APPENDIX 10

DEVELOPMENT OF ON-ROAD EMISSION INVENTORIES FOR THE YEARS 2011, 2017, AND 2018

HOUSTON-GALVESTON-BRAZORIA 2008 EIGHT-HOUR OZONE NONATTAINMENT AREA REASONABLE FURTHER PROGRESS ON-ROAD MOBILE SOURCE EMISSIONS INVENTORIES

This appendix documents the development of the on-road mobile emissions inventory (EI) for the updates to the Houston-Galveston-Brazoria Ozone Nonattainment Area (HGB) Reasonable Further Progress (RFP) State Implementation Plan.

The development of the RFP EIs was done by the Texas Agricultural and Mechanical Transportation Institute (TTI) at the request and under the direction of the Texas Commission on Environmental Quality (TCEQ). The on-road mobile source EIs and control strategy reduction estimates reflect the most recent planning assumptions for the HGB transportation network. Complete documentation of the development and resulting EI is provided in the attached document, *HGB RFP Inventories, Control Strategy Reductions, and Contingency Estimates for 2011, 2017, and 2018*. The final emissions estimates are summarized in Chapter 5: *Summary of Vehicle Miles Travel, Speed, and Emissions*, in Exhibit 5-1. The supporting electronic documents for the EI development, including MOVES2014a input and output files and the post processing spreadsheets used to summarize the inventories are available upon request in electronic format. Please contact the TCEQ, Air Quality Division, Area and Mobile Source Inventory and Data Support Team if a copy of the electronic information is needed.

The report also documents the development of control strategy reduction estimates for both the RFP attainment year 2018, and the contingency analysis year 2018. Control strategy emission reduction estimates include the effects of the Federal Motor Vehicle Control Program, the HGB vehicle inspection and maintenance program, federal reformulated gasoline Phase 1 and Phase 2, and the Texas Low Emission Diesel Program. The emissions summaries include estimates for all control scenarios. The control scenarios are the basis for quantifying the reductions for each control strategy.

Texas Commission on Environmental Quality

Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories

Prepared by the Texas A&M Transportation Institute

August 2016

PRODUCTION OF HGB REASONALBE FURTHER PROGRESS ON-ROAD MOBILE EMISSIONS INVENTORIES

TECHNICAL REPORT

FINAL

Prepared for the
Texas Commission on Environmental Quality
Air Quality Planning and Implementation Division

Prepared by the
Transportation Modeling Program
Texas A&M Transportation Institute
TTI Study No.: 607041
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EXECUTIVE SUMMARY

The Texas Commission on Environmental Quality (TCEQ) sponsored work by the Texas A&M Transportation Institute (TTI) to develop and produce on-road emissions inventory data needed in support of the TCEQ's Houston-Galveston-Brazoria (HGB) 2008-eight-hour ozone nonattainment area reasonable further progress (RFP) state implementation plan (SIP) revision. This work by TTI produced ozone season, summer weekday on-road mobile source RFP scenario emissions inventories and individual control strategy reduction estimates needed for the HGB eight-county area consisting of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties.

For RFP base, attainment, and contingency year (i.e., 2011, 2017, and 2018, respectively) inventories, TTI produced the seven RFP inventory scenarios described in Table A; for the attainment and contingency years TTI also produced individual control strategy reduction estimates. Six gaseous pollutants and particulate matter (PM) pollutants in both 2.5 and 10 micron size categories ($PM_{2.5}$ and PM_{10}) were estimated.

Table A. HGB RFP Inventory Scenarios.

Number	RFP Inventory	Activity Input[1]	Emissions Rates Input[2]
1	2011 Control Strategy (Base Year)	2011	2011 Control Strategy
2	2011 Adjusted Base Year		2011 Pre-1990 Control
3	2017 Adjusted Base Year		2017 Pre-1990 Control
4	2017 Pre-1990 Control	2017	2017 Pre-1990 Control
5	2017 Control Strategy		2017 Control Strategy
6	2018 Pre-1990 Control	2018	2018 Pre-1990 Control
7	2018 Control Strategy		2018 Control Strategy

[1] Activity inputs to the external inventory calculations: vehicle miles of travel (VMT) mix, link VMT/speeds, and off-network activity.

[2] "Pre-1990 Control" rates are for calendar year of evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls – no Inspection and Maintenance (I/M) program, no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, no reformulated gasoline (RFG) (uses pre-1992 conventional gasoline with 1992 summer Reid Vapor Pressure [RVP] limit promulgated prior to enactment of 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, RFG, I/M [depending on county], TxLED fuel).

TTI used the latest, official version of the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model (MOVES2014a), as required for SIP analyses, in combination with TTI's SIP-quality inventory development methodology, recently updated for use with MOVES2014a.[1] This is the detailed, disaggregate, travel demand model (TDM) link-based rates-per-activity inventory process. It produces MOVES-based emissions rate look-up tables for external emissions calculations performed at detailed, disaggregate, temporal, and spatial levels, using latest (readily) available data, models, and procedures. The latest planning assumptions were used to assure that motor vehicle emissions budgets to be

[1] MOVES2014a (December 2015 release) is the latest, official MOVES model version.

established by TCEQ in the SIP will be consistent with transportation conformity analysis requirements.

Hourly inventories were estimated by MOVES source use type (SUT) and fuel type (FT) combination (or vehicle type) and TDM roadway class. TDMs were post-processed to estimate hourly, directional, link (roadway segment)-level fleetwide VMT and operational speeds, for use in combination with time-of-day VMT mix estimates (fractional VMT by vehicle type[2]), for the roadway-based emissions calculations. Using estimates of vehicle operating hours (VHT), vehicle populations, truck hotelling activity, and other data, TTI estimated hourly off-network activity factors for the parked vehicle-based emissions calculations. Off-network activity types are: source-hours-parked (SHP); starts; and source hours extended idling (SHI) and auxiliary power unit (APU) hours (which comprise combination long-haul truck hotelling hours). Particular off-network evaporative rates, in mass/SHP form not directly available from MOVES, were produced by a post-processing method, and compiled with other rates produced directly by MOVES to yield look-up tables of all rates in the appropriate activity terms, as needed in the external emissions calculations. For applicable RFP scenarios, rates were further post-processed to factor in the TxLED effects, which were unavailable in MOVES. The analysis used TTI's MOVES-based inventory development utilities recently updated for use with MOVES2014a.[3] EPA's *Technical Guidance*[4] is the primary technical reference for guidance on appropriate inputs and use of MOVES.

Table B and Table C summarize the inventory estimates and individual control strategy reduction estimates for the HGB eight-county area. A more detailed summary is provided in the following sections, along with the methods used and details of modeling input usage and development.

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[2] The predominant fuel types of gasoline and diesel were estimated, with alternative fuels treated as de minimis.

[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.

[4] *MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, November 2015.

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

Inventory Type	Year	VMT	Speed	VOC	CO	NO_x	CO_2
Adjusted Base Year[1]	2011	153,411,903	38.17	236.90	3,234.68	586.15	81,891.57
	2017	153,411,903	38.17	240.14	3,243.10	583.63	81,113.71
Pre-1990 Controls[2]	2017	169,918,016	38.48	279.72	3,625.86	657.23	90,155.45
	2018	173,241,732	38.46	284.92	3,691.02	670.54	91,990.67
Base Year and Control Strategy[3]	2011	153,411,903	38.17	80.73	915.91	188.02	85,699.09
	2017	169,918,016	38.48	56.37	737.57	98.15	88,935.59
	2018	173,241,732	38.46	52.79	713.70	87.42	88,975.84

[1] Adjusted base year inventories: 2011 activity inputs (VMT mix, link VMT/speeds, and off-network activity) and analysis year pre-1990 control emissions rates.
[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 control emissions rates. Rates are for analysis year fleet but exclude post-1990 CAAA controls – no I/M program, post-1990 FMVCP effects, RFG (uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to enactment of the 1990 CAAA), or TxLED.
[3] Base Year and control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 RFG and Ultra Low Sulfur Diesel, I/M [depending on county], and TxLED).

Table C. HGB Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC		NO_x	
		2017	**2018**	**2017**	**2018**
Inventory	**Pre-90 Control**	279.72	284.92	657.23	670.54
	Control Strategy	56.37	52.79	98.15	87.42
Reductions	**Total**	223.35	232.13	559.08	583.11
	Tier 3 RFG and ULSD[1]	16.87	17.15	85.13	86.58
	FMVCP	198.54	207.55	464.25	488.09
	I/M	7.93	7.43	6.89	5.95
	TxLED	0.00	0.00	2.81	2.50

[1] RFG with Tier 3 sulfur and pre-1990 diesel replaced with Ultra Low Sulfur Diesel.
Note: Columns may not total due to rounding.

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PURPOSE

This analysis developed and produced on-road mobile, link-based emissions inventories for the eight Houston-Galveston-Brazoria (HGB) ozone nonattainment counties for analysis years 2011, 2017, and 2018. These emissions inventories were needed to support reasonable further progress (RFP) analyses for the eight HGB ozone nonattainment counties required to develop the state implementation plan (SIP) revision for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS).

BACKGROUND

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. TxDOT typically funds transportation conformity determinations required under 40 Code of Federal Regulations Part 93. TCEQ funds mobile source inventory work in support of federal Clean Air Act (CAA) requirements, such as supporting attainment of the NAAQS and the study and control of hazardous air pollutants, including those from motor vehicles and/or motor vehicle fuels (as mandated under CAA sections 202 and 211).

TCEQ is planning an update to the HGB SIP, which will require an RFP analysis from the base year to an attainment year, as determined in the final implementation rule, to demonstrate continued progress toward attainment of the U.S. Environmental Protection Agency's (EPA) 2008 eight-hour ozone standard for the HGB eight-county nonattainment area consisting of: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties. The HGB RFP emissions inventories for use in the HGB SIP update were developed using the latest version of MOVES, MOVES2014a, and used the latest planning assumptions to assure the motor vehicle emissions budgets to be set by the SIP will be consistent with transportation conformity analysis requirements.

To complete the HGB RFP SIP analysis, RFP inventories were required for a base year, RFP milestone years, and an attainment year, as well as individual control measure reduction estimates, and contingency measure control reduction estimates. This work was accomplished in three parts: "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight HGB 2008 Eight-Hour Ozone NAAQS Nonattainment Counties;" "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the HGB Eight-Hour Ozone Nonattainment Counties for the RFP Attainment Year, 2017;" and "Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the HGB Eight-Hour Ozone Nonattainment Counties for the Contingency Year, 2018." The data products were combined by TTI and provided to TCEQ in one data submittal, which is described in Appendix A.

Development of On-Road Mobile Source RFP Emissions Inventories for the Eight HGB 2008 Eight-Hour Ozone NAAQS Nonattainment Counties

For this part of the work, TTI developed link-based on-road mobile emissions estimates for the eight HGB ozone nonattainment counties for three RFP analysis years: 2011, 2017, and 2018. For the 2011 RFP base year, two inventories were required: an RFP base-year inventory and an

RFP adjusted base-year inventory. For the 2017 attainment year, three inventories were required: an RFP adjusted base-year inventory based upon 2011; an RFP inventory with pre-1990 controls only; and an RFP inventory with pre- and post-1990 control strategies. For the 2018 contingency year, two inventories were required: an RFP inventory with pre-1990 controls only and an RFP inventory with pre- and post-1990 control strategies.

The seven RFP inventories are summarized in terms of their activity and emissions rate components in Table 1.

Table 1. HGB RFP Inventory Scenarios.

Number	RFP Inventory	Activity Input[1]	Emissions Rates Input[2]
1	2011 Control Strategy (Base Year)	2011	2011 Control Strategy
2	2011 Adjusted Base Year		2011 Pre-1990 Control
3	2017 Adjusted Base Year		2017 Pre-1990 Control
4	2017 Pre-1990 Control	2017	2017 Pre-1990 Control
5	2017 Control Strategy		2017 Control Strategy
6	2018 Pre-1990 Control	2018	2018 Pre-1990 Control
7	2018 Control Strategy		2018 Control Strategy

[1] Activity inputs to the external inventory calculations: vehicle miles of travel (VMT) mix, link VMT/speeds, and off-network activity.
[2] "Pre-1990 Control" rates are for calendar year of evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls – no Inspection and Maintenance (I/M) program, no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, no reformulated gasoline (RFG) (uses pre-1992 conventional gasoline with 1992 summer Reid Vapor Pressure [RVP] limit promulgated prior to enactment of 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, RFG, I/M [depending on county], TxLED fuel).

For the HGB area RFP inventories to be consistent with inventory development for other SIP analyses, the most recent activity information, based upon current travel demand modeling, and the EPA's on-road mobile source emissions model, MOVES2014a, were used. The RFP inventories were produced based on methods agreed upon in consultation with the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance. Individual control reduction calculations were consistent with the capabilities of MOVES.

TTI also adhered to the following:

- Used the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015 as the emissions factor model for developing inventories for this work;[5]

[5] The latest version of MOVES (the *December 2015 Update to MOVES2014a*) was used, which is available at: https://www3.epa.gov/otaq/models/moves/index.htm#user-2014a.

- The geographic scope for the summer weekday emissions was the eight county HGB ozone nonattainment area consisting of: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties;
- The inventories included the following criteria pollutants and ozone precursors: volatile organic compounds (VOC), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), ammonia (NH_3), carbon dioxide (CO_2), particulate matter with an aerodynamic diameter equal to or less than 2.5 microns ($PM_{2.5}$), and particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10});
- Used summer weekday as the day type for inventories. Adjusted average daily activity levels for the activity level difference between average annual and average for summer months and for weekday;
- Used 2011 climate inputs. Used temperature, humidity, barometric pressure, and other data, as agreed upon and provided by TCEQ (TCEQ monitoring operations or national climatic data, for subject counties or meteorologically similar county groups);[6]
- Used the most current vehicle miles traveled (VMT) mixes. The VMT mixes were consistent with the EPA MOVES source use types (SUTs);
- Used regional registration data as input for locality-specific age distributions. For historical years, used registration data for each historical year. For future analysis years, used the most recent year vehicle registration distributions;
- A link-based, time-of-day emissions analysis methodology was used for all of the HGB counties. For VMT by summer work weekday, TTI used travel demand model (TDM) network link-based VMT for all HGB counties;
- Used 2011 and most recently available data for the off-network activity development. Developed 2011 and future year off-network activity inputs based on current Texas on-road inventory development processes and documented the process for development in the pre-analysis plan;
- Used MOVES individual fuel parameter inputs consistent with CFR Title 40 – Protection of the Environment, Part 80 – Regulation of Fuels and Fuel Additives, Section 27 – Controls and Prohibitions on Gasoline Volatility (40 CFR § 80.27), as appropriate for RFP control scenarios;
- Used EPA's reformulated gasoline (RFG) compliance data and TCEQ fuel property survey data, including Reid vapor pressure (RVP), to develop model inputs. TCEQ provided the 2011 and 2014 Summer Fuel Field Study Final Report and associated electronic files;
- Modeled the effects of all the federal motor vehicle control programs (FMVCP) as appropriate for RFP control scenarios;
- Modeled the HGB RFG program as appropriate for RFP control scenarios;

[6] The inputs used were taken from the HGB 2011 Houston summer day Air Emissions Reporting Requirements (AERR) inventories developed for TCEQ as documented in *2011 On-Road Mobile Source Actual Annual and Weekday Emissions Inventories: Houston Area*, TTI, August 2012.

- Modeled federally regulated gasoline and diesel sulfur levels or latest available fuel survey data, as appropriate for RFP control scenarios;
- Used control program parameters, including Reid vapor pressure and fuel settings, based upon the inventory type as defined by the RFP analysis control scenarios; and
- Post-processed the diesel vehicle NO_x emissions factors to account for the Texas Low Emission Diesel (TxLED) program, consistent with 30 Texas Administrative Code (TAC) Sections 114.312-114.319, as appropriate for RFP control scenarios. Used year-specific TxLED adjustment factors developed using the benefit information described in the EPA Memorandum on Texas Low Emission Diesel Fuel Benefits, and the method as documented in previous Texas on-road inventory development reports. Inventory reports documenting the TxLED methodology were available from the TCEQ, Mobile Source Programs Team.

Quantification of Individual On-Road Mobile Source RFP Control Reductions for the HGB Eight-Hour Ozone Nonattainment Counties for the RFP Attainment Year, 2017

To complete this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the 2017 attainment year. The entire MOVES2014a-based control strategy reduction was subdivided into individual control reductions using a MOVES2014a-based methodology as agreed upon by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance. The methodology included turning on successive control strategies and re-running the emissions model. Since MOVES2014a does not separate the reductions from the individual components of the FMVCP, such as Tier 1, Tier 2, and the 2007 heavy-duty diesel vehicle certification standard, the effect of FMVCP was calculated as one control reduction. For the HGB area RFP control reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using MOVES2014a. The methodology and MOVES2014a inputs were consistent with the work described in the previous section entitled "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight HGB 2008 Eight-Hour Ozone NAAQS Nonattainment Counties."

Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the HGB Eight-Hour Ozone Nonattainment Counties for the Contingency Year, 2018

For this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the HGB RFP contingency measure analysis year, 2018. The entire MOVES2014a control strategy reduction for 2018 was subdivided into individual control strategy reductions using the MOVES2014a methodology as agreed upon by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance. The methodology included turning on successive control strategies and re-running the emissions factor model. For the HGB area RFP contingency measure reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using MOVES2014a. The methodology and MOVES2014a inputs were consistent with the work described in the previous two sections, entitled "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight HGB 2008 Eight-Hour Ozone NAAQS Nonattainment Counties," and "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the HGB Eight-Hour Ozone Nonattainment Counties for the RFP Attainment Year, 2017."

Deliverables

The deliverable is a Technical Report (a narrative in memorandum format that explains the tasks, the approaches used, and the findings) provided to the Project Manager as a loose-bound original suitable for copying, and in both Microsoft® Word and Adobe® Acrobat Portable Document Format (PDF) files, delivered in conjunction with supporting electronic files. The report includes documentation of all pertinent activities related to completion of the work. All data are being submitted in the specified summary levels and electronic format.

Appendix A describes all the electronic data sets TTI submitted to TCEQ associated with this work, which includes but is not limited to:

- A document listing all the files being submitted and documenting file naming conventions;
- All pertinent data relating to task activities (for MOVES emissions rates-related data this includes: county and scenario MOVES inputs, MySQL scripts used to load county and scenario MOVES inputs into MOVES2014a county database files, MOVES2014a county database files, and MOVES run specification files);
- The standard set of activity and inventory summary files (includes tab-delimited format based upon the MOVES SUTs with hourly and 24-hour emissions, speed, VMT and off-network activity summaries by vehicle type and by facility type for each county); and
- The inventory summaries in a format compatible with TCEQ's Texas Air Emissions Repository (TexAER), based on the most recent version of the EPA's National Emission Inventory Format, the Consolidated Emissions Reporting Schema (CERS) written in Extensible Markup Language (XML).

TTI maintains a record of all electronic files developed or used in conjunction with the completion of this project. All pertinent data relating to project activities were submitted to TCEQ in the specified electronic format, in conjunction with supporting electronic document files, and copies of the this report.

ACKNOWLEDGMENTS

Dennis Perkinson, Ph.D., L.D. White, Stacey Schrank, and Martin Boardman, all of TTI, contributed to the development of the MOVES link-based emissions estimates. Dr. Perkinson produced the VMT mixes used to divide fleet VMT activity into MOVES SUT by fuel type categories, county VMT control totals, and hourly VMT factors. Houston-Galveston Area Council (HGAC) staff provided the HGB regional travel model data sets. White processed roadway based activity (VMT and speeds), and Schrank processed and off-network vehicle activity estimates (and vehicle population estimates) needed for the emissions calculations. Boardman developed the MOVES-based emissions rates with adjustments for TxLED fuel. Schrank and White were responsible for the emissions inventory set-ups and execution and post-processing to produce the various inventory formats and summaries. Gary Lobaugh, of TTI, was responsible for editing, design, and production of this Technical Report. Each member of the assigned TTI staff contributed to the quality assurance of the inventory data and process. Dr.

Perkinson was the principle investigator for this project. This work was performed by TTI under contract to TCEQ. Mary McGarry-Barber was the TCEQ project technical manager.

The report is organized in the following sections: Summary of Results, Overview of Methodology, Development of Vehicle Type VMT Mix, Estimation of VMT, Estimation of Link Speeds, Estimation of Off-Network Activity, Estimation of Emissions Rates, Emissions Calculations, Quality Assurance, and References.

SUMMARY OF RESULTS

Table 2 summarizes the RFP inventories (VMT and speed, and VOC, CO, NO_x, and CO_2 emissions) for the HGB region. The emissions reductions estimates from the incremental inclusion of control measures in the modeling are summarized for VOC and NO_x in Table 3.

Table 2. HGB Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_x	CO_2
Adjusted Base Year[1]	2011	153,411,903	38.17	236.90	3,234.68	586.15	81,891.57
	2017	153,411,903	38.17	240.14	3,243.10	583.63	81,113.71
Pre-1990 Controls[2]	2017	169,918,016	38.48	279.72	3,625.86	657.23	90,155.45
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	2017	169,918,016	38.48	56.37	737.57	98.15	88,935.59
	2018	173,241,732	38.46	52.79	713.70	87.42	88,975.84

[1] Adjusted base year inventories: 2011 activity inputs (VMT mix, link VMT/speeds, and off-network activity) and analysis year pre-1990 control emissions rates.

[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 control emissions rates. Rates are for analysis year fleet but exclude post-1990 CAA controls – no I/M program, post-1990 FMVCP effects, RFG (uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to enactment of the 1990 CAA), or TxLED.

[3] Base Year and control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 RFG and Ultra Low Sulfur Diesel, I/M [depending on county], and TxLED).

