activity. ONI hours are not related to combination truck hours of hotelling activity. ONI is idling activity that occurs 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 hours activity factors (or source hours idling [SHI] off-network) following the MOVES methodology, by employing key MOVES defaults derived from telematics data, in combination with local network link-level activity estimates. This is accomplished using the formula that calculates ONI[17] as a function of the:

- Total idle fraction (TIF) (MOVES default derived from telematics data), or total idling hours on and off-network divided by total SHO (on network plus ONI hours): $TIF = (SHI_{network} + ONI) / (SHO_{network} + ONI)$,
- SHOnetwork (from local link VMT and speeds), and
- SHI on network ($SHI_{network}$). SHInetwork is calculated using the MOVES default road idle fractions (RIF) applied to local SHOnetwork (VMT/speed) at the link level.

The equation for calculating ONI Hours is:

$$ONI = SHO_{network} \times TIF - SHI_{network})/(1 - TIF)$$

[17] Population and Activity of Onroad Vehicles in MOVES4 (pdf) (August 2023, EPA-420-R-23-005)

3.3.3 Estimation of SHP

Another 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 SHO was calculated using the link VMT and speeds and the TxDOT district-level vehicle type VMT mixes by MOVES road-type category (see the "Development of Vehicle Type VMT Mix" section for more details). The ONI hours estimated in the previous step are then subtracted from the total SHP to produce the adjusted SHP (for vehicles with their engine off) used in the analysis. Appendix E includes the 24-hour summaries of the county-level weekday estimates of the adjusted SHP by vehicle type for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix B for electronic data descriptions).

3.3.3.1 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 activity scenario year.

3.3.3.2 Vehicle Type SHO

To calculate SHO for a given link, the VMT was allocated to each vehicle type using the TxDOT 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 SHO. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 14 and Appendix C). This SHO calculation was performed for each link in a given hour, aggregating the SHO to one value per vehicle type per hour.

3.3.4 Estimation of Starts

Another 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. The engine starts were estimated using county-level vehicle type populations and data from MOVES representing the average number of vehicle starts per vehicle type per hour. The starts per vehicle are calculated using the applicable MOVES algorithm with data on the age distribution and fuel fractions of the local fleet. Local age distributions and fuelfractions inputs to MOVES are combined with MOVES default parameters (startsageadjustment, startsmonthadjust [three-month seasonal average for June, July and August for summer weekday scenario], and startspervehicle) to produce 24-hour starts per vehicle output representative of the summer weekday. The MOVES output provides the scenario-specific starts per vehicle defined by the study scope. For each hour of the day, the starts per vehicle data calculated by the MOVES algorithm are multiplied by the local vehicle type population estimates to produce the total number of starts by vehicle type per hour.

Appendix E includes the 24-hour summaries of the county-level vehicle type starts for the activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix B for electronic data descriptions).

3.3.5 Estimation of SHEI 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, FT 2 [CLhT_Diesel]) emissions-producing hotelling activity factors (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 electricity power or no power. For each activity scenario, hotelling hours were first estimated, followed by an estimation of the SHEI and diesel APU hours components of hotelling hours. The hotelling hours for heavy-duty diesel and electricity trucks (SUT 62, FT 9 [CLhT_Electricity]) were calculated. The discussion and associated emission calculation 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 and CLhT_Electricity hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHEI and APU hours factors were then applied to the hotelling hours to produce the hourly SHEI and APU hours of activity. This procedure was performed for each activity scenario. Appendix E includes the 24-hour summaries of the county-level estimates of hotelling hours, SHEI, and APU hours for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix B for electronic data descriptions).

The SHEI and APU hours activity distribution fractions were each first multiplied by the travel distribution (model year operating mode activity fraction multiplied by the associated model year travel fraction).

The product of the SHEI fractions and travel fractions were then summed to produce the total SHEI fraction, and the same process was performed for APU hours to produce total APU hours fraction. (The sum of the SHEI and APU hours fractions subtracted from 1.0 results in the remaining fraction of hotelling hours, consisting of the electricity power or no power in use modes.)

3.3.5.1 Hotelling Scaling Factors

To estimate the county-level 24-hour hotelling by activity scenario, county-level hotelling scaling factors were developed for each activity scenario. These scaling factors were produced using the county-level 2017 winter weekday link-level VMT and speeds, the TxDOT district-level base weekday vehicle type VMT mix (by MOVES road type), the county-level activity scenario link-level VMT and speeds, and the TxDOT district-level activity scenario vehicle type VMT mix (by MOVES road type). The 2017 winter weekday link-level VMT and speeds were developed similarly to the 2017 summer weekday link-level VMT and speed data except using a 2017 winter weekday VMT control total. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 14 and Appendix C). For the base weekday vehicle type VMT mix, the 2015 weekday vehicle type VMT mix was used and for the future year analyses the 2025 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 and CLhT_Electricity 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 and CLhT_Electricity 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 hotelling scaling factors by activity scenario were calculated by dividing the activity scenario CLhT_Diesel and CLhT_Electricity 24-hour VMT by the CLhT_Diesel 24-hour 2017 winter weekday VMT.

3.3.5.2Hotelling 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 activity scenario.

3.3.5.3Hotelling 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) were performed for each county in the three nonattainment areas for each activity scenario.

3.3.5.4SHEI and APU Hours Estimation

The hourly, county-level, hotelling estimates for each activity scenario were then factored to produce the SHEI 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 SHEI fraction to calculate the hourly SHEI and by the APU fraction to calculate the hourly APU hours.

The aggregate SHEI 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 MOVES default hotelling distributions were shown in Table 28. 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 SHEI and APU fractions. (The sum of the resulting SHEI and APU fractions, when subtracted from 1.0, leaves the portion of hotelling hours in which trucks were using electricity power or using no power.)

Table 28. Hotelling Activity Distributions by Model Year and Operating Mode.

fuelType	Begin Model Year	End Model Year	200 Extend Idling	201 Diesel Aux	203 Battery AC	204 APU Off
Diesel	1960	2009	0.8	0	0	0.2
	2010	2020	0.73	0.07	0	0.2
	2021	2023	0.48	0.24	0.08	0.2
	2024	2026	0.4	0.32	0.08	0.2
	2027	2060	0.36	0.32	0.12	0.2
Electricity	1960	2060	0	0	0.8	0.2

4 ESTIMATION OF EMISSIONS RATES

TTI developed the emissions rates needed for the on-road mobile source emissions inventories according to TTI's detailed MOVES rates-per-activity, county-level, link-based method. On-road mobile emission rates data from the EPA's latest emissions factor model, MOVES4 (version 4.0.1; database = movesdb20240104), were used in TTI's rates post-processing utilities to produce rates in the form needed as input for to the external inventory calculation procedure.

Emission rates were developed as required for an average summer weekday for the RFP SIP emissions inventories. A conversion was performed of MOVES mass/vehicle rates for parked vehicle evaporative emission rates to mass/SHP, as needed for the activity-based emissions estimation methodology. Emission rates were produced by hour, year, vehicle type (source type and FT), MOVES road type (and speed), pollutant, and emission process. Emission rates are for gasoline, diesel, and electricity-powered vehicles (with other alternative fuel vehicles currently assumed negligible).

The emissions rates were developed based on the latest TTI emission inventory development methods and procedures but updated to accommodate MOVES4. The EPA's current *Technical Guidance*[18] applicable to MOVES4 inventory development was used. The TTI MOVES4 data post-processing utilities used to produce the databases of rates look-up tables are consistent in concept with the prior MOVES2014-based TTI utilities, as described, along with TTI's other EI utilities, in Appendix A.

The following sections describe the emission rates development process, inputs, data sources, and post-processing performed in the development of MOVES emission rates.

4.1 PROCESS OVERVIEW

The general process involves setting up and executing MOVES emissions rates mode runs to produce the emissions and activity data needed for the development of on-road mobile source, county-level emissions rates, for an average summer weekday. For the initial post-processing step following the MOVES emission rates mode run, TTI uses an on-road rates look-up table post processor utility to convert the mass/vehicle evaporative rates to mass/SHP, and to compile all the needed rates into look-up tables. When appropriate, a subsequent post-processing step applies adjustment factors to

[18] EPA. 2023. *MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, EPA-420-B-23-011, Office of Transportation and Air Quality. August 2023.

incorporate TxLED effects on diesel vehicle NOx emission rates. Using this process, on-road rates look-up tables are produced from each set of MOVES runs, in the form needed for input to the external inventory calculations utility.

For the external inventory calculations, the method requires that all rates be in terms of mass per unit of activity, as opposed to particular off-network rates of mass per vehicle, which is the only output option available for off-network "parked vehicle" evaporative emissions output by MOVES. Table 29 summarizes the form of rates produced for the external inventory calculations. The MOVES input files (MOVES run specification input files [RunSpec or MRS] and county database input files [CDBs]) are provided as a part of the electronic data submittal (Appendix B).

Table 29. Emissions Rates by MOVES Emissions Process and Activity Factor.

Process (Process ID)	Activity Factor[1]	Emissions Rates[2]
Running Exhaust (1)	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust (15)	VMT	mass/mi
Brake Wear (9)	VMT	mass/mi
Tire Wear (10)	VMT	mass/mi
Start Exhaust (2)	starts	mass/start
Crankcase Start Exhaust (16)	starts	mass/start
Extended Idle Exhaust (90)	SHEI	mass/hour
Crankcase Extended Idle Exhaust (17)	SHEI	mass/hour
Auxiliary Power Exhaust (91)	APU Hours	mass/hour
Running exhaust (1) – Road Type 1 Off-network	ONI Hours	mass/hour
Evaporative Permeation (11) Evaporative Fuel Vapor Venting (12) Evaporative Fuel Leaks (13)	VMT, SHP	mass/mi, mass/hour

[1] VMT, ONI hours, SHP, vehicle starts, and hotelling activity (SHEI and APU hours) are the basic activity factors. SHEI and APU hours are for combination long-haul trucks only.
[2] All mass per activity rates shown are available in MOVES rate mode table output, except for mass/SHP, which is produced using the TTI EI utilities.

The RFP inventory analysis required sets of emissions factors for the three main RFP control scenarios: pre-1990 controls (except for current FMVCP EIs), and incremental control strategy and full control strategy. The current methodology is mostly consistent with TTI's fiscal year 2020 RFP EIs methodology[19], except individual control reductions for post-1990 FMVCP was not estimated. This change is needed because the EPA removed the MOVES4 model's capability to switch off the post-1990 FMVCP effects.

[19] As documented in *Houston-Galveston-Brazoria (HGB) 2015-Eight-Hour Ozone Reasonable Further Progress (RFP) On-Road Mobile Emissions Inventories* (TTI, June 2021).

Since MOVES4 is only capable of modeling full FVMCP effects for each RFP analysis year, MOVES4 cannot be used to accurately estimate emissions reductions solely attributable to post-1990 FMVCP.

To estimate emissions reductions from individual control measures, the CS2 and CS3 runs were needed in addition to CS1. The CSC TxLED post-processing run was also needed.

- "CS1" = Pre-1990 control scenario except for current FMVCP;
- "CS2" = CS1 + current fuels;
- "CS3" = CS2 +I/M programs;
- "CSC" = CS3 + TxLED (i.e., full control strategy scenario).

The main purpose of this overall discussion is three-fold. First, the MOVES-based emissions rate look-up table development process is explained. Second, specifics are provided on emission rates modeling for the two main RFP control scenarios - Pre-1990 controls (CS1) and control strategy (CSC)—the first and last bullets of the previously listed control scenarios. TTI produced all emissions rates consistent with the methods and procedures presented for these two main RFP control scenarios. Third and last, the control scenario rates development for the estimation of individual control measure impacts (i.e., CS1, CS2, CS3, CSC) is detailed.

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions factors. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions, where available and consistent with the methodology. Local data were developed to reflect county weather conditions, regional seasonal (summer) fuel properties, and county vehicle age distributions.

For the activity input data to MOVES, the MOVES defaults are generally used, which is basic to the emissions rates method (i.e., inventory scenario emission rates produced via post-processing were externally multiplied by the actual local VMT and off-network activity estimates, detailed in previous sections, to calculate emissions external to MOVES). Where local data is required, MOVES default data are replaced with local data using the MRS and MOVES CDBs. The MRS files, CDBs, and MOVES default database provide the input data tailored for each local scenario model run.

For each analysis year MOVES run, there was a corresponding RunSpec, one input CDB, and one MOVES output database.

MOVES set-ups and runs were executed and the results were post-processed to produce county-level, summer weekday, activity-based emission rates of the desired pollutants and processes. The emission rates were estimated by speed (for miles-based rates), process, hour, MOVES road type (road type 1 for off-network), SUT, and FT. The following sections describe the emission rates estimation process used for setting up the MOVES RunSpec files and CDBs, executing MOVES emissions rate mode runs, and post-processing.

4.2 Summary of Control Programs Modeled by RFP Control Scenario

Table 30 shows the control measures modeled in each of the RFP control scenarios, pre-1990 controls except full FMVCP (CS1) and current control strategy (CSC).

Table 30. Control Measure Modeling by RFP Control Scenario.

Individual Control Measures[1]	Method	RFP Control Scenario			
		Pre-1990 Controls (CS1)	Incremental Control Strategy (CS2)	Incremental Control Strategy (CS3)	Control Strategy (CSC)
Pre-1990 CAA FMVCP	MOVES inputs	√	√	√	√
1992 Federal Controls on Gasoline Volatility	MOVES inputs	√			
Current Federal and State Fuels Standards	MOVES inputs		√	√	√
Post-1990 CAA FMVCP Tier 1 National Low Emission Vehicle Program Tier 2 Tier 3 Heavy-Duty 2004 Diesel 2005 Gasoline 2007 Gasoline and Diesel Highway Motorcycle 2006 Light- and Medium-Duty 2010 Cold Weather Light- and Heavy-Duty Greenhouse Gas (GHG) Heavy-Duty Phase 2 GHG Safer Affordable Fuel Efficient (SAFE) Vehicles 2023 Heavy-Duty Engine and Vehicle Standards (HD2027)	MOVES inputs	√	√	√	√

Individual Control Measures[1]	Method	RFP Control Scenario			
		Pre-1990 Controls (CS1)	Incremental Control Strategy (CS2)	Incremental Control Strategy (CS3)	Control Strategy (CSC)
Revised 2023 and later model year light-duty vehicle GHG standards (LDGHG2023)					
I/M Program	MOVES inputs			√	√
TxLED Fuel	Post-processing rates adjustment				√

[1] For the pre-1990 scenario, MOVES diesel and gasoline property inputs reflected pre-1990 diesel sulfur and pre-1992 conventional gasoline with 1992 summer Reid vapor pressure [RVP] limit promulgated prior to enactment of the 1990 CAAA. For the control strategy scenario, MOVES gasoline and diesel inputs reflected Ultra Low Sulfur Diesel, CG for 2017 consistent with the actual, summer 2017 survey data, and for 2023 the same as 2017 CG inputs except with sulfur set to the Tier 3 sulfur (10 ppm) standard; Post-1990 FMVCP altogether, per MOVES limitation.

4.3 MOVES Run Specification Input Files

The MRS is a file (in XML format) that defines the place, time, road categories, vehicle and FTs, pollutants and emissions processes, and the overall scale and level of output detail for the modeling scenario. TTI created an MRS for one county and scenario using the MOVES graphical user interface, then converted the MRS to a template, and used it as a base from which to build all the needed MRS files.

Table 31 describes the MRS selections used to produce MOVES output needed for post-processing the emissions rates for the two main RFP control scenarios, with further details on the selections provided after the table.

Table 31. RFP Control Scenario MRS Selections by MOVES GUI Panel.

<table>
<tr><th>Navigation Panel</th><th>Detail Panel</th><th colspan="6">Selection</th></tr>
<tr><td>Scale[1]</td><td>Model; Domain/Scale; Calculation Type</td><td colspan="6">On-Road; County;
Emissions Rates</td></tr>
<tr><td>Time Spans[1]</td><td>Time Aggregation Level;
Years – Months – Days – Hours</td><td colspan="6">Hour;
<<i>YEAR</i>>[1] - July – Weekday - All</td></tr>
<tr><td>Geographic Bounds[1]</td><td>Region;</td><td colspan="6">Zone and Link;
<<i>COUNTY</i>>;[1]
<<i>COUNTY INPUT DATABASE (CDB) NAME</i>>[1]</td></tr>
<tr><td rowspan="3">On-Road Vehicles[2]</td><td rowspan="3">SUT/Fuel Combinations</td><td>SUT</td><td>1</td><td>2</td><td>3</td><td>5</td><td>9</td></tr>
<tr><td>Motorcycle</td><td>X</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Passenger Car</td><td>X</td><td>X</td><td>-</td><td>-</td><td>X</td></tr>
</table>

Navigation Panel	Detail Panel	Selection					
	(1- gasoline, 2- diesel, 3- CNG, 5- E85, 9- electricity)	Passenger Truck	X	X	-	-	X
		Light Commercial Truck	X	X	-	-	X
		Other Buses	X	X	X	-	X
		Transit Bus	X	X	X	-	X
		School Bus	X	X	X	-	X
		Refuse Truck	X	X	X	-	X
		Single Unit Short-Haul Truck	X	X	X	-	X
		Single Unit Long-Haul Truck	X	X	X	-	X
		Motor Home	X	X	X	-	X
		Combination Short-Haul Truck	X	X	X	-	X
		Combination Long-Haul Truck	-	X	-	-	X
Road Type	Selected Road Types	Off-Network – Rural Restricted Access – Rural Unrestricted Access – Urban Restricted Access – Urban Unrestricted Access					
Pollutants[3] and Processes	VOC; CO; NO_X; Atmospheric CO_2; SO_2; NH_3; $PM_{2.5}$: Total Exhaust, Brakewear, and Tirewear; PM_{10}: Total Exhaust, Brakewear, and Tirewear	Dependent on pollutants: Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Evap Fuel Vapor Venting, Evap Fuel Leaks; Brakewear, Tirewear					
General Output	Output Database; Units; Activity	***<MOVES OUTPUT DATABASE NAME>***;[1] Grams, KiloJoules, Miles; Hotelling Hours, Population, Starts (not adjustable, pre-selected)					
Output Emissions Detail	Always; For All Vehicles/Equipment; On Road	Time: Hour – Location: Link – Pollutant; FT, Emission Process; Road Type, Source Use Type					
Advanced Features	Aggregation and Data Handling	Only the "clear BaseRateOutput after rate calculations" box was checked					

[1] County FIPS code, year, season/daytype, and control scenario labels were included in the MRS file and output database names. The same is true for the CDBs, except for season/daytype label.
[2] Although MOVES requires all FTs be included in MRSs, only gasoline, diesel, and electricity were modeled.
[3] Pre-requisite pollutants that were needed to model the reported pollutants are not shown.

