APPENDIX 10

BEXAR COUNTY 2015-EIGHT-HOUR OZONE NONATTAINMENT AREA REASONABLE FURTHER PROGRESS (RFP) ON-ROAD MOBILE EMISSIONS INVENTORIES

Bexar County Moderate Area Reasonable Further Progress State Implementation Plan Revision for the 2015 Eight-Hour Ozone National Ambient Air Quality Standard

Project Number 2022-024-SIP-NR

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)

June 2021

Texas A&M Transportation Institute

FINAL REPORT

Grant No: 582-21-11551-021

Task 5.2 **Final Report – Bexar County 2015-Eight-Hour Ozone Nonattainment Area Reasonable Further Progress (RFP) On-Road Mobile Emissions Inventories**

DATE: June 25, 2021

TO: Aaron Slevin, Air Quality Division
Texas Commission on Environmental Quality (TCEQ)

COPY TO: Julie Vanden Berg, TCEQ
Brenda Fritz, Air Quality Division, TCEQ

FROM: Madhusudhan Venugopal, P.E.
Marty Boardman
Chaoyi Gu, P.E.
Andrew Birt, Ph.D.
Apoorba Bibeka, P.E.
Robert Huch, P.G., CPESC
Transportation Modeling Program
Texas A&M Transportation Institute

FOR MORE INFORMATION:
Madhusudhan Venugopal, P.E.
972.994.2213
m-venugopal@tti.tamu.edu

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This report describes emissions inventory (EI) development work conducted by the Texas A&M Transportation Institute (TTI) on behalf of the Texas Commission on Environmental Quality (TCEQ). Specifically, TTI developed a set of on-road mobile source EIs for the Bexar County ozone nonattainment area under the 2015 eight-hour ozone standard. TTI developed ozone season, summer weekday EIs for 2017, 2023, and 2024. The project also produced individual control strategy emission reductions estimates for the 2023 and 2024 analysis years. This work was in support of TCEQ's plans to update the state implementation plan (SIP) which will require a reasonable further progress (RFP) analysis that demonstrates continued progress toward attainment of the United States Environmental Protection Agency's (EPA) 2015 eight-hour ozone standard. There were five RFP scenario EIs as delineated in Table 1.

Table 1. Bexar County RFP Inventory Scenarios.

No.	RFP Inventory	Activity Input[1]	Emission rates Input[2]
1	2017 Base Year	2017 (Base Year)	2017 Control Strategy
2	2023 Pre-1990 Controls	2023 (Attainment Year)	2023 Pre-1990 Controls
3	2023 Control Strategy	2023 (Attainment Year)	2023 Control Strategy
4	2024 Pre-1990 Controls	2024 (Attainment Contingency Year)	2024 Pre-1990 Controls
5	2024 Control Strategy	2024 (Attainment Contingency Year)	2024 Control Strategy

[1] For external inventory calculations: vehicle miles traveled (VMT) mix, link VMT/speeds, and off-network activity.

[2] "Pre-1990 Controls" rates are for the calendar year of the evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls –no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, uses pre-1992 conventional gasoline with 1992 summer Reid vapor pressure (RVP) limit promulgated prior to the enactment of the 1990 CAAA, no Texas Low Emissions Diesel (TxLED). "Control Strategy" rates include effects of control strategies current for subject analysis year (i.e., both pre- and post-1990 FMVCP, current fuels, TxLED fuel).

TTI developed the inventories of traffic activity and total emissions at a temporal scale of each hour of the day based on individual roadway links acquired from the Bexar County travel demand model (TDM) provided by the Alamo Area Metropolitan Planning Organization (AAMPO). TTI estimated on-road mobile source vehicle activity and emissions for on-network (roadways) and off-network (e.g., parking areas, driveways) activity categories. As shown in Table 1, the RFP EIs include the control strategy scenario for all years and the pre-1990 (pre-90) controls scenario for all analysis years other than the base year. These two RFP scenarios enable the estimation of emissions reductions from control strategies. The following pollutants were modeled: volatile organic compounds (VOC), oxides of nitrogen (NO_X), carbon monoxide (CO), ammonia (NH_3); sulfur dioxide (SO_2), atmospheric carbon dioxide (CO_2), and particulate matter (PM) pollutants in both 2.5 and 10-micron size categories ($PM_{2.5}$ and PM_{10}). Individual control strategy emissions reduction estimates were produced for VOC and NO_X.

TTI developed the EIs using the latest version of the MOtor Vehicle Emissions Simulator (MOVES)—MOVES3 and associated EPA guidance documentation.[1, 2] The EIs were developed using a rates-per-activity approach, which develops and applies MOVES emission rates externally with local activity data. The inventory methods included gasoline and diesel-powered vehicle combinations modeled for on-network and off-network activity and emissions. The on-network or roadway-based activity consists of VMT and average operational speeds and off-network activity consists of off-network idling hours, source hours parked, vehicle starts, source hours extended idling, and diesel auxiliary power unit hours. The EIs were calculated using a mix of local data inputs (e.g., registration data, local TDMs, traffic count data) and MOVES defaults. The latest (readily) available data, models, and procedures were used, as well as the latest planning assumptions, to assure that motor vehicle emissions budgets to be established by TCEQ in the SIP will be consistent with transportation conformity analysis requirements.

TTI calculated the EIs using utilities developed and maintained by TTI (the TTI EI utilities, updated for use with MOVES3).[3] The EI results were summarized into various formats specified for reporting and air quality planning processes as described below:

- Emissions Inventory Data Files:
  - RFP EI and individual control reductions summaries (spreadsheet file).
  - EI output files – standard tab-delimited, hourly, and 24-hour report summaries of EIs by MOVES source use type (SUT) and fuel type (FT) combination (or vehicle type) and TDM roadway class.
  - EI extracts – various tab-delimited EI aggregations from the TTI EI utilities standard output.
  - Extensible markup language (XML)-formatted EI summaries – for uploading to TCEQ's Texas Air Emissions Repository (TexAER).

[1] EPA's latest March 2021 MOVES3.0.1 release was used in this analysis.

[2] *MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, November 2020.

[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 MOVES3, 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 MOVES3 utilities document is available.

- Emission Factor Data Files:
  - MOVES model input data, build and run files, as well as post-processing adjustment factors.

Table 2 and Table 3 summarize the pollutant totals EI estimates and individual control strategy reduction estimates for Bexar County. Table 2 regional EI pollutant totals are for VOC, NO_X, CO, NH_3, SO_2, CO_2, $PM_{2.5}$, and PM_{10}. The PM estimates are the aggregates of exhaust, brakewear, and tirewear processes. VOC includes exhaust and evaporative emissions processes. Table 3 summarizes control strategy reduction estimates for VOC and NO_X.

Table 2. 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	48,023,548	28.83	17.35	313.17	33.94	0.34	1.43	28,346.59	1.37	4.21
Pre-1990 Controls[2]	2023	56,682,813	27.10	225.67	3,015.52	356.10	17.66	6.61	34,940.42	7.91	12.09
Pre-1990 Controls[2]	2024	58,054,375	26.77	232.16	3,101.05	365.38	18.15	6.79	35,928.25	8.14	12.46
Control Strategy[3]	2023	56,682,813	27.10	12.38	256.45	20.63	0.18	1.45	29,474.74	1.00	4.50
Control Strategy[3]	2024	58,054,375	26.77	11.91	249.74	19.50	0.18	1.48	29,589.81	1.00	4.62

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

[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 controls emission rates. Rates are for analysis year fleet but exclude post-1990 CAAA controls – no post-1990 FMVCP effects, uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to the enactment of the 1990 CAAA, no TxLED.

[3] Control strategy inventories: analysis year activity inputs and analysis year control strategy emission rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 gasoline and Ultra Low Sulfur Diesel (ULSD), and TxLED).

Table 3. Bexar County Summer Weekday RFP Control Scenario Inventories and VOC and NO_X Reductions (Tons) by Analysis Year.

Emissions Analysis	VOC 2017	VOC 2023	VOC 2024	NO_X 2017	NO_X 2023	NO_X 2024
Pre-90 Control Inventory	-	225.67	232.16	-	356.10	365.38
Control Strategy Inventory	17.35	12.38	11.91	33.94	20.63	19.50
Total Reductions	-	213.29	220.25	-	335.47	345.88
FMVCP Reductions	-	210.78	217.78	-	329.09	339.92
Tier 3 CG and ULSD Reductions [1]	-	2.51	2.47	-	5.67	5.26
TxLED Reductions	-	-	-	-	0.71	0.70

[1] Current conventional gasoline (CG) standards with Tier 3 sulfur and pre-1990 diesel replaced with ULSD.

Note: Columns may not total due to rounding, and "-" = "not applicable".

1.0 INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) works with local planning districts, the Texas Department of Transportation (TxDOT), and the Texas A&M Transportation Institute (TTI) to provide on-road, mobile source emissions inventories of air pollutants. TCEQ typically funds mobile source inventory work in support of the federal Clean Air Act Amendment (CAAA).

Accurate emissions inventories (EIs) are critical if state, local, and federal agencies are to attain, and maintain, the National Ambient Air Quality Standards (NAAQS) that the U.S. Environmental Protection Agency (EPA) has established for criteria pollutants such as ozone, particulate matter (PM), and carbon monoxide (CO), as well as to control hazardous air pollutant (HAP) emissions.

This report describes work conducted by TTI on behalf of TCEQ. The work involves the calculation of EIs for the Bexar County ozone nonattainment area. Ozone season, summer weekday EIs were developed for 2017, 2023, and 2024, along with emissions reductions from individual control strategies estimated for the 2023 and 2024 analysis years.

The EIs and control strategy reduction estimates have been commissioned to be used for air quality planning by TCEQ. Specifically, this work was in support of TCEQ's plans to update the state implementation plan (SIP) which will require a reasonable further progress (RFP) analysis from the base year to the attainment year to demonstrate continued progress toward attainment of the EPA's 2015 eight-hour ozone standard for the Bexar County ozone nonattainment area. The Bexar County RFP EIs were developed using the latest version of EPA's Motor Vehicle Emissions Simulator (MOVES) and the latest planning assumptions to assure the motor vehicle emissions budgets set by the SIP revision will be consistent with transportation conformity analysis requirements.

1.1 OBJECTIVE

The purpose of this document is to describe the methods and data used to develop on-road mobile source, ozone season, summer weekday RFP EIs and control strategy reductions for Bexar County. The RFP EIs were required for the base year (2017), attainment year (2023), and an attainment contingency year (2024). Individual control measure reduction estimates were required for the attainment year and attainment contingency year.

The pollutants inventoried were volatile organic compounds (VOC), oxides of nitrogen (NO_X), CO, ammonia (NH_3); sulfur dioxide (SO_2), atmospheric carbon dioxide (CO_2), and PM pollutants in both 2.5 and 10-micron size categories ($PM_{2.5}$ and PM_{10}). Individual control strategy emissions reduction estimates were produced for VOC and NO_X. The EIs were estimated based on on-network and off-network traffic activity. On-network activity includes vehicle miles traveled on regional roadways. Off-network activity includes traffic activity such as vehicle starts, off-network idling (ONI), source hours parked, and long-haul truck hotelling.

The methods used to calculate the EIs are an extension of historically consistent traffic activity and emission rate methods developed by TTI. The Bexar County area is served by a Travel Demand Model (TDM) administered by the Alamo Area Metropolitan Planning Organization (AAMPO). As such, the EI calculations described in this document are based on an hourly, link-level analysis that uses the outputs of the San Antonio regional TDM, other local data sources consistent with the region (e.g., seasonal day type and hourly travel factors; vehicle population data; and environmental inputs), and MOVES default inputs. This report details all the data sources used to define the EIs developed for this project.

At the request of TCEQ, the EIs were developed using the latest version of the EPA's on-road emissions inventory software—MOVES3. MOVES3 was released in November 2020 (and updated in March 2021) to replace the MOVES2014b version of the software. The EI methods described in this document have been developed to incorporate the latest information on on-road mobile source emissions and methods outlined in the associated EPA guidance for conducting MOVES3 based EIs.

In addition to calculating EIs and control strategy reductions, this project involves the development of electronic deliverables that were post-processed from the EI results into formats suitable for reporting and air quality planning. These outputs include:

- Emissions inventory data files:
  - RFP EI and individual control reductions summaries (spreadsheet file).
  - EI output files – standard tab-delimited, hourly and 24-hour EI summaries by county, MOVES source use type (SUT) and fuel type (FT) combination (or vehicle type), and TDM roadway class.
  - EI extracts – various tab-delimited EI aggregations from the TTI EI utilities standard output.
  - Extensible markup language (XML)-formatted EI summaries – for uploading to TCEQ's Texas Air Emissions Repository (TexAER).

- Emission factor data files:
    - MOVES model input data, build and run files, as well as post-processing adjustment factors.

1.2 Summary of Modeling Methodology

Each EI was calculated using a detailed MOVES rates-per-activity method based on the San Antonio regional TDM data for Bexar County. This approach calculates on-network emissions at the scale of each link defined by the regional TDM outputs.

The TTI rates-activity estimation methods were performed in four basic steps, simplified below:

1. **Calculate Emission Rates:** MOVES3 was used to estimate regional emission rates (or factors) relevant to the analysis area and RFP scenario. The rates were calculated based on local inputs to MOVES such as temperature and humidity, fuel formulations, etc. These emission rates were post-processed into the input form specific to RFP scenarios and required by the utility for the emissions calculations (to include conversions, adjustments, and reformatting).
2. **Estimate Traffic Activity:** The local TDM data sets (designated for each analysis year) were processed to derive 24 hourly vehicle miles traveled (VMT) and speed estimates for all TDM links as well as for added intrazonal links. Further processing was done to convert VMT based on Highway Performance Monitoring System (HPMS) factors and seasonal and daily adjustment factors. Local automatic traffic recorder (ATR) traffic count data was used to process the TDM activity information. After the on-network activity was estimated, off-network activity was calculated using outputs from the processed travel model, vehicle population data, and MOVES default inputs. The traffic activity was processed to replicate operating conditions described by the summer weekday EI scenario.
3. **Calculate Total Emissions:** The emission rates calculated in Step 1 were multiplied by the on- and off-network activity calculated in Step 2. This yielded emissions estimates in units of mass calculated at a spatial scale of each link (on-network) or county (off-network) for each hour of the day.
4. **Postprocess EI Outputs:** Outputs (for each pollutant) were post-processed into a variety of formats and electronic deliverables for reporting purposes and for air quality planning.

Subsequent sections of this report describe these simplified steps in more detail.

1.3 Emissions Inventory and Control Strategy Reductions Scope

The following is a simplified view of the scope (entities modeled and data inputs) agreed upon with the TCEQ project manager. The scope for the EIs is outlined first followed by the scope for estimation of the control strategy reductions.

1.3.1 RFP Emissions Inventories

For consistency with EPA EI development guidance, TTI used the most recent activity information, based upon current travel demand modeling; the most recent version of the EPA's on-road emissions model, MOVES3[4]; and methods agreed upon with the TCEQ Project Manager and consistent with EPA's RFP guidance.

Geography, Time Period, and Day Type:

- Bexar County.
- Analysis years 2011, 2023, and 2024.
- Summer season of June through August.
- Weekday activity (average Monday through Friday).

Two RFP Control Scenarios:

- EIs with pre-1990 controls only.
- EIs with pre- and post-1990 controls strategies.

Table 4 lists the RFP EIs with associated activity and emission rate components.

[4] MOVES3.0.1 (EPA, March 2021), the latest version of MOVES3 at the time of the analysis, was used.

Table 4. Bexar County RFP Inventory Scenarios.

No.	RFP Inventory	Activity Input[1]	Emission Rates Input[2]
1	2017 Base Year	2017 (Base Year)	2017 Control Strategy
2	2023 Pre-1990 Controls	2023 (Attainment Year)	2023 Pre-1990 Controls
3	2023 Control Strategy	2023 (Attainment Year)	2023 Control Strategy
4	2024 Pre-1990 Controls	2024 (Attainment Contingency Year)	2024 Pre-1990 Controls
5	2024 Control Strategy	2024 (Attainment Contingency Year)	2024 Control Strategy

[1] For external inventory calculations: vehicle miles traveled (VMT) mix, link VMT/speeds, and off-network activity.

[2] "Pre-1990 Controls" rates are for the calendar year of evaluation fleet but exclude post-1990 CAAA controls –no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, uses pre-1992 conventional gasoline with 1992 summer Reid vapor pressure (RVP) limit promulgated prior to the enactment of the 1990 CAAA, no Texas Low Emissions Diesel (TxLED). "Control Strategy" rates include effects of control strategies current for subject analysis year (i.e., both pre- and post-1990 FMVCP, current fuels, TxLED fuel).

Source Use Types, Activity Types, and Emissions Processes:

- *Source use and fuel types (the various combinations of these are referred to as vehicle types) modeled*: See Table 5.
- *Traffic activity modeled*: VMT, vehicle starts, hotelling hours (classified by auxiliary power unit [APU], engine on, engine off), source hours parked, off-network idling.
- *Vehicle-based emissions processes modeled*: running exhaust; crankcase running exhaust; start exhaust; crankcase start exhaust; extended idle exhaust; crankcase extended idle exhaust; auxiliary power exhaust; evaporative permeation; evaporative fuel vapor venting; evaporative liquid leaks; brakewear; tirewear.
- *Refueling emissions processes modeled*: not applicable.

Table 5. MOVES SUT/Fuel Types (Vehicle Types).

SUT ID	SUT Description	SUT Abbreviation[1]	Fuel Types
11	Motorcycle	MC	Gasoline
21	Passenger Car	PC	Gasoline, Diesel
31	Passenger Truck	PT	Gasoline, Diesel
32	Light Commercial Truck	LCT	Gasoline, Diesel
41	Other Buses	OBus	Gasoline, Diesel
42	Transit Bus	TBus	Gasoline, Diesel
43	School Bus	SBus	Gasoline, Diesel
51	Refuse Truck	RT	Gasoline, Diesel
52	Single Unit Short-Haul Truck	SUShT	Gasoline, Diesel
53	Single Unit Long-Haul Truck	SULhT	Gasoline, Diesel
54	Motor Home	MH	Gasoline, Diesel
61	Combination Short-Haul Truck	CShT	Gasoline, Diesel
62	Combination Long-Haul Truck	CLhT	Diesel

[1] The SUT/fuel type, or vehicle type, labels are the combined SUT abbreviation and fuel type names separated by an underscore (e.g., MC_Gas, RT_Diesel, and SBus_Gas are gasoline-powered motorcycles, diesel-powered refuse trucks, and gasoline-powered school buses, respectively).

Pollutants Modeled:

- VOC; CO; NO_X; NH_3; SO_2; primary PM_{10} - exhaust, brakewear, and tirewear; primary $PM_{2.5}$ - exhaust, brakewear, and tirewear; and atmospheric CO_2.

Emission Rate (MOVES) Input Data and Adjustments:

- *Emission rates*: EPA's latest Mobile Source Emission Rates Model – MOVES3.0.1 (herein abbreviated to MOVES). This latest version of the model was released in March 2021 and downloaded from the following link: https://www.epa.gov/moves/latest-versionmotor-vehicle-emission-simulator-moves.
- *Local environmental input data*: 2017 climate inputs (temperature, humidity, barometric pressure) provided by TCEQ.
- *Local age distributions*: County registration data for locality-specific age distributions input. The latest available registration data (2018 end-of-year [no mid-year available]) was used for the historical year (no other local registration data was available) and for the future analysis years.
- *Control program parameters*: RVP and fuel settings, for example, based upon the EI type as defined by the RFP analysis control scenarios.
- *Local fuel formulation input data*:
    - Consistent with Code of Federal Regulations (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.
  - Federally regulated gasoline and diesel sulfur levels or latest available fuel survey data for RFP control scenarios.
  - TCEQ fuel property survey data, including RVP, to develop model inputs. TCEQ provided the 2017 and 2020 Summer Fuel Field Study Final Report and associated electronic files.