Table 3. HGB Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC		NO_x	
		2017	2018	2017	2018
Inventory	Pre-90 Control	279.72	284.92	657.23	670.54
	Control Strategy	56.37	52.79	98.15	87.42
Reductions	Total	223.35	232.13	559.08	583.11
	Tier 3 RFG and ULSD[1]	16.87	17.15	85.13	86.58
	FMVCP	198.54	207.55	464.25	488.09
	I/M	7.93	7.43	6.89	5.95
	TxLED	0.00	0.00	2.81	2.50

[1] RFG with Tier 3 sulfur and pre-1990 diesel replaced with Ultra Low Sulfur Diesel.
Note: Columns may not total due to rounding.

RFP inventory and individual control measure emissions reductions estimates with more detail (e.g., by county, SUT/fuel type) may be found in the electronic data submittal (see description in Appendix A).

OVERVIEW OF METHODOLOGY

TTI used its detailed TDM link-based, rates-per-activity inventory methodology to produce MOVES-based, highway vehicle, historical and future case inventories.

This TDM link-based, on-road mobile inventory method produces hourly seasonal, day-type (e.g., summer weekday) estimates by vehicle type (Table 4), pollutant (Table 5), and process (Table 6) for each county. MOVES rates are modeled and combined externally with each link (or roadway segment) VMT estimate to calculate the roadway-based inventories. This MOVES-based method is an adaptation of the previous TDM link-based on-road inventory method used with the MOVES model predecessor (MOBILE6), which applied emissions rates for all emissions processes in terms of miles-traveled activity (e.g., grams/mile [g/mi]).

In addition to the VMT-based calculations of roadway-based estimates, the TTI MOVES inventory development process uses off-network activity measures (i.e., starts, source hours parked [SHP], source hours extended idling [SHI], and auxiliary power unit [APU] hours). Associated rates must be produced in these terms for the off-network process calculations. MOVES2010b and earlier versions of MOVES provided the off-network start, evaporative, and extended idling rates only in "per vehicle" units, not applicable to the TTI activity-based inventory process; TTI post-processing utilities were used to produce the MOVES off-network rates in all the needed activity units. The previous version of MOVES (MOVES2014) added several new types of emissions rates (i.e., off-network process rates in terms of mass per unit of activity). All the activity-based rates required in the TTI inventory process are now directly available from MOVES, except for the SHP-based rates; these are produced using TTI inventory utilities.

TTI previously developed a set of external inventory development utilities for use with MOVES. These were recently updated for compatibility with MOVES2014a. See Appendix B for more information on TTI's MOVES2014a-compatible inventory utilities.[7]

Table 4. MOVES SUT/Fuel Types (Vehicle Types).

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

[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 motorcycles, diesel-powered refuse trucks, and gasoline-powered school buses, respectively).

The methodology estimates emissions for an estimated regional fleet mix composed of the predominant gasoline-powered and diesel-powered vehicles. Alternatively fueled vehicles were treated as *de minimis*.

[7] The TTI's MOVES2014a-compatible inventory estimation utilities are detailed in: *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide*, TTI, August 2016.

Table 5. MOVES Pollutants Inventoried.

Pollutant ID	Pollutant Name
2	Carbon Monoxide (CO)
3	Oxides of Nitrogen (NO_x)
30	Ammonia (NH_3)
31	Sulfur Dioxide (SO_2)
87	Volatile Organic Compounds (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
111	Organic Carbon (OC)
112	Elemental Carbon (EC)
115	Sulfate Particulate
116	Primary $PM_{2.5}$ – Brakewear Particulate
117	Primary $PM_{2.5}$ – Tirewear Particulate
118	Composite – NonECPM

Table 6 shows the MOVES on-road emissions rates with associated processes and activity factors used.

Table 6. Emissions Rates by MOVES Emissions Process and Activity Factor.

Process (Process ID)	Activity[1]	Emissions Rates[2]
Running Exhaust (1)	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust (15)	VMT	mass/mi
Brake Wear (9)	VMT	mass/mi
Tire Wear (10)	VMT	mass/mi
Start Exhaust (2)	starts	mass/start
Crankcase Start Exhaust (16)	starts	mass/start
Extended Idle Exhaust (90)	SHI	mass/shi
Crankcase Extended Idle Exhaust (17)	SHI	mass/shi
Auxiliary Power Exhaust (91)	APU Hours	mass/APU hour
Evaporative Permeation (11) Evaporative Fuel Vapor Venting (12) Evaporative Fuel Leaks (13)	VMT, SHP	mass/mi, mass/shp[2]

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

Major Inventory Components

The county inventory estimation process requires development of the following major inventory components. All are inputs to the emissions calculation utility, except vehicle populations, which are an intermediate input needed for calculating estimates of SHP and vehicle starts activity.

- District, four-period, time-of-day, vehicle type VMT mix;
- County, hourly, on-road fleet link VMT and average speeds;
- County vehicle type populations;
- County, hourly vehicle type SHP;
- County, hourly vehicle type starts;
- County, hourly combination long-haul truck SHI and APU hours;
- County, hourly vehicle type MOVES-based on-road rates: mass/mile, mass/SHP, mass/start, mass/SHI, and mass/APU hour; and
- On-road source classification codes (SCCs) from MOVES.

The TTI utilities used to develop or process these inventory components are outlined and described in Appendix B, which also includes an inventory production process flow diagram.

VMT Mix

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

The VMT mixes were estimated based on TTI's 24-hour average VMT mix method, expanded to produce the four-period, time-of-day estimates.[8] The procedure sets Texas vehicle registration category aggregations for MOVES SUT categories to be used in the VMT mix estimates, as well as for developing other fleet parameter inputs needed in the process (e.g., vehicle age distributions). The VMT mix procedure produced a set of four-period, time-of-day average vehicle type VMT allocations by MOVES road type and by day type, estimated for each TxDOT district for use with the counties associated with each district. The data sources used were recent, multi-year TxDOT vehicle classification counts, year-end TxDOT/Texas Department of Motor Vehicles (TxDMV) registration data, and MOVES default data.

On-Road Fleet Link-VMT and Speeds

Period and day-type-specific fleet VMT and average operational speed inputs to the roadway-based calculations (product of "per mile" rates and VMT) were required.

TTI used data sets extracted from the latest, four-period, time-of-day, directional, regional HGB travel models (data sets provided by the H-GAC), seasonal day-type adjustments, Highway Performance Monitoring System (HPMS) VMT-consistency adjustments, and hourly allocation factors to estimate the hourly, directional, link-VMT and associated average fleet speed inputs to the inventory calculations. The seasonal period, day type, and hourly distributions used were based on factors developed with TxDOT automatic traffic recorder (ATR) data from the Houston area. The hourly average operational fleet speeds were estimated corresponding to the link VMT estimates using the Houston speed model, which estimates operational speeds based on a link's estimated free-flow speed and congestion-related speed reduction.

Vehicle Population and Off-Network Vehicle Activity Estimates

The non-roadway-based inventory estimates (e.g., from vehicle starts, parked vehicle evaporative processes, hotelling activity) were calculated as the product of the amount of associated activity and the mass per unit of activity (rate per activity terms as shown in Table 6). To estimate the SHP and vehicle starts activity, vehicle population estimates were needed. Hotelling activity estimates (comprised of SHI and APU hours) were based on county-specific actual estimates.[9]

Vehicle Type Populations: TTI based the vehicle population estimates on vehicle registration data, vehicle population factors developed from the VMT mix, and, additionally for future years, VMT growth estimates. For a historical year, the vehicle population estimates are based solely

[8] *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009, and *Update of On-Road Inventory Development Methodologies for MOVES2010b*, TTI, August 2013.

[9] *Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study*, ERG, August 2004.

on mid-year TxDOT (or TxDMV) county registrations data and regional, all roads-weekday VMT mix-based vehicle type population factors for the analysis year. For future years, vehicle type populations were estimated as a function of base (e.g., latest available, mid-year) registrations, grown to a future value (growth as a function of base and future VMT), and all roads-weekday VMT mix-based vehicle type population factors for the analysis year.

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

Starts: Engine starts were based on the MOVES national default starts per vehicle, and the local, county vehicle type population estimates. MOVES default weekday starts per vehicle were used. The starts were calculated as the product of starts/vehicle from MOVES, and the county vehicle type population estimates. This was performed by county and hour.

SHI and APU Hours: The SHI and APU hours comprise the diesel combination long-haul truck hotelling hours, estimated based on information from the TCEQ *Extended Idling Study* (ERG, August 2004), and additional factors developed by TTI. Hotelling activity for a 2004 base year was developed from the idle activity study 2004 summer weekday extended idling hours estimates by Texas county. TTI used summer weekday 24-hour 2004 base hotelling estimates developed from this study in combination with scaling factors estimated from summer weekday 2004 base year and future analysis year link VMT and VMT mix (for each county and activity scenario) to produce 2011, 2017, and 2018 analysis year, county, hourly hotelling activity estimates. Hotelling hourly factors (estimated by inverting hourly VMT factors) were then applied to allocate the 24-hour hotelling hours estimates for each county activity scenario to each hour of the day. Estimated proportions of SHI and APU hours were used to divide hourly hotelling hours into SHI and APU hours activity.

MOVES Emissions Factors

TTI produced the emissions rate look-up table inputs to the TTI's EmsCalc inventory calculation utility in three basic steps: set up and execute the MOVES emissions rate mode runs; perform the initial post-processing, which calculates rates in the form needed that are not directly available from MOVES; and perform the final post-processing to make needed adjustments and screen out non-applicable pollutants.

Local input parameters were developed and used to produce rates reflective of the local scenario conditions (e.g., weather and fleet characteristics, fuel properties, I/M program). MOVES county scale, rates mode modeling scenarios produced rates for the MOVES weekday day type by pollutant, process, speed (for roadway-based processes), hour, road type, and average SUT/fuel type. Two rates post-processing steps were performed to produce the final rates in the form needed. MOVES data were post-processed to produce the mass-per-SHP form of off-network evaporative rates not available from MOVES, and to tabulate them along with the other MOVES-produced activity-based rates (mass/mile, mass/hour, mass/start) into rate look-up table databases. The final rates post-processing step extracted the rates needed in the inventory calculations (i.e., screened out any unneeded pollutants/processes remaining from the previous step), and made required adjustments (i.e., for pertinent RFP control scenarios applied estimated TxLED effects on diesel vehicle NO_x rates for all eight counties).

County-level, MOVES weekday hourly emissions factors were developed for two RFP control scenarios: 1) pre-1990 controls, and 2) control strategy (or "current controls"). For the estimation of emissions reductions by individual control measure an additional set of MOVES runs was performed, for a representative county (i.e., Harris County), for which control measures were incrementally added to the pre-1990 scenario in this sequence: RFG, post-1990 FMVCP, and I/M Program. Actual, local, activity estimates for each county were then externally combined with the associated rates in the EmsCalc utility inventory calculations, as needed to produce the inventories for each particular RFP scenario and for the individual control measure emissions reductions estimation procedure.

Inventory Calculations

Using the EmsCalc utility, inventories for each RFP control scenario were calculated for each county, and "incremental control" inventories were calculated for Harris as the representative county. The major inputs, in summary, were: TxDOT district-level, day type, time-of-day, VMT mix by MOVES road type; county, hourly on-road fleet link VMT and speed estimates for each activity scenario; county, hourly, off-network activity estimates by vehicle type for each activity scenario of SHP, starts, SHI, and APU hours; and county-level look-up tables of hourly MOVES weekday rates by road type, speed bin, vehicle type (SUT/fuel type), and process.

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

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

The on-road mobile inventory utilities produce two types of tab-delimited summary output files and optionally a set of 24 link-emissions files (not included for this analysis). The standard on-road tab-delimited output file includes hourly and 24-hour activity and emissions results summarized by vehicle type and road type. The SCC tab-delimited output feature produces 24-hour activity and emissions data in a form (aggregated and coded) consistent with the EPA's 2014 NEI inventory, as needed for uploading specified inventory data to TCEQ's TexAER. Appendix A contains more information on the output definitions and specifications, including the inventory data formatted for compatibility with TexAER.

TTI developed and maintains a series of computer utilities to calculate and summarize detailed on-road mobile source emissions inventories in various formats, such as those used in this analysis. Appendix B describes these applications.

Individual Control Strategy Emissions Reductions Estimation

Additional emissions modeling for attainment and contingency years was performed to estimate emissions reductions by individual control strategy for all of the HGB counties. Individual control measure emissions reductions were first estimated for Harris County, as representative of all HGB counties. From the Harris County-based representative individual control reductions estimates, the fraction of total reductions (i.e., pre-1990 scenario emissions minus control strategy scenario emissions) was calculated for each individual control. These estimated representative incremental reduction fractions were used to break out individual control measure reduction estimates for all counties. The individual controls modeling sequence (beginning with the pre-1990 control base) was:

- Pre-1990 FMVCP (i.e., base from which sequential reductions were calculated);
- RFG (i.e., pre-1990 controls with RFG added);
- Post-1990 FMVCP (i.e., pre-1990 controls, RFG, post-1990 FMVCP);
- I/M Program, (i.e., pre-1990 controls, RFG, post-1990 FMVCP, I/M); and
- TxLED (i.e., pre-1990 controls, RFG, post-1990 FMVCP, I/M, and TxLED).

DEVELOPMENT OF VEHICLE TYPE VMT MIX

VMT mix is a major input to the MOVES link-based emissions estimation process. It is an estimate of the fraction of on-road fleet VMT attributable to each SUT by fuel type, and is used to subdivide the total VMT estimates on each link into VMT by vehicle type. These hourly VMT estimates by vehicle type are combined with the appropriate emissions factors in the link-emissions calculations.

On-road mobile emissions are dependent upon the VMT assigned to each vehicle category. The VMT mix is used to distribute link VMT values to each vehicle category. Since the VMT mix can vary by time-of-day (and thus have an effect of the emissions totals), the TTI VMT mix procedure allows the option to develop VMT mix by time period. Time period VMT mix (by MOVES roadway type and vehicle type) consists of four time periods: morning rush hour (AM peak), mid-day, evening rush hour (PM peak), and overnight.

TxDOT district-level, time period, and Weekday (average Monday through Friday) VMT mix (for gasoline-powered and diesel-powered vehicles) is estimated by the four MOVES road-type categories using the methodology characterizing VMT by vehicle type for a region (or district) as follows.[10]

1. MOVES – Data files of MOVES default values extracted from MOVES databases or pro forma runs.

2. TxDOT Classification Counts – Data files of standard TxDOT classification data assembled and used for determining the in-use road fleet mix.

3. Texas Department of Motor Vehicles (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 vs. 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 vs. Total SUT_HDXyy – Procedure based on registration data to generate short-haul and long-haul combination truck proportions by region.

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 vs. 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 vs. Long-Haul SUT_CSHZ – Procedure to separate combined short-haul versus combined long-haul using factors generated at SUT_HDXyy and classification count data. Short-haul and long-haul are functionally defined as local and pass through.

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.

[10] *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.

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.

TxDOT district-level Weekday VMT mixes by MOVES road-type category are produced based on recent multi-year vehicle classification counts and appropriate end-of-year TxDOT vehicle registrations data. Using the same data sets and a similar procedure, aggregate (i.e., all road-type categories), TxDOT district-level weekday vehicle type VMT mixes (used in the vehicle population estimation) are also produced. To ensure general applicability and consistency across all study areas, all VMT mixes are developed in five-year increments beginning with the year 2005 and applied to the analysis years based on Table 7.

Table 7. 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

ESTIMATION OF VMT

The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDMs. This analysis also required that VMT be adjusted for HPMS consistency and to reflect estimated levels characteristic of a typical activity scenario (i.e., 2011, 2017, and 2018 summer weekday). The TRANSVMT utility (see Appendix B for a description of the utility), the latest available data sets from the HGB 2011, 2017, and 2018 TDMs, and post-processing factors developed from several other data sources, were used to produce this hourly VMT by direction. The hourly and 24-hour VMT and vehicle hours traveled (VHT) summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

Data Sources

The latest available link data, trips data, and zonal radii data sets extracted from the HGB 2011, 2017, and 2018 TDMs were used to estimate the directional link VMT and speeds by hour. Since intrazonal VMT are not accounted for in the TDMs, the intrazonal VMT was estimated using the TDM's trip matrix and zonal radii data sets.

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

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

Multiple years (2005 through 2014) of data from the ATR stations were grouped for this analysis at different aggregation levels, depending upon the purpose. This data source was used to produce the day-type-specific adjustment factor, in which the data from the ATR stations within the Beaumont TxDOT District were combined for use with Chambers and Liberty counties and the ATR data within the Houston TxDOT District were combined for use with Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties. This data source was also used to produce the time-of-day (hourly) allocation factors, in which the data from the ATR stations within the eight-county region were combined.

VMT Adjustments

For each activity scenario, the TDM VMT was adjusted for HPMS consistency and for seasonality (i.e., summer weekday). For the 2011 activity scenario, which by definition is a historical year (i.e., HPMS VMT data exists for those years), county-level VMT control totals were used to develop VMT adjustment factors. For the remaining activity scenario years (2017 and 2018), which are considered future years (i.e., HPMS VMT data does not exist), a regional HPMS factor and seasonal weekday factors were used. Hourly travel factors were also applied to distribute this adjusted VMT over each hour of the day.

2011 Historical Year Activity Scenario – VMT Control Totals and VMT Adjustments

To estimate the 2011 HPMS-consistent summer weekday VMT, county-level VMT control totals were used to develop county-level VMT adjustment factors. The VMT control totals are comprised of two key components: the 2011 county-level HPMS AADT VMT and the AADT-to-summer weekday adjustment factors.

The AADT-to-summer weekday adjustment factors were developed using aggregated ATR data for the years 2005 through 2014. Since the HGB area spans two TxDOT districts, two summer weekday adjustment factors were developed. One factor was developed for Liberty and Chambers counties (which are located in the Beaumont TxDOT District) and one factor was developed for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties (which are located in the Houston TxDOT District). These regional factors were calculated by dividing the average day-of-week count by the AADT traffic count. Table 8 shows the HGB AADT-to-summer weekday factors used in developing the VMT control totals.

Table 8. HGB AADT-to-Summer Weekday Factors for Control Total Development.

TxDOT District	Weekday Adjustment Factor
Beaumont[1]	1.07152
Houston[2]	1.06592

[1] Only used for Liberty and Chambers counties.
[2] Only used for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties.

The VMT control totals were then developed by multiplying the 2011 HPMS AADT VMT for each county by the appropriate summer weekday adjustment factor to produce eight VMT control totals (one for each county). To develop the county-level VMT adjustment factors, each county's respective control total was divided by the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from the 2011 TDM to produce eight county-level VMT adjustment factors. For each link in the TDM, the volume was multiplied by the corresponding VMT adjustment factor (based on the county where the link is located). The adjusted link volumes were then multiplied by the associated link lengths to produce the 2011 link-level HPMS consistent, summer weekday VMT estimates. Table 9 shows the weekday VMT control totals, the total TDM VMT, and the VMT adjustment factors for 2011.

Table 9. HGB 2011 Weekday VMT Control Totals and VMT Adjustment Factors.

County	VMT Control Total	TDM VMT	VMT Adjustment Factor
Harris	111,924,534	116,630,046	0.95965437
Brazoria	6,121,372	7,802,691	0.78452061
Fort Bend	10,127,862	11,714,232	0.86457757
Waller	2,067,984	2,068,780	0.99961509
Montgomery	12,190,603	13,522,014	0.90153755
Liberty	2,337,045	2,702,900	0.86464366
Chambers	2,811,745	3,361,561	0.83644022
Galveston	5,830,758	6,232,758	0.93550206

Future Year Activity Scenarios – HPMS Adjustment Factor

For the future year activity scenarios, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from each TDM for HPMS consistency. While TTI typically calculates this factor, the HPMS factor used in this analysis (0.90955) was based on the 2012 TDM and was provided directly by H-GAC.

Future Year Activity Scenarios – Seasonal Adjustment Factors

For the future year activity scenarios, seasonal adjustment factors were used to adjust the TDM and estimated intrazonal VMT to summer weekday VMT. The seasonal adjustment factors were developed using aggregated ATR data for the years 2005 through 2014. Since the HGB area spans two TxDOT districts, two ozone season summer weekday adjustment factors were developed. One factor was developed for Liberty and Chambers counties (which are located in the Beaumont TxDOT District) and one factor was developed for Harris, Galveston, Fort Bend, Brazoria, Waller, and Montgomery counties (which are located in the Houston TxDOT District). These factors were calculated by dividing the average day-of-week (weekday) count by the annual non-summer weekday traffic (ANSWT) traffic count. Table 10 shows the seasonal adjustment factors by TxDOT district.

Table 10. HGB Weekday Seasonal Adjustment Factors for Future Year Activity Scenarios.

TxDOT District	Weekday Seasonal Adjustment Factor
Beaumont[1]	1.03501
Houston[2]	0.99847

[1] Only used for Liberty and Chambers counties.
[2] Only used for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties.

Future Year Activity Scenarios – VMT Summary

For each future year activity scenario (i.e., 2017 and 2018 summer weekday), the final HPMS-consistent, VMT is comprised of two parts: the link-level VMT and the estimated intrazonal VMT. The volume for each link was multiplied by the HPMS factor, the seasonal adjustment factor, and the link's respective length to estimate the link-level VMT (hourly factors were applied to distribute the resulting VMT over each hour of the day, discussed in a later section). The HPMS and seasonal adjustment factors (as well as the hourly factors mentioned previously) were also applied to the estimated intrazonal VMT. Table 11 shows the TDM and summer weekday VMT summaries.

Table 11. HGB 2017and 2018 VMT Summary.