4.3.1 Scale

The MOVES Domain/Scale "County" was selected as is required for SIP inventory estimates. The MOVES Calculation Type "Emissions Rates" was selected for MOVES to produce the emissions rates with speed bin indexing, as needed for the link-based inventory estimation process.

4.3.2 Time Spans

The Time Spans parameters were specified to provide the most detail available, which is the hourly aggregation level, for all hours of the day, for the selected year, month, and day type. One analysis year (2017, 2023, 2024, 2026, or 2027) was selected, and one "Months" (July) and one "Days" (Weekdays) selection was made. Table 32 shows the season used for emissions rate development.

Table 32. Seasonal Analysis Period.

Season	MOVES monthID	Months	Label[1]
Summer	7	June through August	S

[1] Label used in filenames

4.3.3 Geographic Bounds

Under Geographic Bounds for the County Domain Scale, only one county may be selected. The local CDB containing the calendar year scenario-specific input data for the county was specified as the County Domain Input Database, and under Region, "Zone & Link" was selected as required for the emissions rates calculation type. With these required set-ups, one county, one year, one day type, 24 hourly periods, and 16 (speed bin) average speeds were modeled per run.

4.3.4 On-Road Vehicles and Road Type

The local VMT mixes developed for the study define the SUT/FT combinations included in the MOVES runs. The VMT mixes specify the vehicle fleet as the gasoline, diesel, and electricity SUTs designated as "on-road vehicle equipment" selections in Table 31. These SUT/FT combinations were chosen in all the MOVES RunSpecs. All other SUT/FT combinations available in MOVES were also selected as required by MOVES, but only gasoline, diesel, and electricity were modeled. FTs output was controlled through adjustments to the MOVES default fuel engine fractions, via the MOVES avft table (discussed later). All five MOVES road type categories were selected.

4.3.5 Pollutants and Processes

In addition to the required pollutants within the scope of the inventory, MOVES requires that additional pollutants be selected for "chained" pollutants (i.e., pollutants that are calculated as a function of another MOVES pollutant). Of the pollutants listed for the inventory, the following additional pollutants were selected, as required by the model, due to chaining: non-methane hydrocarbons and total gaseous hydrocarbons (for VOC); total energy consumption (TEC) (for CO_2 and SO_2); and Composite – NonECPM, Elemental Carbon, H_2O (aerosol), and sulfate for Primary Exhaust $PM_{2.5}$ - Total. All of the associated on-road processes available by the selected pollutants were included; the two refueling emissions processes were excluded (in Texas refueling emissions are in the area source category).

4.3.6 Output Features

The output units were grams, kilojoules, and miles. The activity categories were pre-set by MOVES rates mode (and not adjustable) for inclusion in the output database. The selected output detail level was by hour, link (in MOVES rates mode "link" is the combination of county, road type, and speed bin), pollutant, process, road type, SUT, and FT.

The MOVES model produces results at different aggregation levels that are selected in the MRS. The detailed, hourly, link-based inventory method required MOVES weekday day-type rates at the following MOVES output detail level:

- Thirteen source types (i.e., vehicle types);
- Up to five FTs (three for this analysis);
- Five road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- Sixteen speed bins (only included in miles-based rate tables);
- Up to one hundred thirteen pollutants (selected per project scope); and
- Up to fifteen emission processes affected by on-road (refueling processes may or may not be selected depending on the project scope).

The vehicle fleet was modeled as powered only by the predominant on-road fuels of gasoline, diesel, and electricity (other alternate fuels were considered *de minimis*). The five road type categories in MOVES are Off-Network (not actually a road type, this category is for parked vehicle activity), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access. The rates for each of the actual four MOVES road types are indexed by the 16 MOVES speed bin average speeds: 2.5, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75 mph. Refueling emissions process were not in the scope of this analysis.

Appendix B lists the electronic data files provided in support of this analysis, which includes the MRSs used.

4.4 MOVES County Input Databases

TTI developed procedures to accommodate building and checking CDBs for EI estimation projects. The basic procedure was to write a MySQL script to produce one county scenario CDB and convert it to a template from which all of the CDB scripts were built. The scripts were then run in batch mode to produce all CDBs for the analysis.

Data for populating the CDBs were first prepared in the form of text files and/or MySQL databases (e.g., for local fuels, and weather data), and some values were provided directly in the CDB builder MySQL script. Any default data used was selected from the MOVES default database, MOVESDB20240104. After running the scripts to produce the CDBs, the CDB were checked to verify all CDB tables were built and populated as intended.

Table 33 provides an outline and brief description of the CDBs, followed by a discussion of the development of the local data and the defaults contained therein. Unless otherwise stated, the CDB table data applies to all counties and years to the full control scenarios (i.e., CSC).

Table 33. CDB Input Tables.

Table	Data Source	Notes
auditlog	Local Input	Table for MOVES to determine if the imcoverage table is required
avft	Local /defaults	Estimated SUT fuel fractions using TxDMV vehicle registration data and MOVES defaults, where needed. Local data sets used were consistent with sourcetypeagedistribution tables. The avft estimate is also consistent with the analysis VMT mix (i.e., gasoline, diesel, and electricity).
county	Local Input	Identifies county with local altitude and barometric pressure (BP). Used 2017 summer average BP provided by TCEQ (from 2017 periodic EI).
fuelformulation	Local Input	• Conventional gasoline (CG) formulations based on TCEQ’s summer 2023 (latest available) fuel survey samples. • The diesel sulfur level is the statewide average from TCEQ’s 2023 survey. • Future years (2024+) diesel sulfur was set to the current expected future year value (MOVES4 default - 6 ppm), which

Table	Data Source	Notes
		is conservative and consistent with the statewide diesel sulfur average from TCEQ's latest (2023) survey. • The latest available (2021) Department of Energy (DOE) state-level transportation sector BD consumption estimates is applied for all future analysis years. Fuel subtype IDs 12 and 21 are 10% ethanol-blend gasoline and biodiesel, respectively.
fuelsupply	Local Input	For each analysis year and season, the local fuel supply will consist of one conventional gasoline formulation and one biodiesel formulation.
fuelusagefraction	Local Input	Flex fuel vehicle FT usage, set for Texas modeling assumptions, i.e., flex-fuel vehicles operate totally on gasoline
imcoverage	Local Input	Empty for all scenarios aside from CSC.
sourcetypeagedistribution	Local Input	Distribution by 31 age categories for each source type, based on the latest available county vehicle registrations (TxDOT district level for county group CDBs), and MOVES defaults where needed (i.e., for buses, refuse trucks, motor homes)
zonemonthhour	Local Input	Summer hourly temperature and relative humidity for the county. 2017 averages: June-July-August from TCEQ's 2017 periodic EI.
avgspeeddistribution	MOVES Default	Used MOVES default average speed distributions.
dayvmtfraction	MOVES Default	Used MOVES default day VMT fractions.
hotellingactivitydistribution	MOVES Default	Used the MOVES default activity distributions.
hotellinghourfraction	MOVES Default	Used the MOVES default hour fraction.
hotellinghoursperday	MOVES Default	Used the MOVES default hours per day.
hotellingmonthadjust	MOVES Default	Used the MOVES default month adjustment.
hourvmtfraction	MOVES Default	Used MOVES default hour VMT fractions.
hpmsvtypeyear	MOVES Default	Used MOVES default national annual VMT by HPMS vehicle type.
monthvmtfraction	MOVES Default	Used MOVES default seasonal average VMT fractions.
roadtypedistribution	MOVES Default	Used MOVES default road type VMT fractions.
sourcetypeyear	MOVES Default	Used MOVES default national SUT populations.
startsageadjustment	MOVES Default	Distribution by 31 age categories for each source type, based on latest available county vehicle registrations (TxDOT district level for county group CDBs), and MOVES defaults where needed (i.e., for buses, refuse trucks, motor homes)
startshourfraction	MOVES Default	Used MOVES default starts hour fractions.
startsmonthadjust	MOVES Default	Used MOVES default seasonal average starts month adjustment fractions. For summer season, use average value from June, July and August.
startsopmodedistribution	MOVES Default	Used MOVES default starts operating mode fractions.
startsperdaypervehicle	MOVES Default	Used MOVES default starts per day per vehicle.
state	MOVES Default	Identifies the state (Texas) for the analysis.
totalidlefraction	MOVES Default	Used MOVES default seasonal average total idle fractions.
year	MOVES Default	Designates analysis year as a base year (base year means that local activity inputs will be supplied rather than forecast by the model).
zone	MOVES Default	Start, hotelling, and SHP zone allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).

Table	Data Source	Notes
zoneroadtype	MOVES Default	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
hotellingagefraction	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Idledayadjust	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Idlemonthadjust	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
idlemodelyeargrouping	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Onroadretrofit	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Starts	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Startsperday	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Hpmsvtypeday	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
Sourcetypedayvmt	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.
sourcetypeyearvmt	Empty Table	An empty table in MOVES default format was created in the database to avoid MOVES run errors.

4.4.1 Year, State, and County Inputs

The year, state, and county tables are populated with data identifying the year, state, and county of the run.

The yearID field of the “year” table was populated with the analysis year value, and the year was set as a base year (to specify that certain user-input fleet and activity data were to be used, rather than forecast by MOVES during the model runs). As part of designating the appropriate fuel supply for the modeling scenario, the fuelyearID in the year table was also set to the analysis year.

StateID “48” (Texas) was inserted in the state table. In addition to identifying the county of analysis, the county table contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data were selected from a prepared local “meteorology” database containing tables of weather data records (i.e., “county” and “zonemonthhour” tables) for the analysis. Countytypeid was set to 1 indicating the nonattainment areas are metropolitan statistical area (MSA) counties, and MSAs were set to “Dallas-Fort Worth-Arlington; TX” for DFW, “Houston-The Woodlands-Sugar Land; TX” for HGB, and “San Antonio-New Braunfels; TX” for Bexar County. Whether a county is in an MSA affects the offnetwork idling emission rates, which vary in MOVES between MSA and non-MSA counties.

4.4.2 Activity and Vehicle Population Inputs

The following activity and vehicle population input parameters under the methodology mostly use the MOVES defaults. The data tables are: hourvmtfraction, dayvmtfraction, monthvmtfraction, hpmsvtypeyear, roadtypedistribution, avgspeeddistribution, sourcetypeyear, startsperdaypervehicle, startshourfraction, startsmonthadjust, startsageadjustment, startssopmodedistribution, totalidelfraction, and hotellingactivitydistribution. Data for all these tables were selected and inserted from the MOVES default database. In the case of the startsmonthadjust and totalidlefraction, that vary by month, the MOVES default data were averaged for each three-month seasonal period (same for MOVES default monthvmtfraction, for consistency).

The zone and zoneroadtype tables contain zonal sub-allocation activity factors. For county scale analyses, county is equal to zone; therefore these allocation factors were set to 1.0. The MOVES default value was used for the fuelusagefraction except that the usage for fueltype 5 was set to zero.

4.4.3 Age Distributions and Fuel Engine Fractions Inputs

The locality-specific inputs of vehicle age and FT fractions by model year, under the SIP county-level inventory procedures, consist of county-level age distributions and statewide gasoline, diesel, E85 and electricity fractions (fuel engine fractions in MOVES). The age distributions and fuel engine fractions inputs were calculated and written to text files in preparation for loading the data into the appropriate CDB input tables: the sourcetypeagedistribution table for age distributions, and the avft table for fuel engine fractions. MySQL scripts were used to populate the CDB input tables.

The age distributions and fuel engine fractions were based on TxDMV year-end 2018 (for 2017 base year) and the latest 2021 (for all future years) county registrations data and MOVES model defaults, where needed. (Typically latest available mid-year age distributions would be used, however no recent mid-year registration data were available.) The local registration data currently available provides no light-duty fuel-type information and provides gasoline and non-gasoline (assumed diesel) registrations for heavy-duty categories. The fuel engine fractions were developed consistent with the local registration data, as well as the VMT mix estimate (i.e., the local fuel engine fractions estimates reflect no compressed natural gas vehicles and no E85 fuel usage, in effect, gasoline, diesel, and electricity use only). MOVES default flex fuel fractions were actually included in the AVFT table giving the potential for E85 use, however E85 use was set to zero via the fuelusagefraction table. Appendix F includes the age distributions and fuel engine fractions summaries.

Table 34 summarizes the data sources and aggregation levels used to estimate the local sourcetypeagedistribution and avft inputs to MOVES.

Table 34. Age Distributions and Fuel/Engine Fractions - Data Sources and Aggregations.

SUT Name	SUT ID	TxDMV Category[1] Aggregations for Age Distributions and Fuel/Engine Fractions	Geographic Aggregation for Age Distributions	Geographic Aggregation for Fuel/Engine Fractions[2]
Motorcycle	11	Motorcycles	County	NA – 100% gasoline, no Fuel/Engine Fractions
Passenger Car	21	Passenger Cars	County	District[2]
Passenger Truck	31	Total Trucks<=8500	County	District[2]
Light Commercial Truck	32	Total Trucks<=8500	County	District[2]
Single-Unit Short-Haul Truck	52	>8500+ >10000+ >14000+>16000	TDM Regional	Texas Statewide
Single-Unit Long-Haul Truck	53	>8500+ >10000+ >14000+>16000	Texas Statewide	Texas Statewide
Refuse Truck	51	MOVES default (for MOVES yearID consistent with the analysis year)		
Motor Home	54			
Other Buses	41			
Transit Bus[2]	42			
School Bus	43			
Combination Short-Haul Truck	61	>19500+ >26000+ >33000+ >60000	TDM Reginal	Texas Statewide
Combination Long-Haul Truck	62	>19500+ >26000+ >33000+ >60000	Texas Statewide	Texas Statewide

[1] TxDMV year-end 2018 (for 2017 base year) and 2021(latest available, used for all future years) county vehicle registrations data were used for developing local inputs (weights are GVWR in units of pounds). The MOVES model default age distributions were from the MOVESDB20240104 database.

[2] MOVES fuel engine fraction defaults (for gasoline, diesel, E85 capability) were used for light-duty SUTs (with E85 use set to zero in the fuelusagefraction table). MOVES default fuel engine fractions were taken from the MOVESDB20240104 sample vehicle population table. District level local EV adjusted MOVES4 default is applied.

4.4.4 Local Meteorological Inputs

Meteorological data was used to develop the "county" (barometric pressure and altitude) and "zonemonthhour" (temperature and relative humidity) table inputs. These inputs were developed as seasonal hourly temperature and relative humidity, and 24-hour barometric pressure averages, using the hourly data from multiple weather stations within DFW and HGB nonattainment area counties and within Bexar County (originally developed and applied in the TCEQ's 2017 Air Emissions Reporting Requirements [AERR] inventory analysis). Altitude was set to low. Table 35 provides examples of the tabulated input values temperatures and relative humidity used as input into MOVES, in this case, for Dallas, Harris, and Bexar Counties. The barometric pressure input for Dallas, Harris, and Bexar County were 29.369, 29.878, and 29.104 inches mercury, respectively.

Table 35. Sample Meteorological Inputs.

Hour	Dallas County (DFW)[1,2]		Harris County (HGB)[1,2]		Bexar County[1]	
	Temperature (°F)	Relative Humidity (%)	Temperature (°F)	Relative Humidity (%)	Temperature (°F)	Relative Humidity (%)
1	79.70	74.88	80.11	81.48	78.99	77.90
2	78.83	77.12	79.53	83.24	77.82	81.39
3	78.01	78.92	79.02	84.64	76.91	84.04
4	77.23	80.95	78.57	85.89	76.21	85.87
5	76.69	82.22	78.16	87.04	75.69	87.13
6	76.12	83.47	77.89	87.53	75.26	88.00
7	75.68	84.39	77.74	87.93	74.88	88.78
8	76.28	82.95	78.94	84.8	75.43	87.31
9	78.08	78.35	81.29	78.22	77.66	81.44
10	80.40	72.27	83.39	71.68	80.33	72.68
11	82.68	66.72	85.27	65.51	82.98	64.24
12	84.81	61.88	86.74	61.08	85.47	57.70
13	86.65	57.99	87.8	58.21	87.72	52.12
14	88.23	54.55	88.38	56.94	89.53	48.18
15	89.28	52.31	88.63	56.56	91.03	44.94
16	89.72	51.21	88.46	57.00	92.13	43.00
17	89.74	50.95	88.3	57.87	92.60	42.18
18	89.31	51.94	88.06	59.12	92.48	42.81
19	88.56	53.47	87.08	61.67	91.50	44.95
20	87.08	56.89	85.44	65.93	89.54	50.16
21	84.87	62.04	83.65	70.85	86.61	56.89
22	83.18	65.89	82.4	74.43	84.11	62.97
23	81.81	69.42	81.45	77.29	82.12	68.75
24	80.69	72.36	80.72	79.47	80.42	73.82

[1] MonthID = 7.

[2] Dallas County is in the DFW 9-County Area, whereas Harris County is in the HGB 6-County Area.

4.4.5 Fuels Inputs

4.4.5.1Overview and Assumptions

TTI uses various data sources to produce best available Texas summer fuel formulation inputs to MOVES. There are four MOVES fuels input tables that must be consistent between the FTs in the scope of the inventory analysis. These are:

- AVFT (source type population FT distributions by model year).
- fuelformulation (fuel properties for each fuel sub type supplied in the study area).
- fuelsupply (market shares of each fuel sub type formulation).
- fuelusagefraction (flex fuel vehicle FT usage).