- *Inspection and maintenance (I/M) program information*: An I/M program is currently not applicable to Bexar County.
- *Federal motor vehicle control programs*: The effects of all the federal motor vehicle control programs that are included as default inputs in MOVES, consistent with RFP control scenarios.
- *Texas Low Emission Diesel*: Post-processed the diesel vehicle NO_X emission factors to account for the TxLED program, consistent with 30 Texas Administrative Code (TAC) Sections 114.312-114.319, for RFP control scenarios as appropriate. Used year-specific TxLED adjustment factors developed using the benefit information described in the EPA Memorandum "Texas Low Emission Diesel Fuel Benefits," and the method as documented in previous Texas on-road emissions inventory development reports.

Traffic Activity Input Data:

- *Traffic activity:* The latest available link data, trips data, and zonal radii data sets extracted for Bexar County from the AAMPO 2017, 2023, and 2024 TDMs were used. TDM link VMT for the historical analysis year was scaled for consistency with analysis year, seasonally adjusted (summer weekday), HPMS-based, county VMT control total.
- *Traffic patterns:* TxDOT traffic count data from the area (multiple years through latest available 2019) was used to derive seasonal, day type, and hour of day traffic patterns.
- *HPMS consistency adjustment factor*: HPMS data and validation year TDM data.
- *Base hotelling hours data*: TTI's 2017 hotelling study.[5]
- *Hotelling mode distributions*: MOVES default.
- *Vehicle starts:* Number of weekday starts per vehicle from MOVES (based on a combination of MOVES default and local data) and local vehicle type population estimates.

[5] Heavy-Duty Vehicle Idle Activity Study Final Report, prepared by TTI for TCEQ, July 2019.

- *Vehicle population data*: End of year 2018 vehicle registrations and age class data classified by source use and fuel type provided by Texas Department of Motor Vehicles (TxDMV), scaled to estimate analysis year values using county VMT ratios.
- *Off-network idling*: MOVES default total idle fractions and road idle fractions in combination with local roadway network activity estimates (VMT and speeds).
- *Local fleet mix data:*
    - TxDOT traffic classification data.
    - TxDMV vehicle registrations data.
    - Classified by gasoline- and diesel-powered MOVES source use types.

Emissions inventory Outputs:

The following output files were produced by county in formats required by TCEQ:

- Emissions inventory data files:
    - RFP EI and individual control reductions summaries (spreadsheet file).
    - EI output files – standard tab-delimited, hourly and 24-hour EI summaries by county, MOVES SUT and fuel type combination (or vehicle type), and TDM roadway class.
    - EI extracts – various tab-delimited EI aggregations from the TTI EI utilities standard output.
    - XML-formatted EI summaries – for uploading to TCEQ's TexAER.
- Emission factor data files:
    - MOVES model input data, build and run files, a well as post-processing adjustment factors (i.e., input data, structured query language [SQL] scripts to load the data into MOVES county input databases [CDBs], CDBs, MOVES run specification [MRS] files, and TxLED NO_X adjustment factors).

1.3.2 RFP Control Reductions

To complete this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the 2023 and 2024 RFP analysis years. The entire MOVES-based control strategy reduction was subdivided into individual control reductions using a MOVES-based methodology submitted to and approved by the TCEQ Project Manager.

TTI ensured the methods were consistent with the standard Texas on-road mobile source control strategy quantification methods, the EPA's RFP guidance, and TxLED NO_X reductions estimation guidance. Other than for TxLED, the applicable methodology included applying successive individual controls—specifically the FMVCP and fuels—and rerunning the MOVES model to obtain information to individually quantify emissions reductions for each control program/technology. TTI post-processed the emissions reductions for TxLED using methods consistent with TxLED effects estimation guidance. Since MOVES does not separate the reductions from the individual components of the FMVCP such as Tier 1, Tier 2, Tier 3, and the 2007 heavy-duty diesel vehicle certification standard, the effects of FMVCP were calculated as one control reduction.

For the Bexar County RFP control reduction estimates to be consistent with the requirements for RFP EI analyses, TTI developed the emissions reduction estimates using the same version of the EPA's MOVES model, MOVES3.0.1, and methods and inputs consistent with the RFP EI analyses described in Section 1.3.1.

1.4 Report Structure

This report is further divided into the following sections:

- Section 2 details the data and calculations used to calculate regional on-network and off-network traffic activity.
- Section 3 details the calculation of emission rates via MOVES and subsequent rates modifications.
- Section 4 details the methods used to calculate regional emissions.
- Section 5 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.

2.0 ESTIMATING TRAFFIC ACTIVITY

On-network and off-network activity are required to estimate mobile source emissions. TTI uses a method that calculates on-network emissions using VMT by hour and direction for each link in a TDM. Off-network emissions are calculated using county-level, hourly estimates of activity, including ONI hours, source hours parked (SHP), starts, source hours extended idling (SHEI), and APU hours. Both on- and off-network activity (and emissions) are divided into the various vehicle type components. This section describes the methods used to develop on- and off-network activity.

2.1 VEHICLE MILES OF TRAVEL

The hourly, link-based EI development process requires VMT estimates by hour and direction for each link in the TDM. VMT is adjusted for HPMS consistency and to reflect estimated traffic activity patterns characteristic of a typical seasonal day type scenario (i.e., analysis year summer weekday). Operational (congested) link speed estimates corresponding to these traffic conditions are also required. All calculations were conducted using a suite of EI utilities developed by TTI (see Appendix A).

2.1.1 Data Sources

Directional link VMT and speeds were calculated using the latest available link data, trips data, and zonal radii data sets extracted from the 2017, 2023, and 2024 TDMs. Since intrazonal VMT are not accounted for in the TDMs, the intrazonal VMT was estimated using the TDM trip matrix and zonal radii data.

Several other data sources were used to adjust the VMT for HPMS consistency and to estimate the season and day type-specific VMT. HPMS VMT estimates[6] were used to adjust the total TDM-based VMT.

Seasonal day type factors derived from local ATR data were used to translate the traffic activity scenario represented by the TDM to those defined by the EI scenario. These seasonal day type factors were estimated using ATR data collected from 2010 through 2019. The data were combined from the ATR stations from the San Antonio District.

[6] HPMS VMT estimates are based on traffic count data collected according to a statistical sampling procedure specified by the Federal Highway Administration (FHWA). The 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.

2.1.2 Travel Model VMT Adjustments

The following sections describe the steps TTI used to transform TDM-based VMT estimates for each analysis year to the summer weekday hourly VMT estimates required for the emissions analysis.

The TDM VMT was adjusted for HPMS consistency and to represent the summer weekday. For 2017, 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 2023 and 2024, which are future years (i.e., HPMS VMT data does not yet exist for these years), a regional HPMS factor and summer weekday factors were used. Hourly travel factors were also applied to distribute the link VMT estimates over each hour of each day.

2.1.2.1 Historical Years – VMT Control Totals and VMT Adjustments

To estimate the HPMS-consistent summer weekday VMT for the 2017 historical year, a Bexar County 2017 summer weekday VMT control total was used to develop a Bexar County VMT adjustment factor. The VMT control total is comprised of two key components: the analysis year county-level HPMS annual average daily traffic (AADT) VMT and the AADT-to-summer weekday adjustment factor.

The AADT-to-summer weekday adjustment factors was developed for Bexar County using aggregated TxDOT San Antonio District ATR data for the years 2010 through 2019. This regional factor was calculated by dividing the average day-of-week count by the AADT traffic count. Table 6 shows the San Antonio District AADT-to-summer weekday factor used in developing the VMT control total.

Table 6. AADT-to-Summer Weekday Factor.

TxDOT District	Weekday Adjustment Factor
San Antonio	1.07525

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

2.1.2.2 Future Years – HPMS Adjustment Factor

For the future years, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from each TDM for HPMS consistency. The HPMS factor used in this analysis (0.935466904) was based on the AAMPO's 2015 TDM validation.

2.1.2.3 Future Years – Summer Weekday Adjustment Factors

Seasonal adjustment factors were used to adjust the future year TDM link and estimated intrazonal VMT to reflect the summer weekday. This adjustment factor was developed using aggregated ATR data for the years 2010 through 2019. This factor was calculated using local ATR data by dividing the average day-of-week traffic volumes by the average non-summer weekday traffic (ANSWT) volumes. Table 7 shows the seasonal adjustment factor for the San Antonio District.

Table 7. ANSWT-to-Summer Weekday Adjustment Factors.

TxDOT District	Weekday Seasonal Adjustment Factor
San Antonio	1.02751

2.1.3 Summer Weekday VMT Summaries

The final HPMS-consistent VMT is comprised of two parts: the link-level VMT and the estimated intrazonal VMT. For the historical year (2017), the volume for each link was multiplied by the county summer weekday VMT control total-based VMT factor corresponding to the link's county code and by the link's respective length to estimate the link-level summer weekday VMT. For the future years (2023 and 2024), the volume on each link was multiplied by the HPMS factor, the summer weekday adjustment factor, and the link's respective length to estimate the link-level summer weekday VMT. These sets of factors were also applied to the associated intrazonal VMT estimates. Table 8 shows the summer weekday VMT summary.

Table 8. Summer Weekday County VMT Summary.

County	2017	2023	2024
Bexar	48,024,019	56,683,057	58,054,626

2.1.4 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 the multi-year (2010 through 2019) aggregated ATR station data for the San Antonio District. 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. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly, summer weekday VMT. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 9 shows the weekday time period hourly travel factors.

Table 9. 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.	0.051328	0.283673
AM Peak	7:00 a.m. to 8:00 a.m.	0.069620	0.384766
AM Peak	8:00 a.m. to 9:00 a.m.	0.059993	0.331561
Mid-Day	9:00 a.m. to 10:00 a.m.	0.049515	0.155896
Mid-Day	10:00 a.m. to 11:00 a.m.	0.048126	0.151523
Mid-Day	11:00 a.m. to 12:00 p.m.	0.051206	0.161220
Mid-Day	12:00 p.m. to 1:00 p.m.	0.053967	0.169913
Mid-Day	1:00 p.m. to 2:00 p.m.	0.055646	0.175200
Mid-Day	2:00 p.m. to 3:00 p.m.	0.059155	0.186248
PM Peak	3:00 p.m. to 4:00 p.m.	0.067807	0.237732
PM Peak	4:00 p.m. to 5:00 p.m.	0.076238	0.267292
PM Peak	5:00 p.m. to 6:00 p.m.	0.078789	0.276236
PM Peak	6:00 p.m. to 7:00 p.m.	0.062390	0.218740
Overnight	7:00 p.m. to 8:00 p.m.	0.045355	0.209763
Overnight	8:00 p.m. to 9:00 p.m.	0.036741	0.169924
Overnight	9:00 p.m. to 10:00 p.m.	0.032410	0.149894
Overnight	10:00 p.m. to 11:00 p.m.	0.025430	0.117612
Overnight	11:00 p.m. to 12:00 a.m.	0.017600	0.081399
Overnight	12:00 a.m. to 1:00 a.m.	0.009831	0.045468
Overnight	1:00 a.m. to 2:00 a.m.	0.006521	0.030159
Overnight	2:00 a.m. to 3:00 a.m.	0.005639	0.026080
Overnight	3:00 a.m. to 4:00 a.m.	0.005709	0.026404
Overnight	4:00 a.m. to 5:00 a.m.	0.009130	0.042226
Overnight	5:00 a.m. to 6:00 a.m.	0.021854	0.101073

[1] Used in the VMT calculation process.

2.1.5 Link Speeds

To estimate link operational (congested) speeds, a speed model involving both the link estimated free-flow speed and estimated directional delay (as a function of volume and capacity) was used. This model was used to estimate the hourly, directional, congested speed for each link, except for the TDM centroid connectors and added intrazonal links. The congested speed was calculated using the following formula:

$$Congested\ Speed = \frac{60}{\frac{60}{Freeflow\ Speed} + Delay}$$

Free-flow speed factors were used to convert TDM speeds (which are by definition level of service C) to a level of service A speeds (free flow). The free-flow speeds were determined using the Highway Capacity Manual, using suitable assumptions to relate the Highway Capacity Manual data to the facility types used in the TDMs. Appendix E shows the free-flow speed factors used by area-type/functional-class combination. The second component of the speed model used to calculate the congested speed is the estimated directional delay. The directional delay (in minutes per mile) due to congestion was calculated using the following volume/delay equation:

$$Delay = Min\left[A\, e^{B\left({}^{V}/_{C}\right)}, M\right]$$

Where:

Delay = congestion delay (in minutes/mile).
A & B = volume/delay equation coefficients.
M = maximum minutes of delay per mile.
V/C = time-of-day directional v/c ratio.

The delay model parameters (*A*, *B*, and *M*) were developed for the Dallas/Fort Worth area and verified by application in other Texas urban areas. Table 10 shows these parameters, followed by Table 11, which lists the facility types used in the TDMs and their capacity category (except for centroid connector and intrazonal, which do not use capacity data).

Table 10. Volume/Delay Equation Parameters.

Facility Category	A	B	M
High-Capacity Facilities	0.015	3.5	5
Low-Capacity Facilities	0.050	3.0	10

Table 11. Facility Type Categories for Applying Delay Parameters.

Category	TDM Functional Class Codes	TDM Functional Class Categories
High-Capacity	1, 2, 3, 4, 5, 6, 7, 8	Freeways
High-Capacity	9, 10	Expressways
High-Capacity	22	Ramp (Freeway-to-Freeway Interchange)
Low-Capacity	0	Centroid Connector
Low-Capacity	11, 12, 13	Principal Arterials
Low-Capacity	14, 15, 16	Minor Arterials
Low-Capacity	17, 18, 19, 20	Collectors and Frontage
Low-Capacity	21	Ramp (between Frontage and Mainlanes)
Low-Capacity	23	Tolled Ramp (Mainlanes to Tolled Lanes)

The time-of-day directional v/c ratios were estimated using the directional volume (from the VMT estimation) and the time-of-day directional capacity. However, the 24-hour user equilibrium assignments were performed using non-directional 24-hour capacities. To estimate the time-of-day directional capacity, the directional split for capacity was assumed at 50/50 and capacity factors were multiplied by the non-directional capacity for each link. Appendix E summarizes the capacity factors for the San Antonio regional TDM by area type/facility type combination. Capacity factors were calculated using the following formula:

$$Capacity\ Factor = \frac{(Hourly\ Capacity\ per\ Lane) * (Length\ of\ the\ Time\ Period)}{24 - (Hour\ Capacity\ per\ Lane)}$$

Capacity data are not used, however, for the centroid connector links and the added intrazonal links (added specifically for air emissions analyses). The centroid connector traffic assignment input speeds were used as the centroid connector operational speeds estimates. Operational speeds for the intrazonal trips category were estimated by zone as the average of the zone's centroid connector speeds.

The hourly and 24-hour speed (VMT/vehicle hours traveled [VHT]) summaries for Bexar County and road type were provided electronically to TCEQ (see Appendix B for electronic data descriptions).

2.2 Off-Network Activity

Off-network activity includes ONI hours, SHP, starts, and long-haul combination truck hotelling hours (split into various fractions of activity, such as SHEI and diesel APU hours). These quantities are estimated for each hour of the day at a spatial scale of a county and each vehicle type.

2.2.1 Vehicle Population

Vehicle population data were used to estimate SHP and vehicle starts off-network activity. The vehicle population estimates were derived from end of year 2018, county-specific TxDMV vehicle registration data, TxDOT district level VMT mix data, and HPMS-reported county-level VMT totals.

Scaling factors (VMT ratios) were used with the 2018 vehicle population estimates to produce the vehicle population estimates specific to each of the analysis years.

The end of year 2018 TxDMV vehicle registration data was provided in the form of total vehicles registered by county, aggregated by the vehicle categories shown in the first column of Table 12. These TxDMV vehicle categories were disaggregated to MOVES SUT and fuel type aggregations shown in the corresponding row of the second column of Table 12.

The following steps were used to disaggregate the TxDMV vehicle registration data to vehicle population data by vehicle type:

1. VMT mix data was used to calculate the proportional representation of each MOVES vehicle type within each TxDMV aggregation class (first column of Table 12).
2. The proportional fractions calculated in Step 1 were multiplied by the total number of vehicles reported in each TxDMV vehicle registration category to obtain the estimated number of vehicles (populations) for each modeled MOVES vehicle type.
3. The long-haul truck vehicle type populations (see the last row of Table 12) were estimated as an extension of their estimated short-haul vehicle type population counterparts. This was accomplished by multiplying a long-haul-to-short-haul ratio derived from the weekday vehicle type VMT mix, by the associated short-haul truck vehicle type populations, from Step 2.

The VMT mix data used in these calculations was the TxDOT district-level, 24-hour weekday VMT mix described in more detail in the "Vehicle Type VMT Mix" section and included in Appendix D.

The methods above yielded 2018 vehicle population data for each of the vehicle types modeled in the EIs.

Analysis year vehicle type populations were then calculated by applying a vehicle types population growth factor (VPGF). The VPGF was calculated using county-level HPMS reported total VMT for the registration data year (2018) and each analysis year (2017, 2023, and 2024):

$$VPGF = Analysis\ Year\ VMT\ /\ Registration\ Year\ VMT$$

Table 12. TxDMV Registration Aggregations for Estimating Vehicle Populations.

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

[1] The four long-haul SUT/fuel type 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 year-end 2018 TxDMV county registrations data extracts were used (i.e., the three-file 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.

2.2.2 ONI Hours

Off-network idling, or 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.

TTI estimates county ONI activity (i.e., source hours idling [SHI] off-network) for each hour of the day using the following formula:

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

Where:

$SHO_{network}$ is the source hours operating on each link. This is calculated by dividing the VMT associated with each link by the link's congested speed.

$SHI_{network}$ is the total source hours idling that occurs on the network (idling that occurs as a component of drive cycles) and is calculated by multiplying $SHO_{network}$ by a road idle fraction (RIF). RIF is the proportion of idling (in units of time) that occurs within a drive-cycle at a specified operational speed. Default values for RIF were used as defined in the MOVES data table "roadidlefraction".

TIF is the total idle fraction, or total idling time on and off-network, divided by total SHO on and off-network: $TIF = (SHI_{network} + ONI) / (SHO_{network} + ONI)$.

Default values for TIF were used as defined in the MOVES data table "totalidlefraction".

TTI estimated the summer weekday county ONI hours by vehicle type using a combination of the MOVES SUT factors that vary by MOVES day type and/or month (i.e., roadidlefraction and June-July-August average totalidlefraction) in combination with local summer weekday activity factors by county.

2.2.3 SHP

County-level, vehicle type SHP was calculated for each hour of the summer weekday as the difference, by vehicle type, between the local vehicle population (total available vehicle hours) minus summer weekday source operating hours (SHO).

Adjusted SHP was then calculated by subtracting ONI hours from the previously calculated SHP. Appendix F summarizes county-level 24-hour summer weekday adjusted SHP by vehicle type for each analysis year. Hourly summaries were provided electronically to TCEQ; see Appendix B for electronic data descriptions.

2.2.4 Vehicle Starts

Vehicle 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 for the summer weekday.

The starts per vehicle type per hour were calculated using MOVES with data on the age distribution and fuel fractions of the local fleet[7]. TTI used local age distributions and fuel fractions inputs to MOVES combined with MOVES default parameters (startsageadjustment, startsmonthadjust [June through August average], and startspervehicle) to produce hourly starts per vehicle output representative of the June through August summer period and the weekday day type.

For each hour of the day, the MOVES summer weekday starts per vehicle output data were multiplied by the local vehicle type population estimates to produce the total number of starts by vehicle type per hour of the average summer weekday. The 24-hour summaries by year, county, and vehicle type are summarized in Appendix F.

[7] Previously with MOVES2014, TTI used MOVES default start per vehicle (which varied only by MOVES day type) in combination with local vehicle populations to estimate vehicle starts activity. In MOVES3, vehicle starts per hour also vary by county (because age distributions also vary by county).

2.2.5 Hotelling: SHEI and APU Hours

Hotelling hours were calculated for heavy-duty, long-haul trucks only (i.e., SUT 62[8]) in several steps. First, the base, total hotelling hours were calculated using information from a TCEQ extended idling study[9]. Scaling factors were then used to convert these base hotelling hours to those relevant to each EI scenario (defined by analysis year, season, and day type); and hourly factors were applied to allocate to each hour of the day. Estimates were then made of the proportions of hotelling hours that occur in each of the four hotelling categories: idling using the main engine (SHEI), diesel APU operation, electric APU operation, or main engine off and no auxiliary power[10].