County	2017		2018	
	TDM[1]	Weekday	TDM[1]	Weekday
Harris	130,550,843	118,560,843	132,508,179	120,338,414
Brazoria	8,963,444	8,140,227	9,159,470	8,318,249
Fort Bend	14,699,803	13,349,749	15,154,171	13,762,388
Waller	2,110,598	1,916,758	2,132,703	1,936,832
Montgomery	17,236,368	15,653,352	17,972,346	16,321,737
Liberty	2,901,485	2,731,439	3,038,386	2,860,317
Chambers	3,545,427	3,337,642	3,624,078	3,411,683
Galveston	6,857,842	6,228,007	6,928,431	6,292,112

[1] Includes intrazonal VMT.

Hourly Travel Factors

Hourly travel factors were used to distribute the TDM and intrazonal VMT to each hour of the day. These hourly travel factors were developed using multi-year (2005 through 2014) aggregated ATR station data for the eight-county HGB region. To maintain VMT proportions within each of the four assignment time periods, the hourly fractions were normalized within each time period to produce the time period hourly travel factors. Each factor (i.e., 24, or one for each hour of the day) was then multiplied by the link volume (in addition to the other VMT adjustment factors). These adjusted link volumes were then multiplied by their respective link lengths to estimate the link level, summer weekday VMT estimates for each activity scenario year. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 12 shows the weekday time period hourly travel factors.

Table 12. Weekday Time Period Hourly Travel Factors.

Assignment	Hour	Base Factor	Time Period Factor[1]
AM Peak	6:00 a.m.	0.033098	0.146667
	7:00 a.m.	0.061002	0.325287
	8:00 a.m.	0.068201	0.363674
Mid-Day	9:00 a.m.	0.058330	0.311039
	10:00 a.m.	0.051836	0.160558
	11:00 a.m.	0.050426	0.156191
	12:00 p.m.	0.052637	0.163039
	1:00 p.m.	0.054543	0.168943
	2:00 p.m.	0.055405	0.171613
PM Peak	3:00 p.m.	0.058002	0.179656
	4:00 p.m.	0.063449	0.240382
	5:00 p.m.	0.068580	0.259821
	6:00 p.m.	0.072135	0.273285
Overnight	7:00 p.m.	0.059788	0.226512
	8:00 p.m.	0.045730	0.202645
	9:00 p.m.	0.035557	0.157564
	10:00 p.m.	0.031484	0.139515
	11:00 p.m.	0.024744	0.109648
	12:00 a.m.	0.016778	0.074348
	1:00 a.m.	0.009279	0.041118
	2:00 a.m.	0.006178	0.027377
	3:00 a.m.	0.005782	0.025622
	4:00 a.m.	0.005811	0.025750
	5:00 a.m.	0.011226	0.049746

[1] Used in the VMT calculation process.

ESTIMATION OF LINK SPEEDS

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

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

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

$$v/c \text{ ratio} = Vh / Ch$$

Where:

Vh = the hourly link volume (travel model × HPMS factor × seasonal adjustment factor × hourly time period factor; Weekend profile factor is included for Saturday and Sunday); and

Ch = the hourly link capacity (travel model capacity × hourly capacity factor). Appendix E shows the hourly capacity factors.

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

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

$$S_{V/C} = S_{0.0} - SRF_{V/C} \times (S_{0.0} - S_{1.0})$$

Where:

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

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

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

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

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

$$S_{V/C} = S_{1.0} \times (1.15/(1.0 + (0.15 \times (v/c)^4)))$$

Where:

$S_{v/c}$	=	estimated directional speed for the forecast V/C ratio on the link in the given direction;
$S_{1.0}$	=	estimated LOS E speed for the V/C ratio equal to 1.0; and
v/c	=	the forecast V/C ratio on the link. The V/C ratio can be 1.0 to 1.5.

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

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

The hourly and 24-hour speed (VMT/VHT) summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates (i.e., mass per SHP, mass per start, and mass per SHI), county-level estimates of the SHP, starts, SHI, and APU hours are required by hour and vehicle type for each activity scenario (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the activity scenario year county-level vehicle population. Summaries of the vehicle population and 24-hour SHP, starts, SHI, and APU hours off-network activity are included as Appendix F. Hourly SHP, starts, SHI, and APU hours activity estimates are included with the detailed inventory data provided (see inventory data file descriptions in Appendix A).

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

Estimation of Vehicle Population

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

For estimating vehicle populations, a historical activity scenario year is defined as any year where actual TxDMV registration data and HPMS VMT data (used in developing population scaling factors) exists. Therefore, the 2011 activity scenario year was considered a historical year and the vehicle population estimates were based on the 2011 TxDMV registration data. Since the HPMS VMT data was not available for 2017 or 2018, these analyses were considered future activity scenario years. For the future activity scenario years, the vehicle population estimates were based on the most recent year (2014) TxDMV registration data set for which HPMS VMT data exists and activity scenario year population scaling factors

The VMT mix used to estimate the vehicle population is the aggregate (i.e., all road-type categories) TxDOT district-level weekday VMT mix. The development of the VMT mix is described in more detail in the "Development of Vehicle Type VMT Mix" section and included as Appendix D.

Historical Vehicle Population Estimates

The county-level vehicle population estimates for the activity scenario year (2011) were calculated using the activity scenario year county-level, mid-year TxDMV vehicle registrations and the assigned aggregate VMT mix (see Table 7 and Appendix D). The vehicle population estimation process assumes that all of the non-long-haul SUT category populations for a county are represented in the county vehicle registrations data. This process also estimates the long-haul category populations as an expansion of the county registrations. There are three main steps in the vehicle population estimation process: registration data category aggregation, calculation of the vehicle type population factors, and estimation of the county-level vehicle population by vehicle type.

The first step in the vehicle estimation process is the registration data category aggregation. For each county, the activity scenario year vehicle registrations were aggregated into five categories. Table 13 shows these five categories.

Table 13. Registration Data Categories.

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

The second step is calculating the vehicle type population factors. Using the assigned aggregate VMT mix, population factors were calculated for each vehicle type. For the non-long-haul SUT categories, the population factors were calculated by dividing the vehicle type VMT mix by the summed total of the VMT mix fractions in its associated vehicle registration data category. For example, the LCT_Diesel population factor using the VMT mix is LCT_Diesel/(PT_Gas + PT_Diesel + LCT_Gas + LCT_Diesel). For the long-haul SUTs, the vehicle type population factors were calculated by taking the ratio of the long-haul and short-haul VMT mix values. For example, the SULhT_Gas population factor using SUT mix fractions is SULhT_Gas/SUShT_Gas. Table 14 shows the vehicle registration aggregations and their associated MOVES SUT/fuel types.

Table 14. TxDMV Vehicle Registration Aggregations and Associated Vehicle Types for Estimating Vehicle Populations.

Vehicle Registration[1] Aggregation	Associated Vehicle Type[2]
Motorcycles	MC_Gas
Passenger Cars (PC)	PC_Gas; PC_Diesel
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 IBus_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 mid-year 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.

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

Future Vehicle Population Estimates

The process for estimating the county-level population estimates for the future activity scenario years (2017 and 2018) is very similar to the historical vehicle population estimates except that instead of using the activity scenario year registration data sets, the most recent (2014) county-level TxDMV registration data sets for which HPMS data exists were used. Using these registration data sets and the assigned aggregate VMT mix, the county-level base 2014 vehicle population estimates were calculated. Future year county-level vehicle population scaling factors were used to scale the county-level base 2014 vehicle population estimates to the activity scenario year. These future year county-level vehicle population scaling factors were calculated as the ratio of the county-level weekday VMT for the activity scenario year to the county-level weekday VMT for the year of the most recent (2014) TxDMV registration data (i.e., vehicle population increases linearly with VMT).

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of SHP by hour and vehicle type for each activity scenario. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type SHO. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The SHO was calculated using the link VMT and speeds and the TxDOT district-level vehicle type VMT mixes by MOVES road-type category (see the "Development of Vehicle Type VMT Mix" section for more details). Appendix F includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Vehicle Type Total Available Hours

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

Vehicle Type SHO

To calculate VHT (or SHO) for a given link, the VMT was allocated to each vehicle type using the TxDOT district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type SHO. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 7 and Appendix C). This SHO calculation was performed for each link in a given hour, aggregating the SHO to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of starts by hour and vehicle type for each activity scenario. For each activity scenario, the vehicle type hourly default starts per vehicle were multiplied by the activity scenario county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix F includes the 24-hour summaries of the county-level vehicle type starts by hour for the activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

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

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) hotelling (comprised of SHI and APU hours). During hotelling, the truck's main engine is assumed to be in idling mode or its auxiliary power unit is in use. For each activity scenario, hotelling hours are first estimated, and then allocated to the SHI and APU hours components.

The hotelling activity was based on information from a TCEQ extended idling study, which produced 2004 summer weekday extended idling estimates for each Texas county, and hotelling data from MOVES. Hotelling scaling factors (by activity scenario) were applied to the base 2004 summer weekday hotelling values from the study to estimate the 24-hour hotelling by activity scenario. Hotelling hourly factors were then applied to allocate the 24-hour hotelling by activity scenario to each hour of the day. To ensure valid hourly hotelling values are used in the emissions estimation, the hourly activity scenario hotelling hours was compared to the CLhT_Diesel hourly activity scenario SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity for each activity scenario. Appendix F incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Hotelling Scaling Factors

To estimate the county-level 24-hour hotelling by activity scenario, county-level hotelling scaling factors were developed for each activity scenario using the county-level 2004 summer weekday link-level VMT and speeds, the TxDOT district-level base weekday vehicle type VMT mix (by MOVES road type), the county-level activity scenario link-level VMT and speeds, and the TxDOT district-level activity scenario vehicle type VMT mix (by MOVES road type). The 2004 summer weekday link-level VMT and speeds were developed using a process similar to the historical activity scenario link-level VMT speed estimation, except using a 2004 summer weekday VMT control total. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 7 and Appendix C). For the base weekday vehicle type VMT mix, the 2005 weekday vehicle type VMT mix was used.

For each link in the 2004 summer weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2004 summer weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24-hour 2004 summer weekday VMT. Using a similar allocation process, the activity scenario CLhT_Diesel hourly and 24-hour VMT was calculated using the activity scenario link-level VMT and speeds and the inventory vehicle type VMT mix. The county-level 24-hour hotelling scaling factors by activity scenario were calculated by dividing the activity scenario and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2004 summer weekday VMT.

Hotelling Hourly Factors

To allocate the activity scenario county-level 24-hour hotelling to each hour of the day, hotelling hourly factors for each activity scenario were used. These hotelling hourly factors were calculated as the inverse of the activity scenario CLhT_Diesel hourly VMT fractions. The activity scenario CLhT_Diesel hourly VMT fractions were calculated using the hourly activity scenario CLhT_Diesel VMT. The activity scenario CLhT_Diesel hourly VMT was converted to hourly fractions, therefore creating activity scenario CLhT_Diesel hourly VMT fractions. The inverse of these hourly VMT fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VMT fractions across all hours to calculate the county-level activity scenario hotelling hourly factors.

County-Level CLhT_Diesel Hotelling by Hour Estimation

The initial activity scenario CLhT_Diesel hotelling by hour was calculated by multiplying the 24-hour 2004 summer weekday hotelling hours by the activity scenario hotelling scaling factor and by the activity scenario hotelling hourly factors. For each hour, the initial activity scenario hotelling was then compared to the activity scenario CLhT_Diesel SHP to estimate the final activity scenario hotelling by hour. If the initial activity scenario hotelling value was greater than the activity scenario SHP value, then the final activity scenario hotelling for that hour was set to the activity scenario CLhT_Diesel SHP value. Otherwise, the final activity scenario hotelling for that hour was set to the base activity scenario hotelling value. All calculations (scaling factors, hotelling hourly factors, and hotelling by hour calculations) were performed by county and activity scenario (i.e., eight hotelling scaling factors were calculated).

County-Level CLhT_Diesel SHI and APU Hours Estimation

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

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the MOVES default hotelling distribution (i.e., a bi-modal distribution of 1.0 SHI prior to the 2010 model year and a 0.7/0.3 SHI/APU activity allocation for 2010 and later model years). The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions (which sum to 1.0).

ESTIMATION OF EMISSIONS RATES

TTI developed the emissions rates needed for the on-road mobile source emissions inventories according to TTI's detailed MOVES rates-per-activity, county-level, link-based, method. On-road mobile emissions rates data from the EPA's latest emissions factor model, MOVES2014a,[11]

[11] Software and database (MOVESDB20151028) downloadable from http://www.epa.gov/otaq/models/moves/index.htm.

together with TTI rates post-processing utilities, RatesCalc and RatesAdj, were used to produce rates in the form needed for input to the TTI external inventory calculation utility, EmsCalc.

The emissions rates were developed based on TTI's *Updated Inventory Methods for MOVES*[12] and the EPA's MOVES inventory development *Technical Guidance*[13] and *User's Guide.*[14] (More information may found in these main references, if desired.) The TTI MOVES data post-processing utilities that are used to produce the databases of rates look-up tables are also described, along with other TTI inventory process utilities, in Appendix B of this Technical Report.

The general process involved setting up and executing MOVES emissions rates mode runs to produce the emissions and activity data needed for the development of on-road mobile source, county-level emissions rates. For the initial post-processing step, TTI's on-road rates look-up table post-processor, RatesCalc, was run to produce rates look-up tables from the MOVES data. The TTI RatesAdj utility was then run to produce the final rates look-up tables by dropping pollutants not needed and making adjustments where required. Using this process, on-road rates look-up tables were produced from each MOVES run in the form needed for input to the EmsCalc utility external inventory calculations.

For the external inventory calculations, the method requires that all rates be in terms of mass per unit of activity, as opposed to the off-network rates of mass per vehicle, which is the only output option available for off-network "parked vehicle" evaporative emissions output by MOVES. Table 15 summarizes the form of rates produced for the external inventory calculations (presented in a previous section, but provided here again for convenience).

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[12] The overall on-road inventory methodologies and development utilities are similar between the previous and latest versions of MOVES. *Update of On-Road Inventory Development Methodologies for MOVES2014*, TTI, December 2014, describes utility updates for the previous (MOVES2014) model. TTI's MOVES2014a-compatible inventory estimation utilities are detailed in: ***TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL*** *User's Guide*, TTI, August 2016.

[13] *MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, November 2015.

[14] *MOVES2014a User Guide*, EPA, November 2015.

Table 15. Emissions Rates by MOVES Emissions Process and Activity Factor.

Process (Process ID)	Activity[1]	Emissions Rates[2]
Running Exhaust (1)	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust (15)	VMT	mass/mi
Brake Wear (9)	VMT	mass/mi
Tire Wear (10)	VMT	mass/mi
Start Exhaust (2)	starts	mass/start
Crankcase Start Exhaust (16)	starts	mass/start
Extended Idle Exhaust (90)	SHI	mass/shi
Crankcase Extended Idle Exhaust (17)	SHI	mass/shi
Auxiliary Power Exhaust (91)	APU Hours	mass/APU hour
Evaporative Permeation (11) Evaporative Fuel Vapor Venting (12) Evaporative Fuel Leaks (13)	VMT, SHP	mass/mi, mass/shp[3]

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

The RFP inventory analysis required sets of emissions factors for the two main RFP control scenarios: pre-1990 controls, and control strategy. Since MOVES does not model TxLED fuel, emissions rates were post-processed to include TxLED effects in the control strategy emissions rates.

The difference between pre-1990 controls and control strategy emissions are emissions reductions due to the post-1990 CAA controls. To estimate emissions reductions from individual control measures, an additional set of MOVES runs was performed. A single county (Harris) was selected, and additional scenarios were set up by adding sequentially to the pre-1990 controls scenario: RFG, post-1990 FMVCP, I/M, and TxLED. The rates from these runs were used in a procedure discussed in a later section for estimating the individual control program emissions reductions.

The five control scenarios (listed by label used in the modeling input/output files and databases) were:

- CS0 – Pre-1990 control scenario;
- CS1 – CS0 + RFG;
- CS2 – CS1 + post-1990 FMVCP;

- CS3 – CS2 + I/M Program; and
- CSC – CS3 +TxLED fuel (i.e., control strategy scenario).

Development of RFP emissions rates required for estimating total emissions reductions from all post-1990 CAA controls (i.e., the pre-1990 control [CS0] and control strategy [CSC] scenarios – the first and last of the five previously listed bullets) will be discussed first, followed by a discussion of the other emissions rates modeling (i.e., CS1, CS2, and CS3 scenarios) needed for use in the estimation of emissions reductions for individual control programs.

Development of RFP Pre-1990 Controls and RFP Control Strategy Scenario Rates

The main purpose of the following "estimation of emissions rates" discussion material, except for the part at the end detailing development of CS1, CS2, and CS3 scenario rates, is two-fold: 1) explain the overall MOVES-based emissions rate look-up table development process; and 2) provide the specifics on modeling emissions rates for the two main RFP control scenarios, Pre-1990 controls (CS0), and control strategy (CSC). All emissions rates for this RFP analysis were produced consistent with the following methods and procedures presented for the two main RFP control scenarios. Again, the other control scenario rates development for individual control measure impacts estimation (CS1, CS2, and CS3) are discussed last.

MOVES Inputs, Outputs, and Post-Processing

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions factors. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions. Local data, where available and consistent with the methodology, replaced MOVES default data by using MOVES Run Specification input files (RunSpecs or MRS) and MOVES county databases (CDBs). (The MRS files, CDBs, and MOVES default database provide the input data tailored for each local scenario model run.) Local data were developed to reflect county June through August period weather conditions, HGB region summer fuel properties, county vehicle age distributions, and the local I/M program (details are provided later). For the activity input data to MOVES, the MOVES defaults were in general used, which is basic to the emissions rates method (i.e., inventory scenario rates produced via post-processing are externally multiplied by the actual local VMT and off-network activity estimates, detailed in the previous sections, to calculate emissions external to MOVES).

There was one RunSpec and one CDB required per county per MOVES run. Each RunSpec was designed to produce a separate, corresponding MOVES output database (i.e., one output database per run). For the two main RFP scenarios, there were 48 runs, requiring 48 MRS input files and 48 CDBs, and correspondingly producing 48 MOVES output databases (i.e., eight each CS0 and CSC scenario runs for the three years – 2011, 2017 and 2018). For the post-processing corresponding to each MOVES run, RatesCalc first processed the MOVES data into one interim "ratescalc" output database. The RatesAdj utility processed the RatesCalc output (filtered and adjusted rates as needed) loading the resulting final rates into one database (for each MOVES run), for subsequent input to TTI's EmsCalc inventory calculation utility. The final rates include TxLED effects adjustments.

MOVES set-ups and runs were executed and the results were post-processed to produce county-level, summer weekday, activity-based emissions rates of the desired pollutants and processes. The rates for each RFP control scenario were estimated by speed (for miles-based rates), process, hour, MOVES road type, SUT, and fuel type.

Summary of Control Programs Modeled by RFP Control Scenario

Table 16 shows the control measures modeled in each of the RFP control scenarios, pre-1990 controls (CS0) and control strategy (CSC).

Table 16. Control Measure Modeling by RFP Control Scenario.

Individual Control Measures[1]	Method	RFP Control Scenario	
		Pre-1990 Controls (CS0)	Control Strategy (CSC)
Pre-1990 CAA FMVCP	MOVES inputs	√	√
1992 Federal Controls on Gasoline Volatility[1]	MOVES inputs	√	
RFG[1]	MOVES inputs		√
Post-1990 CAA FMVCP[1] 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)	MOVES inputs		√
I/M Program[1]	MOVES inputs		√
TxLED Fuel[1]	Post-process diesel vehicle NOx rates		√

[1] For the pre-1990 scenario, pre-1990 diesel sulfur was modeled. For the control strategy scenario, Ultra Low Sulfur Diesel was modeled and RFG for 2017 and 2018 was modeled consistent with the Tier 3 sulfur standard. Post-1990 FMVCP was modeled all together per MOVES limitation. I/M was modeled for Harris, Brazoria, Fort Bend, Galveston, and Montgomery counties. TxLED effects were modeled as a post-processing procedure adjustment to diesel vehicle NO_x emissions for all counties.

MOVES Emissions Factor Aggregation Levels

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

- Up to 13 source types (i.e., vehicle types);
- Up to six fuel types;
- Up to five road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- 16 speed bins (only included in miles-based rate tables);
- Up to 156 pollutants; and
- Up to 14 on-road processes.

The vehicle fleet was modeled as powered only by 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 (not actually a road type, this category is for parked vehicle activity), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access.[15] 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.

MOVES Run Specification Input Files

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 an MRS for one county and scenario using the MOVES graphical user interface (GUI), converted this MRS to a template, and used it as a base from which to build all the MRSs needed.

Table 17 describes the MRS selections used to produce MOVES output needed for post-processing the emissions rates for the two main RFP control scenarios, with further details on the selections provided after the table.

[15] The MOVES "separate ramps" feature is not available for MOVES emissions rates mode.

Table 17. RFP Control Scenario MRS Selections by MOVES GUI Panel.