The FTs in the scope of the inventory analysis for Texas FY2024 is gasoline, diesel, and electricity with other alternative fuels assumed to have insignificant impact. Thus the AVFT model year fuel fractions are normalized for only gasoline, diesel, electricity, and flex fuel vehicles (i.e., vehicles with capability to be powered by gasoline or E85 [gasoline with about a 15% by volume ethanol content]). Since the analysis scope is gasoline, diesel and electricity, flex fuel vehicle fuel usage is set to 100% gasoline (via the fuelusagefraction table). With the gasoline, diesel, and electricity scope set by the AVFT and fuelusagefraction tables, the fuelformulation and fuelsupply table's gasoline and diesel fuel properties and market shares must be specified.

4.4.5.2Texas FT details

The Texas MOVES4 fuels inputs consist of gasohol (gasoline blended with roughly 10% ethanol - for CG and reformulated gasoline [RFG] - fuelsubtypeID 12) and biodiesel (BD) (ultra low sulfur diesel [USLD] - in Texas blended with roughly 5% biodiesel - fuelsubtypeid 21), and electricity (fuelsubtypeID 90). Except for electricity, the other alternative fuels available in MOVES4 are treated as negligible and are excluded from the analysis (via use of the MOVES avft and fuelusagefraction tables fuelfraction inputs). Since MOVES4 requires all (5) available FTs to be included in the fuelformulation and fuelsupply inputs for error-free runs, the MOVES4 default fuelformulations for CNG (fuelsubtypeid 30) and E85 (ethanol - blended with roughly 15% gasoline - fuelsubtypeid 51) are included, as well as the MOVES4 default for electricity, with 1.0 marketshare in the fuel supply, are included in the CDBs. (TTI inserted these alternative fuel formulations and supplies, and the updated avft fuel fractions [i.e., gasoline, diesel, electricity, and flex FTs only], and set flex fuel vehicles to 100 percent gasoline use in the fuelusagefraction table, via CDB builder scripts.)

4.4.5.3 Data Sources

The local data include historical and current, latest available retail outlet seasonal fuel surveys of gasoline and diesel fuel, and annual, estimated state level fuels sales statisctics including summaries from which to estimate biodiesel volumes relative to petroleum diesel sales volumes and gasoline sales estimates by the three grades (regular, mid-grade, premium). Survey data consists of TCEQ statewide summer gasoline and diesel retail outlet sampling surveys. The TCEQ survey data applicable to FY2024 TCEQ inventories includes the 2017, 2020, and 2023 summer season statewide surveys. TTI uses the TCEQ E10 conventional gasoline data processed by MOVES fuel regions for non-RFG regions, and produces statewide diesel sample averages (sulfur content) assumed for all counties, supplemented with biodiesel volume content estimates based on the DOE Energy Information Administration's (EIA’s) diesel sales statistics (historical and latest available).

4.4.5.4 General Procedure

The goal is to use the best available local fuel survey data by season and year, supplemented as needed by defaults and other data (e.g., DOE annual fuel sales statistics). For future years where no survey data is yet available, the latest available local fuel properties are used, where particular regulated properties are replaced with expected future year values (e.g., regulatory standards or limits, typically reflected in the MOVES analysis year and season default values).

The fuel formulation development procedures by MOVES fuel regions are documented in the latest TTI EI development reports sponsored by TCEQ[20]. In general, the sample data are aggregated and averaged by fuel grade within each MOVES fuel region (e.g., consistent with Texas fuel regulation jurisdictions and distribution networks), then weighted into gasoline composite averages using relative sales volumes by grade.

The application of summer fuel formulations is for the June through August season, referenced in MOVES by month ID 7 (for July).

The local, summer season, fuels inputs to MOVES were supplied in the CDB fuelsupply and fuelformulation tables. The fuel supply for each county, year, and RFP scenario

[20] For more information, refer to TTI’s (2024) Protocols for the Development of Emission Inventory Modeling Parameters and Calculation of Local Values for Texas report. (PGA: 582-23-43429-012).

consisted of one gasoline, one diesel, and one electricity formulation, to be modeled in the inventories, plus one each of the other deminimis MOVES alternative FTs required to run MOVES but excluded from the inventory via the AVFT. Each fuel formulation market share in the fuel supply was therefore set to 1.0. These FTs are consistent with the local SUT/FT VMT mix and AVFT estimates. TTI prepared both RFP pre-1990 and control strategy scenario inputs.

TTI developed the control strategy fuels inputs based on local, retail outlet survey data, and where appropriate, expected future year values.

For the pre-1990 controls scenario, TTI used an appropriate MOVES default gasoline formulation. The pre-1990 controls diesel formulation used was developed by TTI for previous analyses based on National Institute for Petroleum and Energy Research (NIPER)-developed information on pre-regulation diesel sulfur content.

The MOVES fuelformulation table fields and units include:

- RVP (pounds per square inch [psi]);
- sulfurLevel (parts per million [ppm]);
- ETOHVolume (volume percent);
- MTBEVolume (volume percent);
- ETBEVolume (volume percent);
- TAMEVolume (volume percent);
- aromaticContent (volume percent);
- olefinContent (volume percent);
- benzeneContent (volume percent);
- e200 (vapor percent at 200 degrees Fahrenheit);
- e300 (vapor percent at 300 degrees Fahrenheit);
- BioDieselEsterVolume (volume percent);
- T50 (degrees Fahrenheit at 50 percent vapor); and
- T90 (degrees Fahrenheit at 90 percent vapor).

Although not listed previously, the fields CetaneIndex, and PAHContent are also included in the fuelformulation table, but are not currently enabled for use in MOVES.

4.4.5.5Fuel Formulations.

Table 36 through Table 39 summarizes the gasoline and diesel fuel property inputs for the nonattainment areas. Prior to 2024, there are two different fuel regions among the counties that made up the DFW 9-county nonattainment areas: the TxLRVPG region ("178010000"), which covers Ellis, Johnson, Kaufman, Parker, and Wise Counties, and the RFG region ("1370011000"), which covers Collin, Dallas, Denton, and Tarrant Counties. Starting in 2024, all nine DFW counties are reclassified under "1370011000".

Table 36. DFW (Fuel Region: 1370011000) Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES.

Fuel Formulation Field	Units	Pre-1990 Control Fuels[1]		Gasoline[2]			Diesel[3]		
		Gasoline	Diesel	2017	2023	2024+	2017	2023	2024+
fuelFormulationID	-	10001	32500	17724	2078	2478	30176	30236	30600
fuelSubtypeID	-	10	20	12	12	12	21	21	21
RVP	psi	7.8	0	7.01	7.09	7.09	0	0	0
sulfurLevel	ppm	429.96	2500	19.49	9.58	7.36	6.37	5.91	6
ETOHVolume	vol.%	0	0	9.67	9.56	9.56	0	0	0
MTBEVolume	vol.%	0	0	0	0	0	0	0	0
ETBEVolume	vol.%	0	0	0	0	0	0	0	0
TAMEVolume	vol.%	0	0	0	0	0	0	0	0
aromaticContent	vol.%	26.4	0	15.62	16.98	16.98	0	0	0
olefinContent	vol.%	11.9	0	10.83	10.08	10.08	0	0	0
benzeneContent	vol.%	1.64	0	0.51	0.37	0.37	0	0	0
e200	vap.%	50	0	49.02	46.96	46.96	0	0	0
e300	vap.%	83	0	84.54	85	85	0	0	0
VolToWtPercentOxy	-	0	0	0.3653	0.3653	0.3653	0	0	0
BioDieseEsterVolume	vol.%	\N	0	\N	\N	\N	4.68	3.13	3.13
CetaneIndex	-	\N	\N	\N	\N	\N	\N	\N	\N
PAHContent	vol.%	\N	\N	\N	\N	\N	\N	\N	\N
T50	deg. F	199.82	0	203.13	210.48	210.48	0	0	0
T90	deg. F	329.41	0	327.89	325.1	325.1	0	0	0

[1] For pre-1990 control fuels, fuel formulation ID 10001 and 32500 are consistent with TCEQ's most recent RFP emissions analysis (for HGB, TTI 2019). The 7.8 psi RVP limit formulation (not available in MOVES4) is from MOVES2014b. The diesel formulation 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 CG and conventional diesel, respectively.

[2] The CG E10 estimates for 2017 and later are based on the TCEQ's summer 2017 and 2020 (latest available) fuel surveys, using MOVES4 defaults for future year expected values (for RVP, sulfur level, and benzene content).

[3] The diesel sulfur level for 2017 is the statewide average of TCEQ's 2017 survey samples. Diesel sulfur for future years is set to the MOVES4 default expected value for future years, which fits well with 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 (2019) for future years. Fuel subtype ID 21 is biodiesel (BD), in Texas, ULSD currently estimated with a blend of about 5% by volume biodiesel ester.

Table 37. DFW (Fuel Region: 178010000) Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES.

Fuel Formulation Field	Units	Pre-1990 Control Fuels[1]		CG[2]			Diesel[3]		
		Gasoline	Diesel	2017	2023	2024+	2017	2023	2024+
fuelFormulationID	-	10002	32500	17702	2372	2472	30176	30236	30600
fuelSubtypeID	-	10	20	12	12	12	21	21	21
RVP	psi	9	0	7.54	7.62	7.8	0	0	0
sulfurLevel	ppm	429.96	2500	21.28	14.08	7.15	6.37	5.91	6
ETOHVolume	vol.%	0	0	9.66	9.7	9.7	0	0	0
MTBEVolume	vol.%	0	0	0	0	0	0	0	0
ETBEVolume	vol.%	0	0	0	0	0	0	0	0
TAMEVolume	vol.%	0	0	0	0	0	0	0	0
aromaticContent	vol.%	26.4	0	25.35	28.39	28.39	0	0	0
olefinContent	vol.%	11.9	0	8.33	9.35	9.35	0	0	0
benzeneContent	vol.%	1.64	0	0.76	0.59	0.976	0	0	0
e200	vap.%	50	0	49.45	50.25	50.25	0	0	0
e300	vap.%	83	0	82.68	84.4	84.4	0	0	0
VolToWtPercentOxy	-	0	0	0.3653	0.3653	0.3653	0	0	0
BioDieseEsterVolume	vol.%	\N	0	\N	\N	\N	4.68	3.13	3.13
CetaneIndex	-	\N	\N	\N	\N	\N	\N	\N	\N
PAHContent	vol.%	\N	\N	\N	\N	\N	\N	\N	\N
T50	deg. F	199.82	0	203.73	199.01	199.01	0	0	0
T90	deg. F	329.41	0	327.68	2372	322.32	0	0	0

[1] For pre-1990 control fuels, fuel formulation ID 10001 and 32500 are consistent with TCEQ's most recent RFP emissions analysis (for HGB, TTI 2019). The 7.8 psi RVP limit formulation (not available in MOVES4) is from MOVES2014b. The diesel formulation 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 CG and conventional diesel, respectively.

[2] The CG E10 estimates for 2017 and later are based on the TCEQ's summer 2017 and 2020 (latest available) fuel surveys, using MOVES4 defaults for future year expected values (for RVP, sulfur level, and benzene content).

[3] The diesel sulfur level for 2017 is the statewide average of TCEQ's 2017 survey samples. Diesel sulfur for future years is set to the MOVES4 default expected value for future years, which fits well with 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 (2019) for future years. Fuel subtype ID 21 is biodiesel (BD), in Texas, ULSD currently estimated with a blend of about 5% by volume biodiesel ester.

Table 38. HGB Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES.

Fuel Formulation Field	Units	Pre-1990 Control Fuels[1]		CG[2]			Diesel[3]		
		Gasoline	Diesel	2017	2023	2024+	2017	2023	2024+
fuelFormulationID	-	10001	32500	17724	2079	2479	30176	30236	30600
fuelSubtypeID	-	10	20	12	12	12	21	21	21
RVP	psi	7.80	\N	7.01	7.15	7.15	0	0	0
sulfurLevel	ppm	429.96	2,500.00	19.49	9.98	7.36	6.37	5.91	6
ETOHVolume	vol.%	0	\N	9.67	9.56	9.56	0	0	0
MTBEVolume	vol.%	0	\N	0	0	0	0	0	0
ETBEVolume	vol.%	0	\N	0	0	0	0	0	0
TAMEVolume	vol.%	0	\N	0	0	0	0	0	0
aromaticContent	vol.%	26.40	\N	15.62	16.92	16.92	0	0	0
olefinContent	vol.%	11.90	\N	10.83	10.24	10.24	0	0	0
benzeneContent	vol.%	1.64	\N	0.51	0.41	0.41	0	0	0
e200	vap.%	50	\N	49.02	48.2	48.2	0	0	0
e300	vap.%	83	\N	84.54	84.92	84.92	0	0	0
VolToWtPercentOxy	-	0	\N	0.3653	0.3653	0.3653	0	0	0
BioDieseEsterVolume	vol.%	\N	0	\N	\N	\N	4.68	3.13	3.13
CetaneIndex	-	\N	\N	\N	\N	\N	\N	\N	\N
PAHContent	vol.%	\N	\N	\N	\N	\N	\N	\N	\N
T50	deg. F	199.82	\N	203.13	206.36	206.36	0	0	0
T90	deg. F	329.41	\N	327.89	326.7	326.7	0	0	0

[1] For pre-1990 control fuels, fuel formulation ID 10001 and 32500 are consistent with TCEQ's most recent RFP emissions analysis (for HGB, TTI 2019). The 7.8 psi RVP limit formulation (not available in MOVES4) is from MOVES2014b. The diesel formulation 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 CG and conventional diesel, respectively.

[2] The CG E10 estimates for 2017 and later are based on the TCEQ's summer 2017 and 2020 (latest available) fuel surveys, using MOVES4 defaults for future year expected values (for RVP, sulfur level, and benzene content).

[3] The diesel sulfur level for 2017 is the statewide average of TCEQ's 2017 survey samples. Diesel sulfur for future years is set to the MOVES4 default expected value for future years, which fits well with 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 (2019) for future years. Fuel subtype ID 21 is biodiesel (BD), in Texas, ULSD currently estimated with a blend of about 5% by volume biodiesel ester.

Table 39. Bexar County Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES.

Fuel Formulation Field	Units	Pre-1990 Control Fuels[1]		CG[2]			Diesel[3]		
		Gasoline	Diesel	2017	2023	2024+	2017	2023	2024+
fuelFormulationID	-	10002	32500	17702	2372	2472	30176	30236	30600
fuelSubtypeID	-	10	20	12	12	12	21	21	21
RVP	psi	9	\N	7.54	7.62	7.8	0	0	0
sulfurLevel	ppm	429.96	2,500.00	21.28	14.08	7.15	6.37	5.91	6
ETOHVolume	vol.%	0	\N	9.66	9.7	9.7	0	0	0
MTBEVolume	vol.%	0	\N	0	0	0	0	0	0
ETBEVolume	vol.%	0	\N	0	0	0	0	0	0
TAMEVolume	vol.%	0	\N	0	0	0	0	0	0
aromaticContent	vol.%	26.4	\N	25.35	28.39	28.39	0	0	0
olefinContent	vol.%	11.9	\N	8.33	9.35	9.35	0	0	0
benzeneContent	vol.%	1.64	\N	0.76	0.59	0.976	0	0	0
e200	vap.%	50	\N	49.45	50.25	50.25	0	0	0
e300	vap.%	83	\N	82.68	84.4	84.4	0	0	0
VolToWtPercentOxy	-	0	\N	0.3653	0.3653	0.3653	0	0	0
BioDieseEsterVolume	vol.%	\N	0	\N	\N	\N	4.68	3.13	3.13
CetaneIndex	-	\N	\N	\N	\N	\N	\N	\N	\N
PAHContent	vol.%	\N	\N	\N	\N	\N	\N	\N	\N
T50	deg. F	199.82	\N	203.73	199.01	199.01	0	0	0
T90	deg. F	329.41	\N	12	322.32	322.32	0	0	0

[1] For pre-1990 control fuels, fuel formulation ID 10001 and 32500 are consistent with TCEQ's most recent RFP emissions analysis (for HGB, TTI 2019). The 7.8 psi RVP limit formulation (not available in MOVES4) is from MOVES2014b. The diesel formulation 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 CG and conventional diesel, respectively.

[2] The CG E10 estimates for 2017 and later are based on the TCEQ's summer 2017 and 2020 (latest available) fuel surveys, using MOVES4 defaults for future year expected values (for RVP, sulfur level, and benzene content).

[3] The diesel sulfur level for 2017 is the statewide average of TCEQ's 2017 survey samples. Diesel sulfur for future years is set to the MOVES4 default expected value for future years, which fits well with 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 (2019) for future years. Fuel subtype ID 21 is biodiesel (BD), in Texas, ULSD currently estimated with a blend of about 5% by volume biodiesel ester.

The actual fuelformation and fuelsupply input database tables used are included in the electronic data submittal as described in Appendix B.

4.4.6 Local I/M Inputs

For this study, analysis year 2017 used 2017 I/M coverage compliance factor, whereas analysis years 2023, 2024, 2026, and 2027 used the latest available 2021 I/M coverage compliance factor. This information was received from TCEQ. Table 40, Table 41, and Table 42 summarizes the I/M program for the DFW 9-county nonattainment area, the HGB 6-county nonattainment area, and Bexar County, respectively. I/M inputs are only used in the “CS3” and “CSC” scenarios for each of the analysis years (Bexar County only has I/M coverage for analysis year 2027). Due to the lack of Bexar county in I/M coverage database, the Travis county is used as a template, and the countyID is revised to Bexar county.