2.2.5.1 24-Hour Hotelling

County-level hotelling scaling factors were developed to transform base 2017 winter weekday total daily hotelling hours to daily hotelling hours for each EI scenario. Scaling factors were calculated using the ratio of heavy-duty long haul VMT for a 2017 winter weekday relative to heavy-duty long haul VMT for each EI scenario (scenario SUT 62 VMT divided by 2017 winter weekday SUT 62 VMT).

Total daily hotelling for each Bexar County EI was calculated by multiplying the appropriate scaling factor by the Bexar County total daily hotelling hours from the 2017 winter weekday total daily hotelling hours study.

2.2.5.2 Hotelling by Hour

Daily hotelling hours were allocated to each hour of the day as a function of the inverse of the activity scenario hourly VHT fractions for SUT 62. The hourly VHT fractions were 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.

If the hourly hotelling hours (as calculated above) were greater than SHP (for SUT 62), the final hotelling hours estimate was set to the SHP.

[8] SUT 62 represents long-haul combination trucks, for which only diesel fuel types are modeled.
[9] *Heavy-Duty Vehicle Idle Activity Study, Final Report*. Texas A&M Transportation Institute, Environment and Air Quality Division. July 2019. https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/mob/582177430806-20190722-TTI-HeavyDutyIdleActivityStudyFinal.pdf
[10] Note that only SHEI and APU diesel hoteling generate emissions. The other fractions are calculated for completeness.

2.2.5.3 SHEI and APU Hours

The hourly, county-level, hotelling estimates were then factored to calculate SHEI and diesel APU hours activity components using extended idle and APU fractions. The SHEI and APU fractions were derived using MOVES defaults based on SUT 62 model year data. The updated MOVES SHEI and APU hotelling distributions[11] are shown in Table 13.

Table 13. Hotelling Activity Distributions by Model Year and Operating Mode Fraction.

First Model Year	Last Model Year	200 ExtendIdling	201 Diesel Aux	203 Battery AC	204 APU Off
1960	2009	0.80	0	0	0.20
2010	2020	0.73	0.07	0	0.20
2021	2023	0.48	0.24	0.08	0.20
2024	2026	0.40	0.32	0.08	0.20
2027	2050	0.36	0.32	0.12	0.20

2.3 Vehicle Type VMT Mix

VMT mix represents the fraction of on-road fleet VMT attributable to each SUT by fuel type. It is used to subdivide the total VMT estimates on each link into VMT by vehicle type. Hourly VMT estimates by vehicle type are combined with the appropriate emission factors in the link-emissions calculations.

VMT mixes were calculated and applied at the scale of:

- Each TxDOT District.
- Each analysis year (EI years).
- Each MOVES roadway type.
- Day Type (Weekday).
- Four time periods per day (AM peak, midday, PM peak, and overnight).

[11] Current MOVES3 defaults (previously adopted while in draft stage for use in the TCEQ 2017 truck extended idling study).

VMT mixes were calculated using local vehicle classification count and ATR data, MOVES defaults, and local registration data. Figure 1 shows a simplified view of the method used to estimate VMT mix[12], which includes the following steps (numbered in Figure 1):

1. MOVES – Data files of MOVES default values extracted from MOVES databases or standard runs.
2. TxDOT Classification Counts – Data files of standard TxDOT classification data assembled and used for determining the in-use road fleet mix.
3. TxDMV Registration Data – Data files of standard TxDMV vehicle registration summary 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-week.
5. Single Unit Local versus Total SUT_HDVyy – Procedure based on registration data to generate factors to separate Single Unit versus Combined Unit trucks by region. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)
6. Combination Local versus Total SUT_HDXyy – Procedure based on MOVES default data to generate short-haul and long-haul combination truck proportions.
7. 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.
8. Single Unit Short-Haul versus Long-Haul SUT_SSHZ – Procedure to separate single unit short-haul versus single unit long-haul using factors generated at SUT_HDVyy and classification count data. Short-haul and long-haul are functionally defined as local and pass-through.
9. Combination Short-Haul versus Long-Haul SUT_CSHZ – Procedure to separate combination short-haul versus combination long-haul with factors generated using MOVES defaults and classification count data. Short-haul and long-haul are functionally defined as local and pass-through.

[12] *Developing MOVES Source Use Types and VMT Mix for Conformity Analysis* (TxDOT Air Quality / Conformity IAC-A - TTI Task 409252-0643: Maintain, Update and Enhance Traffic Activity Estimation and Forecasting Methods), Texas Department of Transportation, Austin, TX, August 2016.

10. PV and LDT Fuel MF_Fuelyy – Procedure to generate passenger vehicle and light truck fuel allocation by year based on MOVES national default values and local registration data.
11. Single Unit and Combination Truck Fuel SUT_HDVyy – Procedure to generate single unit and combined truck fuel allocation factors from registration data. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)
12. SUT_yyddtt – Procedure to generate SUT proportions by year, day type, and time period, based on the previous steps.
13. MOVES SUTs – Output file of MOVES SUTs by region, analysis year, day type, and time period. For MOVES3, P_ICB41D is renamed P_OB41D (per the redefined MOVES3 category equivalent to the previous MOVES2014 category), and P_OB41G is added and set to zero (since we have no data to support the proportion of the "Other Buses" category that is gasoline-fueled).[13]

[13] Specifically, the intercity bus category (ICB41) is redefined and renamed "Other Buses" (OB41). Intercity bus was previously considered diesel only. While there is currently no data available to determine the proportion, or even existence of gas fueled "Other Buses" vehicles, the category is necessary to be consistent with MOVES3. Pending additional data, "Other Buses" (OB41) is treated as equivalent to "Intercity Bus" (ICB41) and a placeholder "null" gasoline fueled "Other Buses" (OB41G) is added. The rest of the procedure is identical to the current VMT mix procedure. Thus, these measures and procedures, as modified, provide a functional, hybrid region-specific, disaggregate link-level application of MOVES3 to the extent possible with the data currently available. This hybrid is consistent with previous applications in terms of activity inputs and fleet data.

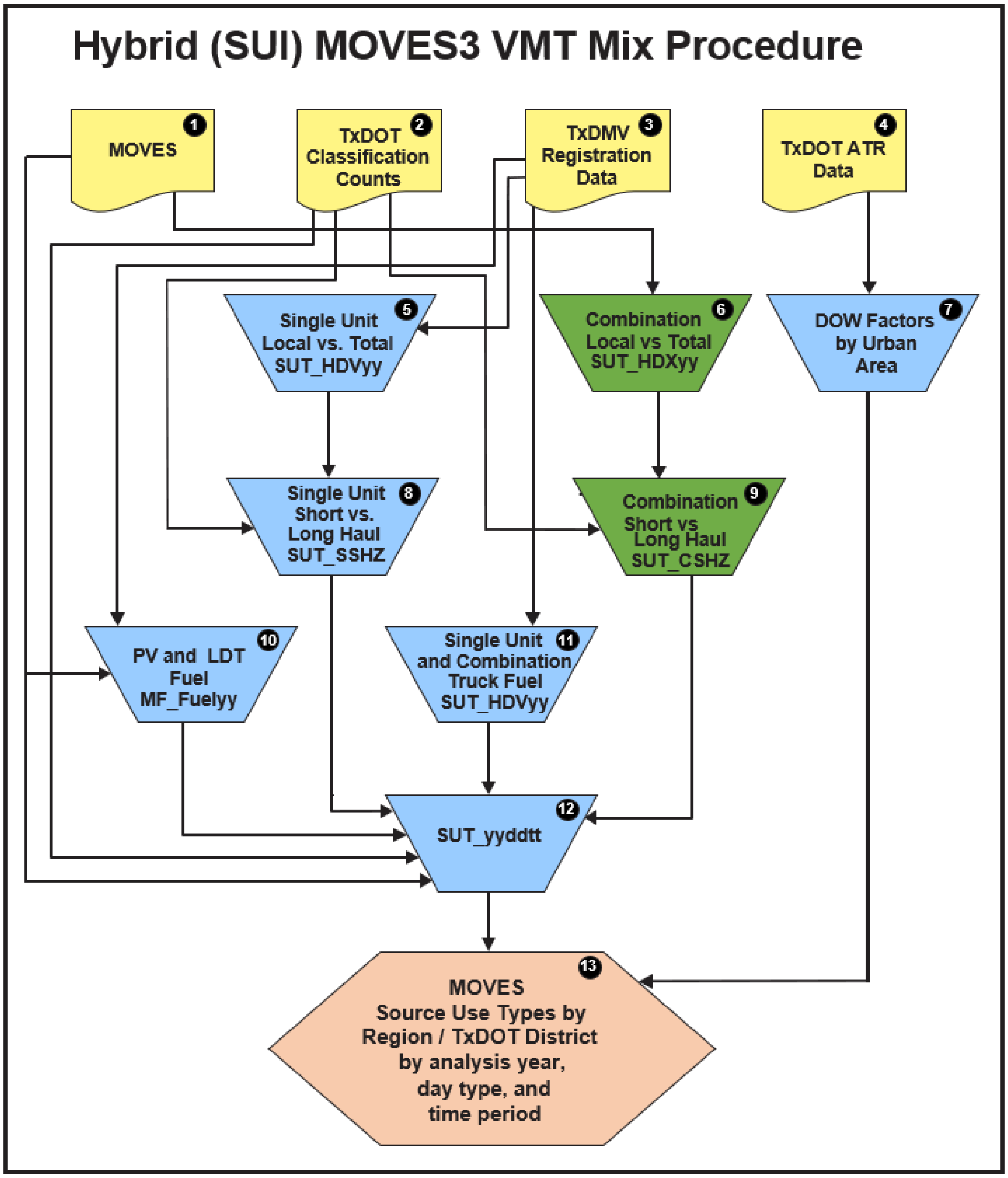

Figure 1. Simplified Overview of the VMT Mix Process.

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 process) were also produced. To ensure general applicability and consistency across all study areas, all VMT mixes were 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

3.0 EMISSION RATES

This section describes the development of the emission rates (for each pollutant). The emission rates were calculated using EPA's MOVES3 emission factor model with local and default data. The resulting MOVES3 emission rates were then post-processed using TTI's EI utilities to yield the emission rates used to calculate total emissions. The emission rates were developed based on the *TTI Emissions Inventory Utilities User's Guide* methods and procedures but updated as needed to accommodate MOVES3 and EPA's *Technical Guidance*[14] applicable to MOVES3 inventory development. Special techniques were employed to model emission rates for particular RFP control scenarios.

This initial focus is on the general emission rates development process used for both of the RFP scenarios (i.e., current controls and pre-1990 controls) and the extra incremental individual control scenarios. The final section provides the details on differences in the inputs between all the scenarios and the stepwise development procedure starting with pre-1990 controls, stepping through adding individual controls, and finishing with the current control scenario.

3.1 OVERVIEW

MOVES emission rates mode runs were developed to produce MOVES output databases containing emissions and activity data (some of which were used during the activity estimation methods described previously). Data contained in each MOVES output database was then post-processed into the final on-road emission rates used in each EI.

Emission rates were developed for the summer weekday. These emission rates were then used with the traffic activity levels characteristic of the average summer weekday time period to calculate the full EI.[15]

MOVES output rates were post-processed using an on-road rates look-up table post-processor utility to convert rates into the units defined by the on- and off-network activity detailed in the previous section (emissions per mile for VMT, emissions per start for vehicle starts, emissions per SHP, etc.). Table 15 defines the rates produced for the external inventory calculations relative to traffic activity measures.

---

[14] EPA. 2020. *MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, EPA-420-B-20-052, Office of Transportation and Air Quality. November 2020.

[15] Separate emission rates are needed by MOVES day type, since some emission rate output varies by day type (e.g., start emission rates, due to different weekday versus weekend cold start distributions by hour of day).

Additional post-processing was done to the rates to adjust diesel NO_X rates to account for the TxLED fuel (a pre-2011-implemented control measure) used in Bexar County.

Table 15. Emission rates by Emissions Process and Activity Factor.

Process (Process ID)	Activity[1]	Emission rates[2]
Running Exhaust	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust	VMT	mass/mi
Brake Wear	VMT	mass/mi
Tire Wear	VMT	mass/mi
Start Exhaust	Starts	mass/start
Crankcase Start Exhaust	Starts	mass/start
Extended Idle Exhaust	SHEI	mass/hour
Crankcase Extended Idle Exhaust	SHEI	mass/hour
Auxiliary Power Exhaust	APU Hours	mass/hour
Running exhaust – Road Type 1 off-network	ONI Hours	mass/hour
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	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 rates table output, except for mass/SHP, which is produced using the TTI EI utility.

This RFP inventory analysis required sets of emission factors for the two main RFP control scenarios: pre-1990 controls, and control strategy (or current controls). The difference between pre-1990 controls and control strategy emissions is the emissions reductions due to the combined effects of individual post-1990 CAAA controls.

For calculating emissions reductions from individual post-1990 controls measures, extra MOVES runs were needed. The set-ups for these runs added post-1990 FMVCP, current federal and state fuels (except TxLED), and TxLED effects sequentially to the pre-1990 controls set-ups. Rates from these runs were used in estimating the individual control program emissions reductions for the 2023 and 2024 analysis years.

The four control scenarios (with labeling as used in the modeling files) are:

- "CS0" = Pre-1990 Controls.
- "CS1" = CS0 + Post-1990 FMVCP.
- "CS2" = CS1 + current state and federal fuels standards (except TxLED).
- "CSC" = CS2 + TxLED fuel (i.e., current control strategy scenario).

Table 16 shows the control measures modeled in the two RFP control scenarios.

Table 16. Control Measure Modeling by RFP Control Scenario.

Individual Control Measures[1]	Method	RFP Pre-1990 Controls (CS0)	RFP Control Strategy (CSC)
Pre-1990 CAAA 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	MOVES inputs		√
I/M Program	MOVES inputs		√ (NA)
TxLED Fuel	Post-process diesel vehicle NO_X rates		√

[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 the enactment of the 1990 CAAA. For the control strategy scenario, MOVES gasoline and diesel inputs reflected Ultra Low Sulfur Diesel (ULSD), conventional gasoline (CG) for 2017 consistent with the actual, summer 2017 survey data for the fuel region applicable to Bexar County, and for 2023 the same as 2017 CG inputs except with sulfur set to the Tier 3 sulfur (10 ppm) standard; Post-1990 FMVCP all together per MOVES limitation; I/M is not applicable for Bexar County; and TxLED effects adjustment to diesel vehicle NO_X emissions.

The following sections describe the emission rates development process in terms of MRS files and CDB inputs, executing MOVES emission rates runs, and post-processing, with the focus mainly on current controls. The last section finishes with the details involving pre-1990 controls and incremental individual control emission rates modeling procedures and inputs.

3.2 MOVES Run Specifications

The MRS is a file (in XML format) that defines the place, time, road categories, vehicle and fuel types, pollutants and emissions processes, and the overall scale and level of output detail for the modeling scenario. TTI created a Bexar County MRS for one scenario using the MOVES graphical user interface (GUI), then converted the MRS to a template from which all the required MRS files were built. Table 17 describes the MRS selections used, followed by sections describing the input data used per selection.

Table 17. MRS Selections by MOVES GUI Panel.

Navigation Panel	Detail Panel	Selection
Scale[1]	Model; Domain/Scale; Calculation Type	On-Road; County; Emission Rates
Time Spans[1]	Years – Months – Days – Hours	***<YEAR>*** - ***<MONTH>*** - ***<DAY-TYPE>*** - All
Geographic Bounds[1]	States; Counties; Selections	Texas – Bexar County, TX (48029);[1]
On-Road Vehicles[2]	SUT/Fuel Combinations: 1 – Gasoline, 2 – Diesel, 3 – Compressed natural gas (CNG), 5 – E85 (85% ethanol-15% gasoline blend), 9 – Electric	SUT: Fuel Types Motorcycle: 1 - - - - Passenger Car: 1 2 - 5 9 Passenger Truck: 1 2 - 5 9 Light Commercial Truck: 1 2 - 5 9 Other Buses: 1 2 3 - - Transit Bus: 1 2 3 - - School Bus: 1 2 3 - - Refuse Truck: 1 2 3 - - Single Unit Short-Haul Truck: 1 2 3 - - Single Unit Long-Haul Truck: 1 2 3 - - Motor Home: 1 2 3 - - Combination Short-Haul Truck: 1 2 3 - - Combination Long-Haul Truck: - 2 - - -
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 pollutant: Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks; Brakewear, Tirewear
General Output	Output Database; Units; Activity	***<MOVES OUTPUT DATABASE NAME>***;[1] Grams, KiloJoules, Miles; Distance Traveled, Hotelling Hours, Population, Starts
Output Emissions Detail	Output Aggregation; For All Vehicles/Equipment; On-Road	Time: Hour, Geographic: Link; Fuel Type, Emissions Process; Road Type, Source Use Type
Create Input Database	Domain Input Database	***<COUNTY DATABASE (CDB) INPUT NAME>***[1]
Advanced Features	Aggregation and Data Handling	Only the "clear BaseRateOutput after rate calculations" box is checked

[1] Limited to one county per County Scale run. County Federal Information Processing Standards (FIPS) code, year, and season/day type labels were included in the MRS file and output database names.
[2] Although MOVES requires all fuel types to be included in MRSs, only gasoline and diesel were modeled.
[3] Pre-requisite pollutants that were needed to model the reported pollutants are not shown.

3.2.1 Scale

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

3.2.2 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, or 2024) was selected, and one "Months" (July) and one "Days" (Weekdays) selection was made. The July weekday MRS selection together with the other MOVES inputs and MRS settings produced emission rates for the average June through August weekday.

3.2.3 Geographic Bounds

Per the MOVES County Scale, (as well as per the analysis scope) only one county was selected per run.

3.2.4 On-Road Vehicles and Road Type

The local VMT mixes developed for the study include the SUT/fuel type combinations modeled with MOVES, namely, gasoline and diesel. The VMT mixes specify the vehicle fleet as the gasoline and diesel SUTs designated as "on-road vehicles" selections in Table 17. These SUT/fuel type combinations were selected in all the MRSs. All other SUT/fuel type combinations available in MOVES were also selected as required by MOVES, but only gasoline and diesel were modeled. Fuel types output was controlled through adjustments to the MOVES default fuel engine fractions via the MOVES Alternate Vehicle and Fuel Technology (AVFT) table and to the MOVES default flex fuel vehicle fuel type usage fractions in the MOVES fuelusagefraction table (discussed later). All five MOVES road type categories were selected.

3.2.5 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, except for the two refueling emissions processes which were not required.

3.2.6 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 fuel type.

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:

- Source use types.
- Fuel types.
- Road type (four actual MOVES road categories and off-network).
- Hours of day.
- Speed bin (16 - in miles-based rate tables).
- Pollutants.
- On-road emissions processes.

For each EI, the vehicle fleet fuel types were modeled using only the predominant on-road fuels of gasoline and diesel (alternate fuels were considered de minimis). The five road type categories in MOVES are Off-Network[16], 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.

[16] The Off-Network road type is not a ‘real’ road type and is instead used as a placeholder to define off-network emissions.

3.3 MOVES COUNTY INPUT DATABASES

MOVES CDBs were created for Bexar County for each year. The CDBs were populated with local input data (such as local fleet age distributions, fuel formulations, meteorological conditions) as well as MOVES defaults.

TTI developed procedures to build and check each CDB. The basic procedure was to write a MySQL script to produce one 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, 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, MOVESDB20210209. After running the scripts to produce the CDBs, the CDBs were checked to verify all CDB tables were built and populated as intended.

Table 18 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 Bexar County and all years. Specific differences in inputs by RFP and incremental control scenarios are discussed in a later section.

Table 18. CDB Input Tables.