<table>
<tr><th>Navigation Panel</th><th>Detail Panel</th><th colspan="3">Selection</th></tr>
<tr><td>Scale[1]</td><td>Model; Domain/Scale;
Calculation Type</td><td colspan="3">On-Road; County;
Emissions Rates</td></tr>
<tr><td>Time Spans[1]</td><td>Time Aggregation Level;
Years – Months – Days – Hours</td><td colspan="3">Hour;
2011 (2017, 2018)[1] - July – Weekday - All</td></tr>
<tr><td>Geographic Bounds[1]</td><td>Region;
Selections;
Domain Input Database</td><td colspan="3">Zone and Link;
<COUNTY>;[1]
<COUNTY INPUT DATABASE (CDB) NAME>[1]</td></tr>
<tr><td rowspan="14">On-Road Vehicle Equipment</td><td rowspan="14">SUT/Fuel Combinations</td><td>SUT</td><td>Gasoline</td><td>Diesel</td></tr>
<tr><td>Motorcycle</td><td>X</td><td>-</td></tr>
<tr><td>Passenger Car</td><td>X</td><td>X</td></tr>
<tr><td>Passenger Truck</td><td>X</td><td>X</td></tr>
<tr><td>Light Commercial Truck</td><td>X</td><td>X</td></tr>
<tr><td>Intercity Bus</td><td>-</td><td>X</td></tr>
<tr><td>Transit Bus</td><td>-</td><td>X</td></tr>
<tr><td>School Bus</td><td>X</td><td>X</td></tr>
<tr><td>Refuse Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Long-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Motor Home</td><td>X</td><td>X</td></tr>
<tr><td>Combination Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Combination Long-Haul Truck</td><td>-</td><td>X</td></tr>
<tr><td>Road Type</td><td>Selected Road Types</td><td colspan="3">Off-Network –
Rural Restricted Access – Rural Unrestricted Access –
Urban Restricted Access – Urban Unrestricted Access</td></tr>
<tr><td>Pollutants[2] and Processes</td><td>VOC; CO; NO_x; Atmospheric CO_2; SO_2; NH_3; $PM_{2.5}$: OC, EC, SO_4, NonECPM, Total Exhaust, Brakewear, and Tirewear;
PM_{10}: Total Exhaust, Brakewear, and Tirewear</td><td colspan="3">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; Refueling Displacement Vapor Loss, Refueling Spillage Loss, Brakewear, Tirewear</td></tr>
<tr><td>Manage Input Data Sets</td><td>Additional Input Database Selections</td><td colspan="3">None</td></tr>
<tr><td>Strategies</td><td>Rate-of-Progress</td><td colspan="3">***Pre-1990 Control***: “No Clean Air Act Amendments” – ON
Control Strategy: “No Clean Air Act Amendments” – OFF</td></tr>
<tr><td>General Output[1]</td><td>Output Database;[1]
Units;
Activity</td><td colspan="3">*<MOVES OUTPUT DATABASE NAME>*;[1]
Pounds, KiloJoules, Miles;
Hotelling Hours, Population, Starts (not adjustable, pre-selected)</td></tr>
<tr><td>Output Emissions Detail</td><td>Always;
For All Vehicles/Equipment;
On Road</td><td colspan="3">Time: Hour – Location: Link – Pollutant;
Fuel Type, Emissions Process;
Road Type, Source Use Type</td></tr>
<tr><td>Advanced Performance Measures</td><td>Aggregation and Data Handling</td><td colspan="3">Only the “clear BaseRateOutput after rate calculations” box was checked</td></tr>
</table>

[1] Only one county and year per run. Input and output database names are distinct by control scenario, county FIPS code, and year.

[2] OC and EC are organic and elemental carbon. Chained pollutants require other pollutants (not listed in the table) to be selected (e.g., VOC requires Total Gaseous Hydrocarbons and Non-Methane Hydrocarbons: CO_2 requires TEC).

Scale, Time Spans, and Geographic Bounds

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

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 (2011, 2017, or 2018) was selected, and one “Months” (July) and one “Days” (Weekdays) selection was made.

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

On-Road Vehicle Equipment and Road Type

The local VMT mixes developed for the study define the SUT/fuel type combinations included in the MOVES runs. The VMT mixes specify the vehicle fleet as the 22 gasoline and diesel SUTs designated as “on-road vehicle equipment” selections in Table 17. These SUT/fuel type combinations were chosen in all the MOVES RunSpecs. The MOVES default fuel engine fractions were also replaced (via the MOVES AVFT table, discussed later) with local input data consistent with the SUT/fuel type combinations selected in Table 17.

All five MOVES road type categories were selected (the “provide separate ramps output” box is not active when using emissions rates mode).

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 Composite – NonECPM (non-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, including the two refueling emissions processes.

Manage Input Data Sets and Strategies

The Manage Input Datasets feature allows alternate inputs other than those included in the CDB. No additional inputs were included via the Manage Input Datasets panel.

The Strategies, Rate-of-Progress feature was used for the pre-1990 control emissions rates modeling scenario. The check-box *Compute Rate-of-Progress “No Clean Air Act Amendments” Emissions* was selected, which models a “No Clean Air Act Amendments” scenario by assigning 1993 model year emissions rates to all post-1993 vehicles.

Output

The output units were pounds, 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.

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

MOVES County Input Databases

The locality-specific input data for the county scale runs were entered through the CDB.

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

Data for populating the CDBs were first prepared in the form of text files and/or MySQL databases (e.g., for local fuels, weather data), and some values provided directly in the CDB builder MySQL script. Any default data used was selected from the latest MOVES default database, MOVESDB20151028 (e.g., for default activity data). After running the scripts to produce the CDBs, a CDB checker utility written by TTI was run to verify that all CDB tables were built and populated as intended.

Table 18 provides an outline and brief description of the CDBs, followed by discussion of the development of the local data and the defaults contained therein. Unless otherwise stated, the CDB table data applies to all counties, years and RFP scenarios.

Table 18. CDB Input Tables.

MOVES Input Table	Data Category	Notes
year	Time	Designates analysis year as a base year (base year means that local activity inputs are supplied rather than forecast by the model).
state	Geography	Identifies the state (Texas) for the analysis.
county	Geography/ Meteorology	Specifies the county, local altitude, and barometric pressure (base year 2011 summer period data were provided by TCEQ).
zonemonthhour	Meteorology	Local, hourly temperature and relative humidity for the county (2011 summer period data were provided by TCEQ).
roadtype[1]	Activity	Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0.
hpmsvtypeyear[2]	Activity	Used MOVES default national annual VMT by HPMS vehicle type.
roadtypedistribution[2]		Used MOVES default road type VMT fractions.
monthvmtfraction[2]		Used MOVES default month VMT fractions.
dayvmtfraction[2]		Used MOVES default day VMT fractions.
hourvmtfraction[2]		Used MOVES default hour VMT fractions.
avgspeeddistribution[2]		Used MOVES default average speed distributions.
sourcetypeyear[2]	Fleet	Used MOVES default national SUT populations.
sourcetypeage-distribution	Fleet	Local SUT age fractions estimated using TxDMV mid-year vehicle registration data and MOVES defaults, as needed. Used TxDMV 2011 and (for future analysis years) latest available (2014) data.
avft	Fleet	Local SUT fuel fractions estimated using TxDMV vehicle registration data, consistent with the data used in the sourcetypeagedistributions, and defaults where needed.
zone	Activity	Start, idle, and SHP zone allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
fuelsupply	Fuel	<u>Control scenario-specific</u>. The fuel supply, or market share, reflecting one RFG and one diesel fuel formulation.
fuelformulation	Fuel	<u>Control scenario-specific</u>. Local gasoline and diesel formulations prepared by TTI. Pre-1990 control scenario – 7.8 psi RVP conventional gasoline and typical pre-1993 regulation diesel sulfur level. Control strategy scenario – RFG (based on latest available survey data with Tier 3-consistent sulfur-level setting for future years), diesel sulfur consistent with federal ultra low sulfur diesel standard and local diesel survey sample data.
imcoverage	I/M	<u>Control scenario-specific</u>. Pre-1990 control scenario – No I/M modeled. Control strategy scenario – For I/M counties, local I/M parameters replaced MOVES defaults, based on current I/M rules, prior modeling set-ups, and available MOVES I/M parameters. Regulatory class coverage adjustments were updated consistent with *MOVES Technical Guidance*, EPA, November 2015.
countyyear	Stage II	N/A.

[1] In MOVES rates mode, "ramp road type" rates are not available.
[2] Use of a default set of activity and population inputs for all MOVES runs is basic to the inventory method, e.g., MOVES default activity is normalized in the calculated rates for applicable processes, and actual local activity estimates are used in the external inventory calculations.

Year, State, and County Inputs to MOVES

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

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

StateID "48" (Texas) was inserted in the state table. In addition to identifying the county of analysis, the county table contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data were selected from a prepared local "meteorology" database containing tables of weather data records (i.e., "county" and "zonemonthhour" tables) for the analysis.

Roadtype Inputs to MOVES

Currently, the MOVES model contains "ramp" emissions rates, but not an (activated) individual road type for separate ramps output (when using MOVES rates mode). In the roadtype table, MOVES provides a field "rampFraction" for including a fraction of estimated ramp activity as a fraction of SHO on each of the MOVES road types. For this analysis, the MOVES default roadtype table data were used, except the ramp fractions were set to zero (i.e., 100 percent of activity on each MOVES road type was based on the road type drive cycles assigned to that road type by MOVES, exclusive of ramp activity).

Activity and Vehicle Population Inputs to MOVES

The activity and vehicle population input parameters under the methodology use the MOVES defaults. The tables are: hpmsvtypeyear, roadtypedistribution, monthvmtfraction, dayvmtfraction, hourvmtfraction, avgspeeddistribution, and sourcetypeyear. Data for all of these tables were selected and inserted from the MOVES default database.

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.

Age Distributions and Fuel Engine Fractions Inputs to MOVES

The locality-specific inputs of vehicle age and fuel type fractions by model year, under the SIP county-level inventory procedures, consist of county-level age distributions and statewide gasoline and diesel fractions (termed fuel engine fractions in MOVES). The age distributions and fuel engine fractions inputs were calculated and written to text files in preparation for loading the data into the appropriate CDB input tables: the sourcetypeagedistribution table for age distributions, and the avft table for fuel engine fractions. The MOVESfleetInputBuild utility see Appendix B) was used to produce local sourcetypeagedistribution and AVFT inputs to MOVES in the required formats, and MySQL scripts were used to populate the CDB input tables.

The age distributions and fuel engine fractions were based on TxDMV mid-year county registrations data and MOVES model defaults, where needed. The fuel engine fractions were developed consistent with the local VMT mix estimate (i.e., the local fuel engine fractions estimates reflect no compressed natural gas [CNG] vehicles, no E-85 fuel type, and no gasoline transit buses, consistent with the VMT mix). Locality-specific SUT age distributions were produced based on the TxDMV county vehicle registration category aggregations, consistent with the vehicle registration category aggregations of the VMT mix. Appendix G includes the age distributions and fuel engine fractions summaries.

Table 19 summarizes the data sources and aggregation levels used to estimate the local sourcetypeagedistribution and avft inputs to MOVES.

Table 19. Data Sources and Aggregations for Age Distributions and Fuel/Engine 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	NA – 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	HGB Region	Texas Statewide
Single-Unit Long-Haul Truck	53	>8500+ >10000+ >14000+>16000	Texas Statewide	Texas Statewide
Refuse Truck	51	MOVES default		
Motor Home	54			
Intercity Bus	41			
Transit Bus[2]	42			
School Bus	43			
Combination Short-Haul Truck	61	>19500+ >26000+ >33000+ >60000	HGB Region	Texas Statewide
Combination Long-Haul Truck	62	>19500+ >26000+ >33000+ >60000	Texas Statewide	NA – 100 % diesel, no Fuel/Engine Fractions

[1] TxDMV mid-year 2011 and 2014 (latest available for future years) county vehicle registrations data (i.e., three-file data set: composite fuel light-duty categories; heavy-duty gasoline by eight weight categories; and heavy-duty diesel by eight weight categories) were used for developing local inputs (weights are GVWR in units of lbs.). The MOVES2014a model default age distributions are from the MOVESDB20151028 database.

[2] Consistent with the local vehicle type VMT mix, MOVES fuel engine fractions for light-duty categories were revised to exclude E-85, and for transit buses were revised to exclude CNG and gasoline components. MOVES default fuel engine fractions were taken from the MOVESDB20151028 sample vehicle population table.

Local Meteorological (County and Zonemonthhour Table) Inputs to MOVES

The meteorological inputs were input via the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These input data (originally developed and applied in the TCEQ's 2011 HGB periodic emissions inventory analysis[16]) were developed as June 1 through August 31, 2011 hourly temperature and relative humidity, and 24-hour barometric pressure averages, using the hourly data from numerous weather stations within the HGB area. Altitude, also an input of the county table, was set to "low" for all counties. Table 20 summarizes the temperatures, relative humidity, and barometric pressure input values.

Table 20. Meteorological Inputs to MOVES.

Hour	Temperature (Degrees Fahrenheit)	Relative Humidity (Percent)	Barometric Pressure (Inches of Mercury)
1	81.78	77.92	29.9544
2	81.05	80.26	
3	80.42	82.41	
4	79.88	83.82	
5	79.38	85.06	
6	78.92	86.09	
7	78.66	86.78	
8	79.91	84.25	
9	82.99	76.56	
10	85.64	67.93	
11	88.01	59.29	
12	90.11	52.73	
13	91.82	48.13	
14	92.94	45.45	
15	93.60	43.78	
16	93.82	43.29	
17	93.55	43.99	
18	92.67	45.94	
19	91.15	49.19	
20	88.90	54.47	
21	86.34	61.24	
22	84.64	66.62	
23	83.45	71.05	
24	82.54	74.73	

Source: Provided by TCEQ. HGB area weather station data averages for the 2011 June through August period developed originally for the 2011 AERR inventories, TTI, August 2012.

[16] *2011 On-Road Mobile Source Actual Annual and Weekday Emissions Inventories: Houston Area*, TTI, August 2012.

Fuels Inputs to MOVES

The local, summer season, fuels inputs to MOVES were supplied in the CDB fuelsupply and fuelformulation tables. The fuel supply for each county consisted of one average gasoline (RFG or conventional gasoline, depending on the RFP control scenario) and one average diesel fuel formulation. The market share attributed to each gasoline and diesel fuel formulation in the fuel supply was therefore 1.0. These fuel types are consistent with the local SUT/fuel type VMT mix and avft estimates. Fuels inputs were prepared for both the RFP pre-1990 controls and control strategy scenario analyses.[17]

TTI developed the control strategy fuels inputs based on local, retail outlet survey data, and where appropriate, expected future year values. For the federal Renewable Fuel Standard (RFS) expected future year effects, renewable fuel volumes (e.g., ethanol, biodiesel) reflected in the latest available local fuel surveys were used.[18]

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.

Using local fuelformulationIDs uniquely different from MOVES default IDs, these input data were then used in the production of CDBs for the MOVES runs.

The MOVES2014a fuelformulation table fields and units include:

- RVP (pounds per square inch [psi]);
- sulfurLevel (parts per million [ppm]);
- ETOHVolume (volume percent);
- MTBEVolume (volume percent);
- ETBEVolume (volume percent);
- TAMEVolume (volume percent);
- aromaticContent (volume percent);

[17] Most fuels inputs were previously developed by TTI for other SIP inventories using standard procedures. 2011 control strategy formulations (updated for use with MOVES2014a) were from the MOVES2010a-based HGB AERR inventories, *2011 On-Road Mobile Source Actual Annual and Weekday Emissions Inventories: Houston Area,* TTI, August 2012. Future year control strategy formulations were produced by TTI earlier this year for a TCEQ statewide inventories project, using newer available (2015) RFG survey data than were previously available.

[18] Note that federal annual RFS volume targets may not always be achieved. Constraints in the fuel market to accommodate mandated increasing renewable fuel volumes (e.g., ethanol, biodiesel) have required EPA to propose reductions in total renewable fuels below statutory volumes. With observed and potential variability in annual renewable fuel volume targets due to such market constraints, the latest available observed renewable fuel volumes in the local survey-based estimates were considered reasonable for expected future year levels. For this analysis ethanol and biodiesel blends were based on the latest available Texas summer fuel surveys, which basically indicates statewide saturation of E10 gasoline (for both conventional and RFG) and no biodiesel.

- olefinContent (volume percent);
- benzeneContent (volume percent);
- e200 (vapor percent at 200 degrees Fahrenheit);
- e300 (vapor percent at 300 degrees Fahrenheit);
- T50 (degrees Fahrenheit at 50 percent vapor); and
- T90 (degrees Fahrenheit at 90 percent vapor).

Although not listed previously, the fields BioDieselEsterVolume, CetaneIndex, and PAHContent are also included in the fuelformulation table, but were not used.

Data Sources – For pre-1990 controls, a MOVES default was used for gasoline, and conventional diesel sulfur content was based on information from NIPER U.S. refiner survey summary information on the typical post-1979/pre-1993 regulation No. 2 diesel.

For the control strategy scenarios, the EPA Office of Transportation and Air Quality (OTAQ) provided TTI with the summer 2011 and summer 2015 retail outlet RFG survey data summaries for the HGB RFG area (sample data by fuel grade: regular [RU], mid-grade [MU], and premium [PU]), collected by the RFG Survey Association.[19] TCEQ provided the summer 2011 and summer 2014 Texas statewide fuel survey data summaries, for which the information on local diesel fuel were used (each includes diesel and three gasoline grade samples from each of 92 locations across Texas).[20]

Development of Gasoline Fuel Formulations Inputs – For the pre-1990 controls scenario, an appropriate gasoline fuel formulation (ID 1007) was taken directly from the MOVES default database and given a unique fuel formulation ID. The particular selection was made by using a combination of fuel region, fuel year and month (July, 1990), and verifying appropriate average fuel property values (e.g., non-oxygenated gasoline, 7.8 psi RVP limit, a typical pre-regulation gasoline sulfur level).

For the control strategy scenarios (2011 and 2017/2018), the standard procedure was used, which involves calculating average fuel properties by fuel grade and calculation of the overall averages as a weighting of the fuel grade results using relative sales volumes. The relative sales volumes were estimated using annual average sales volumes per day through retail outlet statistics for Texas.[21] For the future years formulation, the latest available (2015) survey-based averages were used as expected future year values, except for average sulfur content, which was replaced with the MOVES default value (consistent with the Tier 3 average annual standard). It was also noted that the summer 2015 RFG survey-based average benzene content estimate was well within the mobile source air toxics (MSAT) rule standard.

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[19] For more information see: http://www.epa.gov/otaq/fuels/gasolinefuels/rfg/properf/perfmeth.htm.
[20] *Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2011 (Revised) Final Report*, ERG, August 31, 2011, Revised March 2015; *2014 Summer Fuel Field Study (Revised) Final Report*, ERG, revised January 2015.
[21] Sales volumes by grade were from the Energy Information Administration's (EIA) *Petroleum Marketing Annuals*. 2011 sales (latest available).

Development of Diesel Fuel Formulation Inputs – For the pre-1990 controls scenario, the diesel sulfur content estimate used was developed by TTI for prior SIP RFP analyses. This diesel sulfur level was based on NIPER U.S. refiner survey summary information, which placed the average sulfur value for the typical No. 2 diesel, within the post-1979/pre-1993 regulation period, in the 2500-3000 ppm range. The conservative, low-end-of-the-range value was chosen.

For the control strategy scenarios, TCEQ's most recent (2011 and 2014) summer fuel surveys were used. These surveys provide similar observations for diesel sulfur content based on individual samples from the 92 locations across the state. Average sulfur content was within the range of 2.5 to 10.6 ppm and the average was approximately 5.8 ppm. The diesel sulfur levels used for 2011 control strategy scenario were taken from the TCEQ 2011 survey summary (Table 5 of the TCEQ 2011 fuel survey report provides the sulfur values by 25 districts). Recent on-road inventory analyses have used a standard future year "expected" average diesel sulfur value (11 ppm) consistent with the federal low sulfur diesel sulfur average annual standard (15 ppm). The 11 ppm expected value, which fits very well with the recent observed data, was also used for the future year control strategy scenarios. (The effects of TxLED were incorporated by emissions factor post-processing, discussed later.)

Table 21 summarizes the gasoline and diesel fuel property inputs by control scenario.

Table 21. HGB Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES by RFP Control Scenario.

Field	Units	Pre-1990 Controls		2011 Control Strategy			2017/2018 Control Strategy	
fuelFormulationID[1]	-	10001	32500	10707	30604[1]	30636[1]	17724	30011
fuelSubtypeID[2]	-	10	20	12	20	20	12	20
RVP	psi	7.80	0.00	7.06	0.00	0.00	7.13	0.00
sulfurLevel	ppm	429.96	2,500	29.42	6.04	6.36	10.00	11.00
ETOHVolume	vol.%	0.00	0.00	9.759	0.00	0.00	9.74	0.00
MTBEVolume	vol.%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ETBEVolume	vol.%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TAMEVolume	vol.%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
aromaticContent	vol.%	26.4	0.00	14.65	0.00	0.00	14.41	0.00
olefinContent	vol.%	11.9	0.00	13.27	0.00	0.00	13.32	0.00
benzeneContent	vol.%	1.64	0.00	0.532	0.00	0.00	0.44	0.00
e200	vap.%	46.04	0.00	49.32	0.00	0.00	49.57	0.00
e300	vap.%	81.43	0.00	84.61	0.00	0.00	84.64	0.00
T50	deg. F	207.90	0.00	201.91	0.00	0.00	201.27	0.00
T90	deg. F	336.54	0.00	328.88	0.00	0.00	328.84	0.00

[1] The 2011 (local survey-based) average diesel sulfur estimates were by TxDOT districts. FuelformulationID 30604 represents the Houston District; 30636 is for the Beaumont District. Liberty and Chambers counties are in the Beaumont District and the other six HGB counties are in the Houston District.

[2] Respectively, fuel subtype IDs 10, 12 and 20 are non-oxygenated conventional gasoline, 10% ethanol-blend gasoline (in this case RFG), and conventional diesel. TTI developed pre-1990 controls gasoline formulation by selecting the appropriate MOVES default (e.g., by region, year, and values of parameters like RVP, ethanol content, average sulfur) and changing fuelformulationID. The pre-1990 controls diesel formulation was based on NIPER U.S. refiner survey summary information for typical No. 2 diesel of the post-1979/pre-1993 regulation period. TTI developed 2011 and future year formulations using local summer fuel survey sample data (TCEQ 2011 diesel survey; EPA 2011 and 2015 Texas RFG surveys). For 2017/2018 RFG, sulfur level was replaced (reduced) using the MOVES default reflecting the Tier 3 standard. Diesel sulfur value was set consistent with the federal standard (within maximum observed from recent local surveys and average annual 15 ppm standard).