Table 40. Local I/M inputs for the DFW 9-County Area

yearID	sourceTypeID	IMProgramID	begModelYearID	endModelYearID	testStandardsID	complianceFactor
2017	21	130	1993	1995	23	94.79
2017	21	151	1993	1995	41	94.79
2017	21	140	1996	2015	51	94.79
2017	21	160	1996	2015	45	94.79
2017	31	130	1993	1995	23	92.17
2017	31	151	1993	1995	41	92.17
2017	31	140	1996	2015	51	92.17
2017	31	160	1996	2015	45	92.17
2017	32	130	1993	1995	23	72.96
2017	32	151	1993	1995	41	72.96
2023	21	140	1999	2021	51	94.00
2023	21	160	1999	2021	45	94.00
2023	31	140	1999	2021	51	91.39
2023	31	160	1999	2021	45	91.39
2023	32	140	1999	2021	51	72.35
2023	32	160	1999	2021	45	72.35
2024	21	140	2000	2022	51	94.00
2024	21	160	2000	2022	45	94.00
2024	31	140	2000	2022	51	91.39
2024	31	160	2000	2022	45	91.39
2024	32	140	2000	2022	51	72.35
2024	32	160	2000	2022	45	72.35
2026	21	140	2002	2024	51	94.00
2026	21	160	2002	2024	45	94.00

yearID	sourceTypeID	IMProgramID	begModelYearID	endModelYearID	testStandardsID	complianceFactor
2026	31	140	2002	2024	51	91.39
2026	31	160	2002	2024	45	91.39
2026	32	140	2002	2024	51	72.35
2027	21	140	2003	2025	51	94.00
2027	21	140	2003	2025	51	94.00
2027	21	160	2003	2025	45	94.00
2027	31	140	2003	2025	51	91.39
2027	31	160	2003	2025	45	91.39
2027	32	140	2003	2025	51	72.35

Table 41. Local I/M inputs for HGB 6-County Area

yearID	sourceTypeID	IMProgramID	begModelYearID	endModelYearID	testStandardsID	complianceFactor
2017	21	130	1993	1995	23	95.50
2017	21	151	1993	1995	41	95.50
2017	21	140	1996	2015	51	95.50
2017	21	160	1996	2015	45	95.50
2017	31	130	1993	1995	23	92.85
2017	31	151	1993	1995	41	92.85
2017	31	140	1996	2015	51	92.85
2017	31	160	1996	2015	45	92.85
2017	32	130	1993	1995	23	73.50
2017	32	151	1993	1995	41	73.50
2017	32	140	1996	2015	51	73.50
2017	32	160	1996	2015	45	73.50
2023	21	140	1999	2021	51	94.00
2023	21	160	1999	2021	45	94.00
2023	31	140	1999	2021	51	91.39
2023	31	160	1999	2021	45	91.39
2023	32	140	1999	2021	51	72.35
2023	32	160	1999	2021	45	72.35
2024	21	140	2000	2022	51	94.00
2024	21	160	2000	2022	45	94.00
2024	31	140	2000	2022	51	91.39
2024	31	160	2000	2022	45	91.39
2024	32	140	2000	2022	51	72.35
2024	32	160	2000	2022	45	72.35

yearID	sourceTypeID	IMProgramID	begModelYearID	endModelYearID	testStandardsID	complianceFactor
2026	21	140	2002	2024	51	94.00
2026	21	160	2002	2024	45	94.00
2026	31	140	2002	2024	51	91.39
2026	31	160	2002	2024	45	91.39
2026	32	140	2002	2024	51	72.35
2026	32	160	2002	2024	45	72.35
2027	21	140	2003	2025	51	94.00
2027	21	160	2003	2025	45	94.00
2027	31	140	2003	2025	51	91.39
2027	31	160	2003	2025	45	91.39
2027	32	140	2003	2025	51	72.35
2027	32	160	2003	2025	45	72.35

Table 42. Local I/M inputs for Bexar County

yearID	sourceTypeID	IMProgramID	begModelYearID	endModelYearID	testStandardsID	complianceFactor
2027	21	140	2003	2025	51	95.77
2027	21	160	2003	2025	45	95.77
2027	31	140	2003	2025	51	93.12
2027	31	160	2003	2025	45	93.12
2027	32	140	2003	2025	51	73.71
2027	32	160	2003	2025	45	73.71

4.4.7 Hotelling Activity Distribution Inputs

The updated hotellingactivitydistribution table inputs were previously shown in Table 28. (These are the MOVES4 defaults.)

4.5 Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 40 tables were in the appropriate CDBs and the tables were populated with data as intended. The MOVES RunSpecs were executed in batches using the MOVES commandline tool. After completion, TTI verified that the MOVES runs were error free (i.e., checked all run log text files for errors and warnings).

4.6 EMISSIONS RATES FOR ESTIMATION OF INDIVIDUAL CONTROL REDUCTIONS

In a manner consistent with the development of the CSC scenario emissions rates, TTI produced emissions rates for the CS1, CS2, and CS3 incremental control scenarios needed for estimating the individual control measure emissions reductions.

Table 43 summarizes the run sequence. Note that existing MOVES and MOVES post-processor utility runs from the CS1, CS2, CS3, and CSC scenarios were used to produce the required 4 scenarios of emissions estimates. Existing runs and new runs are summarized together for the overall emissions rates development process, which includes development of MOVES setups (MRSs, CDBs), and post-processing set-ups. (Utility runs to calculate the emissions estimates are discussed in the next section).

Table 43. Emissions Factor Modeling Control Scenarios and Sequence.

Scenario Label	Controls Increment	MOVES CDB	MRS	MOVES Runs	Post-process Rates
CS1	Pre-1990 Controls Except Full FMVCP (base)	All pre-1990 controls except FMVCP are current as of each year	CS1 labels		√ CS1_calc (no TxLED)
CS2	CS1 + current fuels	Same as CS1 except pre-1990 fuels are replaced with current fuels	CS2 labels		√ CSC_calc (no TxLED)
CS3[2]	CS2 +I/M	Same as CS2 CDB with I/M inputs	CSC labels		√ CS1_calc (no TxLED)
CSC[3]	CS3 + TxLED	none	none		√ CSC_adj (TxLED-adjusted)

[1] MOVES output will be post-processed for all scenarios to produce SHP-based emission rates as a conversion of the MOVES vehicle-based off-network evaporative rates and to format the rates for input to the TTI EI utilities. Additionally, the full control CSC rates will be adjusted for TxLED effects.

[2] For non-I/M county runs, CS3 is skipped and CS2 output will be post-processed for TxLED effects with post-processor output labeled as shown in the last row and column.

[3] The full control strategy (CSC) will include TxLED effects on diesel vehicle NOx emissions, to be incorporated into the emission rates via the TTI ratesadjust post-processing utility.

As shown in Table 43, CS1, CS2, CS3 required the full process stream of MOVES set-ups and runs, plus post-processing to format and convert the rates to TTI EI utility input specifications. CSC only required post-processing of MOVES CS3 output to incorporate TxLED effects. This series of emission factor modeling set-ups was executed for RFP analysis years 2023, 2024, 2026, and 2027.

The emissions factor MOVES set-ups used (MRS files and CDBs) were provided as a part of the electronic data submittal (see Appendix B).

5 EMISSIONS CALCULATIONS

Using TTI's EI utilities and the previously detailed inventory activity and emissions rate inputs, TTI calculated the hourly on-road mobile EI estimates for each applicable RFP scenario.

Under the TDM link-based inventory methodology, the on-road emissions calculation process falls into two vehicle activity categories: VMT-based emissions calculations and off-network emissions calculations. The VMT-based emissions calculations use the TDM link-based VMT and speeds to estimate emissions at the TDM roadway network link level. The off-network emissions calculations use off-network activity factors (ONI hours, SHP, starts, SHEI and APU hours) to estimate emissions at the county level.

The EI utilities produced a standard tab-delimited EI summary.

5.1 Hourly Link-Based Emissions Calculations

The hourly link-based emissions by county for each inventory scenario were calculated using the EI utilities and the following major inputs.

- Time period TxDOT district-level SUT/FT VMT mix – by MOVES roadway type;
- Time period designation – the four VMT mix time periods (periods (Morning Peak, Mid-Day, Evening Peak, Overnight) to hour-of-day associations;
- Roadway-based activity – link (and intrazonal link)-specific, hourly, directional, operational VMT and speed estimates as developed by the utility to include: A node, B node, county number, TDM road type (functional class) code, link length, congested (operational) speed, VMT, and TDM area type code;
- TDM road type designations – TDM road type and area type codes to MOVES road type codes (and to VMT mix road type, and to rates road type codes) (see Table 46);
- Off-network activity factors – county, hourly ONI hours, SHP, starts, SHEI, and APU hours by vehicle type;
- Pollutant/process/units list – for emissions to be calculated and written to output in tab-delimited emissions summary files;
- Roadway-based emissions factors – MOVES-based, county level by pollutant, process, hour, average speed, MOVES road type, SUT, and FT;

- Off-network (parked vehicle) emissions factors – MOVES-based, county level by pollutant, process, hour, SUT, and FT, associated with MOVES road type ID 1;
- SCCs – mapping for MOVES source type, FT, road type, and process codes to output SCCs; and
- MOVES pollutant codes to NEI pollutant codes – for SCC output.

The VMT-based emissions were calculated for each hour using the time-period TxDOT-level SUT/FT VMT mix, the link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the link road type/area type-to-MOVES road type designations. For each link, the link was assigned a MOVES road type based on the link's road type and area type (see Table 44 through Table 46). The link VMT was distributed to each SUT/FT using the VMT mix from the appropriate time period based on the link's designated MOVES road type.

The time period VMT mixes were applied by hour as follows: morning peak, mid-day, evening, and overnight. For DFW, the morning peak spans three and a half hours from 6:30 a.m. to 10 a.m., mid-day spans six hours from10 a.m. to 4 p.m., the evening peak spans four and a half hours from 4 p.m. to 6:30 p.m. and overnight spans twelve hours from 6:30 p.m. to 6:30 a.m; where for HGB and SAN, the morning peak spans three hours from 7 a.m. to 10 a.m.; mid-day spans six hours from 10 a.m. to 4 p.m., the evening peak spans four hours from 4 p.m. to 8 p.m., and and overnight spans eleven hours from 8 p.m. to 7 a.m.

Table 44. DFW TDM Road Type/Area Type to MOVES Road Type Designations

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
1 - Freeway 8 - Hov 10 - Managed 12 - Tollroad	5 – Rural	2 – Rural Restricted Access
0 - Centroid Connector 2 - Principal Arterial 3 - Minor Arterial 4 - Collectors 6 - Freeway Ramp 7 - Frontage Road	5 – Rural	3 – Rural Unrestricted Access
1 - Freeway 8 - Hov 10 - Managed	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	4 – Urban Restricted Access

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
12 - Tollroad		
0 - Centroid Connector	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	5 – Urban Unrestricted Access
2 - Principal Arterial		
3 - Minor Arterial		
4 - Collectors		
6 - Freeway Ramp		
7 - Frontage Road		
40 - Local (Intrazonal)	40 – Local Intrazonal	

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.
[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three and a half hours of 6:30 a.m. to 10 a.m.; mid-day – six hours of 10 a.m. to 4 p.m.; PM peak – four and a half hours of 4 p.m. to 6:30 p.m.; and overnight – twelve hours of 6:30 p.m. to 6:30 a.m.

Table 45. HGB TDM Road Type/Area Type to MOVES Road Type Designations

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
3 - Toll Roads	5 – Rural	2 – Rural Restricted Access
10 - Rural Interstate		
11 - Rural Other Fwy.		
4 - Ramps (Fwy/Toll/Frnt)	5 – Rural	3 – Rural Unrestricted Access
8 - Local (Cent. Conn.)		
12 - Rural Prin. Art.		
13 - Rural Other Art.		
14 - Rural Major Col.		
1 - Urban Interstate	1 – CBD; 2 – Urban; 3 – Urban Fringe	4 – Urban Restricted Access
2 - Urban Other Freeway	2 – Urban; 3 – Urban Fringe	
3 - Toll Roads	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
10 - Rural Interstate	2 – Urban; 3 – Urban Fringe; 4 – Suburban	
11 - Rural Other Fwy.	2 – Urban; 3 – Urban Fringe	
4 - Ramps (Fwy/Toll/Frnt)	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	5 – Urban Unrestricted Access
5 - Urban Prin. Art.	1 – CBD; 2 – Urban; 3 – Urban Fringe	
6 - Urban Other Art.	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
7 - Urban Collector	1 – CBD; 2 – Urban; 3 – Urban Fringe	
8 - Local (Cent. Conn.)	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
12 - Rural Prin. Art.	3 – Urban Fringe; 4 – Suburban	
13 - Rural Other Art.	3 – Urban Fringe; 4 – Suburban	
14 - Rural Major Col.	3 – Urban Fringe; 4 – Suburban	
15 - Rural Collector	3 – Urban Fringe; 4 – Suburban	
40 - Local (Intrazonal)	40 – Local Intrazonal	

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.
[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three hours of 7 a.m. to 10 a.m.; mid-day – six hours of 10 a.m. to 4 p.m.; PM peak – four hours of 4 p.m. to 8 p.m.; and overnight – eleven hours of 8 p.m. to 7 a.m.

Table 46. SAN TDM Road Type/Area Type to MOVES Road Type Designations.

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
1 - Radl IH Fwy ML	5 – Rural	2 – Rural Restricted Access
2 - Radl IH Fwy Toll/HOV		
3 - Circ IH Fwy ML		
4 - Circ IH Fwy Toll/HOV		
5 - Radl Oth Fwy ML		
6 - Radl Oth Fwy Tol/HOV		
7 - Circ Oth Fwy ML		
8 - Circ Oth Fwy Tol/HOV		
9 - Radial Expressways		
10 - Circ. Expressways		
22 - Ramp (Fwy-to-Fwy)		
23 – Ramp (Fwy-to-Fwy) T/HV		
0 - Local (Cent Conn)	5 – Rural	3 – Rural Unrestricted Access
11 - Prin Art Div		
12 - Prin Art CLT Lane		
13 - Prin Art Undiv		
14 - Min Art Div		
15 - Min Art CLT Lane		
16 - Min Art Undiv		
17 - Coll Div		
18 - Coll CLT Lane		
19 - Coll Undiv		
20 - Frontage Road		
21 - Ramp (Between FR/ML)		
1 - Radl IH Fwy ML	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	4 – Urban Restricted Access
2 - Radl IH Fwy Toll/HOV		
3 - Circ IH Fwy ML		
4 - Circ IH Fwy Toll/HOV		
5 - Radl Oth Fwy ML		
6 - Radl Oth Fwy Tol/HOV		
7 - Circ Oth Fwy ML		
8 - Circ Oth Fwy Tol/HOV		
9 - Radial Expressways		

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
10 - Circ. Expressways		
22 - Ramp (Fwy-to-Fwy)		
23 - Ramp(Fwy-to-Fwy)T/HV		
0 - Local (Cent Conn)	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	5 – Urban Unrestricted Access
11 - Prin Art Div		
12 - Prin Art CLT Lane		
13 - Prin Art Undiv		
14 - Min Art Div		
15 - Min Art CLT Lane		
16 - Min Art Undiv		
17 - Coll Div		
18 - Coll CLT Lane		
19 - Coll Undiv		
20 - Frontage Road		
21 - Ramp (Between FR/ML)		
40 - Local (Intrazonal)	40 – Local Intrazonal	

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.
[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three hours of 7 a.m. to 10 a.m.; mid-day – six hours of 10 a.m. to 4 p.m.; PM peak – four hours of 4 p.m. to 8 p.m.; and overnight – eleven hours of 8 p.m. to 7 a.m.

The emissions factors by hour for each SUT/FT were selected based on the designated hour of the link file, and the link's designated MOVES road type and the link speed. For link speeds falling between MOVES speed bin average speeds, emissions factors were interpolated from bounding speeds. For link speeds falling outside of the MOVES speed range (less than 2.5 mph and greater than 75 mph), the emissions factors for the associated bounding speeds were used. The mass/mi rates were multiplied by the link SUT/FT VMT producing the linklevel emissions estimates. This was performed for each hour of the day.

The off-network emissions were calculated at the county-level by multiplying the hourly MOVES-based SUT/FT off-network emissions factors by the appropriate county-level hourly SUT/FT off-network activity, which was determined by the pollutant process and associated emissions rate table.

5.2 Off-Network Emission Calculations

The off-network emissions were calculated at the county-level by multiplying the hourly MOVES-based SUT/FT off-network emissions factors by the appropriate county-level hourly SUT/FT off-network activity factor, which was determined by the pollutant process (and road type ID 1 for ONI) and associated emission rates table. The off-network emissions calculations used off-network activity (ONI hours, SHP, starts, SHEI, and APU hours) to estimate emissions at the county level.

5.3 Emissions Output

The EI utilities produced the hourly link-based emissions output data sets consisting of two output files per run. These output files are:

- A tab-delimited summary output file consisting of one header section followed by hourly and 24-hour totals data blocks of on-road activity and emissions (in units of pounds). Hourly and 24-hour total summaries are by road type and vehicle type of VMT, VHT, speed (VMT/VHT), pollutant totals, and pollutant process totals (with the "off-network" category listed as the last road type preceding the TOTALS row in each data block), and with starts, SHP, SHEI, and APU activity rows last in the activity data block for each time period; and
- A tab-delimited summary SCC output file that contains the 24-hour totals of VMT and emissions (in units of pounds) using inventory data aggregations, SCCs, and pollutant codes consistent with the EPA's 2020 NEI.

The pollutants included are:

- VOC, CO, NO_X, NH_3, SO_2, CO_2, PM_{10} Total Exhaust, PM_{10} Brakewear, PM_{10} Tirewear, $PM_{2.5}$ Total Exhaust, $PM_{2.5}$ Brakewear, $PM_{2.5}$ Tirewear
- See Appendix A for further details on the EI utilities.

5.4 XML-Formatted 24-Hour Summaries for TexAER

TTI post-processed the 24-hour summer weekday 2017, 2023, 2024, 2026, and 2027 RFP control strategy scenario SCC-labeled inventory output, using the TTI's EI utilities, in the NEI Emission Inventory System (EIS) CERS XML format for inclusion in TCEQ's TexAER database.

The tab-delimited SCC-based inventory data files output by the emissions utility were produced for direct input to the XML format utility using inventory data aggregation and coding (SCCs and pollutant codes) consistent with EPA's latest 2020 NEI, as required for compatibility with TexAER. The current NEI SCC codes are aggregations of the more detailed MOVES SCC codes, providing the total emissions for each valid NEI pollutant by source type and FT (e.g., for on-road, by pollutant, the total of all roadway-based and off-network processes, excluding refueling).

The on-road EI XML summaries include VOC, CO, NO_X, SO_2, NH_3, CO_2, $PM_{2.5}$ and PM_{10} (PMs are aggregate of exhaust, tirewear, and brakewear). Each run produced the XML file and one tab-delimited SCC-labeled inventory summary per county included in the run. Further details may be found in Appendix B.