Table	Data Source	Notes
auditlog	empty table used	Table must be present for MOVES to recognize CDB
year	MOVES default	Sets analysis year as base year (i.e., activity inputs supplied, not forecast by MOVES)
state	MOVES default	Identifies the state and idle region
hourvmtfraction	MOVES default	Hourly VMT fractions by source type, road type, day type
dayvmtfraction	MOVES default	Weekend and weekday period VMT fractions by month for each source type and road type
monthvmtfraction	MOVES default (3-month average)	Month VMT fractions by source type
hpmsvtypeyear	MOVES default	Annual VMT by HPMS vehicle type
roadtypedistribution	MOVES default	Source type VMT fractions by MOVES road type
avgspeeddistribution	MOVES default	Driving time fractions by speed bin for each source type, road type, day type, hour
sourcetypeyear	MOVES default	Source type populations
startsperdaypervehicle	MOVES default	Average starts per day by source type and day type

Table	Data Source	Notes
startshourfraction	MOVES default	Average hourly allocation of starts by source type and day type
startsmonthadjust	MOVES default (3-month average)	Average monthly multiplicative adjustment to startspervehicleperday
startsageadjustment	MOVES default	Source type starts by vehicle age relative to the number of starts at age 0 (lower frequency of starts with age)
startsopmodedistribution	MOVES default	Distribution of engine start soak times by source type, age, day type, hour
totalidlefraction	MOVES default (3-month average)	Ratio of total source hours idling (SHI) and total source hours operating (SHO) for each source type by month, day type, idle region, county type (Metropolitan Statistical Area [MSA] or non-MSA)
hotellingactivitydistribution	MOVES default	Allocation of hoteling to four operating modes by zone (e.g., county) and model year group
hotellingagefraction	empty table used	Hourly hoteling distribution by age for each zone and day type – included to preempt commandline execution errors
hotellinghourfraction	empty table used	Zone and day type hoteling hourly allocations – included to preempt commandline execution errors
hotellinghoursperday	empty table used	Year, zone, day type hoteling hours – included to preempt commandline execution errors
hotellingmonthadjust	empty table used	Hotelling monthly adjustment for each zone and month – included to preempt commandline execution errors
zone	MOVES default (set factors = 1)	SHO geographic allocation factors, set to 1.0 for county scale runs
zoneroadtype	MOVES default (set factors = 1)	Road type VMT allocation factors to county road type VMT, set to 1.0 for county scale runs
fuelusagefraction	Local	Flex fuel vehicle fuel type usage, set for Texas modeling assumption: flex fuel vehicles operate totally on gasoline
fuelsupply	Local /defaults	Market shares of fuel formulations set to reflect Texas modeling assumptions of gasoline and diesel only, although all MOVES default alternative fuels were also included as required to run MOVES3 (i.e., CNG, E85, and electric were included but not used as specified by AVFT and fuel usage configurations)
fuelformulation	Local /defaults	Gasoline and diesel formulations by fuel region based on Texas regional survey data and defaults as needed, with MOVES default CNG, E85, and electric as required to run MOVES3
avft	Local /defaults	Set for Texas modeling assumptions, i.e., gasoline and diesel only, but also include default flex fuel vehicle fractions which are set to 100% gasoline use via the fuelusagefraction table

Table	Data Source	Notes
sourcetypeagedistribution	local/default (actual analysis year default)	Distribution by 31 age categories for each source type, based on latest available county vehicle registrations, and MOVES defaults where needed (i.e., for buses, refuse trucks, motor homes)
imcoverage	local	Empty table since Bexar County is currently a non-I/M county.
county	local	Identifies the county, barometric pressure, high or low altitude, and whether the county is an MSA or non-MSA county
zonemonthhour	local	Provides zone hourly temperatures and relative humidity by month using month ID 7 (July) to represent the summer season (populated with local June through August averages)
countyyear	local	Stage II refueling control program adjustments, set to zero to reflect the program is no longer in effect (applicable to area sources and does not affect on-road emission rates, but is included as a standard practice)

3.3.1 Year, State, and County Inputs

The year, state, and county tables are populated with data identifying the analysis 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. With MOVES3, an idleregionID was added to modify the state table.

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 for the analysis. Additionally, information on whether the county is in an MSA is included in the county table.

3.3.2 Activity and Vehicle Population Inputs

The TTI EI methodology uses an emission rate by activity method that calculates emissions by multiplying local activity estimates and MOVES-based emission rates external to MOVES. However, MOVES rates mode CDBs require activity inputs to calculate the emission rates per activity estimates used in the TTI EI method.

For this reason, default activity input parameters were used to populate the following MOVES tables: 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, which vary by month, the MOVES default data were averaged for the three-month summer season 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.

3.3.3 Age Distributions and Fuel Engine Fractions Inputs

Local age distributions, or age fractions for each SUT, and local fuel fractions by SUT and model year (or technology), were used, in conjunction with MOVES defaults as needed. These data were sourced from TxDMV 2018 year-end registration data for Bexar County (this data was used for each analysis year). The age distributions and fuel engine fractions inputs were calculated and written to text files in preparation for loading the data into their CDB tables: the sourcetypeagedistribution table for age distributions and the avft table for fuel engine fractions.

The local TxDMV registration data provides fuel type fractions (proportion of gasoline or diesel-powered vehicles) for heavy-duty vehicles but does not for light-duty vehicles. MOVES default fuel fractions were therefore applied to estimate light-duty fuel fractions. Only gasoline and diesel vehicles were explicitly included in the CDBs[17].

[17] This was decided after consultation with the TCEQ sponsor.

Table 19 summarizes the data sources and aggregation levels used to estimate the local sourcetypeagedistribution and avft inputs to MOVES (inputs summarized in Appendix G).

Table 19. Sources and Aggregations for Age Distributions and Fuel Fractions.

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	n/a – 100% gasoline, no Fuel/Engine Fractions
Passenger Car	21	Passenger Cars	County	MOVES default[2]
Passenger Truck	31	Total Trucks<=8500	County	MOVES default[2]
Light Commercial Truck	32	Total Trucks<=8500	County	MOVES default[2]
Single-Unit Short-Haul Truck	52	>8500+ >10000+ >14000+>16000	Region	Texas Statewide
Single-Unit Long-Haul Truck	53	>8500+ >10000+ >14000+>16000	Texas Statewide	Texas Statewide
Refuse Truck	51	MOVES default[3]	MOVES default[3]	MOVES default[3]
Motor Home	54	MOVES default[3]	MOVES default[3]	MOVES default[3]
Other Buses	41	MOVES default[3]	MOVES default[3]	MOVES default[3]
Transit Bus[2]	42	MOVES default[3]	MOVES default[3]	MOVES default[3]
School Bus	43	MOVES default[3]	MOVES default[3]	MOVES default[3]
Combination Short-Haul Truck	61	>19500+ >26000+ >33000+ >60000	Region	Texas Statewide
Combination Long-Haul Truck	62	>19500+ >26000+ >33000+ >60000	Texas Statewide	n/a – 100 % diesel, no Fuel/Engine Fractions

[1] TxDMV year-end 2018 (latest available, used for all 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 MOVESDB20210209 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 MOVESDB20210209 sample vehicle population table.

[3] MOVES default values consistent with the analysis year.

3.3.4 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 Bexar County (originally developed and applied in the TCEQ's 2017 Air Emissions

Reporting Requirements [AERR] inventory analysis). Altitude was set to low. Table 20 provides tabulated input values temperatures and relative humidity used as input into MOVES. The barometric pressure input for Bexar County is 29.104 inches mercury.

Table 20. Meteorological Inputs.

Hour	Temperature (Degrees Fahrenheit)	Relative Humidity (Percent)
1	78.99	77.90
2	77.82	81.39
3	76.91	84.04
4	76.21	85.87
5	75.69	87.13
6	75.26	88.00
7	74.88	88.78
8	75.43	87.31
9	77.66	81.44
10	80.33	72.68
11	82.98	64.24
12	85.47	57.70
13	87.72	52.12
14	89.53	48.18
15	91.03	44.94
16	92.13	43.00
17	92.60	42.18
18	92.48	42.81
19	91.50	44.95
20	89.54	50.16
21	86.61	56.89
22	84.11	62.97
23	82.12	68.75
24	80.42	73.82

Source: San Antonio area weather station data averages for stations within Bexar County for the 2017 June through August period, provided by TCEQ originally for the 2017 AERR inventories analysis.

3.3.5 Fuels Inputs

TTI used various data sources to produce the best available summer fuel formulation inputs to MOVES.

3.3.5.1 Assumptions, Sources, and Procedures

Four MOVES fuels input tables must be consistent for the fuel types defined by the scope of the inventory analysis. These are:

- AVFT (SUT fuel type distributions by model year).
- fuelformulation (fuel properties for the fuels supplied in the study area).
- fuelsupply (market shares of each study area fuel formulation).
- fuelusagefraction (fuel types used by flex fuel vehicles).

As defined by the scope of the EIs, only gasoline and diesel fuels were modeled[18]. Therefore the AVFT model year fuel fractions were normalized for only gasoline, diesel, and flex fuel vehicles (i.e., vehicles with the capability to be powered by gasoline or E85 [a blend of 85 percent ethanol and 15 percent gasoline, by volume]). Flex fuel vehicle fuel usage was set to 100 percent gasoline via the fuelusagefraction table. Gasoline and diesel fuel properties and market shares were then specified in the fuelformulation and fuelsupply tables.

The gasoline and diesel fuel property inputs were sourced using local fuel survey data by season and year, supplemented as needed by MOVES defaults and other data (e.g., the U.S. Department of Energy [DOE] annual fuel sales statistics). For future years where no survey data was yet available, the latest available local fuel properties were used, and particular regulated properties were replaced with expected future year values (e.g., regulatory standards or limits, reflected in the MOVES default values for the analysis year and season).

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 statistics. The local data also includes summaries from which to estimate biodiesel (BD) volumes relative to petroleum diesel sales volumes and gasoline sales estimates by the three grades (regular, mid-grade, premium).

The applicable retail outlet survey data consisted of TCEQ statewide summer gasoline and diesel sampling surveys for 2017 and 2020 (latest available for future years). TTI uses the TCEQ E10[19] conventional gasoline data processed by MOVES fuel regions for the counties within each fuel region. With the TCEQ diesel sample data summaries, TTI

[18] MOVES3 requires that inputs are developed for all on-road vehicle fuel types available in MOVES, regardless of the local inventory scope. Inclusion of all on-road fuels in the MRSs was needed to prevent MOVES "missing fuels inputs" run errors.

[19] E10 is gasoline (CG or RFG) blended with a nominal 10 percent by volume of ethanol.

produces a statewide diesel sulfur content average by year (for use with all Texas counties), , supplemented with biodiesel volume content estimates by year based on the DOE Energy Information Administration's (EIA) diesel sales statistics (historical and latest available). Biodiesel percentages were based on EIA State Energy Data System (SEDS) state-level 2017 and 2018 (latest available for future years) transportation sector BD consumption estimates for Texas.

The fuel formulation development procedures for gasoline involved aggregating and averaging gasoline properties by grade, then weighting them into composite properties using relative sales volumes by grade, which was performed within each fuel region. Note that the diesel sulfur level has been relatively stable across the state and survey years (as observed in the last four TCEQ surveys), such that the statewide averages by year are reasonably used for all counties..

TTI prepared inputs for both the pre-1990 and control strategy RFP scenarios. The control strategy fuel formulation inputs were based on the local, retail outlet survey data, and where appropriate, expected future year values, as described above. 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 local, summer season, fuels inputs to MOVES were supplied in the CDB fuelsupply and fuelformulation tables. The fuel supply for Bexar County, for each year, and month (July for summer) consisted of one local gasoline and one local diesel formulation. Each gasoline and diesel formulation market share in the fuel supply was therefore 1.0.[20]

3.3.5.2 Fuel Formulations

Table 21 and Table 22 summarize the gasoline and diesel fuel property inputs. Note that CetaneIndex and PAHContent fields in the fuelformulation table are not currently enabled for use in MOVES. Fuel formulation inputs for the other fuel types in MOVES (i.e., CNG, E85, and electricity), although not shown, were also input as required.

[20] As stated previously, MOVES3 requires inputs for all on-road vehicle fuel types available in MOVES to be included, regardless of the local inventory scope. The other on-road fuels in MOVES (i.e., CNG, E85, and electricity) were also selected in the MRSs to prevent MOVES "missing fuels inputs" run errors.

Table 21. Conventional Gasoline MOVES Fuel Formulation Table Inputs.

Fuel Formulation Field	Unit	Pre-1990 Controls Fuel[1]	2017[2]	2021+[2]
fuelFormulationID	-	10001	17702	14702
fuelSubtypeID	-	10	12	12
RVP	psi	7.80	7.54	7.80
sulfurLevel	ppm	429.96	21.28	10.00
ETOHVolume	vol.%	0	9.66	9.56
MTBEVolume	vol.%	0	0	0
ETBEVolume	vol.%	0	0	0
TAMEVolume	vol.%	0	0	0
aromaticContent	vol.%	26.40	25.35	22.22
olefinContent	vol.%	11.90	8.33	8.69
benzeneContent	vol.%	1.64	0.76	0.99
e200	vap.%	46.04	49.45	49.64
e300	vap.%	81.43	82.68	84.60
VolToWtPercentOxy	-	0	0.3653	0.3653
BioDieseEsterVolume	vol.%	\N	\N	\N
CetaneIndex	-	\N	\N	\N
PAHContent	vol.%	\N	\N	\N
T50	deg. F	207.90	203.73	202.53
T90	deg. F	336.54	327.68	319.75

[1] For pre-1990 controls fuels, fuel formulation ID 10001 is consistent with TCEQ's most recent RFP emissions analysis (TTI 2019). The 7.8 psi RVP limit formulation (not available in MOVES3) is from MOVES2014b. Fuel subtype ID 10 is non-oxygenated CG.

[2] The CG E10 estimates for 2017 and later are based on the TCEQ's summer 2017 and 2020 (latest available) fuel surveys, using MOVES3 defaults for future year expected values (for RVP, sulfur level, and benzene content).

Table 22. Diesel MOVES Fuel Formulation Table Inputs.

Fuel Formulation Field	Unit	Pre-1990 Controls Fuel[1]	2017[2]	2021+[2]
fuelFormulationID	-	32500	31706	30600
fuelSubtypeID	-	20	21	21
RVP	psi	\N	\N	\N
sulfurLevel	ppm	2500.00	6.37	6.00
ETOHVolume	vol.%	\N	\N	\N
MTBEVolume	vol.%	\N	\N	\N
ETBEVolume	vol.%	\N	\N	\N
TAMEVolume	vol.%	\N	\N	\N
aromaticContent	vol.%	\N	\N	\N
olefinContent	vol.%	\N	\N	\N
benzeneContent	vol.%	\N	\N	\N
e200	vap.%	\N	\N	\N
e300	vap.%	\N	\N	\N
VolToWtPercentOxy	-	\N	\N	\N
BioDieseEsterVolume	vol.%	0	4.68	4.86
CetaneIndex	-	\N	\N	\N
PAHContent	vol.%	\N	\N	\N
T50	deg. F	\N	\N	\N
T90	deg. F	\N	\N	\N

[1] For pre-1990 controls fuels, fuel formulation ID 32500 is consistent with TCEQ's most recent RFP emissions analysis (TTI 2019). 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 ID 20 is conventional diesel.

[2] 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 MOVES3 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 the latest available data (2018) for future years. Fuel subtype ID 21 is biodiesel, in Texas, ULSD is 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.

3.3.6 I/M Inputs

An I/M program is currently not applicable to Bexar County. The MOVES imcoverage table as a standard is included in all CDBs, but in cases where an I/M program is not applicable, such as is the case currently for Bexar County, the imcoverage table is left empty.

3.4 Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 32 tables were in the CDBs and the tables were populated with data as intended. The MRSs 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 and compared record counts in each rate table between output databases).

3.5 Post-Processing Runs

Each MOVES output database was post-processed using the TTI's MOVES emission rates post-processing utilities, updated for MOVES3, for on-road mobile emission rates. Post-processing for each MOVES run was essentially performed in two steps, first to convert MOVES output mass/vehicle parked vehicle evaporative rates to mass/SHP-based emission rates, then, as applicable adjustments for TxLED effects on diesel vehicle NO_X emission rates. The final emission rates were compiled in lookup tables for input to the emission calculations.

- The mass/SHP off-network evaporative process rates were calculated using data from the CDB, the MOVES default database, and the MOVES rateperprofile and ratepervehicle emission rate output. The utility also copied the mass/mile, mass/start, and mass/hour rates along with the units into emission rate tables. The utility created the look-up tables ttirateperdistance (which also includes the rateperhour rates for off-network idling), ttirateperstart, ttirateperhour (for SHEI and APU hours), and ttiratepershp for each scenario.
- For the RFP control strategy scenario runs, in this step the TxLED adjustments (see factors provided by TCEQ in Table 23) were applied to the diesel vehicle NO_X emission rates for Bexar County.[21] (TxLED was not included for the pre-1990 controls scenario modeling.) TCEQ produced these average diesel SUT NO_X adjustments using 4.8 percent and 6.2 percent reductions for 2002 and later, and 2001 and earlier model years, respectively.[22] The adjusted rate tables were input to the on-road mobile source emissions calculator utility.

[21] The TxLED counties list may be found at: http://www.tceq.texas.gov/airquality/mobilesource/txled/txled-affected-counties. For full details on the TCEQ TxLED factor development procedure, see TxLED estimation speadsheets at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/.

[22] Reductions as detailed in the EPA Office of Transportation and Air Quality Memorandum, RE: Texas Low Emission Diesel [LED] Fuel Benefits, September 27, 2001.

See the utility descriptions in Appendix A for more information.

Table 23. TxLED NO_X Adjustment Factors Summary.

Diesel Fuel Source Use Type	2017 Reduction	2023 Reduction	2024 Reduction	2017 Adjustment	2023 Adjustment	2024 Adjustment
Passenger Car	5.09%	4.86%	4.84%	0.9491	0.9514	0.9516
Passenger Truck	5.41%	5.11%	5.06%	0.9459	0.9489	0.9494
Light Commercial Truck	5.45%	5.15%	5.10%	0.9455	0.9485	0.9490
Other Bus	5.50%	5.19%	5.14%	0.9450	0.9481	0.9486
Transit Bus	5.07%	4.92%	4.90%	0.9493	0.9508	0.9510
School Bus	5.34%	5.06%	5.03%	0.9466	0.9494	0.9497
Refuse Truck	5.37%	5.05%	5.00%	0.9463	0.9495	0.9500
Single Unit Short-Haul Truck	4.92%	4.82%	4.81%	0.9508	0.9518	0.9519
Single Unit Long-Haul Truck	4.91%	4.84%	4.83%	0.9509	0.9516	0.9517
Motor Home	5.53%	5.33%	5.26%	0.9447	0.9467	0.9474
Combination Short-Haul Truck	5.00%	4.87%	4.85%	0.9500	0.9513	0.9515
Combination Long-Haul Truck	5.18%	4.93%	4.90%	0.9482	0.9507	0.9510

Source: TCEQ provided the MOVES3-based TxLED factors developed using the TxLED factor procedure in combination with the latest available data (i.e., statewide age distributions based on year-end 2018 TxDMV vehicle registrations for all analysis years).

The resulting hourly on-road rates were input to the emissions utility to calculate the on-road mobile source inventories for each county RFP inventory scenario. All emission factor modeling inputs used in the inventories were provided electronically as described in Appendix B.

3.6 Pre-1990 Controls Scenario and Emission Rates for Individual Control Reductions

In a manner consistent with the development of the CS0 and CSC scenario emission rates, TTI produced emission rates for the CS1 and CS2 incremental control scenarios needed for estimating the individual control measure emissions reductions. Table 24 summarizes the run sequence.

Note that MOVES2014b includes the *Compute Rate-of-Progress "No Clean Air Act Amendments"* feature which assigns 1993 model year emission rates to all post-1993 vehicles. This enabled exclusion of the post-1990 CAAA FMVCP effects in emission rates output, needed for the pre-1990 controls (CS0) scenario. Since this feature was omitted from MOVES3, TCEQ and TTI agreed on using an alternative method for excluding post-1990 FMVCP effects. This alternative used for the CS0 scenario was to modify the age distributions input to MOVES by setting the 1994 and later model year age fractions to zero and renormalizing the distributions for 1993 and older model years. This alternative provided a conservative result in that "less-deteriorated" or lower mileage 1993 model year vehicles were modeled as not existing in the fleet, shifting toward an overall higher average mileage, or older fleet. Also, since 1993 model year vehicles completely rotate out of the MOVES fleet starting in 2024, the 2023 analysis year CS0 emission rates were used as surrogates for the 2024 analysis year CS0 RFP scenario emission rates.