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

Local I/M Inputs to MOVES

In general, MOVES produces a local I/M program effect as an adjustment to the model's reference I/M program effect (i.e., the "standard I/M difference" in MOVES-based emissions rates, which are specific to vehicle regulatory class categories of which the higher level source types are composed). MOVES contains a large set of "I/M factors" by source type (in the imfactor table) computed specifically for adjusting the MOVES standard I/M difference to reflect the effects of various local I/M program design alternatives. To model a local I/M program design, it must be defined using MOVES I/M coverage parameters by source type, entered in the MOVES imcoverage table. The appropriate MOVES I/M factors for modeling a local I/M program are designated in a model run by the local program data in the imcoverage table.

MOVES adjusts emissions (Hydrocarbons [HC], CO, and NO_x) at the source-type level to incorporate the benefits of the local I/M program design defined using the MOVES I/M coverage table parameters. TTI previously produced a comprehensive set of MOVES imcoverage records for Texas I/M counties to use in place of MOVES defaults. TTI also updated this Texas local imcoverage database to include a small change in one regulatory class coverage adjustment.[22]

The imcoverage parameters (by field header) are:

- polProcessID (pollutant and emissions process affected by the program);
- stateID (state subject to the I/M program);
- countyID (county FIPS);
- yearID (year administered);
- sourceTypeID (source type affected);
- fuelTypeID (fuel type for the program);
- IMProgramID (arbitrary ID number specific to a local program);
- begModelYearID (first model year included);
- endModelYearID (last model year included);
- inspectFreq (inspection frequency for the program);
- testStandardsID (I/M test type);
- useIMyn (a Y/N [yes/no] switch that specifies whether or not to use the record); and
- complianceFactor (an adjustment factor reducing the I/M effects for compliance rate, waiver rates, regulatory class coverage adjustments, or other adjustments, if needed).

To use the local imcoverage inputs, both the MOVES default imcoverage records (flagged for non-use) and local imcoverage records (flagged for use) were required in each CDB. I/M effects were modeled for the RFP control strategy scenarios.

Data Sources – TTI produced the local I/M coverage input parameters to represent Texas I/M program designs as specified in the Texas I/M SIP and Texas rules. The I/M program requires annual emissions testing of gasoline vehicles within a 2-through-24 year vehicle age coverage window (motorcycles, military tactical vehicles, diesel-powered vehicles, and antique vehicles are excluded). A gas cap integrity test is required on all these vehicles, and depending

[22] TTI compared I/M data (e.g., emissionratebyage standard I/M difference; imfactors; and regulatory class coverage adjustments) between MOVES 2014a and 2014 to determine if changes called for updating local imcoverage parameters. Only a minor difference in one regulatory class coverage adjustment was found warranting an update of light commercial truck imcoverage compliancefactor value. (For further details, see Table 22 notes.)

on the model year, gross vehicle weight (GVW) (threshold of 8,500 GVW separating light-duty and heavy-duty class), and I/M area, current vehicle emissions testing may use On-Board Diagnostics (OBD) tests, the Acceleration Simulation Mode (ASM-2) test, or the Two-Speed Idle (TSI) test. Table 22 and associated notes describe MOVES imcoverage records developed by TTI for the years available in MOVES applicable to each HGB I/M county. For additional I/M program details, see the current I/M SIP and/or pertinent Texas Administrative Code.[23]

Local I/M Coverage Input Data Development Approach – Following is the general approach used to build the Texas imcoverage tables:

- Identified MOVES I/M test standards applicable to Texas I/M counties in consultation with TCEQ (see Table 22, column 4);
- Queried the MOVES database to determine the extent to which MOVES provides I/M effects corresponding to Texas I/M Programs (i.e., local I/M test frequency, fuel type, and test types [test standards]). From the result, listed the SUTs, test standards, pollutant and emissions process combinations with I/M effects in MOVES (i.e., with non-zero MOVES I/M factors and corresponding base emissions rates with non-zero standard I/M differences);
- Categorized counties and years in groups under the same MOVES test standards; and
- Assigned MOVES I/M Program IDs such that: 1) all MOVES default I/M Program IDs were excluded; and 2) for each year ID, each I/M Program ID represented a unique combination of test standard, test frequency, begin model year, and end model year.

[23] *Revision to the State Implementation Plan Mobile Source Strategies, Inspection and Maintenance State Implementation Plan Revision*, TCEQ, adopted February 12, 2014.

Table 22. MOVES I/M Coverage Inputs for Annual Inspections of Gasoline Vehicles – Used for HGB RFP Control Strategy Scenarios.

YearID[1]	begModel YearID[1]	endModel YearID[1]	testStandardsID[2]	Sourcetypeid[3]
Harris, Brazoria, Fort Bend, Galveston, Montgomery				21 (PC- Passenger Car), 31 (PT – Passenger Truck), 32 (LCT – Light Commercial Truck)
2011, 2017, 2018	*X*	1995	23 (A2525/5015 Phase)	
	X	1995	41 (Evp Cap)	
	1996	*Y*	51 (Exh OBD)	
	1996	*Y*	45 (Evp Cap, OBD)	

[1] begmodelyearID (*X*) and endmodelyearID (*Y*) define the range of model years covered – where represented by "*X*" and "*Y*," respectively, are calculated as YearID – 24, and YearID – 2.
[2] The model processes/pollutants affected are start and running exhaust HC, CO, NO_x, and tank vapor venting HC.
[3] Compliancefactor values by source type (PC – 93.12 percent; PT – 91.26 percent; LCT – 85.67 percent) were calculated per Section 4.10.6, *MOVES Technical Guidance*, EPA, November 2015, using Texas modeling protocol compliance and waiver rates of 96 percent and 3 percent, and regulatory class adjustments per *MOVES Technical Guidance*, Appendix A. The regulatory class adjustments provide a conservative result in that small portions of PT and LCT, attributable to regulatory class 40 (Class 2b Trucks with 2 Axles/4 Tires [8,500 lbs. < GVWR <= 10,000 lbs.], or "LHD <= 10k"), exclude a potential evaporative gas cap effect available in MOVES for LHD<= 10k.

The MOVES input files (MRSs and CDBs) were provided as a part of the electronic data submittal (Appendix A) of this Technical Note.

Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 20 tables were in the appropriate CDBs and the tables were populated with data as intended. The MOVES RunSpecs were executed in batches using the MOVES commandline tool. After completion, TTI verified that the MOVES runs were error free (i.e., checked all run log text files for errors and warnings).

The MOVES runs summaries are included as Appendix H.

Post-Processing Runs

Each MOVES output database was post-processed using the TTI's MOVES emissions rates post-processing utilities for on-road mobile emissions rates, RatesCalc and RatesAdj. Post-processing for each MOVES run was performed in two steps – RatesCalc first produced and interim "ratescalcs" rate database, followed by an "ratesadj" database containing the final on-road rate tables for subsequent input to the EmsCalc inventory calculation utility. The following post-processing procedures were performed on each MOVES output database.

- Interim Rate Databases: Using RatesCalc, 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 emissions rate output. The utility also copied the mass/mile, mass/start, and mass/hour rates along with the units into emissions rate tables. This utility does not perform any unit conversions, and excludes total energy and refueling processes. The utility created the look-up tables ttirateperdistance, ttirateperstart, ttirateperhour (for SHI and APU hours), and ttiratepershp in a "ratescalcs" interim output database for each scenario.

- Final Rate Databases: Using RatesAdj, TTI produced the final on-road mobile emissions rates for input to the EmsCalc emissions calculator. RatesAdj extracted emissions rates from the RatesCalc rate tables for only those pollutants needed in the emissions calculations. For the RFP control strategy scenario runs, this step applied TxLED adjustments (see factors developed by TTI in Table 23) to the diesel vehicle NO_x emissions rates for all HGB counties. (TxLED was not included for the Pre-1990 Controls scenario modeling.) TTI 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.[24] The extracted and adjusted rate tables were placed in "outRatesAdj" databases (one each per run) for subsequent input to the on-road mobile source emissions calculator, EmsCalc.[25]

See the utility descriptions in Appendix B for more information.

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

[25] The TxLED counties list may be found at: http://www.tceq.texas.gov/airquality/mobilesource/txled/txled-affected-counties. For full details on the TCEQ TxLED factor development procedure, see "mvs14-statewide-txled-analysis-06-12-17-18.zip" found at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/.

Table 23. TxLED Adjustment Factors Summary.

Diesel Fuel Source Use Type	Reduction			Adjustment		
	2011	2017	2018	2011	2017	2017
Passenger Car	5.88%	5.17%	4.99%	0.9412	0.9483	0.9501
Passenger Truck	5.35%	5.08%	5.04%	0.9465	0.9492	0.9496
Light Commercial Truck	5.69%	5.35%	5.32%	0.9431	0.9465	0.9468
Intercity Bus	5.84%	5.69%	5.65%	0.9416	0.9431	0.9435
Transit Bus	5.80%	5.66%	5.60%	0.9420	0.9434	0.9440
School Bus	5.80%	5.67%	5.63%	0.9420	0.9433	0.9437
Refuse Truck	5.64%	5.38%	5.30%	0.9436	0.9462	0.9470
Single Unit Short-Haul Truck	5.06%	4.89%	4.88%	0.9494	0.9511	0.9512
Single Unit Long-Haul Truck	5.05%	4.90%	4.89%	0.9495	0.9510	0.9511
Motor Home	5.59%	5.38%	5.36%	0.9441	0.9462	0.9464
Combination Short-Haul Truck	5.49%	5.19%	5.16%	0.9451	0.9481	0.9484
Combination Long-Haul Truck	5.59%	5.26%	5.21%	0.9441	0.9474	0.9479

Source: TTI, March 2016. TTI used the TxLED factor procedure from TCEQ (available in "mvs14-statewide-txled-analysis-06-12-17-18.zip" available at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/) in combination with 2011 data and the latest available data (i.e., statewide age distributions based on mid-year 2014 TxDMV vehicle registrations for future years).

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

Emissions Rates for Estimation of Individual Control Reductions

In a manner consistent with the development of the CS0 and CSC scenario emissions rates, TTI produced emissions rates for the CS1, CS2 and CS3 incremental control scenarios needed for estimating the individual control measure emissions reductions.

Table 24 summarizes the run sequence. Note that existing MOVES and MOVES post-processor utility runs from the CS0 and CSC scenarios were used in combination with output from the extra runs needed, to produce the required five scenarios of Harris County emissions estimates. Existing runs and new runs are summarized together for the overall emissions rates development process, which includes development of MOVES setups (MRSs, CDBs), RatesCalc set-ups, and RatesAdj set-ups. (EmsCalc runs to calculate the emissions estimates are discussed in the next section).

Table 24. Harris County Emissions Factor Modeling Control Scenarios and Sequence.

Scenario Label	Controls Increment	MOVES CDB	MRS	MOVES Runs	RatesCalc Runs	RatesAdj Runs
CS0	Pre-1990 Controls (base)	Existing "pre-1990 controls" scenario set-ups and runs				
CS1	CS0 + RFG and ULSD	Same as CS0 except for current fuels	Changes only in input/output labeling	√	√	√ (no TxLED)
CS2	CS1 + post-FMVCP	Same as CS1 CDB	"No CAA" switched off Input/output labels changed	√	√	√ (no TxLED)
CS3	CS2 + I/M	Existing set-ups and runs (i.e., CSC set-ups and runs prior to TxLED adjustments, or CSC scenario - TxLED)				√ (no TxLED)
CSC	CS3 + TxLED	Existing "control strategy" scenario set-ups and runs				

As shown in Table 24, of the five control scenarios, three (CS1, CS2, and CS3) required some modeling set-ups and runs. The CS1 and CS2 control scenarios required the full process stream of set-ups and runs, whereas the CS3 control scenario only required set-ups and runs beginning with the RatesAdj step (since CS3 is the same as CSC, except with no TxLED). Therefore, the CSC RatesCalc step output was input to a new "CS3" RatesAdj utility run with no TxLED adjustments applied to produce the CS3 scenario rate tables. This series of additional emissions factor modeling set-ups and runs was developed and executed for 2017 and 2018 analysis years.

The Harris County emissions factors for the CS1, CS2 and CS3 incremental control scenarios for each year were input with appropriate activity inputs into EmsCalc 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 emissions factor MOVES set-ups used (MRS files and CDBs) were provided as a part of the electronic data submittal (see Appendix A).

EMISSIONS CALCULATIONS

Using TTI's EmsCalc utility and the previously detailed inventory activity and emissions rate inputs, TTI calculated hourly on-road mobile emissions by HGB county for each RFP inventory scenario, and additionally for Harris County, the extra incremental control measure scenarios.

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

EmsCalc produced three output files per run. These outputs consist of a listing file (summarizing information regarding the execution of the utility), a standard tab-delimited emissions inventory summary, and a tab-delimited 24-hour emissions inventory summary by SCCs and pollutant codes consistent with EPA's 2014 NEI.

Hourly Link-Based Emissions Calculations

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

- Time period TxDOT district-level SUT/fuel type 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 TRANSVMT utility to include: A node, B node, county number, TDM road type (functional class) code, link length, congested (operational) speed, VMT, and TDM area type code;
- TDM road type designations – TDM road type and area type codes to MOVES road type codes (and to VMT mix road type, and to rates road type codes) (see Table 25);
- Off-network activity – county, hourly SHP, starts, SHI, and APU hours by vehicle type;
- Pollutant/process/units list – for emissions to be calculated and output in tab-delimited emissions summary files;
- Roadway-based emissions factors – MOVES-based, county level by pollutant, process, hour, average speed, MOVES road type, SUT, and fuel type;
- Off-network (parked vehicle) emissions 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; and
- MOVES pollutant codes to NEI pollutant codes – for SCC output.

The VMT-based emissions were calculated for each hour using the time-period TxDOT-level SUT/fuel type VMT mix, the link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the link road type/area type-to-MOVES road type designations. For each link, the link was assigned a MOVES road type based on the link's road type and area type (see Table 25). The link VMT was distributed to each SUT/fuel type using the VMT mix from the appropriate time period based on the link's designated MOVES road type. The time period VMT mixes were applied by hour as follows: morning peak – 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 emissions factors by hour for each SUT/fuel type were selected based on the designated hour of the link file, and the link's designated MOVES road type and the link speed. For link speeds falling between MOVES speed bin average speeds, emissions factors were interpolated from bounding speeds. For link speeds falling outside of the MOVES speed range (less than 2.5 mph and greater than 75 mph), the emissions factors for the associated bounding speeds were used. The mass/mi rates were multiplied by the link SUT/fuel type VMT producing the link-level emissions estimates. This was performed for each hour of the day.

Table 25. H-GAC TDM Road Type/Area Type to MOVES Road Type Designations.

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

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.

[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three hours of 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.

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

Hourly Link-Based Emissions Output

The EmsCalc hourly link-based emissions output data sets consisted of three output files per run. These output files are:

- A listing file that summarizes the utility execution information, including the inputs and outputs used, a summary of the VMT mix, a summary of the off-network activity, a summary of the emissions factor dimensions (i.e., hour, MOVES road type, MOVES speed bin, SUT, fuel type, pollutant, process), and an hourly totals summary of the totals for VMT, VHT, speed, off-network activity, and emissions in pounds;
- 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, SHI, and APU activity rows last in the activity data block for each time period; and
- A tab-delimited summary SCC output file that contains the 24-hour totals of VMT and emissions (in units of pounds) using inventory data aggregations, SCCs, and pollutant codes consistent with the EPA's 2014 NEI.

The pollutants included are:

- VOC, CO, NO_x, NH_3, SO_2, CO_2,PM_{10} Total Exhaust, PM_{10} Brakewear, PM_{10} Tirewear, $PM_{2.5}$ Total Exhaust, $PM_{2.5}$ Brakewear, $PM_{2.5}$ Tirewear, OC, EC, and Composite Non-elemental Carbon.

See Appendix B for further details on the EmsCalc utility.

XML-Formatted 24-Hour Summaries for TexAER

TTI post-processed the EmsCalc 24-hour summer weekday 2011, 2017, and 2018 RFP control strategy scenario SCC-labeled inventory output, using the TTI's MOVESSCCXMLFormat utility, into the NEI EIS CERS XML format for inclusion in TCEQ's TexAER database.

The tab-delimited SCC-based inventory data files output by EmsCalc were produced for direct input to the XML format utility using inventory data aggregation and coding (SCCs and pollutant codes) consistent with EPA's latest (2014) 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 emissions inventory 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 a LST file, the XML file, and one tab-delimited SCC-labeled inventory summary per county included in the run. All eight HGB counties were included in each of the three (one per year) MOVESSCCXMLFormat runs. (Further details may be found in Appendix A.)

QUALITY ASSURANCE

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

The 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,[26] 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),[27] in the following description.

A. Project Management

The project management was as listed previously in the Acknowledgments section.

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

After receiving the Notice to Commence (NTC) from TCEQ, the TTI project manager provided a detailed pre-analysis plan to the TCEQ project manager for review and concurrence. Upon concurrence of the pre-analysis plan, the TTI project manager distributed the pre-analysis plan to the TTI inventory developers for use in both the inventory development and QA review process. TTI maintains records of the project QA checks as a part of the project archive, for at least five years.

The objective was to produce the emissions inventory product of the quality suited to its purpose as specified (i.e., inventories needed for ozone modeling purposes), in accordance with

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

the appropriate guidance and methods documents as referenced, as detailed in the pre-analysis plan, and in consultation with the TCEQ project manager.

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

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

B. Measurement and Data Acquisition

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

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

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

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

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

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

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

C. Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked that input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan.
- Checked that correct output data were produced (includes interim output [output that becomes input to a subsequent step in the inventory development process], as well as the final product). Records were kept of the checks performed.

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

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

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

D. Data Validation and Usability

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

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

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

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

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

- Input data preparation checks:
    - Verified the basis of input data sets against the pre-analysis plan: Actual historical or latest available data, validated model, expected values or regulated limits, regulatory program design, model defaults, surrogates, professional judgment; checked aggregation levels.
    - Data development: Depending on the procedure and particular input data set, calculations were verified (e.g., re-calculated independently and compared with originally prepared values – when spot-checking a series of results, included extremes and intermediate values).

  - Completeness: Verified that input data sets were within the required dimensions, and all required fields were populated and properly coded or labeled.
  - Format: Verified that formats were within required specifications (e.g., field positions, data types and formats, and file formats), if any.
  - Reasonability checks: (discussed in the next section).
  - Ensured that any inputs provided from external sources were quality assured, as listed previously.
- Checked the model or utility execution instructions:
  - Verified that the correct number of utility or model run specifications were prepared for each application (e.g., by year, county, season, day type).
  - Verified that each utility or model run script included the correct modeling specifications for the application per applicable user guide (e.g., commands, input values, input and output file paths, output options).
- Checked for the successful completion of model and utility executions:
  - Verified that the correct number of each type of output file was produced by the particular model or utility.
  - Checked for any unusual output file sizes.
  - Searched output for warnings and errors (e.g., utility listing files or model execution logs that contain error and warning records).
  - Checked the summary information provided in output listing files for any unusual results.

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

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

- Calculated county, 24-hour, aggregate emissions rates (from aggregate VMT and emissions output) and compared the rates between counties examining the results for outliers while assessing the reasonability of any relative and directional differences (e.g., qualify based on activity distributions by road type and speed, mix of vehicles by road type, meteorological variation, control program coverage). Compared the results to results from previous emissions analyses where available.
- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns.

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

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APPENDIX A:
HGB RFP ON-ROAD INVENTORIES ELECTRONIC DATA SUBMITTAL

HGB RFP MOVES-Based, County-Level, On-Road Emissions Inventories and Control Measure Emissions Reductions Estimates – Electronic Data Submittal

This appendix describes the electronic data package TTI submitted to TCEQ per Amendment No. 1 to Proposal for Grant Activities No. 582-16-63597-04.

Data File Labels Key

The MOVES rates-per-activity, TDM link-based method externally combined emissions rates and activity factors to produce ozone season weekday county inventories.[28] The seven HGB Area RFP inventories (by county, 56 provided), in terms of activity and emissions rates, are:

HGB Area RFP On-Road Inventory Scenario Descriptions and Data Labels.

Number	RFP Inventory	Activity[1]	Emissions Rates[2]
1 (2011 CSC)	2011 Control Strategy (Base Year)	2011	2011 Control Strategy (CSC)
2 (2017 ABY)	2017 Adjusted Based Year		2017 Pre-1990 Controls (CS0)
3 (2018 ABY)	2018 Adjusted Based Year		2018 CS0
4 (2017 CS0)	2017 Pre-1990 Controls	2017	2017 CS0
5 (2017 CSC)	2017 Control Strategy		2017 CSC
6 (2018 CS0)	2018 Pre-1990 Controls	2018	2018 CS0
7 (2018 CSC)	2018 Control Strategy		2018 CSC

[1] External activity input includes VMT mix, link VMT/speeds, and off-network activity.
[2] "Pre-1990 Controls" (CS0) rates model future year fleets with pre-1990 controls: excludes I/M program, post-1990 FMVCP, Ultra Low Sulfur Diesel, Tier 3 RFG (summer 1992 gasoline parameters were used with 1992 RVP limit promulgated prior to 1990 CAAA enactment), and TxLED fuel. "Control Strategy" (CSC) rates model control measures for an analysis year's current regulations (all controls through the evaluation year).

Representative county (Harris) inventory scenarios (CS1, CS2, and CS3) were produced for estimating HGB RFP individual control reductions (2017) and contingency reductions (2018):

[28] Inventories: VOC, CO, NO_x, SO_2, NH_3, $PM_{2.5}$, PM_{10}, and CO_2. PM includes total exhaust, brakewear and tirewear. In addition to total exhaust, $PM_{2.5}$ exhaust subcomponents included are elemental and organic carbon, sulfate, and composite non-elemental carbon PM.