6 QUALITY ASSURANCE

Analyses and results were subjected to appropriate internal review and QA/QC procedures, including independent verification and reasonableness checks. All work was completed consistent with applicable elements of American Society for Quality, American National Standard ASQ/ANSI: E4:2014: *Quality Management Systems for Environmental Information and Technology Programs – Requirements with Guidance for Use,* February 2014, and the TCEQ Quality Management Plan.

The Quality Assurance Project Plans (QAPP) category and project type most closely matching the intended use of this analysis are QAPP Category II (for important, highly visible Agency projects involving areas such as supporting the development of environmental regulations or standards) and Modeling for NAAQS Compliance. Internal review and quality control measures consistent with the QA category and project type-specific requirements provided in Guidance for Quality Assurance Project Plans for Modeling, EPA QA/G-5M,[21] along with appropriate audits or assessments of data and reporting of findings, were employed. These include but are not limited to the elements outlined, per EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5),[22] in the following description.

6.1 PROJECT MANAGEMENT

The definition and background of the problem addressed by this project, the project/task description, and project documents and records produced are as described previously in the Purpose and Background sections. No special training or certifications were required. The TTI project manager assured that the appropriate project personnel had and used the most current, approved version of the QAPP.

The objective was to produce the EI product of the quality suited to its purpose as specified (i.e., inventories needed to support RFP analyses), in accordance with the appropriate guidance and methods documents as referenced, as detailed in the Grant Activity Description (GAD), and in consultation with the TCEQ project manager.

Basic criteria were used to assure that the acceptable quality of the product was met – product developers verified that the process and product as specified, to include:

[21] PDF available at: https://www.epa.gov/sites/production/files/2015-06/documents/g5m-final.pdf.
[22] PDF available at: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf.

- The product met the purpose of the emissions analysis (i.e., for use in support of RFP SIP analyses);
- The full extent of the modeling domain (i.e., analysis years, geographic coverage, seasonal periods, alternate scenarios, days, sources, pollutants) was included;
- Agreed methods, models, tools, and data were used (i.e., as listed in the GAD);
- The required output data sets were produced in the appropriate formats in accordance with the GAD;
- Any deficiencies found during development and end-product quality checks (as discussed in QAPP Part D) were corrected; and
- Aggregate emissions estimate results were comparable with available, similarly produced emissions estimates.

6.2 Measurement and Data Acquisition

Note that no sampling of data was involved in the EI development, thus only existing data (non-direct measurements) were used for this project.

The data needed for project implementation were in the categories needed for development of emissions rate model inputs and adjustment factors, and for development of the activity inputs for external emissions calculations. These emissions factor model inputs and activity inputs were developed using data sources as outlined previously and/or methods and procedures as detailed in the references listed, and as provided in the GAD.

All data used either as direct input or to produce inputs (e.g., to the MOVES model or to TTI's EI development utilities used) were reviewed by TTI for suitability before use. The data sets for the project were provided by TxDOT, a Metropolitan Planning Organization (MPO) or Council of Governments (COG), TCEQ, and/or the EPA, and in most cases were QA'd by the providing agency. The data needed may include: HPMS data (from TxDOT's Roadway Inventory Functional Classification Record [RIFCREC] report); regional travel demand model data; speed model data; vehicle registration data; ATR data; vehicle classification count data; meteorological data; fuels data; MOVES emissions model data; extended idling activity data; and vehicle I/M program design data.

Any significant problems found during data review, verification, and/or validation (see QA criteria and methods discussed in Section D) were corrected, and the QA procedure was repeated until satisfied. No significant problems were found.

6.3 Data Management

TTI EI data developers work as a closely coordinated team. The assigned staff used the same electronic project folder structure on their individual workstations. As various scripts, inputs, and outputs were developed in the EI development process, data were shared within the team for crosschecking via an intra-net, flash drive, or external hard drive. To perform the MOVES model runs, a computer cluster (multiple computer) configuration or individual workstation configuration was used. After input data were QA'd, depending on the size of the data set, the data sets were backed up and stored in compressed files. These activities were performed throughout the process until the final products were produced.

For MOVES model runs to produce emissions factor look-up tables for the emissions inventories, all run files (MOVES model inputs and batch files) were produced on an individual workstation. After the MOVES input data and batch files (i.e., Run Files) were QA'd they were either executed on an individual workstation, or they were copied (via external hard drive) to the cluster's Master computer and executed. Upon execution, completion, and error checking, the MOVES output databases were (for cluster runs first copied to an individual workstation) archived and processed further in preparation for input to the emissions calculations utility.

After the final product was completed, all the project data archives were compiled on a set of optical data discs (CD-ROM or DVD, depending on size), or on an external drive for very large project data sets. A complete archive of the project data is kept by TTI (the computer models and EI development utilities used in the process are included). An electronic data submittal package (containing the project deliverables as listed in Appendix B) was produced along with data description (on CD-ROM, DVDs, or external hard drive, depending on needed storage space) and delivered to TCEQ.

6.4 Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked that input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan.

- Checked that correct output data were produced (includes interim output [output that becomes input to a subsequent step in the inventory development process], as well as the final product). Records were kept of the checks performed.

In the case that any inconsistencies or deficiencies were found, the issue was directly communicated to the responsible staff for corrections (or the outside agency staff involved, if provided from outside of TTI, if needed). After a correction was made, the QA checks were performed again to ensure that the additional work resulted in the intended quality assured result, and the correction was noted in the QA record (process was performed until QA check was satisfied).

Any major problem was reported to the project manager and communicated to the project team as needed, as well as when the various data elements in the process passed QA checks and were ready for further processing. The project manager ensured that all of the QA checks performed were compiled, and maintained in the project archives.

In addition, technical systems audits were performed as appropriate. Audits of data quality at the requisite 25 percent level were performed for any data collected or produced as part of this study. QA findings were reported in both the draft and the final reports.

6.5 Data Validation and Usability

Erroneous or improper inputs at any point during the EI development process may produce resulting emissions estimates that are inaccurate and may not be suitable for their intended purpose. Adherence to the inventory process flow with performance of the integrated QA checks at each step of the process was of the utmost importance to ensure that the results met the project objectives.

The criteria for passing quality checks and the checks typically performed on each major inventory input component (i.e., input estimates of source activity, activity distributions, and emissions factors; as well as the resulting emissions estimates) are summarized in the following. These QA guidelines were used to ensure the development of EI estimates that were as accurate as possible and met the requirements of TCEQ's intended use.

TTI verified that the overall scope of the emissions analysis has been met as prescribed in the GAD, to include:

- Purpose of the emissions analysis (i.e., needed for RFP SIP analysis);

- Extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, alternate scenarios, days, sources, pollutants);
- Methods, models, and data used (e.g., default versus local input data sources); and
- Procedures and tools used and all required emissions output data sets were produced.

TTI performed checks on input data preparation, model or utility execution instructions (e.g., run specifications, scripts, job control files, command files), and output, as appropriate to the component.

- Input data preparation checks:
    - Verified the basis of input data sets: Actual historical or latest available data, validated model, expected values or regulated limits, regulatory program design, model defaults, surrogates, professional judgment; checked aggregation levels.
    - Data development: Depending on the procedure and particular input data set, calculations were verified (e.g., re-calculated independently and compared with originally prepared values – when spot-checking a series of results, included extremes and intermediate values).
    - Completeness: Verified that input data sets were within the required dimensions, and all required fields were populated and properly coded or labeled.
    - Format: Verified that formats were within required specifications (e.g., field positions, data types and formats, and file formats) if any.
    - Reasonability checks: (discussed in the next section).
    - Ensured that any inputs provided from external sources were quality assured, as listed previously.
- Checked the model or utility execution instructions:
    - Verified that the correct number of utility or model run specifications were prepared for each application (e.g., by year, county, season, day type).
    - Verified that each utility or model run script included the correct modeling specifications for the application per applicable user guide (e.g., commands, input values, input and output file paths, output options).
- Checked for the successful completion of model and utility executions:

- Verified that the correct number of each type of output file was produced by the particular model or utility.
- Checked for any unusual output file sizes.
- Searched output for warnings and errors (e.g., utility listing files or model execution logs that contain error and warning records).
- Checked the summary information provided in output listing files for any unusual results.

TTI performed further checks for consistency, completeness, and reasonability of data output from model or utility applications.

- Verified that the data distributions and allocation factors produced or used sum to 1.0, as appropriate (e.g., hourly travel factors within a time period, proportion of travel by vehicle categories on a particular roadway category).
- Verified that the required data fields were present, populated, and properly coded or labeled; verified that data and file formats were within specifications.
- Verified that any activity, emissions rate, or emissions adjustments were performed as intended (e.g., seasonal activity factor, emissions control program adjustment).
- For data sets prepared with temporal or geographic variation, compared and noted whether directional differences were as expected (e.g., activity distributions between weekends/weekdays, vehicle mix, or average speeds between road types or time periods).
- Checked for consistency between data sets (e.g., compared detailed spatially and temporally disaggregated activity estimates [e.g., link VMT] to original aggregate totals, activity total summaries between utility applications [e.g., link-VMT producer and emissions calculator], and input hourly distributions versus hourly summaries from the link activity output data).
- Calculated county, 24-hour, aggregate emissions rates (from aggregate VMT and emissions output) and compared the rates between counties examining the results for outliers while assessing the reasonability of any relative and directional differences (e.g., qualify based on activity distributions by road type and speed, mix of vehicles by road type, meteorological variation, control program coverage). Compared the results to results from previous emissions analyses where available.

- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns.

Any additional data products required for the emissions analysis were subjected to the appropriate QA checks previously listed. Any issues found needing resolution were corrected, and appropriate QA checks were performed until satisfied, ensuring the project results met TCEQ requirements, i.e., as outlined in the GAD and QAPP.

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APPENDIX A:
EMISSIONS ESTIMATION UTILITIES FOR MOVES-BASED EMISSIONS INVENTORIES (ELECTRONIC ONLY)

APPENDIX B:
RFP ON-ROAD INVENTORIES ELECTRONIC DATA SUBMITTAL (ELECTRONIC ONLY)

APPENDIX C:
TXDOT DISTRICT VMT MIX BY TIME OF DAY

VMT Mix Year/Analysis Year Correlations

Roadway Type	Roadway Code
Rural Restricted	RT2
Rural Unrestricted	RT3
Urban Restricted	RT4
Urban Unrestricted	RT5

2015 Weekday VMT Mix – Dallas TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00146	0.00146	0.00108	0.00123	0.00155	0.00198	0.00131	0.00145	0.00144	0.00216	0.00160	0.00170	0.00120	0.00208	0.00150	0.00171
21_D	0.00499	0.00442	0.00511	0.00515	0.00461	0.00431	0.00489	0.00504	0.00515	0.00485	0.00533	0.00542	0.00491	0.00459	0.00517	0.00538
21_E	0.00064	0.00079	0.00100	0.00109	0.00060	0.00077	0.00095	0.00107	0.00066	0.00086	0.00104	0.00115	0.00063	0.00082	0.00101	0.00114
21_G	0.66868	0.59268	0.68430	0.69085	0.61817	0.57811	0.65485	0.67585	0.69027	0.64953	0.71416	0.72694	0.65748	0.61552	0.69228	0.72074
31_D	0.00627	0.00786	0.00629	0.00656	0.00611	0.00779	0.00630	0.00659	0.00610	0.00741	0.00605	0.00620	0.00493	0.00612	0.00526	0.00551
31_E	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000
31_G	0.19597	0.24587	0.19664	0.20531	0.19112	0.24373	0.19692	0.20619	0.19074	0.23164	0.18918	0.19401	0.15413	0.19147	0.16452	0.17228
32_D	0.00121	0.00142	0.00163	0.00152	0.00118	0.00141	0.00163	0.00152	0.00118	0.00134	0.00157	0.00143	0.00095	0.00111	0.00136	0.00127
32_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32_G	0.01596	0.01874	0.02151	0.02000	0.01557	0.01858	0.02154	0.02008	0.01554	0.01765	0.02070	0.01890	0.01256	0.01459	0.01800	0.01678
41_D	0.00073	0.00101	0.00083	0.00133	0.00064	0.00073	0.00078	0.00087	0.00046	0.00059	0.00064	0.00074	0.00041	0.00064	0.00071	0.00063
41_E	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41_G	0.00014	0.00019	0.00016	0.00025	0.00012	0.00014	0.00015	0.00016	0.00009	0.00011	0.00012	0.00014	0.00008	0.00012	0.00013	0.00012
42_D	0.00025	0.00035	0.00036	0.00048	0.00022	0.00026	0.00034	0.00031	0.00016	0.00021	0.00028	0.00027	0.00014	0.00022	0.00031	0.00023
42_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42_G	0.00006	0.00009	0.00009	0.00012	0.00005	0.00006	0.00008	0.00008	0.00004	0.00005	0.00007	0.00006	0.00003	0.00005	0.00007	0.00005
43_D	0.00045	0.00073	0.00046	0.00076	0.00040	0.00053	0.00043	0.00050	0.00028	0.00043	0.00036	0.00042	0.00025	0.00046	0.00040	0.00036
43_G	0.00002	0.00003	0.00002	0.00003	0.00002	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002
51_D	0.00042	0.00058	0.00048	0.00041	0.00060	0.00061	0.00060	0.00048	0.00034	0.00035	0.00032	0.00024	0.00033	0.00034	0.00032	0.00024
51_G	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00001	0.00001	0.00000
52_D	0.00949	0.02812	0.02066	0.02129	0.01342	0.02926	0.02564	0.02463	0.00767	0.01670	0.01352	0.01250	0.00733	0.01632	0.01383	0.01224
52_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_G	0.00329	0.00976	0.00717	0.00739	0.00466	0.01016	0.00890	0.00855	0.00266	0.00580	0.00469	0.00434	0.00254	0.00566	0.00480	0.00425
53_D	0.01305	0.00393	0.00373	0.00078	0.01846	0.00409	0.00463	0.00091	0.01055	0.00233	0.00244	0.00046	0.01007	0.00228	0.00250	0.00045
53_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
53_G	0.00447	0.00134	0.00128	0.00027	0.00632	0.00140	0.00159	0.00031	0.00361	0.00080	0.00084	0.00016	0.00345	0.00078	0.00086	0.00015
54_D	0.00068	0.00090	0.00061	0.00061	0.00096	0.00094	0.00076	0.00070	0.00055	0.00054	0.00040	0.00036	0.00052	0.00052	0.00041	0.00035
54_G	0.00131	0.00174	0.00117	0.00117	0.00185	0.00181	0.00146	0.00136	0.00106	0.00103	0.00077	0.00069	0.00101	0.00101	0.00079	0.00067
61_D	0.00547	0.03683	0.01669	0.02501	0.00881	0.04407	0.02434	0.03247	0.00477	0.02625	0.01320	0.01786	0.01065	0.06388	0.03152	0.04155
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
62_D	0.06495	0.04114	0.02872	0.00835	0.10453	0.04923	0.04187	0.01084	0.05665	0.02933	0.02271	0.00596	0.12637	0.07137	0.05422	0.01388

2025 Weekday VMT Mix – Dallas TxDOT District (2023, 2024, 2026, and 2027 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00146	0.00146	0.00108	0.00123	0.00155	0.00198	0.00131	0.00145	0.00144	0.00216	0.00160	0.00170	0.00120	0.00208	0.00150	0.00171
21_D	0.00283	0.00251	0.00289	0.00292	0.00262	0.00244	0.00277	0.00286	0.00292	0.00275	0.00302	0.00307	0.00278	0.00260	0.00293	0.00305
21_E	0.01586	0.01943	0.02454	0.02687	0.01466	0.01895	0.02349	0.02629	0.01637	0.02129	0.02562	0.02828	0.01559	0.02018	0.02483	0.02804
21_G	0.65563	0.57596	0.66296	0.66730	0.60610	0.56180	0.63443	0.65281	0.67679	0.63121	0.69190	0.70216	0.64465	0.59815	0.67070	0.69617
31_D	0.00528	0.00659	0.00526	0.00549	0.00515	0.00654	0.00527	0.00551	0.00514	0.00621	0.00506	0.00519	0.00415	0.00514	0.00440	0.00460
31_E	0.00256	0.00444	0.00389	0.00440	0.00250	0.00441	0.00389	0.00442	0.00250	0.00419	0.00374	0.00416	0.00202	0.00346	0.00325	0.00369
31_G	0.19425	0.24252	0.19358	0.20181	0.18944	0.24041	0.19387	0.20267	0.18906	0.22849	0.18624	0.19071	0.15277	0.18887	0.16196	0.16934
32_D	0.00105	0.00122	0.00140	0.00130	0.00102	0.00121	0.00140	0.00130	0.00102	0.00115	0.00135	0.00123	0.00082	0.00095	0.00117	0.00109
32_E	0.00022	0.00035	0.00044	0.00044	0.00021	0.00035	0.00044	0.00045	0.00021	0.00033	0.00042	0.00042	0.00017	0.00027	0.00037	0.00037
32_G	0.01606	0.01876	0.02150	0.01995	0.01566	0.01860	0.02153	0.02004	0.01563	0.01768	0.02068	0.01885	0.01263	0.01461	0.01799	0.01674
41_D	0.00067	0.00093	0.00077	0.00122	0.00059	0.00067	0.00072	0.00080	0.00042	0.00055	0.00059	0.00068	0.00038	0.00059	0.00066	0.00058
41_E	0.00001	0.00002	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
41_G	0.00024	0.00033	0.00028	0.00044	0.00021	0.00024	0.00026	0.00029	0.00015	0.00020	0.00021	0.00025	0.00014	0.00021	0.00024	0.00021
42_D	0.00020	0.00028	0.00028	0.00038	0.00017	0.00020	0.00027	0.00025	0.00012	0.00016	0.00022	0.00021	0.00011	0.00018	0.00024	0.00018
42_E	0.00000	0.00001	0.00001	0.00001	0.00000	0.00000	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
42_G	0.00008	0.00011	0.00011	0.00015	0.00007	0.00008	0.00011	0.00010	0.00005	0.00007	0.00009	0.00008	0.00004	0.00007	0.00010	0.00007
43_D	0.00041	0.00066	0.00042	0.00069	0.00036	0.00048	0.00039	0.00045	0.00026	0.00039	0.00032	0.00038	0.00023	0.00042	0.00036	0.00032
43_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_G	0.00004	0.00007	0.00004	0.00007	0.00004	0.00005	0.00004	0.00005	0.00003	0.00004	0.00003	0.00004	0.00002	0.00004	0.00004	0.00003
51_D	0.00029	0.00040	0.00033	0.00028	0.00042	0.00042	0.00041	0.00033	0.00024	0.00024	0.00022	0.00017	0.00023	0.00023	0.00022	0.00016
51_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
51_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_D	0.00907	0.02685	0.01972	0.02033	0.01283	0.02795	0.02448	0.02352	0.00733	0.01595	0.01290	0.01194	0.00700	0.01559	0.01320	0.01169
52_E	0.00004	0.00012	0.00009	0.00009	0.00006	0.00013	0.00011	0.00011	0.00003	0.00007	0.00006	0.00005	0.00003	0.00007	0.00006	0.00005
52_G	0.00383	0.01134	0.00833	0.00858	0.00542	0.01180	0.01033	0.00993	0.00310	0.00673	0.00545	0.00504	0.00296	0.00658	0.00557	0.00494
53_D	0.01232	0.00370	0.00352	0.00074	0.01742	0.00385	0.00437	0.00085	0.00996	0.00220	0.00230	0.00043	0.00951	0.00215	0.00236	0.00042
53_E	0.00006	0.00002	0.00002	0.00000	0.00008	0.00002	0.00002	0.00000	0.00005	0.00001	0.00001	0.00000	0.00005	0.00001	0.00001	0.00000
53_G	0.00536	0.00161	0.00153	0.00032	0.00757	0.00168	0.00190	0.00037	0.00433	0.00096	0.00100	0.00019	0.00413	0.00093	0.00102	0.00018
54_D	0.00063	0.00084	0.00057	0.00057	0.00089	0.00087	0.00070	0.00065	0.00051	0.00050	0.00037	0.00033	0.00049	0.00049	0.00038	0.00033
54_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
54_G	0.00112	0.00148	0.00100	0.00100	0.00158	0.00154	0.00125	0.00116	0.00090	0.00088	0.00066	0.00059	0.00086	0.00086	0.00067	0.00058
61_D	0.00547	0.03679	0.01667	0.02498	0.00880	0.04402	0.02431	0.03243	0.00477	0.02622	0.01319	0.01784	0.01064	0.06382	0.03148	0.04150
61_E	0.00001	0.00004	0.00002	0.00003	0.00001	0.00005	0.00003	0.00004	0.00001	0.00003	0.00002	0.00002	0.00001	0.00008	0.00004	0.00005
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62_D	0.06490	0.04111	0.02869	0.00835	0.10445	0.04920	0.04184	0.01084	0.05661	0.02930	0.02269	0.00596	0.12627	0.07131	0.05418	0.01386
62_E	0.00005	0.00003	0.00002	0.00001	0.00008	0.00004	0.00003	0.00001	0.00004	0.00002	0.00002	0.00000	0.00010	0.00006	0.00004	0.00001