MOVES post-processor utility runs on the CS0 and CSC scenarios were used in combination with post-processor results for the extra runs needed to produce the four scenarios of emissions estimates. The CS0 and CSC runs and added individual control runs are summarized for the overall emission rates development process, which includes the 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 24. Emission Factor Control Scenarios Modeling Sequence.

Scenario Label	Controls Increment	MOVES CDB	MRS MOVES Runs	Post-process Rates/SHP (TxLED)
CS0	Pre-1990 Controls (base)	"pre-1990 controls" scenario set-ups (age distributions set to 1993 model year fleet)	CS0 labels	√ CS0_calc (no TxLED)
CS1	CS0 + post-1990 FMVCP	CS1 same as CS0 except CDB switched to current age distributions	CS1 labels	√ CS1_calc (no TxLED)
CS2	CS1 + CG and ULSD	CS2 same as CS1 except for current fuels replace "pre-1990 fuels" in CDB	CS2 labels	√ CS2_calc (no TxLED)
CSC	CS2 + TxLED	Same as CS2 CDB	CS2 labels	√ CSC_adj (TxLED-adjusted)

As shown in Table 24, the CS1 and CS2 control scenarios required the full process stream of set-ups and runs, with no TxLED adjustment applied. This series of additional emission factor modeling set-ups and runs was executed for analysis years 2023 and 2024.

The emission factors for the CS1 and CS2 incremental control scenarios for each year were input with appropriate activity inputs into the emissions calculation utility to produce the emissions estimates that, together with the existing CS0 and CSC scenario emissions, were used to quantify the individual control measure emissions reductions, discussed in a later section.

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

4.0 EMISSIONS CALCULATIONS

TTI calculated hourly on-road mobile emissions for Bexar County for each inventory scenario using the TTI EI utilities. The TDM link-based inventory methodology calculated on- and off-network emissions by multiplying traffic activity by emission rates. The VMT-based emissions calculations used the TDM link-based VMT and congested speeds to estimate link-level emissions. The off-network emissions calculations used off-network activity (ONI hours, SHP, starts, SHEI, and APU hours) to estimate emissions at the county level.

The TTI EI utilities produced emissions outputs aggregated by county, hour, road functional class, road area type, vehicle type, pollutant, pollutant process, and link for on-network emissions; and county, hour, road functional class, vehicle type, pollutant, and pollutant process for off-network emissions.

These outputs were then post-processed to produce electronic files in formats suitable for submission to the TCEQ sponsor, including a standard tab-delimited EI summary, various tab-delimited EI summary aggregations, a tab-delimited source classification code (SCC)-coded EI summary and an XML-formatted EI summary of the RFP control strategy EIs.

4.1 INPUTS

County-level hourly link (on-network) and off-network emissions for each inventory scenario were calculated using TTI's EI utilities and the following inputs:

- *County of inventory* – from study area counties list, including county FIPS, link data county code, TxDOT district ID, county group FIPS (where applicable), TxLED flag, county type flag (MSA or non-MSA).
- *Vehicle type VMT mix* – time period TxDOT district-level VMT mix by MOVES roadway type.
- *Time period designation* – the four VMT mix time periods to hour-of-day associations.
- *Roadway-based activity* – link (and intrazonal link)-specific, hourly, directional, operational VMT and speed estimates as developed by the EI 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 rates road type codes) (see Table 25).

- *Off-network activity* – county, hourly ONI hours, SHP, starts, SHEI, and APU hours by vehicle type.
- *Pollutant/process/units list* – for emissions.
- *Roadway-based emission factors* – MOVES-based, county level by pollutant, process, hour, average speed, MOVES road type, SUT, and fuel type.
- *Off-network (parked vehicle) emission factors* – MOVES-based, county level by pollutant, process, hour, SUT, and fuel type.
- *SCCs* – mapping for MOVES source type, fuel type, road type, and process codes to output SCCs.
- *MOVES pollutant codes to National Emissions Inventory (NEI) pollutant codes* – for SCC output.

4.1.1 VMT-Based On-network Emissions

The VMT-based emissions were calculated for each hour using the time period TxDOT-level SUT/fuel type VMT mix, the link VMT and speeds estimates, the MOVES-based "on-network" emission factors, and the link road type/area type-to-MOVES road type designations. Each link was assigned a MOVES road type based on the link's road type and area type (see Table 25). The link VMT was distributed to each vehicle type using the VMT mix from the appropriate time period based on the link's MOVES road type. The time period VMT mixes were applied by the hour as follows: morning peak – 6 a.m. to 9 a.m.; mid-day – 9 a.m. to 3 p.m.; evening peak – 3 p.m. to 7 p.m.; and overnight – 7 p.m. to 6 a.m.

The emission factors by hour for each vehicle type and MOVES road type were selected based on the designated hour of the link data file, each link's MOVES road type code, and each link's speed. For link speeds falling between MOVES speed bin average speeds, emission 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 emission factors for the associated bounding speeds were used. The mass/mile rates were multiplied by the link vehicle type VMT producing the link-level emissions estimates. This was performed for each hour of the day.

Table 25. AAMPO TDM Road Type/Area Type to MOVES Road Type Designations

TDM Road Type (Code - Name)	TDM Area Type (Code - Name)	MOVES Road Type (Code - Name)[1,2]
1 - Radl IH Fwy ML 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	5 - Rural	2 – Rural Restricted Access
0 - Local (Cent Conn) 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)	5 - Rural	3 – Rural Unrestricted Access
1 - Radl IH Fwy ML 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	1 - Central Business District (CBD) 2 - CBD Fringe 3 - Urban 4 - Suburban	4 – Urban Restricted Access
0 - Local (Cent Conn) 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)	1 - CBD 2 - CBD Fringe 3 - Urban 4 - Suburban	5 – Urban Unrestricted Access

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emission 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 6 a.m. to 9 a.m.; mid-day – six hours of 9 a.m. to 3 p.m.; PM peak – four hours of 3 p.m. to 7 p.m.; and overnight – 11 hours of 7 p.m. to 6 a.m.

4.1.2 Off-Network Emissions

The off-network emissions were calculated at the county-level by multiplying the hourly MOVES-based SUT/fuel type off-network emission factors by the appropriate county-level hourly SUT/fuel type off-network activity, which was determined by the pollutant process (and MOVES road type "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.

4.2 Emissions Output

The TTI EI utilities hourly link-based emissions output data sets included three output files per run:

- A log file summarizing run times and min/max output file sizes, etc.
- 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.
- 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 reported are listed in Table 26.

Table 26. Pollutants.

Pollutant ID	Pollutant Name
2	CO
3	NO_X
30	NH_3
31	SO_2
87	VOC
90	Atmospheric CO_2
100	Primary Exhaust PM_{10} – Total
106	Primary PM_{10} –Brakewear Particulate
107	Primary PM_{10} – Tirewear Particulate
110	Primary Exhaust $PM_{2.5}$ – Total
116	Primary $PM_{2.5}$ – Brakewear Particulate
117	Primary $PM_{2.5}$ – Tirewear Particulate

Additional post-processors produced inventory extracts from the standard tab-delimited output in seven different aggregations. All these files were provided as a part of the data package as described in Appendix B.

4.2.1 Summary of Results

Table 27 and Table 28 summarize the resulting pollutant totals inventory estimates and individual control strategy reduction estimates for the Bexar County ozone nonattainment area. The PM emissions estimates in Table 27 are aggregates of exhaust processes, brakewear, and tirewear.

Table 27. 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	48,023,548	28.83	17.35	313.17	33.94	0.34	1.43	28,346.59	1.37	4.21
Pre-1990 Controls[2]	2023	56,682,813	27.10	225.67	3,015.52	356.10	17.66	6.61	34,940.42	7.91	12.09
Pre-1990 Controls[2]	2024	58,054,375	26.77	232.16	3,101.05	365.38	18.15	6.79	35,928.25	8.14	12.46
Control Strategy[3]	2023	56,682,813	27.10	12.38	256.45	20.63	0.18	1.45	29,474.74	1.00	4.50
Control Strategy[3]	2024	58,054,375	26.77	11.91	249.74	19.50	0.18	1.48	29,589.81	1.00	4.62

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

[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 controls emission rates. Rates are for analysis year fleet but exclude post-1990 CAAA controls – no post-1990 FMVCP effects, uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to the enactment of the 1990 CAAA, no TxLED.

[3] Control strategy inventories: analysis year activity inputs and analysis year control strategy emission rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 gasoline and ULSD, and TxLED).

Table 28. Bexar County Summer Weekday RFP Control Scenario Inventories and VOC and NO_X Reductions (Tons) by Analysis Year.

Emissions Analysis	VOC 2017	VOC 2023	VOC 2024	NO_X 2017	NO_X 2023	NO_X 2024
Pre-90 Control Inventory	-	225.67	232.16	-	356.10	365.38
Control Strategy Inventory	17.35	12.38	11.91	33.94	20.63	19.50
Total Reductions	-	213.29	220.25	-	335.47	345.88
FMVCP Reductions	-	210.78	217.78	-	329.09	339.92
Tier 3 CG and ULSD Reductions [1]	-	2.51	2.47	-	5.67	5.26
TxLED Reductions	-	-	-	-	0.71	0.70

[1] Current CG standards with Tier 3 sulfur and pre-1990 diesel replaced with ULSD.

Note: Columns may not total due to rounding, and "-" = "not applicable".

4.3 XML-Formatted 24-Hour Summaries for TexAER

TTI further post-processed the 24-hour summer weekday control strategy scenario SCC-labeled inventory output for each analysis year, using the TTI's XML formatting utility, into the NEI Emissions Inventory System (EIS) Consolidated Emissions Reporting Schema (CERS) XML format for inclusion in TCEQ's TexAER database.

The tab-delimited SCC-based inventory data files output by the utility were produced for direct input to the XML 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 fuel type (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 an XML file and one tab-delimited SCC-labeled inventory summary for Bexar County. Further details may be found in Appendix B.

5.0 QUALITY ASSURANCE

Analyses and results were subjected to appropriate internal review and quality assurance (QA)/quality control (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,[23] 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),[24] in the following description.

5.1 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 of the Grant Activity Description (GAD). 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 emissions inventory 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, and in consultation with the TCEQ project manager.

Basic criteria were used to assure the acceptable quality of the product, including the following.

[23] PDF available at: https://www.epa.gov/sites/production/files/2015-06/documents/g5m-final.pdf.
[24] 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.
- The full extent of the modeling domain was included.
- Agreed methods, models, tools, and data were used.
- The output data sets were produced in required formats.
- Any deficiencies found (as discussed in Section 5.5) were corrected.
- Aggregate results were comparable with available, similarly produced emissions estimates.

5.2 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 was for the development of emission rates model inputs and adjustment factors and the development of the activity inputs for external emissions calculations. Existing data acquired from various organizations (e.g., TxDOT, metropolitan planning organizations (MPOs), TCEQ, EPA) was reviewed by TTI for suitability, and in most cases was previously QA'd by the providing agency. These data sets 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 the review, verification, and/or validation (see QA criteria and methods discussed in Section 5.5) were corrected, and the QA procedure was repeated until satisfied. No significant problems were found.

5.3 Data Management

The project team used the same electronic project folder structure on each workstation. As various scripts, inputs, and outputs were developed in the process, data were shared within the team for crosschecking. To perform the MOVES model runs, a computer cluster (multiple computers) configuration or individual workstation configuration was used. After input data were QA'd, data sets were backed up and stored in compressed files.

After the final product was completed, all the project data was archived onto a local or an external drive. A complete archive of the project data is kept by TTI (the computer models and EI development utilities used in the process included). The electronic data submittal package (containing the project deliverables as listed in Appendix B) was produced along with the data description (and copied to a shared folder and/or external hard drive) and delivered to TCEQ.

5.4 Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (i.e., consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked that input data was prepared according to the plan.
- Checked that correct output data was produced. Records were kept of the checks performed.

In the case of any inconsistency or deficiency found, the issue was directly communicated to responsible staff for correction (or outside agency staff involved, if any). After any correction, QA checks were repeated to assure the additional work resulted in the intended result and were noted in the QA record.

Any major problems were reported to the project manager and communicated to the project team as needed, as well as when various data elements passed QA checks and were ready next steps. The project manager ensured all of the QA checks performed were compiled and maintained in the project archives.

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

5.5 Data Validation and Usability

Erroneous or improper inputs at any point during the EI development process may produce inaccurate emissions estimates. The TTI project team performed QA checks at each step of the analysis to ensure data quality.

The criteria for passing quality checks are summarized in the following. These QA guidelines were used to ensure the development of EIs that were as accurate as possible and met the requirements of TCEQ's intended use.

As previously stated, TTI verified the overall scope of the emissions analysis to include:

- Purpose (i.e., needed for RFP SIP analysis).
- Modeling domain (e.g., analysis years, geographic coverage, seasonal periods, days, sources, pollutants).
- Methods, models, and data (e.g., default versus local input data sources).
- Procedures, tools, and required emissions output data sets.

TTI performed checks on input data, model execution, and output, as follows:

- Input data preparation:
    - The basis of input data sets as planned (e.g., actual, historical, latest available, validated model); aggregation levels.
    - Depending on the procedure and input data set, verification of calculations.
    - Use of correct data dimensions, fields, coding, labeling, formats; distributions sum to 1.0 where appropriate.
    - Reasonability checks: (discussed in the next section).
    - External data sources quality assurance verification.
- Model or utility execution:
    - Correct number of utility or model run input files per application.
    - Utility control or model run specifications verification (e.g., per the applicable user guide, correct inputs, output options).
- Output:
    - Correct output files by type and quantity.
    - Expected output file sizes.
    - Warnings and errors (e.g., checks of any written to output run logs).
    - Required data, proper coding/labeling, formats.
    - Assessment of any unusual results.

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

- Any activity, emission rate, or emissions adjustments were performed as intended.
- Noted whether directional differences were as expected (e.g., between scenarios with temporal or geographic variation).
- Checked for consistency (e.g., input data control totals versus output summaries, utility raw results versus post-processed results).
- Compared results to results from previous similar analyses where available.

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.

REFERENCES

EPA. 1992. Guidance on the Adjusted Base Year Emissions Inventory and the 1996 Target for the 15 Percent Rate-of-Progress Plans, EPA-452/R-92-005, Ozone/Carbon Monoxide Programs Branch, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. October 1992.

EPA. 1992. Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, EPA420-R-92-009, Emission Planning and Strategies Division, Office of Mobile Sources and Technical Support Division, Office of Air Quality Planning and Standards. December 1992.

EPA. 1994. Guidance on the Post-1996 Rate-of-Progress Plan and the Attainment Demonstration, Corrected Version as of February 18, 1994, EPA-452-R-93-015, Ozone/Carbon Monoxide Programs Branch, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. February 1994.

EPA. 2001. Memorandum: Texas Low Emission Diesel (LED) Fuel Benefits. To Karl Edlund, EPA, Region VI, from Robert Larson, EPA, Office of Transportation and Air Quality (OTAQ), National Vehicle and Fuel Emissions Laboratory at Ann Arbor, Michigan. September 27, 2001.

EPA. 2002. Guidance for Quality Assurance Project Plans for Modeling, EPA QA/G-5M, EPA/240/R-02/007, Office of Environmental Information. December 2002.

EPA. 2009. Emission Inventory System Implementation Plan, Section 5 Submitting XML Data to EIS, available at: https://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-documentation-draft

EPA. 2009. Emission Inventory System Implementation Plan, Appendix 6 EIS Code Tables (including SCCs), available at: https://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-documentation-draft

EPA. 2014. Emissions Inventory Guidance for Implementation of Ozone [and Particulate Matter]* National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, Draft, April 11, 2014.

EPA. 2014. Motor Vehicle Emission Simulator (MOVES), User Guide for MOVES2014, EPA 420-B-14-055, Assessment and Standards Division, Office of Transportation and Air Quality. July 2014.

EPA. 2014. Policy Guidance on the Use of MOVES2014 for State Implementation Plan Development, Transportation Conformity, and Other Purposes, EPA420-B-14-008, Transportation and Climate Division, Office of Transportation and Air Quality. July 2014.

EPA. 2015. MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity, EPA 420-B-15-093, Assessment and Standards Division, Office of Transportation and Air Quality. November 2015.

EPA. 2015. Motor Vehicle Emission Simulator (MOVES), User Guide for MOVES2014a, EPA420-B-15-095, Assessment and Standards Division, Office of Transportation and Air Quality. November 2015.

EPA. 2015. Motor Vehicle Emission Simulator (MOVES), MOVES2014a User Interface Reference Manual, EPA420-B-15-094, Assessment and Standards Division, Office of Transportation and Air Quality. November 2015.

EPA. 2015. Motor Vehicle Emission Simulator (MOVES), MOVES2014a Software Design Reference Manual, EPA420-B-15-096, Assessment and Standards Division, Office of Transportation and Air Quality. November 2015.

EPA. 2015. Motor Vehicle Emission Simulator (MOVES), MOVES2014a Module Reference, Assessment and Standards Division, Office of Transportation and Air Quality. October 2015.

EPA. 2017. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA-454/B-17-002, Issued By: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. May 2017.

EPA. 2017. Air Emissions Inventories, 2017 National Emissions Inventory (NEI) Documentation, available at: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-documentation

ERG, 2017. 2017 Summer Fuel Field Study. Final Report. Prepared for Mr. Michael Regan, Texas Commission on Environmental Quality. August.

ERG. 2020. 2020 Summer Fuel Survey, Final Report; Eastern Research Group, Inc. August 24, 2020. https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/mob/5822011094002-20200909-erg-2020SummerFuelFieldStudy.pdf.

Federal Register, Thursday, November 17, 2016, Part III, Environmental Protection Agency, 40 CFR Parts 50 and 51. Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications and State Implementation Plan Requirements; Proposed Rule.

Federal Register, Tuesday, October 7, 2014, Environmental Protection Agency, 40 CFR Parts 51 and 93, Official Release of the MOVES2014 Motor Vehicle Emissions Model for SIPs and Transportation Conformity.

Federal Register, Thursday, December 6, 2018, Part III, Environmental Protection Agency, 40 CFR Parts 51. Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area State Implementation Plan Requirements; Final Rule.

Texas A&M Transportation Institute. 2016. TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide. August 2016.

TTI. 2009. *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*. Texas A&M Transportation Institute, August 2009, ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/MOVES/VMT_Mix/MOVES_VMT_Mix_Methodology.pdf.

EPA. 2020. MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity, EPA-420-B-20-052, Office of Transportation and Air Quality. November 2020.

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

This appendix is available separately in an electronic format (e.g., .docx, .xlsx, .pdf, .txt, .zip, or other format.) and can be provided upon request.

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

This appendix is available separately in an electronic format (e.g., .docx, .xlsx, .pdf, .txt, .zip, or other format.) and can be provided upon request.