Representative County Incremental Controls Inventory Descriptions and Data Labels.

Number	Incremental Control Inventory[1]	Activity	Emissions Rates[1]
8 (2017 CS1)	2017 CS0 plus Post-1990 Federal Fuels	2017	2017 CS1
9 (2017 CS2)	2017 CS1 plus Post-1990 FMVCP		2017 CS2
10 (2017 CS3)	2017 CS2 plus I/M Program		2017 CS3
11 (2018 CS1)	2018 CS0 plus Post-1990 Federal Fuels	2018	2018 CS1
12 (2018 CS2)	2018 CS1 plus Post-1990 FMVCP		2018 CS2
13 (2018 CS3)	2018 CS2 plus I/M Program		2018 CS3

[1] CS0 is pre-1990 controls. CS1 is pre-1990 controls (CS0) except with post-1990 federal fuels (Tier 3 RFG and Ultra Low Sulfur Diesel); CS2 is pre-1990 controls plus post-1990 federal fuels plus post-1990 FMVCP; CS3 is pre-1990 controls plus post-1990 federal fuels plus post-1990 FMVCP with I/M program added.

Electronic Media

The electronic data submittal described in the following was provided on one DVD, entitled:[29]

"*HGB RFP MOVES2014a-Based On-Road Mobile Source Inventories – TTI FY2016.*"

Emissions Inventory Data Files:

- RFP inventory and individual control reductions summary tables (one page *.doc file) and individual control reductions calculations spreadsheets (one each for 2017 and 2018).
- RFP inventory and incremental control inventory output files – EmsCalc utility TAB-delimited, hourly and 24-hour inventory report summary files and other associated output files (LSTs and SCC output);
- Inventory extracts – Seven different tab-delimited aggregations extracted from EmsCalc standard output for inventories listed in the previous bullet; and
- XML-formatted inventory summaries (control strategy scenario) for TexAER.

Emissions Factor Data Files:

- MOVES inputs - MOVES run specification files, CDBs, and data and MySQL scripts for building CDBs; and
- Final, MOVES-based, TTI RatesAdj-utility-produced, rate-per-activity emissions factor databses (emissions factor inputs to the external emissions calculations), and TxLED adjustment factor files used.

[29] "***CCCC***" in data descriptions denotes HGB county FIPS codes, which are: Brazoria - 48039, Chambers - 48071, Fort Bend - 48157, Galveston - 48167, Harris - 48201, Liberty - 48291, Montgomery - 48339, and Waller - 48473. Databases provided are MySQL databases, which consist of a folder containing one "db.opt" file and one or more database tables, where each table is composed of three files of the type: *.frm, *.MYD, and *.MYI.

Emissions Inventory Data Files

RFP Inventory Summary Tables and Individual Control Reductions Tables – The HGB Area aggregate RFP inventories and individual control measure reduction estimates summary tables, along with reduction estimates spreadsheet calculations, were provided in the following files:

- HGB RFP summary.doc (summary tables); and
- HGB RFP 2017 Reductions Calc.xlsx and HGB RFP 2018 Reductions Calc.xlsx (controls reduction calculations).

RFP Inventory and Incremental Control Inventory Scenario EmsCalc Output – The EmsCalc output files provided are listed by output filename prefixes below, followed by the three output file type name extensions and data descriptions:

<table>
<tr><th>Year
(YYYY)</th><th>Control Scenario
(SSSS)[1]</th><th>RFP Inventory Scenario EmsCalc Output File Prefixes
(Where CCCC is each HGB Area county FIPS code)</th></tr>
<tr><td>2011</td><td>ABY, CSC</td><td>HGBRFP_MVS14A_CCCC_2011SWK_SSSS_*</td></tr>
<tr><td>2017</td><td>ABY, CS0, CSC</td><td>HGBRFP_MVS14A_CCCC_2017SWK_SSSS_*</td></tr>
<tr><td>2018</td><td>CS0, CSC</td><td>HGBRFP_MVS14A_CCCC_2018SWK_SSSS_*</td></tr>
<tr><td colspan="3">Additional EmsCalc Output Files for Control Reductions Estimation</td></tr>
<tr><td>2017, 2018</td><td>CS1, CS2, CS3</td><td>HGBRFP_MVS14A_48201YYYYSWK_SSSS_*</td></tr>
<tr><td colspan="3">The following three EmsCalc inventory output file-types for each above listed run (62 runs produced 186 output files) were provided in “hgbrfp_mvs14a_emscalc.zip:”
• “*ems.TAB:” a tab-delimited file of hourly and 24-hour activity and emissions summaries (pounds): by roadway and vehicle type (SUT/Fuel Type) for roadway processes – VMT, VHT, average speed (VMT/VHT), and associated pollutant/process emissions; by vehicle type for off-network processes – SHP, SHI and APU Hours, starts, and associated pollutant/process emissions (excluding refueling);
• “*sccoutput_ems.TAB:” a tab-delimited file of 24-hour activity and emissions summaries (pounds) using aggregations, SCCs, and pollutant codes consistent with EPA’s 2014 NEI (for subsequent conversion to XML form uploadable to TexAER); and
• “*ems.LST:” a file listing run times; run script; file locations, data descriptions; data codes keys; tab output data label descriptions; and data summaries including hourly and 24-hour activity, pollutant/process emissions totals, and average speed (VMT/VHT).</td></tr>
</table>

Inventory Extracts – Seven different inventory aggregations extracted from the EmsCalc standard output were provided by year for each RFP inventory and extra incremental control scenario inventory. Output filenames are similar to the EmsCalc output, except with no county codes and with an identifier (***????***) for each aggregation type. One LST file was output for each inventory scenario along with the seven tab-delimited inventory aggregation files:

- HGBRFP_MVS14A_<year>SWK_<type>_EMS_tabtots.LST
- HGBRFP_MVS14A_<year>SWK_<type>_EMS_***????***.TAB

Where the aggregation types "????" are:

- "tabtots" (24-hr totals);
- "tabtots_Hr" (hourly totals);
- "tabtots_HrST" (hourly, SUT/fuel type totals);
- "tabtots_RdType" (hourly, road type totals);
- "tabtots_ST" (24-hr SUT/fuel type totals);
- "tabtots_RdTypeST" (hourly, road type, SUT/fuel type totals); and
- "tabtots_24hourRdTypeST" (24 hour, road type, SUT/fuel type totals).

"HGBrfp_mvs14a_tabtotals.zip" contains the extracts output (104 files).

XML-Formatted 24-Hour Inventory Summaries for the TexAER – Using TTI's MOVESsccXMLFormat utility, TTI post-processed the 24-hour CSC scenario emissions inventory SCC-labeled output from EmsCalc to a form consistent with 2014 NEI EIS CERS XML specifications, for inclusion in the TexAER. The XML summaries use 10-digit SCCs providing the inventory data at the source type and fuel type level. Only VMT activity is reported. Using gasoline passenger cars, for example, the SCCs are:

- On-road processes excluding refueling – 2201210080:
  - 22 – mobile sources;
  - 01 – highway vehicles, gasoline (MOVES fueltypeID);
  - 21 – passenger car (MOVES SourcetypeID);
  - 00 – all road types; and
  - 80 – all on-network and off-network processes (except refueling).

The pollutants included are: VOC, CO, NO_x, SO_2, NH_3, $PM_{2.5}$ and PM_{10} (aggregate of exhaust, tirewear, brakewear), and CO_2. Each run produced a LST file, the XML file, and one tab-delimited SCC-labeled summary per county. The files are named:

- MOVESsccXMLformat_hgbRFP_mvs14a_***YYYY***swk_CSC.LST;
- MOVESsccXMLformat_hgbRFP_mvs14a_***YYYY***swk_CSC.XML; and
- MOVESsccXMLformat_hgbRFP_mvs14a_***YYYY***swk_CSC_***CCCC***_summary.TAB.

"HGBrfp_mvs14a_CSC_XMLformat.zip" contains XML format utility output (30 files).

MOVES Emissions Rates Data Files

The following lists the emissions rate development files and final emissions rates provided. These consist of the MOVES run specification files; MOVES CDB files; MySQL scripts and data files used to produce the CDBs; and additionally the final, MOVES-based emissions rates produced with TTI's RatesAdj utility for input to the external inventory calculations.

MOVES Input Files (CDBs and MRSs), MySQL CDB Scripts, and Final Rates Developed –

<table>
<tr><th>Control Scenario (SSSS)[1]</th><th>Year (YYYY)</th><th>CDB MySQL Script Files; CDBs; MRS Files; Final RatesAdj Rate Tables[2]
(Where CCCC is FIPS county code for each of the eight HGB counties)</th></tr>
<tr><td>CS0
CSC[3]</td><td>2011
2017
2018</td><td>mvs14a_hgbrfp_YYYYswkd_SSSS_CCCC_er_cdb_in.SQL
mvs14a_hgbrfp_YYYYswkd_SSSS_CCCC_er_cdb_in
mvs14a_hgbrfp_YYYYswkd_SSSS_CCCC_er.mrs
mvs14a_hgbrfp_YYYYswkd_SSSS_CCCC_er _outRatesAdj</td></tr>
<tr><td>CS1</td><td>2017
2018</td><td>mvs14a_hgbrfp_YYYYswkd _CS1_48201_er_cdb_in.SQL
mvs14a_hgbrfp_YYYYswkd _CS1_48201_er_cdb_in
mvs14a_hgbrfp_YYYYswkd _CS1_48201_er.mrs
mvs14a_hgbrfp_YYYYswkd _CS1_48201_er_outRatesAdj</td></tr>
<tr><td>CS2</td><td>2017
2018</td><td>mvs14a_hgbrfp_YYYYswkd _CS2_48201_er.mrs
(used 48201 CS1 CDB -- only change from CS1 is in MRS file)
mvs14a_hgbrfp_YYYYswkd _CS2_48201_er_outRatesAdj</td></tr>
<tr><td>CS3</td><td>2017
2018</td><td>(used MOVES 48201 CSC run output)
mvs14a_hgbrfp_YYYYswkd _CS3_48201_er_outRatesAdj</td></tr>
<tr><td colspan="3">The files were provided in the following zip files:
• hgbRFP_mvs14a_CDBscripts.zip (50 files);
• hgbRFP_mvs14a_CDBs.zip (50 CDBs, 3,050 files);
• hgbRFP_mvs14a_MRSs.zip (52 files);
• hgbRFP_mvs14a_RatesAdjDBs.zip (54 final rates databases, 864 files); and
• mvs14a_txled_analysis_2011-17-18-20-23-26_regdat14_tti.zip (assorted files).[4]</td></tr>
</table>

1 CS0 is pre-1990 controls; CS1 is CS0 + post-1990 federal fuels; CS2 is CS1 + post-1990 FMVCP; CS3 is CS2 + I/M; CSC is CS3 + TxLED.

2 Emissions rates (MySQL databases) input to the emissions inventory calculations (EmsCalc utility).

3 Only the CSC (control strategy) scenario RatesAdj output was adjusted for TxLED effects.

4 Contains TxLED adjustment factor files input to RatesAdj for the CSC scenario rates TxLED adjustments (by year "***YYYY***_NO_x_txledFactors*.tab") along with associated TxLED factors development files.

RatesAdj output (emissions rate look-up table) databases include a "ratesadjrun" table (run log) and four rate tables: "ttirateperdistance" for roadway-based processes; "ttirateperhour," "ttiratepershp," and "ttirateperstart" for off-network processes. Each rates table contains its namesake rates field: ratePerDistance, ratePerHour, ratePerSHP, or ratePerStart. Rates are in terms of pounds per unit of activity. Common fields are: pollutantID, processID, hourID, sourceTypeID, fuelTypeID, and Units_Per_Activity. The ttirateperdistance table also includes the avgSpeedBinID and roadTypeID fields.

County, Scenario MOVES Input Data Loaded in CDBs – Rates mode CDBs input to the MOVES rates mode runs for the rates-per-activity method external emissions inventory calculations were populated with a combination of local data and MOVES default data from the MOVES database (movesdb20151028 available from EPA's MOVES website). The following local data used were provided (103 files in "hgbrfp_mvs14a_localMOVESdata.zip"):

- “hgb_metinputs_summer2011aerr” (database with meteorological inputs – MOVES “county” and “zonemonthhour” tables – and a readme file) (eight files);
- “hgb_fuelsinputs_summer_rfppre1990cs_mvs14a,” “hgb_fuelsinputs_summer2011_mvs14a,” and “_2017plus_1415base_s_6regions_tx_fuels_mvs14a” (three fuels databases of “fuelformulation” and “fuelsupply” tables with a readme file for each, and several data development files for the “2017plus” fuels database, including a spreadsheet “_2017plus_1415base_s_6regions_tx_fuels_mvs14a_workup.xlsx” with additional details in the “notes” tab) (51 files);
- “mvs14a_movesdb20151028_HGB***CCCC_XXXX***j_SUTage.tab” and “*.LST,” where ***XXXX*** is 2011 and 2014 vehicle registration data years and ***CCCC*** is FIPS county code (tab-delimited, county “sourcetypeagedistribution” text files and associated “*.LST” text files from the MOVESfleetbuilder utility runs, plus a readme file) (33 files);
- “mvs14a_movesdb20151028_TX_***XXXX***j_SUTage.tab,” “mvs14_movesdb20151028_TX_***XXXX***j_SUTavft.tab,” and “*.LST,” where ***XXXX*** is 2011 and 2014 registration data years (statewide “sourcetypeagedistribution” and “avft” tab-delimited files and “*.LSTs” from each MOVESfleetbuilder utility run) (six files);
- “_tx1990_19992050_mvs14a_imcoverage_213132” (imcoverage database table used and a readme file) (five files); and
- “MOVESDB20151028” (the MOVES default database, although not provided in this submittal, was also used in building the CDBs).

APPENDIX B:
EMISSIONS ESTIMATION UTILITIES FOR MOVES-BASED EMISSIONS INVENTORIES

TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES2014A-BASED EMISSIONS INVENTORIES

The following is a summary of utilities developed by TTI (written in the Visual Basic programming language) for producing detailed, link-based, hourly, and 24-hour emissions estimates for on-road mobile sources using the latest version of EPA's MOVES model (MOVES2014a). These utilities produce inputs used with the MOVES model, make special adjustments to the emissions factors (when required), and multiply them with travel model link-based or Highway Performance Monitoring System (HPMS)-based (virtual link) activity estimates to produce emissions at user-specified temporal and spatial scales.

The main utilities for calculating hourly and 24-hour emissions using MOVES are TRANSVMT, VirtualLinkVMT, VehPopulationBuild, OffNetActCalc, MOVESactivityInputBuild, MOVESfleetInputBuild, RatesCalc, RatesAdj, and EmsCalc. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The VehPopulationBuild utility builds the vehicle population used to calculate the off-network activity. The OffNetActCalc utility builds the SHP, starts, SHI, and APU hours required to estimate emissions using the rate-per-activity emissions rates produced by the RatesCalc or RatesAdj utilities. The MOVESactivityInputBuild and MOVESfleetInputBuild utilities build inputs used in MOVES. The RatesCalc utility assembles the emissions rates from the MOVES output in terms of rate-per-activity, including rate-per-SHP for the evaporative emissions processes. The RatesAdj utility makes special adjustments to the emissions rates when required. The EmsCalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals), hourly link emissions output files (optional), and an optional tab-delimited summary file by MOVES source classification code (SCC).

A process flow diagram follows the utility descriptions.

TRANSVMT

The TRANSVMT utility post-processes travel demand models (TDMs) to produce hourly, on-road vehicle, seasonal and day-of-week specific, directional link VMT, and speed estimates. The TRANSVMT utility processes a TDM traffic assignment by multiplying the link volumes by the appropriate HPMS, seasonal, or other VMT factors. Hourly factors are then used to distribute the link VMT to each hour in the day. The TTI speed model is used to estimate the operational time-of-day link speeds for each direction. Since intrazonal links are not included in the TDM, special intrazonal links are created and the VMT and speeds for these special links are estimated using the intrazonal trips from the trip matrix and the zonal radii. The link VMT and speeds produced by TRANSVMT are subsequently input to the EmsCalc utility for applying the MOVES-based emissions factors (as well as with other utilities to develop off-network activity estimates).

VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS average annual daily traffic (AADT) VMT, centerline miles, and lane miles by functional classification and area type (from the Texas Department of Transportation's [TxDOT's] annual Roadway Inventory Functional Classification Record [RIFCREC]) to produce hourly, on-road vehicle fleet, seasonal and day-of-week specific actual or projected VMT, and directional operational speed estimates. These estimated VMT and speeds are produced for up to 42 directional HPMS functional classification/area type combinations, or "links." The VirtualLinkVMT utility was developed for use in areas that do not have TDM networks, as well as for inventory applications for which network link-based detail is not required. The main inputs to VirtualLinkVMT are:

- County HPMS data sets, which include AADT VMT, centerline miles, and lane miles by HPMS area type and functional class;
- County-level VMT control totals;
- Hourly VMT distributions; and
- Speed model inputs to include volume/delay equation parameters adapted for HPMS, and free-flow speeds and lane capacities by HPMS functional classification and area type.

VirtualLinkVMT initially scales the county HPMS AADT VMT at the link level to the appropriate VMT (e.g., uses a county-level VMT control total-to-AADT ratio to produce seasonal, day-of-week specific VMT). Hourly factors and directional split factors are applied to the adjusted VMT on each link to estimate the hourly, directional VMT (and volumes) by HPMS link. Congested speed models, each for the high- and low-capacity links, are used to estimate the hourly operational speeds by direction for each link. The operational speeds are based on volume/capacity (v/c)-derived directional delay (minutes/mile) applied to the estimated free-flow speeds for each link. The virtual-link VMT and speeds produced using the VirtualLinkVMT utility are an input to the emissions calculation utility, EmsCalc (as well as with other utilities to develop off-network activity estimates).

VehPopulationBuild

The VehPopulationBuild utility builds the sourcetypeyear data files in a format consistent with the MOVES input database table and the SUT/fuel type population input file (can be used with the EmsCalc utility to estimate emissions or the OffNetActCalc utility to estimate starts and SHP) using the VMT mix and the Texas Department of Motor Vehicles (TxDMV) registration data sets. The TxDMV registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- County ID file, which specifies the county for which the output will be calculated;
- Age registration data file, which lists 31 years of registration data for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, Gas >60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000, and Diesel Totals diesel truck categories;

- VMT mix by TxDOT district, MOVES SUT, and MOVES fuel type;
- TxDOT district name file, which specifies the VMT mix TxDOT district;
- MOVES default database;
- Population factor file (optional); and
- Year ID file (optional, only used if population factors are used), which specifies the year for calculating the output.

For the desired county (from the county ID file), the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, and Gas >60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, and Diesel >60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array. The age registration data array and the diesel/gas registration data array are combined to form the registration category data array (seven categories for 31 years of data and the total) using the combinations in Table 26.

Table 26. Registration Categories.

Registration Category	Vehicle Category	Data Location
1	Passenger Vehicle	Age registration data array
2	Motorcycles	
3	Total Trucks <=8500	
4	Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000	Diesel/gas registration data array
5	Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000	
6	Gas >8500, Gas >10000, Gas >14000, Gas >16000	
7	Gas >19500, Gas >26000, Gas >33000, Gas >60000	

The registration category data array is used to fill the SUT population array (by SUT and fuel type) for all vehicles except long-haul trucks. Each SUT/fuel type combination is assigned the total registrations from one or more of the registration categories in the registration category data array. Table 27 shows the SUTs and their associated registration category in the registration category data array.

Table 27. SUT/Registration Category Correlation.

SUT	Registration Category
11	2
21	1
31, 32	3
41, 42, 43, 51, 52, 54	4 + 6
61	5 + 7

SUT population factors are calculated by SUT/fuel type using the data from the VMT mix input for all SUTs except motorcycles (SUT 11) and the long-haul trucks (SUTs 53 and 62) and saved in the SUT population factors array. For SUT 21, the fuel type VMT mix is divided by the total VMT mix for SUT 21. For SUT 31, the fuel type VMT mix is divided by the total VMT mix for SUTs 31 and 32. The same process applies to SUT 32. For SUT 41, the fuel type VMT mix is divided by the total VMT mix for SUTs 41, 42, 43, 51, 52, and 54. The same process applies to SUTs 42, 43, 51, 52, and 54. For SUT 61, the fuel type VMT mix is divided by the total VMT mix for SUT 61.

For SUT 11, the SUT population factor for fuel type 1 (gasoline) is set 1 with all other factors set to 0. For SUT 53, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 53 by the fuel type VMT mix for SUT 52. For SUT 62, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 62 by the fuel type VMT mix for SUT 61, therefore creating a ratio of long-haul and short-haul trucks.

The SUT population factors and the population factor (if desired) are applied to the SUT population array for all SUTs except SUT 53 and 62. For SUT 53, the SUT population factors for SUT 53 are applied to the SUT population array for SUT 52. For SUT 62, the SUT population factors for SUT 62 are applied to the SUT population array for SUT 61.

Using the appropriate MySQL code, a new sourcetypeyear database table is created. The data in the SUT population array is aggregated by fuel type and used to fill the sourcetypeyear database table, along with the yearID, salesGrowthFactor, and migrationrate. For the yearID, the year of the registration data is used, unless a population factor is used, in which case the year from the year ID input is used. The salesGrowthFactor and migrationrate for each SUT is set 1. A text format of this database table is written by the utility as well. The SUT/fuel type population input file is written using the SUT population array.