2015 Weekday VMT Mix – Fort Worth TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00149	0.00134	0.00151	0.00182	0.00204	0.00186	0.00179	0.00182	0.00237	0.00193	0.00196	0.00210	0.00154	0.00158	0.00190	0.00260
21_D	0.00405	0.00483	0.00511	0.00507	0.00411	0.00458	0.00496	0.00496	0.00461	0.00500	0.00532	0.00530	0.00379	0.00487	0.00534	0.00520
21_E	0.00031	0.00031	0.00068	0.00064	0.00031	0.00029	0.00066	0.00063	0.00035	0.00032	0.00070	0.00067	0.00029	0.00031	0.00071	0.00066
21_G	0.54220	0.64756	0.68532	0.67881	0.55000	0.61286	0.66487	0.66523	0.61736	0.66998	0.71305	0.71078	0.50792	0.65198	0.71569	0.69697
31_D	0.00664	0.00719	0.00656	0.00675	0.00650	0.00737	0.00655	0.00672	0.00655	0.00722	0.00637	0.00622	0.00493	0.00603	0.00552	0.00541
31_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31_G	0.20776	0.22493	0.20516	0.21117	0.20338	0.23051	0.20500	0.21022	0.20503	0.22589	0.19930	0.19455	0.15428	0.18867	0.17278	0.16925
32_D	0.00128	0.00130	0.00170	0.00156	0.00126	0.00133	0.00170	0.00155	0.00127	0.00131	0.00165	0.00144	0.00095	0.00109	0.00143	0.00125
32_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32_G	0.01692	0.01714	0.02245	0.02057	0.01657	0.01757	0.02243	0.02048	0.01670	0.01722	0.02180	0.01895	0.01257	0.01438	0.01890	0.01648
41_D	0.00237	0.00116	0.00101	0.00164	0.00093	0.00084	0.00072	0.00117	0.00166	0.00084	0.00065	0.00107	0.00104	0.00078	0.00037	0.00109
41_E	0.00001	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41_G	0.00044	0.00022	0.00019	0.00031	0.00017	0.00016	0.00014	0.00022	0.00031	0.00016	0.00012	0.00020	0.00020	0.00015	0.00007	0.00021
42_D	0.00081	0.00041	0.00044	0.00059	0.00032	0.00030	0.00031	0.00042	0.00057	0.00029	0.00028	0.00039	0.00036	0.00027	0.00016	0.00039
42_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42_G	0.00020	0.00010	0.00011	0.00014	0.00008	0.00007	0.00008	0.00010	0.00014	0.00007	0.00007	0.00009	0.00009	0.00007	0.00004	0.00009
43_D	0.00147	0.00083	0.00056	0.00093	0.00057	0.00061	0.00040	0.00067	0.00102	0.00060	0.00036	0.00061	0.00064	0.00056	0.00021	0.00062
43_G	0.00007	0.00004	0.00003	0.00004	0.00003	0.00003	0.00002	0.00003	0.00005	0.00003	0.00002	0.00003	0.00003	0.00003	0.00001	0.00003
51_D	0.00062	0.00044	0.00046	0.00037	0.00059	0.00055	0.00057	0.00045	0.00039	0.00031	0.00030	0.00027	0.00043	0.00031	0.00027	0.00025
51_G	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000
52_D	0.01377	0.02141	0.01976	0.01939	0.01323	0.02648	0.02445	0.02319	0.00879	0.01500	0.01285	0.01394	0.00965	0.01471	0.01168	0.01275
52_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_G	0.00478	0.00743	0.00686	0.00673	0.00459	0.00919	0.00849	0.00805	0.00305	0.00521	0.00446	0.00484	0.00335	0.00510	0.00405	0.00442
53_D	0.01893	0.00299	0.00357	0.00071	0.01819	0.00370	0.00442	0.00085	0.01208	0.00210	0.00232	0.00051	0.01327	0.00205	0.00211	0.00047
53_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
53_G	0.00648	0.00102	0.00122	0.00024	0.00623	0.00127	0.00151	0.00029	0.00414	0.00072	0.00079	0.00018	0.00454	0.00070	0.00072	0.00016
54_D	0.00099	0.00069	0.00058	0.00056	0.00095	0.00085	0.00072	0.00066	0.00063	0.00048	0.00038	0.00040	0.00069	0.00047	0.00035	0.00036
54_G	0.00189	0.00132	0.00112	0.00107	0.00182	0.00163	0.00139	0.00128	0.00121	0.00093	0.00073	0.00077	0.00133	0.00091	0.00066	0.00070
61_D	0.01294	0.02707	0.01308	0.03064	0.01306	0.03681	0.01794	0.03822	0.00868	0.02096	0.00974	0.02749	0.02161	0.04958	0.02095	0.06043
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00001
62_D	0.15356	0.03024	0.02250	0.01023	0.15504	0.04112	0.03086	0.01276	0.10303	0.02342	0.01676	0.00918	0.25648	0.05539	0.03605	0.02018

2025 Weekday VMT Mix – Fort Worth TxDOT District (2023, 2024, 2026, and 2027 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00149	0.00134	0.00151	0.00182	0.00204	0.00186	0.00179	0.00182	0.00237	0.00193	0.00196	0.00210	0.00154	0.00158	0.00190	0.00260
21_D	0.00230	0.00274	0.00290	0.00287	0.00233	0.00260	0.00281	0.00281	0.00261	0.00284	0.00302	0.00301	0.00215	0.00276	0.00303	0.00295
21_E	0.00751	0.00758	0.01664	0.01582	0.00762	0.00718	0.01615	0.01551	0.00855	0.00785	0.01732	0.01657	0.00704	0.00764	0.01738	0.01625
21_G	0.53675	0.64238	0.67156	0.66582	0.54447	0.60796	0.65152	0.65250	0.61115	0.66462	0.69874	0.69718	0.50281	0.64676	0.70133	0.68364
31_D	0.00563	0.00610	0.00553	0.00569	0.00551	0.00625	0.00552	0.00567	0.00555	0.00613	0.00537	0.00524	0.00418	0.00512	0.00465	0.00456
31_E	0.00159	0.00145	0.00275	0.00272	0.00155	0.00149	0.00275	0.00270	0.00157	0.00146	0.00267	0.00250	0.00118	0.00122	0.00231	0.00218
31_G	0.20703	0.22441	0.20325	0.20933	0.20267	0.22998	0.20309	0.20840	0.20431	0.22537	0.19744	0.19286	0.15374	0.18824	0.17117	0.16777
32_D	0.00111	0.00113	0.00147	0.00135	0.00109	0.00116	0.00147	0.00134	0.00110	0.00113	0.00143	0.00124	0.00083	0.00095	0.00124	0.00108
32_E	0.00013	0.00011	0.00031	0.00027	0.00013	0.00012	0.00031	0.00027	0.00013	0.00012	0.00030	0.00025	0.00010	0.00010	0.00026	0.00022
32_G	0.01712	0.01736	0.02257	0.02069	0.01675	0.01779	0.02255	0.02060	0.01689	0.01743	0.02192	0.01906	0.01271	0.01456	0.01901	0.01658
41_D	0.00217	0.00106	0.00093	0.00150	0.00085	0.00078	0.00067	0.00107	0.00152	0.00077	0.00060	0.00099	0.00095	0.00071	0.00034	0.00100
41_E	0.00004	0.00002	0.00002	0.00003	0.00002	0.00001	0.00001	0.00002	0.00003	0.00001	0.00001	0.00002	0.00002	0.00001	0.00001	0.00002
41_G	0.00078	0.00038	0.00034	0.00054	0.00031	0.00028	0.00024	0.00039	0.00055	0.00028	0.00022	0.00036	0.00034	0.00026	0.00012	0.00036
42_D	0.00064	0.00032	0.00035	0.00046	0.00025	0.00023	0.00025	0.00033	0.00045	0.00023	0.00022	0.00030	0.00028	0.00021	0.00013	0.00031
42_E	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00001	0.00000	0.00000	0.00001
42_G	0.00025	0.00013	0.00014	0.00018	0.00010	0.00009	0.00010	0.00013	0.00018	0.00009	0.00009	0.00012	0.00011	0.00009	0.00005	0.00012
43_D	0.00132	0.00075	0.00051	0.00084	0.00052	0.00055	0.00036	0.00060	0.00092	0.00054	0.00033	0.00055	0.00058	0.00051	0.00019	0.00056
43_E	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_G	0.00014	0.00008	0.00005	0.00009	0.00005	0.00006	0.00004	0.00006	0.00010	0.00006	0.00003	0.00006	0.00006	0.00005	0.00002	0.00006
51_D	0.00043	0.00031	0.00032	0.00026	0.00041	0.00038	0.00039	0.00031	0.00027	0.00022	0.00021	0.00019	0.00030	0.00021	0.00019	0.00017
51_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
51_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_D	0.01316	0.02045	0.01886	0.01852	0.01265	0.02529	0.02334	0.02215	0.00840	0.01433	0.01227	0.01331	0.00923	0.01405	0.01115	0.01217
52_E	0.00006	0.00009	0.00009	0.00009	0.00006	0.00012	0.00011	0.00010	0.00004	0.00007	0.00006	0.00006	0.00004	0.00006	0.00005	0.00006
52_G	0.00556	0.00863	0.00796	0.00782	0.00534	0.01068	0.00985	0.00935	0.00354	0.00605	0.00518	0.00562	0.00389	0.00593	0.00471	0.00514
53_D	0.01787	0.00282	0.00337	0.00067	0.01717	0.00349	0.00417	0.00080	0.01140	0.00198	0.00219	0.00048	0.01253	0.00194	0.00199	0.00044
53_E	0.00009	0.00001	0.00002	0.00000	0.00008	0.00002	0.00002	0.00000	0.00006	0.00001	0.00001	0.00000	0.00006	0.00001	0.00001	0.00000
53_G	0.00777	0.00123	0.00146	0.00029	0.00747	0.00152	0.00181	0.00035	0.00496	0.00086	0.00095	0.00021	0.00545	0.00084	0.00087	0.00019
54_D	0.00092	0.00064	0.00054	0.00052	0.00088	0.00079	0.00067	0.00062	0.00058	0.00045	0.00035	0.00037	0.00064	0.00044	0.00032	0.00034
54_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
54_G	0.00162	0.00113	0.00096	0.00091	0.00156	0.00140	0.00119	0.00109	0.00103	0.00079	0.00062	0.00066	0.00114	0.00078	0.00057	0.00060
61_D	0.01293	0.02704	0.01306	0.03060	0.01305	0.03677	0.01792	0.03818	0.00867	0.02094	0.00973	0.02746	0.02159	0.04953	0.02093	0.06037
61_E	0.00002	0.00003	0.00002	0.00004	0.00002	0.00004	0.00002	0.00005	0.00001	0.00002	0.00001	0.00003	0.00003	0.00006	0.00002	0.00007
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62_D	0.15344	0.03022	0.02248	0.01022	0.15492	0.04109	0.03084	0.01275	0.10295	0.02340	0.01675	0.00917	0.25628	0.05535	0.03602	0.02017
62_E	0.00012	0.00002	0.00002	0.00001	0.00012	0.00003	0.00002	0.00001	0.00008	0.00002	0.00001	0.00001	0.00020	0.00004	0.00003	0.00002

2015 Weekday VMT Mix – Beaumont TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00072	0.00122	0.00051	0.00110	0.00128	0.00177	0.00083	0.00164	0.00107	0.00192	0.00093	0.00176	0.00082	0.00172	0.00071	0.00158
21_D	0.00423	0.00483	0.00425	0.00484	0.00405	0.00469	0.00392	0.00459	0.00452	0.00511	0.00443	0.00498	0.00420	0.00515	0.00428	0.00499
21_E	0.00019	0.00012	0.00012	0.00013	0.00018	0.00011	0.00011	0.00013	0.00020	0.00012	0.00012	0.00014	0.00019	0.00012	0.00012	0.00014
21_G	0.56693	0.64624	0.56982	0.64781	0.54218	0.62774	0.52515	0.61528	0.60542	0.68391	0.59312	0.66674	0.56301	0.68928	0.57370	0.66835
31_D	0.00738	0.00723	0.00812	0.00740	0.00710	0.00714	0.00824	0.00748	0.00716	0.00720	0.00854	0.00760	0.00548	0.00611	0.00683	0.00643
31_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31_G	0.23070	0.22617	0.25402	0.23163	0.22200	0.22342	0.25774	0.23400	0.22401	0.22530	0.26710	0.23771	0.17132	0.19098	0.21358	0.20107
32_D	0.00142	0.00131	0.00211	0.00171	0.00137	0.00129	0.00214	0.00173	0.00138	0.00130	0.00222	0.00176	0.00106	0.00110	0.00177	0.00148
32_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32_G	0.01879	0.01724	0.02779	0.02256	0.01809	0.01703	0.02820	0.02279	0.01825	0.01717	0.02922	0.02315	0.01396	0.01456	0.02337	0.01958
41_D	0.00137	0.00177	0.00191	0.00143	0.00103	0.00095	0.00091	0.00084	0.00114	0.00103	0.00113	0.00087	0.00121	0.00051	0.00109	0.00061
41_E	0.00001	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41_G	0.00026	0.00033	0.00036	0.00027	0.00019	0.00018	0.00017	0.00016	0.00021	0.00019	0.00021	0.00016	0.00023	0.00010	0.00020	0.00011
42_D	0.00047	0.00062	0.00083	0.00051	0.00036	0.00033	0.00039	0.00030	0.00039	0.00036	0.00049	0.00031	0.00041	0.00018	0.00047	0.00022
42_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42_G	0.00011	0.00015	0.00020	0.00012	0.00009	0.00008	0.00009	0.00007	0.00009	0.00009	0.00012	0.00007	0.00010	0.00004	0.00011	0.00005
43_D	0.00085	0.00127	0.00107	0.00082	0.00064	0.00068	0.00051	0.00048	0.00070	0.00074	0.00063	0.00049	0.00075	0.00037	0.00061	0.00035
43_G	0.00004	0.00006	0.00005	0.00004	0.00003	0.00003	0.00002	0.00002	0.00003	0.00003	0.00003	0.00002	0.00003	0.00002	0.00003	0.00002
51_D	0.00052	0.00048	0.00062	0.00045	0.00057	0.00056	0.00074	0.00059	0.00033	0.00029	0.00033	0.00030	0.00038	0.00027	0.00037	0.00029
51_G	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
52_D	0.01154	0.02305	0.02661	0.02331	0.01280	0.02719	0.03178	0.03070	0.00732	0.01380	0.01436	0.01560	0.00856	0.01295	0.01594	0.01506
52_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_G	0.00400	0.00800	0.00923	0.00809	0.00444	0.00944	0.01103	0.01065	0.00254	0.00479	0.00498	0.00541	0.00297	0.00449	0.00553	0.00523
53_D	0.01586	0.00322	0.00481	0.00086	0.01759	0.00380	0.00574	0.00113	0.01006	0.00193	0.00260	0.00057	0.01177	0.00181	0.00288	0.00055
53_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
53_G	0.00543	0.00110	0.00165	0.00029	0.00602	0.00130	0.00197	0.00039	0.00344	0.00066	0.00089	0.00020	0.00403	0.00062	0.00099	0.00019
54_D	0.00083	0.00074	0.00079	0.00067	0.00092	0.00087	0.00094	0.00088	0.00052	0.00044	0.00042	0.00045	0.00061	0.00042	0.00047	0.00043
54_G	0.00159	0.00142	0.00151	0.00128	0.00176	0.00168	0.00181	0.00169	0.00101	0.00085	0.00082	0.00086	0.00118	0.00080	0.00091	0.00083
61_D	0.00985	0.02524	0.03073	0.03347	0.01222	0.03291	0.04321	0.04831	0.00856	0.01547	0.02473	0.02312	0.01614	0.03232	0.05368	0.05428
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00001
62_D	0.11690	0.02819	0.05287	0.01118	0.14508	0.03677	0.07434	0.01613	0.10161	0.01728	0.04255	0.00772	0.19159	0.03610	0.09235	0.01813