APPENDIX C:
TXDOT DISTRICT VMT MIX BY TIME OF DAY

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

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 – San Antonio TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak RT2	AM Peak RT3	AM Peak RT4	AM Peak RT5	Mid-Day RT2	Mid-Day RT3	Mid-Day RT4	Mid-Day RT5	PM Peak RT2	PM Peak RT3	PM Peak RT4	PM Peak RT5	Over-night RT2	Over-night RT3	Over-night RT4	Over-night RT5
11_G	0.00061	0.00056	0.00068	0.00068	0.00054	0.00052	0.00065	0.00064	0.00057	0.00059	0.00071	0.00072	0.00047	0.00056	0.00067	0.00074
21_G	0.60546	0.55744	0.67658	0.67310	0.53126	0.51905	0.64897	0.63840	0.56523	0.58095	0.70123	0.70987	0.46369	0.55578	0.66255	0.73208
21_D	0.00427	0.00393	0.00477	0.00474	0.00375	0.00366	0.00457	0.00450	0.00398	0.00410	0.00494	0.00500	0.00327	0.00392	0.00467	0.00516
31_G	0.18625	0.23825	0.19562	0.20555	0.19213	0.24953	0.20026	0.22154	0.18746	0.24751	0.18484	0.20253	0.14123	0.21300	0.16526	0.18305
31_D	0.00284	0.00363	0.00298	0.00313	0.00293	0.00380	0.00305	0.00337	0.00285	0.00377	0.00281	0.00308	0.00215	0.00324	0.00252	0.00279
32_G	0.04566	0.05841	0.04795	0.05039	0.04710	0.06117	0.04909	0.05431	0.04595	0.06067	0.04531	0.04965	0.03462	0.05221	0.04051	0.04487
32_D	0.00250	0.00320	0.00263	0.00276	0.00258	0.00336	0.00269	0.00298	0.00252	0.00333	0.00249	0.00272	0.00190	0.00286	0.00222	0.00246
41_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
41_D	0.00024	0.00055	0.00027	0.00159	0.00037	0.00035	0.00023	0.00084	0.00023	0.00022	0.00017	0.00032	0.00052	0.00026	0.00023	0.00018
42_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
42_D	0.00048	0.00111	0.00053	0.00319	0.00073	0.00070	0.00047	0.00169	0.00046	0.00044	0.00034	0.00064	0.00103	0.00053	0.00046	0.00036
43_G	0.00001	0.00003	0.00001	0.00009	0.00002	0.00002	0.00001	0.00005	0.00001	0.00001	0.00001	0.00002	0.00003	0.00001	0.00001	0.00001
43_D	0.00132	0.00304	0.00146	0.00876	0.00201	0.00193	0.00129	0.00464	0.00126	0.00122	0.00094	0.00177	0.00283	0.00145	0.00126	0.00099
51_G	0.00065	0.00102	0.00050	0.00057	0.00077	0.00113	0.00064	0.00085	0.00055	0.00077	0.00033	0.00038	0.00064	0.00090	0.00038	0.00037
51_D	0.00082	0.00129	0.00064	0.00072	0.00098	0.00144	0.00081	0.00108	0.00069	0.00098	0.00042	0.00048	0.00082	0.00114	0.00048	0.00047
52_G	0.01323	0.02063	0.01023	0.01162	0.01571	0.02306	0.01295	0.01727	0.01113	0.01567	0.00679	0.00777	0.01308	0.01823	0.00775	0.00758
52_D	0.01676	0.02616	0.01297	0.01473	0.01991	0.02923	0.01642	0.02189	0.01411	0.01986	0.00860	0.00985	0.01659	0.02311	0.00983	0.00961
53_G	0.00110	0.00172	0.00085	0.00097	0.00131	0.00192	0.00108	0.00144	0.00093	0.00131	0.00057	0.00065	0.00109	0.00152	0.00065	0.00063
53_D	0.00140	0.00218	0.00108	0.00123	0.00166	0.00244	0.00137	0.00183	0.00118	0.00166	0.00072	0.00082	0.00138	0.00193	0.00082	0.00080
54_G	0.00051	0.00080	0.00040	0.00045	0.00061	0.00089	0.00050	0.00067	0.00043	0.00061	0.00026	0.00030	0.00051	0.00070	0.00030	0.00029
54_D	0.00065	0.00101	0.00050	0.00057	0.00077	0.00113	0.00063	0.00085	0.00055	0.00077	0.00033	0.00038	0.00064	0.00089	0.00038	0.00037
61_G	0.00214	0.00139	0.00073	0.00028	0.00325	0.00176	0.00101	0.00039	0.00297	0.00103	0.00071	0.00006	0.00582	0.00219	0.00184	0.00013
61_D	0.02459	0.01602	0.00840	0.00323	0.03732	0.02020	0.01159	0.00452	0.03413	0.01186	0.00815	0.00065	0.06692	0.02513	0.02114	0.00153
62_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	0.08849	0.05763	0.03021	0.01163	0.13430	0.07270	0.04170	0.01626	0.12281	0.04269	0.02932	0.00233	0.24078	0.09041	0.07607	0.00550

2025 Weekday VMT Mix – San Antonio TxDOT District (2023 and 2024 Activity Scenarios)

SUT/FT	AM Peak RT2	AM Peak RT3	AM Peak RT4	AM Peak RT5	Mid-Day RT2	Mid-Day RT3	Mid-Day RT4	Mid-Day RT5	PM Peak RT2	PM Peak RT3	PM Peak RT4	PM Peak RT5	Over-night RT2	Over-night RT3	Over-night RT4	Over-night RT5
11_G	0.00061	0.00056	0.00068	0.00068	0.00054	0.00052	0.00065	0.00064	0.00057	0.00059	0.00071	0.00072	0.00047	0.00056	0.00067	0.00074
21_G	0.60303	0.55520	0.67386	0.67039	0.52912	0.51696	0.64635	0.63582	0.56296	0.57861	0.69841	0.70701	0.46182	0.55354	0.65988	0.72913
21_D	0.00671	0.00618	0.00749	0.00746	0.00589	0.00575	0.00719	0.00707	0.00626	0.00644	0.00777	0.00786	0.00514	0.00616	0.00734	0.00811
31_G	0.18549	0.23729	0.19482	0.20471	0.19135	0.24851	0.19945	0.22064	0.18670	0.24650	0.18409	0.20171	0.14065	0.21214	0.16459	0.18231
31_D	0.00359	0.00460	0.00377	0.00396	0.00371	0.00481	0.00386	0.00427	0.00362	0.00477	0.00357	0.00391	0.00272	0.00411	0.00319	0.00353
32_G	0.04561	0.05834	0.04790	0.05033	0.04705	0.06110	0.04904	0.05425	0.04590	0.06061	0.04526	0.04960	0.03458	0.05216	0.04047	0.04483
32_D	0.00255	0.00327	0.00268	0.00282	0.00263	0.00342	0.00274	0.00304	0.00257	0.00339	0.00253	0.00278	0.00194	0.00292	0.00226	0.00251
41_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
41_D	0.00024	0.00055	0.00027	0.00159	0.00037	0.00035	0.00023	0.00084	0.00023	0.00022	0.00017	0.00032	0.00052	0.00026	0.00023	0.00018
42_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
42_D	0.00049	0.00112	0.00054	0.00323	0.00074	0.00071	0.00047	0.00171	0.00046	0.00045	0.00035	0.00065	0.00105	0.00054	0.00047	0.00036
43_G	0.00001	0.00003	0.00001	0.00009	0.00002	0.00002	0.00001	0.00005	0.00001	0.00001	0.00001	0.00002	0.00003	0.00001	0.00001	0.00001
43_D	0.00132	0.00302	0.00145	0.00872	0.00200	0.00193	0.00128	0.00462	0.00125	0.00121	0.00094	0.00176	0.00282	0.00145	0.00126	0.00098
51_G	0.00064	0.00099	0.00049	0.00056	0.00075	0.00111	0.00062	0.00083	0.00053	0.00075	0.00033	0.00037	0.00063	0.00088	0.00037	0.00036
51_D	0.00081	0.00126	0.00062	0.00071	0.00096	0.00140	0.00079	0.00105	0.00068	0.00095	0.00041	0.00047	0.00080	0.00111	0.00047	0.00046
52_G	0.01330	0.02075	0.01029	0.01169	0.01580	0.02318	0.01302	0.01737	0.01119	0.01575	0.00683	0.00781	0.01316	0.01833	0.00779	0.00762
52_D	0.01685	0.02630	0.01304	0.01481	0.02002	0.02939	0.01651	0.02201	0.01418	0.01997	0.00865	0.00990	0.01668	0.02324	0.00988	0.00966
53_G	0.00111	0.00173	0.00086	0.00098	0.00132	0.00193	0.00109	0.00145	0.00093	0.00131	0.00057	0.00065	0.00110	0.00153	0.00065	0.00064
53_D	0.00141	0.00219	0.00109	0.00124	0.00167	0.00245	0.00138	0.00184	0.00118	0.00167	0.00072	0.00083	0.00139	0.00194	0.00082	0.00081
54_G	0.00045	0.00070	0.00035	0.00039	0.00053	0.00078	0.00044	0.00059	0.00038	0.00053	0.00023	0.00026	0.00044	0.00062	0.00026	0.00026
54_D	0.00057	0.00089	0.00044	0.00050	0.00068	0.00099	0.00056	0.00074	0.00048	0.00067	0.00029	0.00033	0.00056	0.00079	0.00033	0.00033
61_G	0.00244	0.00159	0.00083	0.00032	0.00371	0.00201	0.00115	0.00045	0.00339	0.00118	0.00081	0.00006	0.00665	0.00250	0.00210	0.00015
61_D	0.02809	0.01830	0.00959	0.00369	0.04263	0.02308	0.01324	0.00516	0.03899	0.01355	0.00931	0.00074	0.07644	0.02870	0.02415	0.00175
62_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	0.08469	0.05516	0.02891	0.01113	0.12853	0.06957	0.03991	0.01556	0.11753	0.04086	0.02806	0.00223	0.23044	0.08653	0.07280	0.00527

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 – San Antonio TxDOT District

SUT/FT	2015[1]	2025[2]
11_G	0.00063	0.00063
21_D	0.00443	0.00696
21_G	0.62861	0.62608
31_D	0.00299	0.00379
31_G	0.19635	0.19556
32_D	0.00264	0.00269
32_G	0.04813	0.04808
41_G	0.00000	0.00000
41_D	0.00029	0.00029
42_D	0.00058	0.00059
42_G	0.00000	0.00000
43_D	0.00160	0.00159
43_G	0.00002	0.00002
51_D	0.00078	0.00076
51_G	0.00061	0.00060
52_D	0.01579	0.01588
52_G	0.01246	0.01253
53_D	0.00132	0.00132
53_G	0.00104	0.00104
54_D	0.00061	0.00054
54_G	0.00048	0.00042
61_D	0.01721	0.01966
61_G	0.00150	0.00171
62_D	0.06192	0.05926
62_G	0.00000	0.00000

[1] 2017 activity scenario.

[2] 2023 and 2024 activity scenarios.

APPENDIX E: TDM AREA TYPE CODES, FUNCTIONAL CLASS CODES, AND DIRECTIONAL SPLIT FACTORS

San Antonio TDM Area Type Codes and Descriptions

Area Type Code	Area Type Description
1	CBD
2	CBD Fringe
3	Urban
4	Suburban
5	Rural

San Antonio TDM Functional Class Codes and Descriptions

Functional Class Code	Functional Class Description
0	Centroid Connector
1	Radial IH Freeways - Mainlanes Only
2	Radial IH Freeways - Tollway or HOV Mainlanes Only
3	Circumferential IH Freeways (Loops) - Mainlanes Only
4	Circumferential IH Freeways (Loops) – Tollway or HOV
5	Radial Other Freeways - Mainlanes Only
6	Radial Other Freeways - Tollway or HOV Mainlanes Only
7	Circumferential Other Freeways (Loops) - Mainlanes Only
8	Circumferential Other Freeways (Loops) - Tollway or HOV Mainlanes Only
9	Radial Expressways
10	Circumferential Expressways
11	Principal Arterial – Divided
12	Principal Arterial - Continuous Left Turn Lane
13	Principal Arterial – Undivided
14	Minor Arterial – Divided
15	Minor Arterial - Continuous Left Turn Lane
16	Minor Arterial – Undivided
17	Collector – Divided
18	Collector - Continuous Left Turn Lane
19	Collector - Undivided
20	Frontage Road
21	Ramp (Between Frontage Road and Mainlanes)
22	Interchange Ramp (Freeway-to-Freeway Interchange Ramps)
23	Tollway or HOV Ramp (Mainlanes-to-Tollway or HOV Lanes)

2017 San Antonio TDM AM Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	25.8	41.2	52.1	54.5	66.4
1	66.1	40.3	47.5	58.2	61.4
2					
3		73.2	52.4	29.8	
4					0.0
5		38.3	64.3	52.6	
6					94.2
7		57.6	67.4	70.8	
8					0.0
9		42.8	46.4	52.2	84.8
10			78.9	59.6	49.9
11	58.5	60.8	50.0	42.2	55.5
12		44.7	43.6	47.3	31.6
13	43.5	49.6	47.5	51.2	46.2
14	43.2	49.0	49.5	71.8	39.0
15		49.6	46.8	48.9	27.0
16	48.1	49.1	48.9	47.7	44.2
17	52.6	51.1	52.5	49.7	58.5
18		50.1	51.5	50.1	56.1
19	46.0	48.7	47.9	48.3	48.7
20	86.3	50.3	62.2	50.8	41.0
21	65.0	69.7	64.9	56.8	65.7
22	29.1	76.8	71.4	50.2	
23					100.0

2017 San Antonio TDM Mid-Day Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	48.9	49.7	50.1	50.3	50.4
1	62.5	42.2	51.8	58.7	63.2
2					
3		72.3	48.0	31.2	
4					0.0
5		48.7	65.6	55.9	
6					93.9
7		50.5	64.7	69.7	
8					0.0
9		43.4	50.8	47.3	76.9
10			77.3	57.4	49.5
11	57.6	62.6	60.3	54.5	62.2
12		49.9	50.0	50.0	49.4
13	44.8	50.7	50.9	50.5	50.5
14	48.1	49.8	52.3	68.7	49.7
15		51.8	50.1	50.0	50.2
16	50.7	50.3	49.4	49.1	49.8
17	37.5	57.5	49.6	50.9	51.9
18		48.3	49.1	49.7	49.8
19	49.8	50.0	48.9	50.5	50.8
20	83.7	50.0	61.5	52.7	54.0
21	67.1	69.2	65.1	58.3	66.2
22	30.3	77.4	73.6	54.5	
23					100.0

2017 San Antonio TDM PM Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	62.9	54.3	48.8	47.5	40.8
1	63.7	42.8	51.1	58.5	64.1
2					
3		71.6	47.2	28.8	
4					0.0
5		54.8	66.6	57.6	
6					94.0
7		45.1	63.5	70.2	
8					0.0
9		44.9	56.5	49.6	70.9
10			76.2	58.8	49.6
11	54.5	63.0	66.0	61.8	67.1
12		53.0	54.4	51.3	60.3
13	47.4	51.1	53.4	50.3	52.3
14	47.7	51.1	54.2	68.3	59.4
15		52.8	52.9	50.6	64.0
16	51.9	51.1	49.9	50.1	53.1
17	42.8	57.5	47.5	51.8	51.6
18		48.1	47.9	48.5	46.6
19	50.0	50.5	50.6	52.2	51.6
20	79.6	50.5	61.6	55.2	58.2
21	67.4	69.8	64.8	58.6	66.3
22	29.2	77.0	75.2	60.4	
23					100.0

2017 San Antonio TDM Overnight Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	54.9	52.5	49.4	48.2	45.3
1	59.4	44.2	52.7	59.0	63.9
2					
3		71.7	47.0	30.1	
4					0.0
5		53.3	66.0	55.1	
6					93.6
7		49.1	64.7	70.2	
8					0.0
9		44.6	52.0	50.3	74.7
10			75.2	56.3	50.0
11	59.4	64.5	64.3	59.0	65.2
12		51.4	52.2	51.2	55.3
13	42.3	50.3	51.6	50.7	50.8
14	47.2	49.8	53.4	69.3	57.1
15		52.1	52.5	50.8	57.5
16	51.2	50.4	49.4	49.9	51.4
17	31.5	57.3	49.4	50.0	47.3
18		47.3	48.4	51.3	49.2
19	51.4	49.8	48.3	50.4	51.3
20	83.4	50.3	62.7	53.8	59.1
21	68.4	68.7	65.2	60.3	63.6
22	28.3	78.7	75.7	57.7	
23					100.0

2023 and 2024 San Antonio TDM AM Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	26.3	42.1	53.2	56.6	66.0
1	66.6	39.8	51.2	57.4	67.6
2		100.0	100.0	100.0	0.0
3		70.9	60.9	22.7	
4					0.0
5		50.6	61.4	80.7	
6		100.0		91.4	68.0
7		66.7	71.6	89.2	
8		100.0	100.0	100.0	0.0
9		49.2	44.0	58.7	96.5
10		57.1	57.7	55.6	61.3
11	58.4	60.1	58.8	50.9	73.1
12	51.0	46.0	43.0	48.1	24.6
13	49.8	48.4	49.0	54.3	46.1
14	38.6	50.6	57.5	59.4	49.9
15		49.2	49.2	50.7	28.7
16	48.5	48.8	48.5	45.5	43.9
17	54.0	53.7	60.5	51.0	67.1
18		50.2	52.2	45.2	55.5
19	43.7	48.1	48.9	50.2	48.9
20	85.4	52.2	68.1	45.3	39.1
21	65.0	68.0	63.6	65.2	61.9
22	29.7	79.6	78.9	61.0	
23					100.0

2023 and 2024 San Antonio TDM Mid-Day Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	48.5	49.8	50.2	50.3	50.3
1	63.7	40.5	58.5	55.8	69.3
2		100.0	100.0	100.0	0.0
3		68.9	57.8	25.1	
4					0.0
5		57.6	62.0	79.6	
6		100.0		97.6	80.5
7		62.8	68.3	87.9	
8		100.0	100.0	100.0	0.0
9		52.1	47.3	53.7	95.0
10		52.3	57.4	48.9	66.8
11	58.0	62.7	66.1	58.6	72.7
12	50.1	50.4	50.2	49.8	48.9
13	44.9	50.1	51.3	50.9	50.8
14	43.2	51.2	58.5	59.6	49.4
15		52.4	50.7	49.7	50.2
16	51.7	50.3	49.5	48.7	49.2
17	42.2	53.9	58.4	49.5	60.0
18		46.8	50.9	50.3	49.5
19	46.1	49.3	50.8	51.3	51.1
20	82.9	52.5	69.4	51.9	49.1
21	67.1	68.2	62.4	65.3	62.3
22	29.1	79.7	74.2	66.1	
23					100.0

2023 and 2024 San Antonio TDM PM Peak Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	62.7	54.0	48.1	46.3	41.0
1	64.4	40.7	63.7	55.7	70.4
2		100.0	100.0	100.0	0.0
3		69.0	53.8	23.8	
4					0.0
5		62.6	62.9	84.6	
6		100.0		95.2	75.6
7		61.4	69.2	86.2	
8		100.0	100.0	100.0	0.0
9		53.1	51.6	52.8	95.6
10		49.3	59.2	45.4	71.5
11	55.2	63.7	67.8	63.5	72.9
12	49.0	53.0	54.8	50.4	63.9
13	44.4	51.3	52.6	48.7	53.1
14	42.3	51.8	59.3	58.1	52.4
15		53.3	51.7	49.7	63.1
16	51.7	51.0	50.2	50.8	52.6
17	47.3	51.2	59.0	48.3	62.5
18		48.5	49.3	52.8	47.1
19	47.6	50.0	51.7	51.9	51.5
20	78.5	53.3	70.3	56.6	54.6
21	67.4	68.9	61.1	66.7	65.0
22	28.5	81.2	76.2	71.5	
23					100.0

2023 and 2024 San Antonio TDM Overnight Directional Split Factors.

Functional Class Code	Area Type Code 1	Area Type Code 2	Area Type Code 3	Area Type Code 4	Area Type Code 5
0	54.3	52.4	48.7	47.8	45.3
1	59.4	41.4	58.7	53.9	69.8
2		100.0	100.0	100.0	0.0
3		68.5	57.5	24.5	
4					0.0
5		60.7	61.2	79.4	
6		100.0		99.0	67.0
7		59.2	67.0	86.7	
8		100.0	100.0	100.0	0.0
9		54.4	48.3	54.1	99.7
10		51.7	56.7	46.3	68.5
11	60.9	65.1	69.6	61.2	72.3
12	48.3	51.5	52.6	51.7	57.7
13	39.4	49.7	52.2	50.1	52.0
14	42.4	51.9	59.4	59.0	53.4
15		53.2	51.0	47.0	57.1
16	54.3	50.3	49.3	49.0	51.2
17	34.2	53.7	57.0	48.1	57.0
18		44.1	48.6	52.1	49.7
19	49.9	48.8	51.1	51.7	51.8
20	82.5	52.3	69.8	55.4	57.5
21	68.3	67.7	63.4	67.8	65.0
22	26.7	80.9	76.6	68.8	
23					100.0

APPENDIX F: VEHICLE POPULATION ESTIMATES AND 24-HOUR SHP, STARTS, SHEI AND APU SUMMARIES

Vehicle Population Estimates for Bexar County by Analysis Year.