OffNetActCalc

The OffNetActCalc calculates the analysis scenario (i.e., year, season, day type) SHP, starts, SHI, and APU hours by hour, SUT, and fuel type used to estimate emissions using the EmsCalc utility. The SHI and APU hours are only calculated for SUT 62, fuel type 2 (CLhT_Diesel). The SHP is calculated using either the TDM or the virtual-link-based link VMT and speeds (same as used in the distance-based emissions estimation), the 24-hour or time period VMT mix (by roadway type and SUT/fuel type), and the SUT/fuel type population (from the VehiclePopulationBuild utility). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically the MOVES default). The SHI and APU hours are a function of hotelling hours. This utility has two options for calculating the hotelling hours. Using the first option, the analysis scenario 24-hour hotelling hours is calculated using a user-supplied extended idle factor to the source hours operating (SHO). However, this method of estimating the hotelling hours as a direct function of the SHO does not consider the availability of locations where extended idling may occur. The second option (and suggested method) uses base data (24-hour hotelling, link VMT and speeds, and VMT mix), the analysis scenario data used to calculate the SHP, and the analysis scenario SHP to calculate the analysis scenario 24-hour hotelling hours.

For the analysis scenario first hourly VMT and speeds input, the utility applies the appropriate VMT mix (either the 24-hour VMT mix or the appropriate time period VMT mix as assigned by the user) to each link that has the desired county code; thus distributing the link VMT to each SUT/fuel type, which is added to the hourly SUT/fuel type VMT. The link VMT by SUT/fuel type is divided by the link speed to calculate the link VHT (or SHO) by SUT/fuel type, which is added to the SUT fuel/type VHT. This calculation process is repeated for each analysis scenario VMT and speeds input; therefore producing the analysis scenario hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The analysis scenario hourly SUT/fuel type speed, total hours (or source hours), and SHP are then calculated. For each hour and SUT/fuel type, the hourly SUT/fuel type VMT is divided by the hourly SUT/fuel type VHT to calculate the hourly SUT/fuel type speed. The hourly SUT/fuel type total hours are set equal to the SUT/fuel type population. The hourly SUT/fuel type SHP is calculated by subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours. If the calculated SHP is negative (i.e., SHO is greater than the total hours), the SHP is set to 0.

To calculate the analysis scenario 24-hour hotelling hours under option 1 (as a direct function of SHO), the utility multiplies the CLhT_Diesel analysis scenario 24-hour SHO by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. For option 2 (as a function of base hotelling data), the utility calculates the base 24-hour CLhT_Diesel VMT using the base VMT and speeds inputs and the base VMT mix with the same procedure used in the analysis scenario SHP calculations. The 24-hour analysis scenario CLhT_Diesel VMT is then divided by the 24-hour base CLhT_Diesel VMT to create a scaling factor, which is then applied to the base 24-hour hotelling hours to calculate the analysis scenario 24-hour hotelling hours.

The utility then calculates the analysis scenario hourly hotelling hours. The analysis scenario hourly CLhT_Diesel SHO (from the SHP calculation process) is converted to hourly VHT fractions. The hourly hotelling fractions are calculated as the inverse of the hourly VHT fractions. The hourly hotelling fractions are then applied to the analysis scenario 24-hour hotelling hours to calculate the hourly hotelling hours. For each hour, the hourly hotelling hours are then compared to the hourly CLhT_Diesel SHP. For those hours where the hotelling hours are greater than the SHP, hotelling hours are set to the SHP for that hour.

The utility then calculates the SHI fraction and the APU fraction using the source type age distribution (same distribution used in the MOVES runs), the relative mileage accumulation rates, and the hotelling activity distribution. Travel fractions for SUT 62 (CLhT) by ageID (0 through 30) are calculated by multiplying the age distribution by the appropriate relative mileage accumulation rate, which is then converted into a distribution by dividing the individual travel fraction (ageID 0 through 30) by the sum of the travel fractions. These travel fractions are then applied to the appropriate operating mode fractions from the hotelling activity distribution (operating mode 200) and summed to calculate the SHI fraction. Using a similar process, the APU fraction is calculated using the operating mode fractions for operating mode 201. For each hour the analysis scenario hotelling hours are multiplied by the SHI fraction to calculate the analysis scenario SHI activity and by the APU fraction to calculate the analysis scenario APU hours.

MOVESactivityInputBuild

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeday, sourcetypedayvmt, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction data files in a format consistent with the MOVES input database tables using the link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility, the VMT mix, and the MOVES defaults. The utility also has the option of building the sourcetypeage (adjusted to reflect the 24-hour VMT mix), starts, and hotellinghours data files in a format consistent with the MVOES input database tables using the output from the OffNetActCalc utility, along with inputs from the MOVES runs and the MOVES defaults. The primary inputs to this utility are:

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility;
- County ID file which specifies the county number in the link-based hourly VMT and speeds for which the output will be calculated;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types (same as used with the EmsCalc utility);
- 24-hour or time period VMT mix by roadway type, MOVES source type, and MOVES fuel type (same as used with the EmsCalc utility);
- Day ID, which specifies the MOVES day ID for calculating the output;
- Year ID, which specifies the year for calculating the output;
- Link/Ramp designations, which designates each link roadway type/area type combination to either ramp or non-ramp;
- MOVES default database;
- Month ID, which specifies the month for calculating the output;
- sourcetypeyear, SUT age, and sourcetypeage inputs from the MOVES runs (optional, only if sourcetypeage table output is to be created);

- Starts output from the OffNetActCalc utility (optional, only if starts table output is to be created); and
- Hotelling, extended idle, and APU hours output from the OffNetActCalc utility (optional, only if hotelling table output is to be created).

For each link in the link-based hourly VMT and speeds in which the county number matches the desired county ID, the link VMT is saved in a VMT summary array based on hour, link functional class, and link area type. The link VHT (link VMT/link speed) is saved in a VHT summary array based on hour, link functional class, link area type, and MOVES average speed bin ID (determined using the MOVES average speed bins and the link speed). The link VHT is also saved in a road type VHT array based on link functional class and link area type, and, if the link is specified as ramp by the link/ramp designations specified by the user, the VHT is additionally saved in the ramp segment of the road type VHT array.

A MOVES roadway type array by MOVES roadway type (roadTypeID codes 2 through 5) is also created using the data in the VMT summary array and VMT roadway type designations. For the link road types designated a MOVES road type of 6 or 8, the VMT is added to MOVES road type 2 in the MOVES roadway type array. For the link road types designated a MOVES road type of 7 or 9, the VMT is added to MOVES road type 4 in the MOVES roadway type array. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the VMT roadway type designations, and the VMT mix. If the time period VMT mix is used, each hour is assigned a time period by the user. Otherwise, the same 24-hour VMT mix is used for all hours. An average speed distribution array (by MOVES SUT, MOVES roadway type, hour, and MOVES speed bin) is created using the VHT summary array and the VMT mix. Using the appropriate MySQL code, the MOVES roadtypedistribution, hourvmtfraction, and avgspeeddistribution default values are extracted and saved for later use.

The VMT in the MOVES roadway type array is used to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is converted to a distribution by MOVES SUT (i.e., the total for a SUT over the five MOVES roadway types should equal 1), with the distribution value for MOVES roadway type 0 (Off-Network) equal to 0. The utility writes the tab-delimited roadtypedistribution table output (optional).

The VMT in the hourly VMT array is added to the hourly VMT fraction array (by SUT, MOVES roadway type, and hour) and for those roadway types where the VMT for all hours is greater than 0, this VMT is converted to an hourly distribution. For those roadway types where the VMT is equal to 0, a value of 1 is placed in the first hour, followed by 0 in the remaining hours. The utility writes the tab-delimited hourvmtfraction table output (optional). For those SUTs where the VMT mix is greater than 0, the hourly VMT fraction array is used. Otherwise, the MOVES hourvmtfraction default values are used.

The VHT in the average speed distribution array is converted to a distribution by SUT, MOVES roadway type, hour/day (combination of hour and the day ID specified by the user), and MOVES average speed bin. The utility writes the tab-delimited avgspeeddistribution table output (optional). For those SUTs where the VMT mix is greater than 0, the average speed distribution array is used. Otherwise, the MOVES avgspeeddistribution default values are used.

The VHT in the road type VHT array is converted to a proportion of ramp VHT by dividing the ramp segment of the road type VHT array by the total VHT for the road type in the road type VHT. The utility writes the tab-delimited roadtype table output (optional). If the ramp fraction for roadTypeID 2 is greater than 0, then roadTypeID 6 (with rampFraction equal to 0) and roadTypeID 8 (with rampFraction equal to 1) are also added to the roadtype database table. If the ramp fraction for roadTypeID 4 is greater than 0, then roadTypeID 7 (with rampFraction equal to 0) and roadTypeID 9 (with rampFraction equal to 1) are also added to the roadtype database table.

The VMT in the hourly VMT array is aggregated to create the 24-hour HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUTs 21, 31 and 32 are HPMS vehicle type 25; SUTs 41, 42, and 43 are HPMS vehicle type 40; SUTs 51, 52, 53, and 54 are HPMS vehicle type 50; and SUTs 61 and 62 are HPMS vehicle type 60). The utility writes the tab-delimited hpmsvtypeday table output (optional).

The VMT in the hourly VMT array is also aggregated by SUT to create the 24-hour SUT VMT array. Using this VMT data, the utility writes the tab-delimited sourcetypedayvmt output table (optional) in a format consistent with the MOVES input.

Using the appropriate MySQL code, the fuel year ID is extracted from the MOVES default year database table for the user-supplied year ID. The tab-delimited year table output is written (optional) using the user-supplied year ID and the extracted fuel year ID. The "isbaseYear" data is written as well (automatically set to "Y").

The utility also produces two tab-delimited summary output files. A tab-delimited VMT summary is output by hour, link road type, and link area type for the user-specified county. A tab-delimited VHT summary is output by hour, link road type, link area type, and MOVES average speed bin for the user-specified county.

The utility creates five other tab-delimited outputs (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction tables) using the user-supplied inputs. For the state table (optional), the utility extracts the data from the MOVES default state database table where the state ID is 48 and writes this data to the tab-delimited state table output. For the zone table (optional), the utility extracts the data from the MOVES default zone data for the county ID greater than 48000 and county ID less than 49000 and writes this data to the tab-delimited zone table output with the start allocation factors, idle allocation factors, and SHP allocation factors replaced with values of 1.

For the zoneroadtype table (optional), the utility extracts the MOVES default zoneroadtype data where the zone ID greater than 480000 and zone ID less than 490000 and writes this data to the tab-delimited zoneroadtype table output, with the SHO allocation factors replaced with values of 1. For the monthvmtfraction table (optional), the utility extracts the data from the MOVES default monthvmtfraction table and writes the data to the tab-delimited monthvmtfraction table output with the month VMT fraction set to 1 for the user-supplied month ID and 0 for all other months. For the dayvmtfraction table (optional), the utility extracts the data from the MOVES default dayvmtfraction table and writes this data to the tab-delimited dayvmtfraction table output with the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

For the sourcetypeage table output (optional, also needed if the hoteling hours table output is to be created), the utility calculates the adjusted relative mileage accumulation rates (MAR) by multiplying the input relative MAR (categorized by SUT and age from the sourcetypeage input) by the SUT-specific relative MAR adjustment factors (one factor per SUT applied across all age categories). These adjustment factors are calculated using inventory SUT VMT fractions within each HPMS vehicle type and the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type. The inventory SUT VMT fractions within each HPMS vehicle type are calculated by dividing the 24-hour SUT VMT by the 24-hour HPMS vehicle type VMT for the respective SUT.

For the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type, the utility uses the same calculation procedures used by MOVES to calculate the normalized travel fractions. The SUT vehicle population is distributed to each age category using the SUT age distribution input. Using the sum of the vehicle population by HPMS vehicle type, the SUT population fraction for each age category within each HPMS vehicle type is calculated by dividing the SUT vehicle population by age by the sum of the vehicle population by HPMS vehicle type. The utility then calculates the initial travel fractions (by SUT and age) by multiplying the SUT population fraction for each age category within each HPMS vehicle type by the relative MAR input.

These initial travel fractions are then normalized within each HPMS vehicle type to produce the SUT and age-specific normalized travel fractions within each HPMS vehicle type. The utility then calculates the SUT-specific relative MAR adjustment factors by dividing the inventory SUT VMT fractions within each HPMS vehicle type by the sum of the SUT and age-specific normalized travel fractions (i.e., aggregated across the age category for each SUT); resulting in one SUT-specific relative MAR adjustment factor for each SUT.

For the starts table output (optional), the utility aggregates the SUT/fuel type hourly starts input (output from the OffNetActCalc utility) by SUT and multiplies the SUT hourly starts by the SUT age distribution (by SUT) to distribute the hourly SUT starts to each age category. The SUT hourly starts by age are written to the starts table output file, along with the user-supplied monthID, yearID, dayID (used to form the output hourDayID), and zoneID (set using the user-supplied county FIPS code.

For the hoteling hours table output (optional), the utility uses travel fractions specific to SUT 62 to distribute the hourly hoteling hours input (output from the OffNetActCalc utility) to each age category. These travel fractions are calculated by multiplying the SUT 62 age distribution by the calculated relative mileage accumulation rates (MOVES defaults adjusted so to reflect the emissions inventory 24-hour VMT mix) for each age category and dividing by the sum of the product for all the age categories. These travel fractions are multiplied by the hourly hoteling hours input and written to the hoteling hours table output, along with the user-supplied dayID (used to form the output hourDayID), monthID, yearID, and zoneID (set using the user-supplied county FIPS code.

MOVESfleetInputBuild
The MOVESfleetInputBuild utility builds the sourcetypeagedistribution database table and fuel/engine fraction inputs to MOVES using the TxDOT registration data sets and the MOVES default database tables. The TxDOT registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- Age registration data file, which lists 31 years of registration data for the Passenger Vehicles, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, Gas > 60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, Diesel > 60000, and Diesel Totals diesel truck categories;
- SUT data sources input, which specifies the data source for each SUT to use when building the sourcetypeagedistribution database table;
- Fuel/engine fractions data sources input, which specifies the data source for each SUT to use when building the fuel/engine fractions;
- Default sourcetypeage distribution input;
- MOVES default database; and
- Year ID file (optional, only if year is not the registration data year as in a future year analysis), which specifies the year for calculating the output.

The SUT data sources input lists the data source for each SUT, either a single county, multiple counties, state, or MOVES default. As this input is processed, the utility maintains a list of the input sources. The same applies to the fuel/engine fractions, except data source inputs are only valid for source types 52, 53, and 61 (other are not valid due to data limitations and source type 62 are all considered diesel).

For each county (or state total) in the list of the input sources, the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, and Diesel > 60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array.

The age registration data array and the diesel/gas registration data array are combined to create the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 26 (Registration Categories**)**. The county is compared to the data sources for each SUT in the SUT data sources input. If the county is found for a given source type, then the 31 years of registration data from the source type's corresponding category in the registration category data array are added to the SUT age distribution array. Table 28 shows the source types and their corresponding registration categories.

Table 28. SUTs/Registration Categories Correlation for SUT Age Distribution.

SUT	Registration Category
11	2
21	1
31, 32	3
52, 53	4
61, 62	5

A similar process is followed for the fuel/engine fractions array. However, only SUTs 52, 53, 61, and 62 are processed due to data limitations. The registration data are saved in the fuel/engine fractions array based on fuel type. Table 29 shows the SUTs and their corresponding registration categories.

Table 29. SUTs/Registration Categories Correlation for Fuel/Engine Fractions.

<table>
<tr><th>SUT</th><th>Fuel Type</th><th>Registration Category</th></tr>
<tr><td rowspan="2">52, 53</td><td>Diesel</td><td>4</td></tr>
<tr><td>Gas</td><td>6</td></tr>
<tr><td rowspan="2">61</td><td>Diesel</td><td>5</td></tr>
<tr><td>Gas</td><td>7</td></tr>
<tr><td rowspan="2">62</td><td>Diesel</td><td>5 + 7</td></tr>
<tr><td>Gas</td><td>None – all are assumed diesel</td></tr>
</table>

After processing all of the counties, the data from the default sourcetypeage distribution input are processed and the data for the registration data year are saved in the default age distribution array. For each source type in which the registration data are to be used for the age distribution, the 31 years of registration data in the SUT age distribution array are converted to a distribution by dividing the source type yearly registration data by the source type total registration data. For each source type in which the defaults are to be used, the defaults values from the default age distribution array are copied to the SUT age distribution array.

The MOVES default fuel/engine fractions are extracted from the MOVES default database (using the appropriate code for MySQL) and saved in the default fuel/engine fractions array. For source types 52, 53, and 61, the source type yearly registration data in the fuel/engine fractions array are converted to fuel/engine fractions by dividing the yearly source type diesel registration data by the sum of the yearly source type diesel registration data and the yearly source type gas registration data.

If the year ID input is used, then these fuel/engine fractions are adjusted to match the year from the year ID input. If the year from the year ID input is greater than the registration data year, then the first fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the end of the fuel/engine fractions to maintain the appropriate distribution. If the year from the year ID input is less than the registration data year, then the last fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the beginning of the fuel/engine fractions to maintain the appropriate distribution. For source type 62, all of the fuel/engine fractions in the fuel/engine fractions array are set to a value of 1.

Using the appropriate MySQL code, a new sourcetypeagedistribution database table is created and the data from the SUT age distribution array, along with the year ID (either from the registration data or the year ID input), are used to fill the new database table. A text format of this database table may be written as well. Using the appropriate MySQL code, a new AVFTfuelengfraction database table is created and the data from the fuel/engine fractions array are used to fill the new database table for SUTs 52, 53, 61, and 62. For all other SUTs, the default fuel/engine fraction array data for the appropriate year (either the registration data year or the year ID input) are used to fill the new database table. A text format of this database table may be written as well.

RatesCalc

The RatesCalc utility calculates emissions rates in terms of rate/SHP for the evaporative emissions processes using the data in the CDB used in the MOVES emissions rates run and the MOVES default database. The utility also creates copies of the rateperdistance, rateperhour, and rateperstartemissions rate tables to include the units for each pollutant. If not specified, emissions rates are assembled for each pollutant and process combination (excluding total energy and the refueling emissions processes) in the MOVES emissions rate tables. The utility also uses the movesrun database table, along with a pollutant energy or mass lookup table (mass, TEQ, or gmole), to determine the units of the emissions rates, which are added to the emissions rate tables, which will allow the user to specify any of the units available in MOVES for the MOVES emissions rate run. The type of activity used for the emissions rate calculation is determined by the process, as Table 30 shows.

Table 30. MOVES2014a Emissions Process and Corresponding Activity for Rate-per-Activity Emissions Rates.

MOVES2014a Emissions Process	Activity	Emissions Rate Units
Running Exhaust	Miles Traveled	Rate/Mile
Crankcase Running Exhaust	Miles Traveled	Rate/Mile
Start Exhaust	Starts	Rate/Start
Crankcase Start Exhaust	Starts	Rate/Start
Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Crankcase Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Auxiliary Power Exhaust	APU Hours	Rate/APU Hour
Evaporative Permeation	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Vapor Venting	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Leaks	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Brake Wear	Miles Traveled	Rate/Mile
Tire Wear	Miles Traveled	Rate/Mile

For the rateperdistance (rate/mile emissions rates) emissions rate table, the utility creates a copy of the emissions rates in the specified output database with the table name ttirateperdistance. If specific pollutants are specified, only the emissions rates for those pollutants are copied to the ttirateperdistance table. Otherwise, the entire rateperdistance table is copied to the ttirateperdistance table. The utility also adds a "Units_Per_Activity" field to the ttirateperdistance table and fills that field based on the pollutants energy or mass designation (mass, TEQ, or gmole). For those pollutants designated as mass, the mass units from the movesrun table are added to the "Units_Per_Activity" field. For those pollutants designated as gmole, the mass units from the movesrun table, along with the text "-mole" (i.e., pound-mole or gram-mole) are added to the "Units_Per_Activity" field. For those pollutants designated as TEQ, the text "TEQ" is added to the "Units_Per_Activity" field. No unit conversions are performed in this utility. The rateperstart and rateperhour, emissions rate tables are processed in a similar manner to produce the ttirateperstart and ttirateperhour, emissions rate tables.

For the evaporative emissions rates, the utility uses the CDB from the MOVES run and the MOVES default database to replicate the MOVES vehicle population and SHP calculation process. Using the emissions rates from the rateperprofile and ratepervehicle emissions rate tables, the utility calculates the rate-per-SHP emissions rates by multiplying the emissions rate by the appropriate vehicle population and dividing by the appropriate SHP value. These rate-per-SHP emissions rates are then saved in the ttiratepershp emissions rate table. Similar to the previous RatesCalc emissions rate tables, the "Units_Per_Activity" field is added to the ttiratepershp table and filled based on the pollutants energy or mass designation.

RatesAdj

The RatesAdj utility applies emissions rate adjustments to an emissions rate database table produced by RatesCalc utility (ttirateperdistance, ttirateperstart, ttirateperhour, or ttiratepershp) or by this utility to produce a new emissions rate database table in the same format as the input emissions rate database table. The emissions rate adjustments can be linear adjustments that are applied to all emissions rates or can be applied by SUT, fuel type, pollutant, and process (adjustments may also include roadway type, average speed bin, and hour). The user has the option of selecting which pollutants will be in the new emissions rate database table, along with the output units of the emissions rates. This allows the user to perform any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) without providing any addition adjustment factors. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility. These types of conversions must be made using the emissions rate adjustment factors. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, if the input emissions rate database tables are in the same format.

For the first input emissions rate database table, the utility extracts the emissions rates for the specified pollutants (or all the pollutants if not specified) from the input database emissions rate table, applies the emissions rate adjustments (if necessary) and any unit conversion adjustments, and saves these adjusted emissions rates. If more than one emissions rate database table is input, then the utility performs a similar calculation process to the first input emissions rate database table for each input emissions rate database table. If pollutants are found in more than one input emissions rate database table, the adjusted emissions rates are summed to produce one emissions rate.