2025 Weekday VMT Mix – Beaumont TxDOT District (2023, 2024, 2026, and 2027 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00072	0.00122	0.00051	0.00110	0.00128	0.00177	0.00083	0.00164	0.00107	0.00192	0.00093	0.00176	0.00082	0.00172	0.00071	0.00158
21_D	0.00240	0.00274	0.00241	0.00275	0.00230	0.00266	0.00223	0.00261	0.00256	0.00290	0.00251	0.00283	0.00239	0.00292	0.00243	0.00283
21_E	0.00465	0.00288	0.00294	0.00328	0.00445	0.00280	0.00271	0.00312	0.00497	0.00305	0.00306	0.00338	0.00462	0.00307	0.00296	0.00339
21_G	0.56430	0.64556	0.56884	0.64675	0.53966	0.62708	0.52425	0.61428	0.60261	0.68319	0.59210	0.66565	0.56039	0.68855	0.57271	0.66726
31_D	0.00627	0.00616	0.00691	0.00630	0.00603	0.00608	0.00701	0.00637	0.00608	0.00613	0.00727	0.00647	0.00465	0.00520	0.00581	0.00547
31_E	0.00104	0.00056	0.00072	0.00065	0.00101	0.00055	0.00073	0.00065	0.00101	0.00055	0.00076	0.00066	0.00078	0.00047	0.00061	0.00056
31_G	0.23059	0.22653	0.25426	0.23188	0.22190	0.22378	0.25799	0.23426	0.22391	0.22566	0.26736	0.23797	0.17124	0.19128	0.21378	0.20129
32_D	0.00124	0.00114	0.00184	0.00149	0.00119	0.00113	0.00186	0.00151	0.00120	0.00114	0.00193	0.00153	0.00092	0.00096	0.00154	0.00129
32_E	0.00009	0.00004	0.00008	0.00007	0.00008	0.00004	0.00008	0.00007	0.00009	0.00004	0.00009	0.00007	0.00007	0.00004	0.00007	0.00006
32_G	0.01906	0.01752	0.02823	0.02292	0.01834	0.01731	0.02864	0.02315	0.01851	0.01745	0.02968	0.02352	0.01416	0.01479	0.02373	0.01989
41_D	0.00126	0.00163	0.00176	0.00131	0.00095	0.00087	0.00084	0.00077	0.00104	0.00095	0.00104	0.00079	0.00111	0.00047	0.00100	0.00056
41_E	0.00002	0.00003	0.00003	0.00002	0.00002	0.00002	0.00001	0.00001	0.00002	0.00002	0.00002	0.00001	0.00002	0.00001	0.00002	0.00001
41_G	0.00045	0.00059	0.00064	0.00047	0.00034	0.00032	0.00030	0.00028	0.00038	0.00034	0.00038	0.00029	0.00040	0.00017	0.00036	0.00020
42_D	0.00037	0.00049	0.00066	0.00040	0.00028	0.00026	0.00031	0.00024	0.00031	0.00029	0.00039	0.00024	0.00033	0.00014	0.00037	0.00017
42_E	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00000
42_G	0.00015	0.00019	0.00026	0.00016	0.00011	0.00010	0.00012	0.00009	0.00012	0.00011	0.00015	0.00010	0.00013	0.00006	0.00015	0.00007
43_D	0.00077	0.00115	0.00097	0.00074	0.00058	0.00062	0.00046	0.00043	0.00064	0.00067	0.00057	0.00045	0.00067	0.00033	0.00055	0.00031
43_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_G	0.00008	0.00012	0.00010	0.00008	0.00006	0.00006	0.00005	0.00004	0.00007	0.00007	0.00006	0.00005	0.00007	0.00003	0.00006	0.00003
51_D	0.00036	0.00033	0.00043	0.00031	0.00040	0.00039	0.00051	0.00041	0.00023	0.00020	0.00023	0.00021	0.00026	0.00019	0.00026	0.00020
51_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
51_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_D	0.01103	0.02202	0.02540	0.02226	0.01223	0.02597	0.03034	0.02932	0.00700	0.01318	0.01371	0.01490	0.00818	0.01237	0.01522	0.01438
52_E	0.00005	0.00010	0.00012	0.00010	0.00006	0.00012	0.00014	0.00013	0.00003	0.00006	0.00006	0.00007	0.00004	0.00006	0.00007	0.00007
52_G	0.00465	0.00929	0.01072	0.00940	0.00516	0.01096	0.01281	0.01238	0.00295	0.00556	0.00579	0.00629	0.00345	0.00522	0.00642	0.00607
53_D	0.01497	0.00304	0.00453	0.00081	0.01660	0.00358	0.00541	0.00106	0.00950	0.00182	0.00245	0.00054	0.01110	0.00171	0.00272	0.00052
53_E	0.00007	0.00001	0.00002	0.00000	0.00008	0.00002	0.00003	0.00001	0.00005	0.00001	0.00001	0.00000	0.00005	0.00001	0.00001	0.00000
53_G	0.00651	0.00132	0.00197	0.00035	0.00722	0.00156	0.00235	0.00046	0.00413	0.00079	0.00106	0.00024	0.00483	0.00074	0.00118	0.00023
54_D	0.00077	0.00069	0.00073	0.00062	0.00085	0.00081	0.00087	0.00082	0.00049	0.00041	0.00039	0.00041	0.00057	0.00039	0.00044	0.00040
54_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
54_G	0.00136	0.00122	0.00129	0.00110	0.00151	0.00144	0.00154	0.00145	0.00086	0.00073	0.00070	0.00073	0.00101	0.00068	0.00077	0.00071
61_D	0.00984	0.02521	0.03070	0.03344	0.01221	0.03287	0.04316	0.04826	0.00855	0.01545	0.02471	0.02309	0.01613	0.03228	0.05362	0.05422
61_E	0.00001	0.00003	0.00004	0.00004	0.00001	0.00004	0.00005	0.00006	0.00001	0.00002	0.00003	0.00003	0.00002	0.00004	0.00006	0.00006
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62_D	0.11680	0.02817	0.05282	0.01117	0.14496	0.03674	0.07428	0.01612	0.10153	0.01727	0.04252	0.00771	0.19144	0.03607	0.09227	0.01811
62_E	0.00009	0.00002	0.00004	0.00001	0.00011	0.00003	0.00006	0.00001	0.00008	0.00001	0.00003	0.00001	0.00015	0.00003	0.00007	0.00001

2015 Weekday VMT Mix – Houston TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00133	0.00083	0.00115	0.00119	0.00172	0.00155	0.00157	0.00161	0.00193	0.00118	0.00172	0.00179	0.00170	0.00104	0.00143	0.00154
21_D	0.00425	0.00477	0.00485	0.00495	0.00417	0.00465	0.00468	0.00468	0.00462	0.00513	0.00511	0.00510	0.00435	0.00524	0.00507	0.00500
21_E	0.00058	0.00067	0.00066	0.00069	0.00057	0.00065	0.00063	0.00065	0.00063	0.00072	0.00069	0.00071	0.00059	0.00073	0.00069	0.00069
21_G	0.56928	0.63861	0.65001	0.66271	0.55890	0.62325	0.62723	0.62693	0.61923	0.68804	0.68515	0.68308	0.58247	0.70157	0.67963	0.67008
31_D	0.00829	0.00751	0.00704	0.00704	0.00809	0.00726	0.00704	0.00716	0.00777	0.00722	0.00685	0.00694	0.00645	0.00608	0.00600	0.00598
31_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31_G	0.25937	0.23480	0.22010	0.22020	0.25298	0.22702	0.22014	0.22408	0.24308	0.22574	0.21435	0.21705	0.20179	0.19023	0.18775	0.18709
32_D	0.00160	0.00136	0.00183	0.00163	0.00156	0.00131	0.00183	0.00165	0.00150	0.00130	0.00178	0.00160	0.00125	0.00110	0.00156	0.00138
32_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32_G	0.02113	0.01790	0.02408	0.02145	0.02061	0.01730	0.02409	0.02183	0.01980	0.01721	0.02345	0.02114	0.01644	0.01450	0.02054	0.01822
41_D	0.00190	0.00090	0.00119	0.00152	0.00147	0.00054	0.00076	0.00099	0.00112	0.00067	0.00087	0.00091	0.00073	0.00051	0.00073	0.00077
41_E	0.00001	0.00000	0.00000	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41_G	0.00036	0.00017	0.00022	0.00029	0.00028	0.00010	0.00014	0.00019	0.00021	0.00013	0.00016	0.00017	0.00014	0.00010	0.00014	0.00014
42_D	0.00065	0.00032	0.00052	0.00054	0.00051	0.00019	0.00033	0.00035	0.00039	0.00023	0.00038	0.00033	0.00025	0.00018	0.00031	0.00028
42_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42_G	0.00016	0.00008	0.00012	0.00013	0.00012	0.00005	0.00008	0.00009	0.00009	0.00006	0.00009	0.00008	0.00006	0.00004	0.00008	0.00007
43_D	0.00117	0.00065	0.00066	0.00087	0.00091	0.00039	0.00043	0.00056	0.00070	0.00048	0.00049	0.00052	0.00045	0.00037	0.00040	0.00044
43_G	0.00005	0.00003	0.00003	0.00004	0.00004	0.00002	0.00002	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
51_D	0.00061	0.00051	0.00055	0.00043	0.00065	0.00057	0.00065	0.00057	0.00037	0.00027	0.00034	0.00032	0.00038	0.00027	0.00034	0.00030
51_G	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
52_D	0.01374	0.02468	0.02358	0.02217	0.01447	0.02757	0.02776	0.02951	0.00818	0.01300	0.01467	0.01640	0.00845	0.01302	0.01478	0.01549
52_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_G	0.00477	0.00857	0.00818	0.00769	0.00502	0.00957	0.00963	0.01024	0.00284	0.00451	0.00509	0.00569	0.00293	0.00452	0.00513	0.00538
53_D	0.01890	0.00345	0.00426	0.00082	0.01989	0.00385	0.00502	0.00109	0.01125	0.00181	0.00265	0.00060	0.01162	0.00182	0.00267	0.00057
53_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
53_G	0.00647	0.00118	0.00146	0.00028	0.00681	0.00132	0.00172	0.00037	0.00385	0.00062	0.00091	0.00021	0.00398	0.00062	0.00091	0.00019
54_D	0.00098	0.00079	0.00070	0.00063	0.00104	0.00088	0.00082	0.00084	0.00059	0.00042	0.00043	0.00047	0.00060	0.00042	0.00044	0.00044
54_G	0.00189	0.00152	0.00134	0.00122	0.00199	0.00170	0.00158	0.00162	0.00113	0.00080	0.00083	0.00090	0.00116	0.00080	0.00084	0.00085
61_D	0.00641	0.02394	0.01744	0.03260	0.00763	0.03318	0.02347	0.04868	0.00549	0.01437	0.01247	0.02694	0.01198	0.02684	0.02592	0.06376
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001
62_D	0.07607	0.02675	0.03000	0.01089	0.09056	0.03707	0.04037	0.01626	0.06520	0.01605	0.02145	0.00900	0.14218	0.02998	0.04459	0.02129

2025 Weekday VMT Mix – Houston TxDOT District (2023, 2024, 2026, and 2027 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00133	0.00083	0.00115	0.00119	0.00172	0.00155	0.00157	0.00161	0.00193	0.00118	0.00172	0.00179	0.00170	0.00104	0.00143	0.00154
21_D	0.00241	0.00270	0.00275	0.00280	0.00236	0.00264	0.00265	0.00265	0.00262	0.00291	0.00290	0.00289	0.00246	0.00297	0.00288	0.00283
21_E	0.01418	0.01646	0.01619	0.01688	0.01392	0.01606	0.01562	0.01597	0.01542	0.01773	0.01706	0.01740	0.01451	0.01808	0.01693	0.01707
21_G	0.55752	0.62489	0.63658	0.64866	0.54735	0.60986	0.61427	0.61363	0.60643	0.67326	0.67100	0.66860	0.57043	0.68649	0.66559	0.65587
31_D	0.00698	0.00632	0.00593	0.00593	0.00681	0.00611	0.00593	0.00603	0.00655	0.00608	0.00577	0.00584	0.00543	0.00512	0.00505	0.00504
31_E	0.00356	0.00334	0.00302	0.00309	0.00348	0.00323	0.00302	0.00315	0.00334	0.00321	0.00294	0.00305	0.00277	0.00270	0.00258	0.00263
31_G	0.25693	0.23249	0.21798	0.21803	0.25060	0.22478	0.21802	0.22187	0.24079	0.22352	0.21228	0.21491	0.19989	0.18835	0.18594	0.18525
32_D	0.00138	0.00117	0.00157	0.00140	0.00135	0.00113	0.00158	0.00143	0.00130	0.00113	0.00153	0.00138	0.00108	0.00095	0.00134	0.00119
32_E	0.00030	0.00026	0.00034	0.00031	0.00029	0.00025	0.00034	0.00032	0.00028	0.00025	0.00033	0.00031	0.00023	0.00021	0.00029	0.00026
32_G	0.02124	0.01798	0.02420	0.02155	0.02072	0.01739	0.02421	0.02193	0.01991	0.01729	0.02357	0.02124	0.01653	0.01457	0.02065	0.01831
41_D	0.00174	0.00083	0.00110	0.00140	0.00135	0.00050	0.00070	0.00090	0.00103	0.00062	0.00081	0.00084	0.00067	0.00047	0.00067	0.00071
41_E	0.00003	0.00001	0.00002	0.00003	0.00002	0.00001	0.00001	0.00002	0.00002	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001
41_G	0.00063	0.00030	0.00040	0.00050	0.00049	0.00018	0.00025	0.00033	0.00037	0.00022	0.00029	0.00030	0.00024	0.00017	0.00024	0.00025
42_D	0.00051	0.00025	0.00041	0.00043	0.00040	0.00015	0.00026	0.00028	0.00030	0.00019	0.00030	0.00026	0.00020	0.00014	0.00025	0.00022
42_E	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00001	0.00001	0.00000	0.00001	0.00001	0.00000	0.00000	0.00001	0.00000
42_G	0.00020	0.00010	0.00016	0.00017	0.00016	0.00006	0.00010	0.00011	0.00012	0.00007	0.00012	0.00010	0.00008	0.00006	0.00010	0.00009
43_D	0.00106	0.00059	0.00060	0.00078	0.00082	0.00035	0.00038	0.00051	0.00063	0.00044	0.00044	0.00047	0.00041	0.00033	0.00037	0.00040
43_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_G	0.00011	0.00006	0.00006	0.00008	0.00008	0.00004	0.00004	0.00005	0.00006	0.00004	0.00005	0.00005	0.00004	0.00003	0.00004	0.00004
51_D	0.00043	0.00035	0.00038	0.00030	0.00045	0.00040	0.00045	0.00039	0.00025	0.00019	0.00024	0.00022	0.00026	0.00019	0.00024	0.00021
51_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
51_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_D	0.01314	0.02357	0.02251	0.02118	0.01383	0.02633	0.02650	0.02818	0.00782	0.01241	0.01401	0.01567	0.00808	0.01244	0.01411	0.01480
52_E	0.00006	0.00011	0.00010	0.00010	0.00006	0.00012	0.00012	0.00013	0.00004	0.00006	0.00006	0.00007	0.00004	0.00006	0.00006	0.00007
52_G	0.00554	0.00995	0.00950	0.00894	0.00584	0.01111	0.01119	0.01190	0.00330	0.00524	0.00591	0.00661	0.00341	0.00525	0.00596	0.00625
53_D	0.01783	0.00325	0.00402	0.00077	0.01877	0.00363	0.00473	0.00102	0.01061	0.00171	0.00250	0.00057	0.01097	0.00171	0.00252	0.00054
53_E	0.00009	0.00002	0.00002	0.00000	0.00009	0.00002	0.00002	0.00000	0.00005	0.00001	0.00001	0.00000	0.00005	0.00001	0.00001	0.00000
53_G	0.00776	0.00141	0.00175	0.00033	0.00816	0.00158	0.00206	0.00045	0.00462	0.00074	0.00109	0.00025	0.00477	0.00075	0.00110	0.00023
54_D	0.00091	0.00074	0.00065	0.00059	0.00096	0.00082	0.00076	0.00078	0.00054	0.00039	0.00040	0.00044	0.00056	0.00039	0.00041	0.00041
54_E	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
54_G	0.00162	0.00130	0.00115	0.00104	0.00170	0.00146	0.00135	0.00139	0.00096	0.00069	0.00071	0.00077	0.00100	0.00069	0.00072	0.00073
61_D	0.00640	0.02392	0.01742	0.03256	0.00762	0.03314	0.02344	0.04863	0.00549	0.01435	0.01246	0.02691	0.01197	0.02681	0.02589	0.06369
61_E	0.00001	0.00003	0.00002	0.00004	0.00001	0.00004	0.00003	0.00006	0.00001	0.00002	0.00001	0.00003	0.00001	0.00003	0.00003	0.00008
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62_D	0.07601	0.02673	0.02997	0.01088	0.09049	0.03704	0.04034	0.01625	0.06515	0.01604	0.02144	0.00899	0.14207	0.02996	0.04456	0.02128
62_E	0.00006	0.00002	0.00002	0.00001	0.00007	0.00003	0.00003	0.00001	0.00005	0.00001	0.00002	0.00001	0.00011	0.00002	0.00003	0.00002