SUT/FT	2017	2023	2024
11_G	19,614	23,151	23,711
21_G	1,074,095	1,262,659	1,293,212
21_D	7,569	14,037	14,376
31_G	242,322	284,852	291,744
31_D	3,690	5,520	5,654
32_G	59,399	70,033	71,728
32_D	3,258	3,918	4,013
41_G	0	0	0
41_D	285	337	345
42_G	0	0	0
42_D	571	685	702
43_G	20	23	24
43_D	1,574	1,846	1,891
51_G	600	697	713
51_D	767	882	904
52_G	12,256	14,547	14,899
52_D	15,532	18,437	18,883
53_G	1,023	1,207	1,237
53_D	1,298	1,533	1,570
54_G	472	488	499
54_D	600	627	642
61_G	1,414	1,665	1,706
61_D	16,218	19,146	19,609
62_G	0	0	0
62_D	58,351	57,709	59,106

24-Hour Weekday ONI Hour Summaries for Bexar County by Analysis Year.

SUT/FT	2017	2023	2024
11_G	0.00	0.00	0.00
21_G	253,198.28	288,136.49	291,569.25
21_D	1,784.07	3,204.67	3,242.86
31_G	74,803.19	84,372.46	85,367.31
31_D	1,138.72	1,633.91	1,653.17
32_G	18,336.96	20,745.18	20,989.75
32_D	1,005.56	1,160.81	1,174.48
41_G	0.00	0.00	0.00
41_D	412.06	498.96	512.76
42_G	0.00	0.00	0.00
42_D	431.52	498.85	505.65
43_G	4.93	4.97	4.87
43_D	533.00	550.40	543.45
51_G	660.62	769.53	791.16
51_D	837.91	974.90	1,002.28
52_G	7,575.62	9,064.24	9,313.07
52_D	9,603.18	11,488.00	11,803.35
53_G	632.26	757.37	778.16
53_D	801.45	960.24	986.60
54_G	0.00	0.00	0.00
54_D	0.00	0.00	0.00
61_G	450.99	567.08	583.88
61_D	5,183.59	6,533.70	6,727.23
62_G	0.00	0.00	0.00
62_D	5,541.85	5,505.44	5,610.39

24-Hour Weekday Adjusted SHP Summaries for Bexar County by Analysis Year.

SUT/FT	2017	2023	2024
11_G	469,610.10	554,190.71	567,582.37
21_G	24,401,189.91	28,602,662.30	29,280,397.80
21_D	171,964.22	317,961.46	325,495.40
31_G	5,408,176.11	6,336,292.61	6,485,417.35
31_D	82,357.89	122,805.94	125,696.21
32_G	1,325,665.18	1,557,818.31	1,594,481.62
32_D	72,716.71	87,153.68	89,204.81
41_G	0.00	0.00	0.00
41_D	5,585.40	6,523.82	6,667.54
42_G	0.00	0.00	0.00
42_D	11,558.23	13,791.36	14,105.13
43_G	419.35	492.64	504.08
43_D	32,557.48	37,946.12	38,816.46
51_G	12,854.29	14,881.47	15,226.42
51_D	16,452.75	18,849.30	19,286.26
52_G	268,523.13	317,687.39	325,090.61
52_D	340,277.56	402,623.07	412,005.64
53_G	22,413.03	26,351.12	26,965.04
53_D	28,450.88	33,448.35	34,227.62
54_G	10,633.56	10,948.42	11,204.79
54_D	13,516.70	14,091.42	14,421.56
61_G	32,478.35	38,101.67	39,005.90
61_D	372,605.26	438,005.77	448,399.73
62_G	0.00	0.00	0.00
62_D	1,353,710.22	1,334,439.49	1,366,247.64

24-Hour Weekday Starts Summaries for Bexar County by Analysis Year.

SUT/FT	2017	2023	2024
11_G	3,404.68	4,018.57	4,115.81
21_G	4,335,177.51	5,098,494.52	5,221,656.65
21_D	32,263.43	56,708.69	58,395.81
31_G	1,033,840.97	1,210,839.67	1,239,363.98
31_D	15,432.90	25,218.44	26,122.11
32_G	270,257.24	317,719.07	325,123.20
32_D	13,535.74	17,007.96	17,654.06
41_G	0.00	0.00	0.00
41_D	1,995.09	2,354.82	2,411.80
42_G	0.00	0.00	0.00
42_D	4,459.11	5,353.86	5,483.41
43_G	71.62	89.72	91.59
43_D	6,890.95	8,062.41	8,257.29
51_G	539.84	372.97	318.25
51_D	1,464.74	1,671.63	1,711.66
52_G	276,833.69	335,841.90	342,517.72
52_D	330,071.32	380,804.57	390,827.37
53_G	1,556.83	1,879.05	1,914.30
53_D	1,832.50	2,096.29	2,153.17
54_G	239.64	249.41	255.66
54_D	327.07	333.46	340.91
61_G	8,494.24	10,731.05	10,984.60
61_D	104,967.16	123,081.71	126,066.35
62_G	0.00	0.00	0.00
62_D	32,534.06	32,175.96	32,954.63

Analysis Year Weekday Hotelling Hours Summaries by Operating Mode for Bexar County.

County FIPS	Hotelling Hours	SHEI	APU Hours	Other Mode Hours
2017	19,505.22	14,668.12	936.06	3,901.04
2023	19,705.59	13,224.68	2,118.91	4,362.01
2024	20,182.41	12,873.95	2,692.52	4,615.94

APPENDIX G: AGE DISTRIBUTIONS AND FUEL ENGINE FRACTIONS INPUTS TO MOVES

Bexar County 2017 Age Distribution Inputs to MOVES.

Age	MC	PC	PT	LCT	OBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.060068	0.087952	0.074745	0.074745	0.078824	0.091142	0.083978	0.031614	0.112341	0.108951	0.016664	0.083482	0.068825
1	0.060618	0.087490	0.064050	0.064050	0.075667	0.090093	0.076580	0.032820	0.104240	0.103650	0.017093	0.065901	0.059543
2	0.059868	0.074908	0.050696	0.050696	0.067199	0.077034	0.075099	0.039904	0.107439	0.111268	0.017428	0.061272	0.047903
3	0.065320	0.077364	0.049685	0.049685	0.063959	0.079629	0.072132	0.035734	0.086920	0.085755	0.016351	0.062571	0.060675
4	0.059968	0.080774	0.047034	0.047034	0.041394	0.062045	0.040955	0.031878	0.102726	0.102451	0.020170	0.087218	0.071965
5	0.057217	0.068666	0.049685	0.049685	0.036596	0.068674	0.042028	0.032138	0.059531	0.056032	0.010539	0.062287	0.057263
6	0.056117	0.064553	0.041997	0.041997	0.032532	0.055132	0.043047	0.023869	0.048401	0.050813	0.019997	0.052745	0.058116
7	0.047614	0.054731	0.036759	0.036759	0.035230	0.072004	0.039560	0.017559	0.070736	0.071436	0.003389	0.053922	0.060032
8	0.037711	0.043723	0.036308	0.036308	0.039392	0.069145	0.049382	0.031958	0.047359	0.048826	0.005994	0.026149	0.030871
9	0.026808	0.039508	0.033622	0.033622	0.039680	0.062851	0.049899	0.027028	0.016241	0.017043	0.022758	0.016363	0.019997
10	0.057817	0.031457	0.024323	0.024323	0.041020	0.044016	0.043545	0.078002	0.015976	0.016190	0.038819	0.025621	0.027428
11	0.056767	0.043483	0.043735	0.043735	0.050566	0.038149	0.041402	0.063658	0.040280	0.041381	0.052497	0.023063	0.024805
12	0.066720	0.041999	0.046411	0.046411	0.030779	0.028742	0.036224	0.054189	0.026784	0.027061	0.041177	0.073291	0.078722
13	0.056567	0.034748	0.042572	0.042572	0.029860	0.029906	0.039417	0.045716	0.029529	0.030204	0.063961	0.048887	0.050902
14	0.042663	0.031684	0.039419	0.039419	0.038819	0.030838	0.029111	0.050432	0.027106	0.025697	0.048354	0.045355	0.043087
15	0.029909	0.026961	0.044206	0.044206	0.035967	0.028980	0.034482	0.045640	0.020784	0.019228	0.045680	0.022738	0.024421
16	0.034860	0.023441	0.043360	0.043360	0.041037	0.026572	0.038448	0.048454	0.015559	0.015792	0.030061	0.021398	0.021618
17	0.027058	0.019385	0.041320	0.041320	0.047968	0.018212	0.033726	0.058821	0.014613	0.013489	0.056177	0.016323	0.016864
18	0.017355	0.015473	0.038253	0.038253	0.028106	0.011607	0.017894	0.047873	0.012493	0.013534	0.087043	0.018962	0.023545
19	0.013404	0.012612	0.028483	0.028483	0.022635	0.006198	0.016732	0.030019	0.009275	0.009828	0.039384	0.027895	0.032228
20	0.013054	0.009538	0.023004	0.023004	0.020051	0.002680	0.014288	0.019410	0.009029	0.009369	0.065558	0.020789	0.024374
21	0.007652	0.006340	0.016482	0.016482	0.015338	0.003551	0.012169	0.024501	0.004770	0.004506	0.034386	0.015836	0.018389
22	0.005952	0.004879	0.016352	0.016352	0.015262	0.000636	0.013276	0.027421	0.004543	0.004678	0.037837	0.011288	0.012671
23	0.005602	0.003204	0.011063	0.011063	0.011438	0.001134	0.006577	0.016877	0.002063	0.002323	0.039588	0.010963	0.012375
24	0.003501	0.002859	0.010819	0.010819	0.009950	0.000160	0.007616	0.013002	0.002253	0.002388	0.023454	0.010313	0.011774
25	0.003651	0.001953	0.009633	0.009633	0.006052	0.000234	0.006794	0.010264	0.001230	0.001414	0.022808	0.007065	0.008079
26	0.002501	0.001465	0.006325	0.006325	0.005200	0.000182	0.008420	0.012742	0.001136	0.001073	0.015103	0.005116	0.006273
27	0.002351	0.001084	0.004666	0.004666	0.007295	0.000215	0.008562	0.014199	0.000852	0.000713	0.022934	0.003330	0.003870
28	0.001250	0.000985	0.003315	0.003315	0.008928	0.000108	0.004271	0.010231	0.000965	0.000730	0.028466	0.003289	0.003640
29	0.001450	0.000733	0.002911	0.002911	0.005620	0.000040	0.004325	0.010633	0.000738	0.000653	0.025257	0.003533	0.003493
30	0.018606	0.006047	0.018767	0.018767	0.017635	0.000091	0.010061	0.013416	0.004089	0.003525	0.031075	0.013034	0.016255

Bexar County 2023 Age Distribution Inputs to MOVES.

Age	MC	PC	PT	LCT	OBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.060068	0.087952	0.074745	0.074745	0.055916	0.055916	0.055916	0.058180	0.112341	0.108951	0.058180	0.083482	0.068825
1	0.060618	0.087490	0.064050	0.064050	0.056272	0.056177	0.056259	0.058179	0.104240	0.103650	0.058578	0.065901	0.059543
2	0.059868	0.074908	0.050696	0.050696	0.053703	0.053595	0.053754	0.056574	0.107439	0.111268	0.057461	0.061272	0.047903
3	0.065320	0.077364	0.049685	0.049685	0.055079	0.054952	0.055275	0.057472	0.086920	0.085755	0.058467	0.062571	0.060675
4	0.059968	0.080774	0.047034	0.047034	0.057299	0.057046	0.057596	0.058908	0.102726	0.102451	0.060375	0.087218	0.071965
5	0.057217	0.068666	0.049685	0.049685	0.053587	0.052974	0.053667	0.055701	0.059531	0.056032	0.058115	0.062287	0.057263
6	0.056117	0.064553	0.041997	0.041997	0.072106	0.081694	0.076767	0.028881	0.048401	0.050813	0.016156	0.052745	0.058116
7	0.047614	0.054731	0.036759	0.036759	0.067500	0.078131	0.068119	0.029440	0.070736	0.071436	0.016327	0.053922	0.060032
8	0.037711	0.043723	0.036308	0.036308	0.057694	0.063477	0.064077	0.034826	0.047359	0.048826	0.016279	0.026149	0.030871
9	0.026808	0.039508	0.033622	0.033622	0.052840	0.062167	0.059003	0.030340	0.016241	0.017043	0.014941	0.016363	0.019997
10	0.057817	0.031457	0.024323	0.024323	0.032885	0.045715	0.032079	0.026323	0.015976	0.016190	0.018033	0.025621	0.027428
11	0.056767	0.043483	0.043735	0.043735	0.027950	0.047838	0.031525	0.025805	0.040280	0.041381	0.009215	0.023063	0.024805
12	0.066720	0.041999	0.046411	0.046411	0.024205	0.037017	0.031373	0.018806	0.026784	0.027061	0.017221	0.073291	0.078722
13	0.056567	0.034748	0.042572	0.042572	0.025189	0.045712	0.027598	0.013446	0.029529	0.030204	0.002852	0.048887	0.050902
14	0.042663	0.031684	0.039419	0.039419	0.027435	0.042348	0.033477	0.024021	0.027106	0.025697	0.004971	0.045355	0.043087
15	0.029909	0.026961	0.044206	0.044206	0.026908	0.037037	0.032845	0.019936	0.020784	0.019228	0.018594	0.022738	0.024421
16	0.034860	0.023441	0.043360	0.043360	0.026714	0.024469	0.027413	0.055915	0.015559	0.015792	0.031004	0.021398	0.021618
17	0.027058	0.019385	0.041320	0.041320	0.032058	0.020412	0.025303	0.044760	0.014613	0.013489	0.041292	0.016323	0.016864
18	0.017355	0.015473	0.038253	0.038253	0.018731	0.014509	0.021163	0.037012	0.012493	0.013534	0.031647	0.018962	0.023545
19	0.013404	0.012612	0.028483	0.028483	0.017689	0.014544	0.022359	0.030639	0.009275	0.009828	0.048417	0.027895	0.032228
20	0.013054	0.009538	0.023004	0.023004	0.022068	0.014159	0.015781	0.032824	0.009029	0.009369	0.035754	0.020789	0.024374
21	0.007652	0.006340	0.016482	0.016482	0.019618	0.012516	0.017856	0.028859	0.004770	0.004506	0.033019	0.015836	0.018389
22	0.005952	0.004879	0.016352	0.016352	0.021770	0.011016	0.019305	0.030050	0.004543	0.004678	0.021400	0.011288	0.012671
23	0.005602	0.003204	0.011063	0.011063	0.024396	0.007096	0.016162	0.035423	0.002063	0.002323	0.039074	0.010963	0.012375
24	0.003501	0.002859	0.010819	0.010819	0.013900	0.004343	0.008313	0.028262	0.002253	0.002388	0.059603	0.010313	0.011774
25	0.003651	0.001953	0.009633	0.009633	0.010880	0.002220	0.007530	0.017378	0.001230	0.001414	0.026560	0.007065	0.008079
26	0.002501	0.001465	0.006325	0.006325	0.009369	0.000923	0.006234	0.011017	0.001136	0.001073	0.043513	0.005116	0.006273
27	0.002351	0.001084	0.004666	0.004666	0.006966	0.001173	0.005145	0.013629	0.000852	0.000713	0.022466	0.003330	0.003870
28	0.001250	0.000985	0.003315	0.003315	0.006734	0.000201	0.005435	0.014955	0.000965	0.000730	0.024344	0.003289	0.003640
29	0.001450	0.000733	0.002911	0.002911	0.004904	0.000344	0.002609	0.009023	0.000738	0.000653	0.025065	0.003533	0.003493
30	0.018606	0.006047	0.018767	0.018767	0.017635	0.000280	0.010061	0.013416	0.004089	0.003525	0.031075	0.013034	0.016255

Bexar County 2024 Age Distribution Inputs to MOVES.

Age	MC	PC	PT	LCT	OBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.060068	0.087952	0.074745	0.074745	0.054446	0.054446	0.054446	0.056971	0.112341	0.108951	0.056971	0.083482	0.068825
1	0.060618	0.087490	0.064050	0.064050	0.055447	0.055341	0.055385	0.057542	0.104240	0.103650	0.058387	0.065901	0.059543
2	0.059868	0.074908	0.050696	0.050696	0.055800	0.055600	0.055725	0.057541	0.107439	0.111268	0.058787	0.061272	0.047903
3	0.065320	0.077364	0.049685	0.049685	0.053253	0.053045	0.053244	0.055954	0.086920	0.085755	0.057665	0.062571	0.060675
4	0.059968	0.080774	0.047034	0.047034	0.054617	0.054387	0.054751	0.056842	0.102726	0.102451	0.058676	0.087218	0.071965
5	0.057217	0.068666	0.049685	0.049685	0.056144	0.055656	0.056327	0.057739	0.059531	0.056032	0.060128	0.062287	0.057263
6	0.056117	0.064553	0.041997	0.041997	0.051875	0.050936	0.051812	0.054102	0.048401	0.050813	0.057432	0.052745	0.058116
7	0.047614	0.054731	0.036759	0.036759	0.069803	0.078552	0.074113	0.028051	0.070736	0.071436	0.015966	0.053922	0.060032
8	0.037711	0.043723	0.036308	0.036308	0.064548	0.074025	0.064910	0.028334	0.047359	0.048826	0.016010	0.026149	0.030871
9	0.026808	0.039508	0.033622	0.033622	0.055171	0.060141	0.061059	0.033517	0.016241	0.017043	0.015963	0.016363	0.019997
10	0.057817	0.031457	0.024323	0.024323	0.050529	0.058900	0.056223	0.029200	0.015976	0.016190	0.014651	0.025621	0.027428
11	0.056767	0.043483	0.043735	0.043735	0.031060	0.042669	0.030166	0.025101	0.040280	0.041381	0.017545	0.023063	0.024805
12	0.066720	0.041999	0.046411	0.046411	0.026398	0.044650	0.029644	0.024606	0.026784	0.027061	0.008965	0.073291	0.078722
13	0.056567	0.034748	0.042572	0.042572	0.022576	0.034029	0.029108	0.017765	0.029529	0.030204	0.016623	0.048887	0.050902
14	0.042663	0.031684	0.039419	0.039419	0.023494	0.042022	0.025605	0.012702	0.027106	0.025697	0.002753	0.045355	0.043087
15	0.029909	0.026961	0.044206	0.044206	0.025589	0.038929	0.031060	0.022692	0.020784	0.019228	0.004799	0.022738	0.024421
16	0.034860	0.023441	0.043360	0.043360	0.024781	0.033526	0.030062	0.018656	0.015559	0.015792	0.017806	0.021398	0.021618
17	0.027058	0.019385	0.041320	0.041320	0.024601	0.022149	0.025090	0.052325	0.014613	0.013489	0.029690	0.016323	0.016864
18	0.017355	0.015473	0.038253	0.038253	0.029146	0.018189	0.022842	0.041490	0.012493	0.013534	0.039226	0.018962	0.023545
19	0.013404	0.012612	0.028483	0.028483	0.017029	0.012929	0.019105	0.034308	0.009275	0.009828	0.030063	0.027895	0.032228
20	0.013054	0.009538	0.023004	0.023004	0.015873	0.012755	0.019904	0.028128	0.009029	0.009369	0.045623	0.020789	0.024374
21	0.007652	0.006340	0.016482	0.016482	0.019803	0.012417	0.014048	0.030134	0.004770	0.004506	0.033691	0.015836	0.018389
22	0.005952	0.004879	0.016352	0.016352	0.017604	0.010977	0.015895	0.026494	0.004543	0.004678	0.031114	0.011288	0.012671
23	0.005602	0.003204	0.011063	0.011063	0.019279	0.009506	0.016943	0.027321	0.002063	0.002323	0.020002	0.010963	0.012375
24	0.003501	0.002859	0.010819	0.010819	0.021604	0.006123	0.014184	0.032206	0.002253	0.002388	0.036520	0.010313	0.011774
25	0.003651	0.001953	0.009633	0.009633	0.012309	0.003747	0.007296	0.025695	0.001230	0.001414	0.055707	0.007065	0.008079
26	0.002501	0.001465	0.006325	0.006325	0.009507	0.001884	0.006514	0.015645	0.001136	0.001073	0.024621	0.005116	0.006273
27	0.002351	0.001084	0.004666	0.004666	0.008187	0.000783	0.005393	0.009918	0.000852	0.000713	0.040336	0.003330	0.003870
28	0.001250	0.000985	0.003315	0.003315	0.006087	0.000996	0.004451	0.012271	0.000965	0.000730	0.020826	0.003289	0.003640
29	0.001450	0.000733	0.002911	0.002911	0.005805	0.000168	0.004633	0.013332	0.000738	0.000653	0.022380	0.003533	0.003493
30	0.018606	0.006047	0.018767	0.018767	0.017635	0.000521	0.010061	0.013416	0.004089	0.003525	0.031075	0.013034	0.016255

Texas Statewide 2017 Fuel Engine Fractions Summary.