2015 Weekday VMT Mix – San Antonio TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00096	0.00147	0.00134	0.00142	0.00146	0.00241	0.00175	0.00191	0.00174	0.00222	0.00181	0.00199	0.00116	0.00154	0.00194	0.00195
21_D	0.00437	0.00450	0.00512	0.00501	0.00417	0.00443	0.00492	0.00485	0.00470	0.00485	0.00523	0.00520	0.00440	0.00472	0.00527	0.00521
21_E	0.00039	0.00039	0.00066	0.00062	0.00038	0.00038	0.00064	0.00060	0.00042	0.00042	0.00068	0.00065	0.00040	0.00041	0.00068	0.00065
21_G	0.58536	0.60329	0.68584	0.67115	0.55859	0.59325	0.65863	0.65025	0.63006	0.64982	0.70107	0.69725	0.58915	0.63290	0.70605	0.69801
31_D	0.00826	0.00805	0.00685	0.00711	0.00819	0.00797	0.00703	0.00718	0.00768	0.00786	0.00680	0.00696	0.00591	0.00653	0.00579	0.00593
31_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31_G	0.25833	0.25178	0.21431	0.22252	0.25606	0.24924	0.22002	0.22473	0.24022	0.24589	0.21273	0.21774	0.18490	0.20432	0.18102	0.18563
32_D	0.00160	0.00145	0.00178	0.00164	0.00158	0.00144	0.00182	0.00166	0.00148	0.00142	0.00176	0.00161	0.00114	0.00118	0.00150	0.00137
32_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32_G	0.02104	0.01919	0.02345	0.02167	0.02086	0.01900	0.02407	0.02189	0.01957	0.01874	0.02327	0.02121	0.01506	0.01557	0.01981	0.01808
41_D	0.00227	0.00209	0.00114	0.00203	0.00116	0.00130	0.00089	0.00116	0.00088	0.00131	0.00083	0.00123	0.00082	0.00100	0.00068	0.00082
41_E	0.00001	0.00001	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41_G	0.00043	0.00039	0.00021	0.00038	0.00022	0.00024	0.00017	0.00022	0.00017	0.00025	0.00016	0.00023	0.00015	0.00019	0.00013	0.00015
42_D	0.00078	0.00073	0.00049	0.00073	0.00040	0.00045	0.00038	0.00041	0.00030	0.00046	0.00036	0.00044	0.00028	0.00035	0.00029	0.00029
42_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42_G	0.00019	0.00018	0.00012	0.00018	0.00010	0.00011	0.00009	0.00010	0.00007	0.00011	0.00009	0.00011	0.00007	0.00008	0.00007	0.00007
43_D	0.00141	0.00151	0.00064	0.00116	0.00072	0.00093	0.00050	0.00066	0.00054	0.00094	0.00046	0.00070	0.00051	0.00072	0.00038	0.00047
43_G	0.00006	0.00007	0.00003	0.00005	0.00003	0.00004	0.00002	0.00003	0.00002	0.00004	0.00002	0.00003	0.00002	0.00003	0.00002	0.00002
51_D	0.00056	0.00051	0.00040	0.00040	0.00068	0.00053	0.00051	0.00051	0.00038	0.00030	0.00028	0.00027	0.00037	0.00030	0.00027	0.00024
51_G	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000
52_D	0.01250	0.02465	0.01713	0.02084	0.01515	0.02563	0.02197	0.02632	0.00857	0.01450	0.01208	0.01398	0.00829	0.01428	0.01173	0.01268
52_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_G	0.00434	0.00855	0.00595	0.00723	0.00526	0.00890	0.00762	0.00913	0.00298	0.00503	0.00419	0.00485	0.00288	0.00495	0.00407	0.00440
53_D	0.01719	0.00344	0.00310	0.00077	0.02083	0.00358	0.00397	0.00097	0.01179	0.00202	0.00218	0.00051	0.01140	0.00199	0.00212	0.00047
53_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
53_G	0.00588	0.00118	0.00106	0.00026	0.00713	0.00123	0.00136	0.00033	0.00404	0.00069	0.00075	0.00018	0.00390	0.00068	0.00073	0.00016
54_D	0.00089	0.00079	0.00051	0.00060	0.00108	0.00082	0.00065	0.00075	0.00061	0.00047	0.00036	0.00040	0.00059	0.00046	0.00035	0.00036
54_G	0.00172	0.00152	0.00097	0.00115	0.00208	0.00158	0.00125	0.00145	0.00118	0.00089	0.00069	0.00077	0.00114	0.00088	0.00067	0.00070
61_D	0.00555	0.03033	0.01062	0.02479	0.00729	0.03613	0.01533	0.03363	0.00486	0.01972	0.00889	0.01775	0.01301	0.05048	0.02074	0.04671
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00001
62_D	0.06588	0.03389	0.01827	0.00828	0.08657	0.04037	0.02637	0.01123	0.05770	0.02203	0.01529	0.00593	0.15443	0.05639	0.03568	0.01560

2025 Weekday VMT Mix – San Antonio TxDOT District (2023, 2024, 2026, and 2027Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
11_G	0.00096	0.00147	0.00134	0.00142	0.00146	0.00241	0.00175	0.00191	0.00174	0.00222	0.00181	0.00199	0.00116	0.00154	0.00194	0.00195
21_D	0.00248	0.00255	0.00290	0.00284	0.00236	0.00251	0.00279	0.00275	0.00267	0.00275	0.00297	0.00295	0.00249	0.00268	0.00299	0.00295
21_E	0.00970	0.00962	0.01631	0.01531	0.00925	0.00946	0.01566	0.01483	0.01044	0.01036	0.01667	0.01590	0.00976	0.01009	0.01679	0.01592
21_G	0.57795	0.59601	0.67241	0.65863	0.55152	0.58609	0.64574	0.63813	0.62209	0.64198	0.68735	0.68425	0.58170	0.62526	0.69222	0.68500
31_D	0.00699	0.00681	0.00577	0.00600	0.00693	0.00674	0.00593	0.00606	0.00650	0.00665	0.00573	0.00587	0.00500	0.00553	0.00488	0.00500
31_E	0.00236	0.00222	0.00281	0.00280	0.00234	0.00219	0.00289	0.00283	0.00220	0.00216	0.00279	0.00274	0.00169	0.00180	0.00237	0.00234
31_G	0.25705	0.25063	0.21237	0.22064	0.25479	0.24810	0.21803	0.22283	0.23903	0.24476	0.21081	0.21590	0.18398	0.20339	0.17939	0.18407
32_D	0.00138	0.00126	0.00153	0.00142	0.00137	0.00125	0.00158	0.00143	0.00129	0.00123	0.00152	0.00139	0.00099	0.00102	0.00130	0.00118
32_E	0.00020	0.00017	0.00032	0.00028	0.00020	0.00017	0.00033	0.00028	0.00019	0.00017	0.00032	0.00028	0.00014	0.00014	0.00027	0.00024
32_G	0.02125	0.01939	0.02358	0.02181	0.02106	0.01919	0.02421	0.02203	0.01976	0.01893	0.02341	0.02134	0.01521	0.01573	0.01992	0.01819
41_D	0.00208	0.00193	0.00105	0.00186	0.00106	0.00119	0.00082	0.00106	0.00081	0.00121	0.00077	0.00113	0.00075	0.00092	0.00062	0.00075
41_E	0.00004	0.00003	0.00002	0.00003	0.00002	0.00002	0.00001	0.00002	0.00001	0.00002	0.00001	0.00002	0.00001	0.00002	0.00001	0.00001
41_G	0.00075	0.00069	0.00038	0.00067	0.00038	0.00043	0.00030	0.00038	0.00029	0.00043	0.00028	0.00041	0.00027	0.00033	0.00022	0.00027
42_D	0.00062	0.00058	0.00039	0.00057	0.00031	0.00036	0.00030	0.00033	0.00024	0.00036	0.00029	0.00035	0.00022	0.00028	0.00023	0.00023
42_E	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00000	0.00000
42_G	0.00024	0.00023	0.00015	0.00023	0.00012	0.00014	0.00012	0.00013	0.00009	0.00014	0.00011	0.00014	0.00009	0.00011	0.00009	0.00009
43_D	0.00127	0.00136	0.00058	0.00104	0.00065	0.00084	0.00045	0.00059	0.00049	0.00085	0.00042	0.00063	0.00046	0.00065	0.00034	0.00042
43_E	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_G	0.00013	0.00014	0.00006	0.00011	0.00007	0.00009	0.00005	0.00006	0.00005	0.00009	0.00004	0.00007	0.00005	0.00007	0.00004	0.00004
51_D	0.00039	0.00035	0.00028	0.00028	0.00047	0.00037	0.00035	0.00035	0.00027	0.00021	0.00019	0.00019	0.00026	0.00021	0.00019	0.00017
51_E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
51_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
52_D	0.01195	0.02354	0.01636	0.01990	0.01448	0.02448	0.02097	0.02514	0.00819	0.01384	0.01153	0.01335	0.00792	0.01364	0.01120	0.01211
52_E	0.00006	0.00011	0.00008	0.00009	0.00007	0.00011	0.00010	0.00012	0.00004	0.00006	0.00005	0.00006	0.00004	0.00006	0.00005	0.00006
52_G	0.00504	0.00994	0.00691	0.00840	0.00611	0.01034	0.00885	0.01061	0.00346	0.00584	0.00487	0.00564	0.00334	0.00576	0.00473	0.00511
53_D	0.01622	0.00325	0.00292	0.00072	0.01965	0.00338	0.00374	0.00091	0.01113	0.00191	0.00206	0.00048	0.01076	0.00188	0.00200	0.00044
53_E	0.00008	0.00002	0.00001	0.00000	0.00010	0.00002	0.00002	0.00000	0.00005	0.00001	0.00001	0.00000	0.00005	0.00001	0.00001	0.00000
53_G	0.00706	0.00141	0.00127	0.00031	0.00855	0.00147	0.00163	0.00040	0.00484	0.00083	0.00089	0.00021	0.00468	0.00082	0.00087	0.00019
54_D	0.00083	0.00073	0.00047	0.00055	0.00101	0.00076	0.00060	0.00070	0.00057	0.00043	0.00033	0.00037	0.00055	0.00043	0.00032	0.00034
54_E	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
54_G	0.00147	0.00130	0.00083	0.00098	0.00178	0.00135	0.00107	0.00124	0.00101	0.00077	0.00059	0.00066	0.00098	0.00075	0.00057	0.00060
61_D	0.00555	0.03030	0.01061	0.02476	0.00729	0.03610	0.01531	0.03359	0.00486	0.01970	0.00888	0.01773	0.01300	0.05043	0.02072	0.04666
61_E	0.00001	0.00004	0.00001	0.00003	0.00001	0.00004	0.00002	0.00004	0.00001	0.00002	0.00001	0.00002	0.00002	0.00006	0.00002	0.00006
61_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62_D	0.06583	0.03386	0.01825	0.00827	0.08650	0.04034	0.02635	0.01122	0.05765	0.02201	0.01528	0.00592	0.15431	0.05635	0.03566	0.01559
62_E	0.00005	0.00003	0.00001	0.00001	0.00007	0.00003	0.00002	0.00001	0.00005	0.00002	0.00001	0.00000	0.00012	0.00004	0.00003	0.00001

APPENDIX D:
TXDOT DISTRICT AGGREGATE WEEKDAY VMT MIX

VMT Mix Year/Analysis Year Correlations

VMT Mix Year	Analysis Years
2000	1998 through 2002
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032

Aggregate Weekday VMT Mix – Dallas TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00146	0.00146
21_G	0.00508	0.00288
21_D	0.00100	0.02462
21_E	0.68059	0.65917
31_G	0.00623	0.00521
31_D	0.00000	0.00385
31_E	0.19476	0.19175
32_G	0.00144	0.00123
32_D	0.00000	0.00039
32_E	0.01899	0.01898
41_G	0.00079	0.00072
41_D	0.00000	0.00001
41_E	0.00015	0.00026
42_G	0.00030	0.00024
42_D	0.00000	0.00001
42_E	0.00007	0.00009
43_G	0.00046	0.00042
43_D	0.00000	0.00000
43_E	0.00002	0.00004
51_G	0.00042	0.00029
51_D	0.00000	0.00000
51_E	0.00001	0.00000
52_G	0.01835	0.01752
52_D	0.00000	0.00008
52_E	0.00637	0.00740
53_G	0.00384	0.00363
53_D	0.00000	0.00002
53_E	0.00132	0.00158
54_G	0.00060	0.00056
54_D	0.00000	0.00000
54_E	0.00115	0.00099
61_G	0.01944	0.01942
61_D	0.00000	0.00002
61_E	0.00000	0.00000
62_D	0.03716	0.03713
62_E	0.00000	0.00003

[1] 2017 activity scenario.
[2] 2023, 2024, 2026 and 2027 activity scenarios

Aggregate Weekday VMT Mix – Fort Worth TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00183	0.00183
21_G	0.00497	0.00282
21_D	0.00058	0.01423
21_E	0.66588	0.65438
31_G	0.00654	0.00552
31_D	0.00000	0.00233
31_E	0.20466	0.20318
32_G	0.00149	0.00128
32_D	0.00000	0.00024
32_E	0.01960	0.01974
41_G	0.00089	0.00082
41_D	0.00000	0.00001
41_E	0.00017	0.00030
42_G	0.00034	0.00027
42_D	0.00000	0.00001
42_E	0.00008	0.00011
43_G	0.00054	0.00048
43_D	0.00000	0.00000
43_E	0.00002	0.00005
51_G	0.00042	0.00029
51_D	0.00000	0.00000
51_E	0.00001	0.00000
52_G	0.01825	0.01743
52_D	0.00000	0.00008
52_E	0.00633	0.00736
53_G	0.00382	0.00361
53_D	0.00000	0.00002
53_E	0.00131	0.00157
54_G	0.00060	0.00055
54_D	0.00000	0.00000
54_E	0.00115	0.00098
61_G	0.02078	0.02076
61_D	0.00000	0.00002
61_E	0.00000	0.00000
62_D	0.03972	0.03969
62_E	0.00000	0.00003

[1] 2017 activity scenario.

[2] 2023, 2024, 2026 and 2027 activity scenarios

Aggregate Weekday VMT Mix – Beaumont TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00140	0.00140
21_G	0.00463	0.00263
21_D	0.00013	0.00332
21_E	0.62071	0.61953
31_G	0.00714	0.00608
31_D	0.00000	0.00066
31_E	0.22348	0.22371
32_G	0.00148	0.00129
32_D	0.00000	0.00006
32_E	0.01952	0.01982
41_G	0.00104	0.00095
41_D	0.00000	0.00002
41_E	0.00019	0.00034
42_G	0.00038	0.00030
42_D	0.00000	0.00001
42_E	0.00009	0.00012
43_G	0.00066	0.00060
43_D	0.00000	0.00000
43_E	0.00003	0.00006
51_G	0.00046	0.00032
51_D	0.00000	0.00000
51_E	0.00001	0.00000
52_G	0.02019	0.01928
52_D	0.00000	0.00009
52_E	0.00701	0.00814
53_G	0.00423	0.00399
53_D	0.00000	0.00002
53_E	0.00145	0.00174
54_G	0.00068	0.00064
54_D	0.00000	0.00000
54_E	0.00132	0.00113
61_G	0.02877	0.02874
61_D	0.00000	0.00003
61_E	0.00000	0.00000
62_D	0.05499	0.05495
62_E	0.00000	0.00004

[1] 2017 activity scenario.

[2] 2023, 2024, 2026 and 2027 activity scenarios

Aggregate Weekday VMT Mix – Houston TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00150	0.00150
21_G	0.00488	0.00277
21_D	0.00067	0.01652
21_E	0.65438	0.64064
31_G	0.00684	0.00576
31_D	0.00000	0.00298
31_E	0.21397	0.21188
32_G	0.00162	0.00139
32_D	0.00000	0.00031
32_E	0.02131	0.02142
41_G	0.00091	0.00084
41_D	0.00000	0.00002
41_E	0.00017	0.00030
42_G	0.00035	0.00028
42_D	0.00000	0.00001
42_E	0.00008	0.00011
43_G	0.00053	0.00048
43_D	0.00000	0.00000
43_E	0.00002	0.00005
51_G	0.00047	0.00032
51_D	0.00000	0.00000
51_E	0.00001	0.00000
52_G	0.02040	0.01948
52_D	0.00000	0.00009
52_E	0.00708	0.00822
53_G	0.00427	0.00403
53_D	0.00000	0.00002
53_E	0.00146	0.00175
54_G	0.00066	0.00061
54_D	0.00000	0.00000
54_E	0.00127	0.00108
61_G	0.01962	0.01960
61_D	0.00000	0.00002
61_E	0.00000	0.00000
62_D	0.03751	0.03748
62_E	0.00000	0.00003

[1] 2017 activity scenario.

[2] 2023, 2024, 2026 and 2027 activity scenarios

Aggregate Weekday VMT Mix – San Antonio TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00179	0.00179
21_G	0.00498	0.00283
21_D	0.00059	0.01447
21_E	0.66773	0.65601
31_G	0.00694	0.00586
31_D	0.00000	0.00254
31_E	0.21705	0.21541
32_G	0.00157	0.00136
32_D	0.00000	0.00026
32_E	0.02075	0.02090
41_G	0.00105	0.00096
41_D	0.00000	0.00002
41_E	0.00020	0.00035
42_G	0.00040	0.00031
42_D	0.00000	0.00001
42_E	0.00010	0.00012
43_G	0.00063	0.00057
43_D	0.00000	0.00000
43_E	0.00003	0.00006
51_G	0.00040	0.00027
51_D	0.00000	0.00000
51_E	0.00001	0.00000
52_G	0.01729	0.01651
52_D	0.00000	0.00008
52_E	0.00600	0.00697
53_G	0.00362	0.00342
53_D	0.00000	0.00002
53_E	0.00124	0.00149
54_G	0.00057	0.00053
54_D	0.00000	0.00000
54_E	0.00109	0.00094
61_G	0.01579	0.01578
61_D	0.00000	0.00002
61_E	0.00000	0.00000
62_D	0.03019	0.03016
62_E	0.00000	0.00002

[1] 2017 activity scenario.
[2] 2023, 2024, 2026, and 2027 activity scenarios

APPENDIX E: VEHICLE POPULATION ESTIMATES AND 24-HOUR SHP, STARTS, SHEI, AND APU SUMMARIES (ELECTRONIC ONLY)

APPENDIX F:
SOURCE TYPE AGE AND FUEL ENGINE FRACTIONS INPUTS TO MOVES (ELECTRONIC ONLY)