SUT	Fuel Type	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.96977	0.94863	0.93751	0.94365	0.94020	0.93965	0.90306	0.93570	0.94665	0.94784	0.96924	0.95752	0.98121	0.98710	0.98163	0.98742
PC	Diesel	0.00026	0.00121	0.02417	0.01499	0.01354	0.01261	0.01177	0.01061	0.00779	0.00069	0.00047	0.00695	0.00491	0.00338	0.00416	0.00464
PT	Gas	0.84358	0.82315	0.76837	0.77491	0.69407	0.68589	0.75726	0.79406	0.84100	0.88674	0.85626	0.91131	0.91051	0.89189	0.85736	0.87238
PT	Diesel	0.03894	0.03474	0.03031	0.02373	0.02009	0.02645	0.02341	0.01328	0.01718	0.03004	0.02790	0.04402	0.03595	0.04059	0.03865	0.03470
LCT	Gas	0.84358	0.82315	0.76837	0.61614	0.59432	0.62654	0.62303	0.63823	0.76558	0.81321	0.81565	0.85179	0.86984	0.85968	0.84007	0.84304
LCT	Diesel	0.03894	0.03474	0.03031	0.02627	0.03117	0.05619	0.06012	0.03476	0.04654	0.08017	0.06792	0.09978	0.08519	0.09267	0.08413	0.08484
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.00791	0.00791	0.00791	0.00791	0.03703	0.04500	0.03143	0.03886	0.02749	0.01298	0.00778	0.01011	0.00660	0.00377	0.00554	0.02596
SBus	Diesel	0.99209	0.99209	0.99209	0.99209	0.96297	0.95500	0.96857	0.96114	0.97251	0.98702	0.99222	0.98989	0.99340	0.99623	0.99446	0.97404
RT	Gas	0.00000	0.00000	0.00000	0.00000	0.00659	0.00000	0.00000	0.00000	0.00460	0.00204	0.00234	0.00086	0.00067	0.00000	0.00036	0.00000
RT	Diesel	1.00000	1.00000	1.00000	1.00000	0.99341	1.00000	1.00000	1.00000	0.99540	0.99796	0.99766	0.99914	0.99933	1.00000	0.99964	1.00000
SUShT	Gas	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345	0.33104	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492
SUShT	Diesel	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655	0.66896	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508
SULhT	Gas	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345	0.33104	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492
SULhT	Diesel	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655	0.66896	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508
MH	Gas	0.57965	0.57965	0.57965	0.57965	0.70761	0.72513	0.70133	0.00585	0.53388	0.38083	0.44201	0.57780	0.34935	0.60161	0.56194	0.60280
MH	Diesel	0.42035	0.42035	0.42035	0.42035	0.29239	0.27487	0.29867	0.99415	0.46612	0.61917	0.55799	0.42220	0.65065	0.39839	0.43806	0.39720
CShT	Gas	0.10616	0.09304	0.07303	0.09762	0.08697	0.08114	0.06454	0.07675	0.07693	0.07895	0.05434	0.06493	0.06068	0.07687	0.08587	0.09318
CShT	Diesel	0.89384	0.90696	0.92697	0.90238	0.91303	0.91886	0.93546	0.92325	0.92307	0.92105	0.94566	0.93507	0.93932	0.92313	0.91413	0.90682
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary – Continued.

SUT	Fuel Type	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.98724	0.98443	0.98118	0.98877	0.99909	0.99876	0.99906	0.99985	0.99931	0.99883	0.99718	0.99894	0.99909	0.99974	0.98723
PC	Diesel	0.00335	0.00309	0.00188	0.00221	0.00091	0.00124	0.00094	0.00015	0.00069	0.00117	0.00282	0.00106	0.00091	0.00026	0.01277
PT	Gas	0.92153	0.90560	0.90991	0.97211	0.95551	0.95753	0.96088	0.96624	0.95751	0.96186	0.96598	0.96917	0.97412	0.98041	0.97672
PT	Diesel	0.04103	0.02973	0.03925	0.01280	0.04449	0.04247	0.03912	0.03376	0.04249	0.03814	0.03402	0.03083	0.02588	0.01959	0.02328
LCT	Gas	0.88196	0.87280	0.86328	0.94144	0.89876	0.90704	0.90831	0.92119	0.90559	0.92221	0.91873	0.92593	0.93758	0.93686	0.93504
LCT	Diesel	0.08819	0.07731	0.09860	0.04495	0.10124	0.09296	0.09169	0.07881	0.09441	0.07779	0.08127	0.07407	0.06242	0.06314	0.06496
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.01166	0.02569	0.01000	0.01000	0.01000	0.04154	0.11428	0.14748	0.12054	0.01004	0.08954	0.12404	0.22904	0.24977	0.26555
SBus	Diesel	0.98834	0.97431	0.99000	0.99000	0.99000	0.95846	0.88572	0.85252	0.87946	0.98996	0.91046	0.87596	0.77096	0.75023	0.73445
RT	Gas	0.00000	0.00000	0.16880	0.40357	0.01932	0.02529	0.02354	0.10504	0.03148	0.21028	0.10123	0.20399	0.02945	0.11391	0.11412
RT	Diesel	1.00000	1.00000	0.83120	0.59643	0.98068	0.97471	0.97646	0.89496	0.96852	0.78972	0.89877	0.79601	0.97055	0.88609	0.88588
SUShT	Gas	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178	0.49004	0.49383	0.50690	0.54528	0.78230	0.78230	0.78230
SUShT	Diesel	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822	0.50996	0.50617	0.49310	0.45472	0.21770	0.21770	0.21770
SULhT	Gas	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178	0.49004	0.49383	0.50690	0.54528	0.78230	0.78230	0.78230
SULhT	Diesel	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822	0.50996	0.50617	0.49310	0.45472	0.21770	0.21770	0.21770
MH	Gas	0.54586	0.65392	0.79746	0.64940	0.83607	0.80080	0.85102	0.80835	0.72757	0.78687	0.84972	0.91993	0.95133	0.98056	0.99176
MH	Diesel	0.45414	0.34608	0.20254	0.35060	0.16393	0.19920	0.14898	0.19165	0.27243	0.21313	0.15028	0.08007	0.04867	0.01944	0.00824
CShT	Gas	0.09572	0.11042	0.11049	0.10920	0.12175	0.11853	0.20831	0.10032	0.10421	0.11622	0.14152	0.13698	0.25559	0.25559	0.25559
CShT	Diesel	0.90428	0.88958	0.88951	0.89080	0.87825	0.88147	0.79169	0.89968	0.89579	0.88378	0.85848	0.86302	0.74441	0.74441	0.74441
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2023 Fuel Engine Fractions Summary.

SUT	Fuel Type	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.96022	0.96167	0.96311	0.96427	0.96679	0.96933	0.96977	0.94863	0.93751	0.94365	0.94020	0.93965	0.90306	0.93570	0.94665	0.94784
PC	Diesel	0.00922	0.00779	0.00656	0.00570	0.00334	0.00108	0.00026	0.00121	0.02417	0.01499	0.01354	0.01261	0.01177	0.01061	0.00779	0.00069
PT	Gas	0.81557	0.81665	0.81850	0.82007	0.82756	0.83585	0.84358	0.82315	0.76837	0.77491	0.69407	0.68589	0.75726	0.79406	0.84100	0.88674
PT	Diesel	0.06775	0.06632	0.06441	0.06285	0.05514	0.04653	0.03894	0.03474	0.03031	0.02373	0.02009	0.02645	0.02341	0.01328	0.01718	0.03004
LCT	Gas	0.81557	0.81665	0.81850	0.82007	0.82756	0.83585	0.84358	0.82315	0.76837	0.61614	0.59432	0.62654	0.62303	0.63823	0.76558	0.81321
LCT	Diesel	0.06775	0.06632	0.06441	0.06285	0.05514	0.04653	0.03894	0.03474	0.03031	0.02627	0.03117	0.05619	0.06012	0.03476	0.04654	0.08017
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.03703	0.04500	0.03143	0.03886	0.02749	0.01298
SBus	Diesel	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.96297	0.95500	0.96857	0.96114	0.97251	0.98702
RT	Gas	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00659	0.00000	0.00000	0.00000	0.00460	0.00204
RT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.99341	1.00000	1.00000	1.00000	0.99540	0.99796
SUShT	Gas	0.51864	0.51864	0.51864	0.51864	0.51864	0.47430	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345	0.33104
SUShT	Diesel	0.48136	0.48136	0.48136	0.48136	0.48136	0.52570	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655	0.66896
SULhT	Gas	0.51864	0.51864	0.51864	0.51864	0.51864	0.47430	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345	0.33104
SULhT	Diesel	0.48136	0.48136	0.48136	0.48136	0.48136	0.52570	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655	0.66896
MH	Gas	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.70761	0.72513	0.70133	0.00585	0.53388	0.38083
MH	Diesel	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.29239	0.27487	0.29867	0.99415	0.46612	0.61917
CShT	Gas	0.08061	0.08061	0.08061	0.08061	0.08061	0.09098	0.10616	0.09304	0.07303	0.09762	0.08697	0.08114	0.06454	0.07675	0.07693	0.07895
CShT	Diesel	0.91939	0.91939	0.91939	0.91939	0.91939	0.90902	0.89384	0.90696	0.92697	0.90238	0.91303	0.91886	0.93546	0.92325	0.92307	0.92105
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2023 Fuel Engine Fractions Summary – Continued.

SUT	Fuel Type	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.96924	0.95752	0.98121	0.98710	0.98163	0.98742	0.98724	0.98443	0.98118	0.98877	0.99909	0.99876	0.99906	0.99985	0.99931
PC	Diesel	0.00047	0.00695	0.00491	0.00338	0.00416	0.00464	0.00335	0.00309	0.00188	0.00221	0.00091	0.00124	0.00094	0.00015	0.00069
PT	Gas	0.85626	0.91131	0.91051	0.89189	0.85736	0.87238	0.92153	0.90560	0.90991	0.97211	0.95551	0.95753	0.96088	0.96624	0.95751
PT	Diesel	0.02790	0.04402	0.03595	0.04059	0.03865	0.03470	0.04103	0.02973	0.03925	0.01280	0.04449	0.04247	0.03912	0.03376	0.04249
LCT	Gas	0.81565	0.85179	0.86984	0.85968	0.84007	0.84304	0.88196	0.87280	0.86328	0.94144	0.89876	0.90704	0.90831	0.92119	0.90559
LCT	Diesel	0.06792	0.09978	0.08519	0.09267	0.08413	0.08484	0.08819	0.07731	0.09860	0.04495	0.10124	0.09296	0.09169	0.07881	0.09441
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.00778	0.01011	0.00660	0.00377	0.00554	0.02596	0.01166	0.02569	0.01000	0.01000	0.01000	0.04154	0.11428	0.14748	0.12054
SBus	Diesel	0.99222	0.98989	0.99340	0.99623	0.99446	0.97404	0.98834	0.97431	0.99000	0.99000	0.99000	0.95846	0.88572	0.85252	0.87946
RT	Gas	0.00234	0.00086	0.00067	0.00000	0.00036	0.00000	0.00000	0.00000	0.16880	0.40357	0.01932	0.02529	0.02354	0.10504	0.03148
RT	Diesel	0.99766	0.99914	0.99933	1.00000	0.99964	1.00000	1.00000	1.00000	0.83120	0.59643	0.98068	0.97471	0.97646	0.89496	0.96852
SUShT	Gas	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178	0.49004
SUShT	Diesel	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822	0.50996
SULhT	Gas	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178	0.49004
SULhT	Diesel	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822	0.50996
MH	Gas	0.44201	0.57780	0.34935	0.60161	0.56194	0.60280	0.54586	0.65392	0.79746	0.64940	0.83607	0.80080	0.85102	0.80835	0.72757
MH	Diesel	0.55799	0.42220	0.65065	0.39839	0.43806	0.39720	0.45414	0.34608	0.20254	0.35060	0.16393	0.19920	0.14898	0.19165	0.27243
CShT	Gas	0.05434	0.06493	0.06068	0.07687	0.08587	0.09318	0.09572	0.11042	0.11049	0.10920	0.12175	0.11853	0.20831	0.10032	0.10421
CShT	Diesel	0.94566	0.93507	0.93932	0.92313	0.91413	0.90682	0.90428	0.88958	0.88951	0.89080	0.87825	0.88147	0.79169	0.89968	0.89579
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2024 Fuel Engine Fractions Summary.

SUT	Fuel Type	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.95860	0.96022	0.96167	0.96311	0.96427	0.96679	0.96933	0.96977	0.94863	0.93751	0.94365	0.94020	0.93965	0.90306	0.93570	0.94665
PC	Diesel	0.01073	0.00922	0.00779	0.00656	0.00570	0.00334	0.00108	0.00026	0.00121	0.02417	0.01499	0.01354	0.01261	0.01177	0.01061	0.00779
PT	Gas	0.81494	0.81557	0.81665	0.81850	0.82007	0.82756	0.83585	0.84358	0.82315	0.76837	0.77491	0.69407	0.68589	0.75726	0.79406	0.84100
PT	Diesel	0.06837	0.06775	0.06632	0.06441	0.06285	0.05514	0.04653	0.03894	0.03474	0.03031	0.02373	0.02009	0.02645	0.02341	0.01328	0.01718
LCT	Gas	0.81494	0.81557	0.81665	0.81850	0.82007	0.82756	0.83585	0.84358	0.82315	0.76837	0.61614	0.59432	0.62654	0.62303	0.63823	0.76558
LCT	Diesel	0.06837	0.06775	0.06632	0.06441	0.06285	0.05514	0.04653	0.03894	0.03474	0.03031	0.02627	0.03117	0.05619	0.06012	0.03476	0.04654
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.00791	0.03703	0.04500	0.03143	0.03886	0.02749
SBus	Diesel	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.99209	0.96297	0.95500	0.96857	0.96114	0.97251
RT	Gas	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00659	0.00000	0.00000	0.00000	0.00460
RT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.99341	1.00000	1.00000	1.00000	0.99540
SUShT	Gas	0.51864	0.51864	0.51864	0.51864	0.51864	0.51864	0.47430	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345
SUShT	Diesel	0.48136	0.48136	0.48136	0.48136	0.48136	0.48136	0.52570	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655
SULhT	Gas	0.51864	0.51864	0.51864	0.51864	0.51864	0.51864	0.47430	0.49915	0.48981	0.44286	0.40011	0.42137	0.27545	0.28371	0.33230	0.38345
SULhT	Diesel	0.48136	0.48136	0.48136	0.48136	0.48136	0.48136	0.52570	0.50085	0.51019	0.55714	0.59989	0.57863	0.72455	0.71629	0.66770	0.61655
MH	Gas	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.57965	0.70761	0.72513	0.70133	0.00585	0.53388
MH	Diesel	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.42035	0.29239	0.27487	0.29867	0.99415	0.46612
CShT	Gas	0.08061	0.08061	0.08061	0.08061	0.08061	0.08061	0.09098	0.10616	0.09304	0.07303	0.09762	0.08697	0.08114	0.06454	0.07675	0.07693
CShT	Diesel	0.91939	0.91939	0.91939	0.91939	0.91939	0.91939	0.90902	0.89384	0.90696	0.92697	0.90238	0.91303	0.91886	0.93546	0.92325	0.92307
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2024 Fuel Engine Fractions Summary – Continued.

SUT	Fuel Type	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994
MC	Gas	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
PC	Gas	0.94784	0.96924	0.95752	0.98121	0.98710	0.98163	0.98742	0.98724	0.98443	0.98118	0.98877	0.99909	0.99876	0.99906	0.99985
PC	Diesel	0.00069	0.00047	0.00695	0.00491	0.00338	0.00416	0.00464	0.00335	0.00309	0.00188	0.00221	0.00091	0.00124	0.00094	0.00015
PT	Gas	0.88674	0.85626	0.91131	0.91051	0.89189	0.85736	0.87238	0.92153	0.90560	0.90991	0.97211	0.95551	0.95753	0.96088	0.96624
PT	Diesel	0.03004	0.02790	0.04402	0.03595	0.04059	0.03865	0.03470	0.04103	0.02973	0.03925	0.01280	0.04449	0.04247	0.03912	0.03376
LCT	Gas	0.81321	0.81565	0.85179	0.86984	0.85968	0.84007	0.84304	0.88196	0.87280	0.86328	0.94144	0.89876	0.90704	0.90831	0.92119
LCT	Diesel	0.08017	0.06792	0.09978	0.08519	0.09267	0.08413	0.08484	0.08819	0.07731	0.09860	0.04495	0.10124	0.09296	0.09169	0.07881
OBus	Gas	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
OBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
TBus	Gas	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
TBus	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
SBus	Gas	0.01298	0.00778	0.01011	0.00660	0.00377	0.00554	0.02596	0.01166	0.02569	0.01000	0.01000	0.01000	0.04154	0.11428	0.14748
SBus	Diesel	0.98702	0.99222	0.98989	0.99340	0.99623	0.99446	0.97404	0.98834	0.97431	0.99000	0.99000	0.99000	0.95846	0.88572	0.85252
RT	Gas	0.00204	0.00234	0.00086	0.00067	0.00000	0.00036	0.00000	0.00000	0.00000	0.16880	0.40357	0.01932	0.02529	0.02354	0.10504
RT	Diesel	0.99796	0.99766	0.99914	0.99933	1.00000	0.99964	1.00000	1.00000	1.00000	0.83120	0.59643	0.98068	0.97471	0.97646	0.89496
SUShT	Gas	0.33104	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178
SUShT	Diesel	0.66896	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822
SULhT	Gas	0.33104	0.27171	0.27333	0.24922	0.25725	0.25116	0.27492	0.30235	0.36286	0.32519	0.41346	0.41543	0.38278	0.62329	0.50178
SULhT	Diesel	0.66896	0.72829	0.72667	0.75078	0.74275	0.74884	0.72508	0.69765	0.63714	0.67481	0.58654	0.58457	0.61722	0.37671	0.49822
MH	Gas	0.38083	0.44201	0.57780	0.34935	0.60161	0.56194	0.60280	0.54586	0.65392	0.79746	0.64940	0.83607	0.80080	0.85102	0.80835
MH	Diesel	0.61917	0.55799	0.42220	0.65065	0.39839	0.43806	0.39720	0.45414	0.34608	0.20254	0.35060	0.16393	0.19920	0.14898	0.19165
CShT	Gas	0.07895	0.05434	0.06493	0.06068	0.07687	0.08587	0.09318	0.09572	0.11042	0.11049	0.10920	0.12175	0.11853	0.20831	0.10032
CShT	Diesel	0.92105	0.94566	0.93507	0.93932	0.92313	0.91413	0.90682	0.90428	0.88958	0.88951	0.89080	0.87825	0.88147	0.79169	0.89968
CLhT	Diesel	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

[1] Conventional internal combustion engine technology only.