After processing all of the input emissions rate database tables, the utility creates a new emissions rate database table in the same format as the first input emissions rate database table and writes the adjusted emissions rates to this new emissions rate database table. Using MySQL code, the utility also creates a minimum and maximum emissions rate summary for each input emissions rate table and the output emissions rate table by pollutant, process, and source type/fuel type, which is written to a tab-delimited file specified by the user.

EmsCalc

The EmsCalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from RatesCalc or RatesAdj), the 24-hour or time period VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (SHP, starts, and SHI). This utility produces a tab-delimited output summary (including hourly and 24-hour totals) and hourly link emissions output files (optional). The primary inputs to EmsCalcare:

- Emissions factors from RatesCalc or RatesAdj;
- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility. For each link, the following information is input to EmsCalc:

link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;

- 24-hour or time period VMT mix by roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity (SHP, starts, SHI, and APU hours) by hour and SUT/fuel type;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types;
- Pollutants input file, which specifies which pollutant/process combinations for which the emissions calculations will be performed and their respective units in the tab-delimited output;
- SCC input file (optional, only if the activity and emissions by SCC are to be created); and
- SCC pollutants input file (optional, only if the activity and emissions by SCC are to be created).

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the roadway-based emissions and the off-network-based emissions. For the roadway-based emissions (ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by roadway type (as designated in the VMT roadway type designations). If the time period VMT mix is input, each hour is assigned a time period by the user. Otherwise, the 24-hour VMT mix is used for all hours. For each pollutant/process combination in the pollutants input file, the emissions factors are selected based on the emissions rate roadway type (as designated in the VMT roadway type designations) and the link speed for each SUT/fuel type combinations listed in the VMT mix. For link speeds greater than 75 mph, the emissions factors for 75 mph are used. For link speeds less than 2.5 mph, the emissions factors for 2.5 mph are used. For those link speeds that fall between the 16 MOVES speeds, the emissions factors are interpolated using the emissions factor interpolation methodology in the following section. These SUT/fuel type combination-specific emissions factors are multiplied by the SUT/fuel type combination-specific VMT to estimate the mobile source emissions for that link by SUT/fuel type combination. If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

For the off-network emissions , the ttirateperstart, ttirateperhour, and ttiratepershp emissions rates(by SUT/fuel type) are multiplied by the appropriate activity, which is determined by the emissions process (see Table 30). If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

The emissions estimates are output in a tab-delimited file (including all of the SUT/fuel type combinations listed in the VMT mix on a single line, separated by a tab character) for the specified county by pollutant, link roadway type, and SUT/fuel type combination for each of the specified episode time periods. A 24-hour (or total if all 24 hours are not specified) output is also included in the tab-delimited file. Only those pollutant/process combinations in the pollutants input file with tab-delimited output units other than “NONE” will appear in the tab-delimited output file. Prior to output, any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) are performed by the utility. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility (these type of unit conversions must be done using the RatesAdj utility). This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by link road type. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination. If specified, the tab-delimited activity and emissions by SCC output file is also created, which lists the activity and emissions for each SCC pollutant by SCC.

Emissions Factor Interpolation Methodology

To calculate emissions factors for link speeds that fall between two of the 16 MOVES speed bin speeds, an interpolation methodology similar to the methodology used with MOBILE6 is used. This methodology interpolates each emissions factor using a factor developed from the inverse link speed and the inverse high and low bounding speed bin speeds. The following is an example for a link speed of 41.2 mph.

The interpolated emissions factor (EF_{Interp}) is expressed as:

$$EF_{Interp} = EF_{LowSpeed} - FAC_{Interp} \times (EF_{LowSpeed} - EF_{HighSpeed})$$

Where:

$EF_{LowSpeed}$ = emissions factor (EF) corresponding to the speed below the link speed;

$EF_{HighSpeed}$ = EF corresponding to the speed above the link speed; and

$$FAC_{Interp} = \left(\frac{1}{Speed_{link}} - \frac{1}{Speed_{low}}\right) \Big/ \left(\frac{1}{Speed_{high}} - \frac{1}{Speed_{low}}\right)$$

Given that:

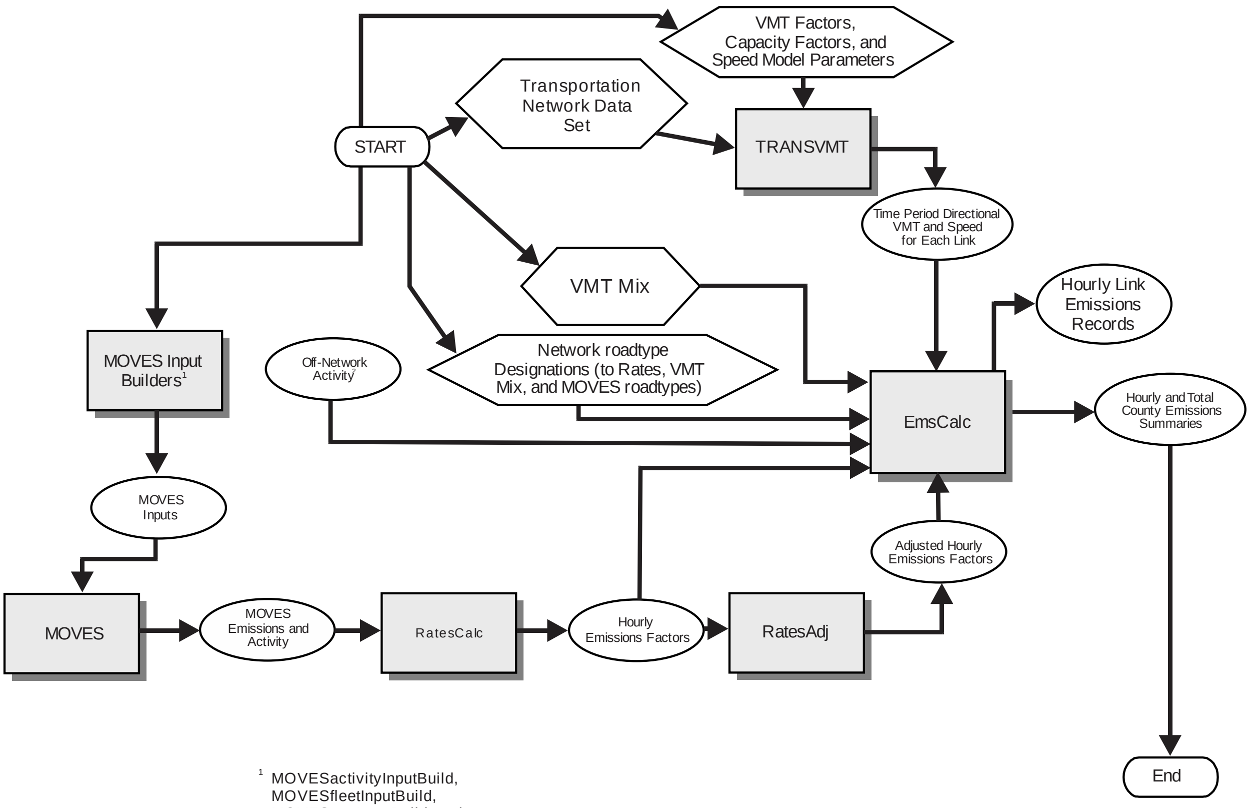
$EF_{LowSpeed}$ = 0.7413 g/mi;
$EF_{HighSpeed}$ = 0.7274 g/mi;
$Speed_{lnk}$ = 41.2 mph;
$Speed_{low}$ = 40 mph; and
$Speed_{high}$ = 45 mph.

$$FAC_{Interp} = \left(\frac{1}{41.2mph} - \frac{1}{40mph}\right) \Big/ \left(\frac{1}{45mph} - \frac{1}{40mph}\right) = \frac{-0.00073}{-0.00278} = 0.26214;$$

$$EF_{Interp} = 0.7413 \text{ g/mi} - (0.26214) \times (0.7413 \text{ g/mi} - 0.7274 \text{ g/mi});$$

$$= 0.7377 \text{ g/mi.}$$

Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates



[1] MOVESactivityInputBuild, MOVESfleetInputBuild, MOVESmetInputBuild, and VehPopulationBuild.

[2] VehPopulationBuild, and OffNetActCalc.

APPENDIX C:
TXDOT DISTRICT VMT MIX BY DAY OF WEEK

TxDOT District/HGB Counties

TxDOT District	HGB County
Beaumont	Liberty
	Chambers
Houston	Harris
	Galveston
	Fort Bend
	Brazoria
	Montgomery
	Waller

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

2010 Weekday VMT Mix - Beaumont TxDOT District (2011 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00200	0.00221	0.00225	0.00237	0.00196	0.00216	0.00217	0.00233	0.00207	0.00241	0.00228	0.00254	0.00169	0.00227	0.00204	0.00239
21_G	0.49880	0.55044	0.55977	0.59080	0.48923	0.53816	0.54090	0.57959	0.51481	0.59952	0.56679	0.63263	0.42150	0.56553	0.50726	0.59411
31_D	0.00303	0.00336	0.00305	0.00377	0.00284	0.00350	0.00288	0.00370	0.00285	0.00348	0.00298	0.00363	0.00241	0.00301	0.00245	0.00390
31_G	0.21360	0.23675	0.21502	0.26562	0.19975	0.24684	0.20314	0.26027	0.20096	0.24487	0.21016	0.25548	0.16991	0.21183	0.17264	0.27439
32_D	0.00298	0.00330	0.00300	0.00370	0.00279	0.00344	0.00283	0.00363	0.00280	0.00341	0.00293	0.00356	0.00237	0.00295	0.00241	0.00383
32_G	0.05323	0.05899	0.05358	0.06619	0.04977	0.06151	0.05062	0.06486	0.05007	0.06102	0.05237	0.06366	0.04234	0.05278	0.04302	0.06837
51_D	0.00156	0.00139	0.00110	0.00113	0.00156	0.00141	0.00128	0.00137	0.00117	0.00092	0.00085	0.00069	0.00131	0.00108	0.00096	0.00079
51_G	0.00044	0.00039	0.00031	0.00032	0.00044	0.00040	0.00036	0.00038	0.00033	0.00026	0.00024	0.00019	0.00037	0.00030	0.00027	0.00022
52_D	0.03363	0.02993	0.02366	0.02436	0.03370	0.03054	0.02769	0.02966	0.02537	0.02007	0.01843	0.01498	0.02897	0.02390	0.02131	0.01752
52_G	0.00943	0.00839	0.00663	0.00683	0.00945	0.00856	0.00776	0.00832	0.00711	0.00563	0.00517	0.00420	0.00812	0.00670	0.00598	0.00491
53_D	0.00173	0.00154	0.00122	0.00126	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00049	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00118	0.00105	0.00083	0.00086	0.00118	0.00107	0.00097	0.00104	0.00088	0.00070	0.00064	0.00052	0.00099	0.00082	0.00073	0.00060
54_G	0.00033	0.00029	0.00023	0.00024	0.00033	0.00030	0.00027	0.00029	0.00025	0.00020	0.00018	0.00015	0.00028	0.00023	0.00020	0.00017
41_D	0.00109	0.00416	0.00132	0.00183	0.00139	0.00192	0.00137	0.00156	0.00104	0.00050	0.00106	0.00090	0.00196	0.00053	0.00151	0.00083
42_D	0.00045	0.00171	0.00054	0.00075	0.00057	0.00079	0.00057	0.00064	0.00043	0.00021	0.00044	0.00037	0.00081	0.00022	0.00062	0.00034
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
43_D	0.00140	0.00534	0.00169	0.00235	0.00179	0.00247	0.00176	0.00200	0.00134	0.00065	0.00136	0.00116	0.00252	0.00069	0.00194	0.00106
43_G	0.00001	0.00005	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00003	0.00001	0.00002	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
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
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

2010 Weekday VMT Mix - Houston TxDOT District (2011 Activity Scenario)

SUF/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00276	0.00267	0.00286	0.00291	0.00253	0.00244	0.00269	0.00271	0.00281	0.00276	0.00290	0.00296	0.00241	0.00271	0.00286	0.00297
21_G	0.68684	0.66377	0.71301	0.72580	0.63085	0.60741	0.66873	0.67461	0.69973	0.68632	0.72275	0.73690	0.59886	0.67428	0.71290	0.73943
31_D	0.00225	0.00277	0.00251	0.00247	0.00234	0.00293	0.00263	0.00267	0.00217	0.00286	0.00251	0.00250	0.00174	0.00271	0.00225	0.00231
31_G	0.15839	0.19490	0.17649	0.17413	0.16458	0.20654	0.18517	0.18797	0.15286	0.20174	0.17659	0.17589	0.12265	0.19072	0.15844	0.16293
32_D	0.00225	0.00277	0.00251	0.00247	0.00234	0.00293	0.00263	0.00267	0.00217	0.00287	0.00251	0.00250	0.00174	0.00271	0.00225	0.00232
32_G	0.03943	0.04851	0.04393	0.04334	0.04097	0.05141	0.04609	0.04679	0.03805	0.05022	0.04396	0.04378	0.03053	0.04747	0.03944	0.04056
51_D	0.00069	0.00095	0.00066	0.00062	0.00086	0.00132	0.00100	0.00101	0.00047	0.00065	0.00048	0.00047	0.00064	0.00073	0.00052	0.00045
51_G	0.00041	0.00057	0.00039	0.00037	0.00051	0.00079	0.00060	0.00060	0.00028	0.00039	0.00029	0.00028	0.00038	0.00043	0.00031	0.00027
52_D	0.01294	0.01788	0.01235	0.01169	0.01650	0.02543	0.01928	0.01941	0.00896	0.01253	0.00928	0.00901	0.01321	0.01496	0.01067	0.00920
52_G	0.00773	0.01068	0.00738	0.00698	0.00986	0.01520	0.01152	0.01160	0.00535	0.00748	0.00554	0.00538	0.00789	0.00893	0.00637	0.00550
53_D	0.00261	0.00361	0.00249	0.00236	0.00291	0.00449	0.00340	0.00343	0.00159	0.00223	0.00165	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00216	0.00149	0.00141	0.00174	0.00268	0.00203	0.00205	0.00095	0.00133	0.00099	0.00096	0.00077	0.00087	0.00062	0.00054
54_D	0.00052	0.00072	0.00050	0.00047	0.00065	0.00100	0.00076	0.00076	0.00035	0.00049	0.00037	0.00035	0.00048	0.00055	0.00039	0.00034
54_G	0.00031	0.00043	0.00030	0.00028	0.00039	0.00060	0.00045	0.00046	0.00021	0.00029	0.00022	0.00021	0.00029	0.00033	0.00023	0.00020
41_D	0.00082	0.00177	0.00151	0.00141	0.00089	0.00102	0.00094	0.00096	0.00070	0.00039	0.00109	0.00053	0.00076	0.00050	0.00109	0.00049
42_D	0.00034	0.00073	0.00062	0.00058	0.00037	0.00042	0.00039	0.00040	0.00029	0.00016	0.00045	0.00022	0.00031	0.00021	0.00045	0.00020
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
43_D	0.00105	0.00228	0.00194	0.00182	0.00114	0.00131	0.00120	0.00123	0.00090	0.00050	0.00140	0.00069	0.00097	0.00065	0.00140	0.00063
43_G	0.00001	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
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
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

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

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00351	0.00387	0.00393	0.00415	0.00344	0.00378	0.00380	0.00407	0.00362	0.00421	0.00398	0.00445	0.00296	0.00397	0.00357	0.00418
21_G	0.49730	0.54879	0.55808	0.58902	0.48775	0.53654	0.53927	0.57784	0.51326	0.59772	0.56508	0.63073	0.42023	0.56383	0.50573	0.59232
31_D	0.00370	0.00410	0.00372	0.00460	0.00346	0.00427	0.00352	0.00450	0.00348	0.00424	0.00364	0.00442	0.00294	0.00367	0.00299	0.00475
31_G	0.21376	0.23692	0.21517	0.26581	0.19989	0.24702	0.20329	0.26046	0.20110	0.24505	0.21032	0.25567	0.17003	0.21198	0.17277	0.27459
32_D	0.00294	0.00325	0.00295	0.00365	0.00275	0.00339	0.00279	0.00358	0.00276	0.00337	0.00289	0.00351	0.00233	0.00291	0.00237	0.00377
32_G	0.05245	0.05813	0.05280	0.06522	0.04905	0.06061	0.04988	0.06391	0.04935	0.06013	0.05161	0.06273	0.04172	0.05202	0.04239	0.06738
51_D	0.00160	0.00142	0.00113	0.00116	0.00159	0.00144	0.00131	0.00140	0.00119	0.00095	0.00087	0.00071	0.00134	0.00111	0.00099	0.00081
51_G	0.00045	0.00040	0.00032	0.00033	0.00045	0.00040	0.00037	0.00039	0.00034	0.00027	0.00024	0.00020	0.00038	0.00031	0.00028	0.00023
52_D	0.03352	0.02983	0.02358	0.02428	0.03359	0.03044	0.02760	0.02956	0.02529	0.02001	0.01837	0.01494	0.02887	0.02382	0.02124	0.01746
52_G	0.00940	0.00836	0.00661	0.00681	0.00942	0.00853	0.00774	0.00829	0.00709	0.00561	0.00515	0.00419	0.00810	0.00668	0.00596	0.00490
53_D	0.00173	0.00154	0.00122	0.00125	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00048	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00126	0.00112	0.00088	0.00091	0.00125	0.00113	0.00103	0.00110	0.00094	0.00074	0.00068	0.00055	0.00105	0.00087	0.00077	0.00064
54_G	0.00035	0.00031	0.00025	0.00026	0.00035	0.00032	0.00029	0.00031	0.00026	0.00021	0.00019	0.00016	0.00030	0.00024	0.00022	0.00018
41_D	0.00035	0.00132	0.00042	0.00058	0.00044	0.00061	0.00044	0.00049	0.00033	0.00016	0.00033	0.00029	0.00062	0.00017	0.00048	0.00026
42_D	0.00069	0.00264	0.00083	0.00116	0.00088	0.00122	0.00087	0.00099	0.00066	0.00032	0.00067	0.00057	0.00124	0.00034	0.00096	0.00053
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
43_D	0.00190	0.00724	0.00229	0.00319	0.00242	0.00335	0.00239	0.00271	0.00181	0.00088	0.00184	0.00157	0.00341	0.00093	0.00262	0.00144
43_G	0.00002	0.00007	0.00002	0.00003	0.00002	0.00003	0.00002	0.00003	0.00002	0.00001	0.00002	0.00002	0.00003	0.00001	0.00003	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
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
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

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

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00483	0.00467	0.00501	0.00510	0.00443	0.00427	0.00470	0.00474	0.00492	0.00482	0.00508	0.00518	0.00421	0.00474	0.00501	0.00520
21_G	0.68477	0.66177	0.71087	0.72362	0.62895	0.60558	0.66671	0.67258	0.69762	0.68425	0.72057	0.73468	0.59706	0.67225	0.71076	0.73721
31_D	0.00274	0.00337	0.00305	0.00301	0.00285	0.00357	0.00320	0.00325	0.00265	0.00349	0.00306	0.00304	0.00212	0.00330	0.00274	0.00282
31_G	0.15851	0.19504	0.17662	0.17426	0.16470	0.20669	0.18530	0.18811	0.15297	0.20188	0.17672	0.17602	0.12274	0.19086	0.15855	0.16304
32_D	0.00214	0.00263	0.00238	0.00235	0.00222	0.00278	0.00250	0.00253	0.00206	0.00272	0.00238	0.00237	0.00165	0.00257	0.00214	0.00220
32_G	0.03893	0.04791	0.04338	0.04280	0.04046	0.05077	0.04552	0.04621	0.03757	0.04959	0.04341	0.04324	0.03015	0.04688	0.03895	0.04005
51_D	0.00070	0.00097	0.00067	0.00064	0.00088	0.00135	0.00103	0.00103	0.00048	0.00067	0.00049	0.00048	0.00066	0.00074	0.00053	0.00046
51_G	0.00042	0.00058	0.00040	0.00038	0.00052	0.00081	0.00061	0.00062	0.00029	0.00040	0.00030	0.00029	0.00039	0.00044	0.00032	0.00027
52_D	0.01290	0.01782	0.01231	0.01165	0.01645	0.02535	0.01922	0.01935	0.00893	0.01249	0.00925	0.00898	0.01317	0.01491	0.01063	0.00917
52_G	0.00771	0.01065	0.00735	0.00696	0.00983	0.01515	0.01148	0.01156	0.00534	0.00746	0.00553	0.00537	0.00787	0.00891	0.00635	0.00548
53_D	0.00260	0.00360	0.00248	0.00235	0.00290	0.00447	0.00339	0.00341	0.00159	0.00222	0.00164	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00215	0.00148	0.00141	0.00173	0.00267	0.00203	0.00204	0.00095	0.00133	0.00098	0.00095	0.00077	0.00087	0.00062	0.00054
54_D	0.00055	0.00076	0.00053	0.00050	0.00069	0.00106	0.00081	0.00081	0.00038	0.00052	0.00039	0.00038	0.00052	0.00058	0.00042	0.00036
54_G	0.00033	0.00046	0.00032	0.00030	0.00041	0.00064	0.00048	0.00049	0.00022	0.00031	0.00023	0.00023	0.00031	0.00035	0.00025	0.00021
41_D	0.00026	0.00056	0.00048	0.00045	0.00028	0.00032	0.00030	0.00030	0.00022	0.00012	0.00035	0.00017	0.00024	0.00016	0.00035	0.00016
42_D	0.00052	0.00112	0.00096	0.00090	0.00056	0.00065	0.00059	0.00061	0.00044	0.00025	0.00069	0.00034	0.00048	0.00032	0.00069	0.00031
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
43_D	0.00142	0.00309	0.00263	0.00246	0.00155	0.00178	0.00163	0.00167	0.00122	0.00068	0.00190	0.00093	0.00132	0.00088	0.00190	0.00086
43_G	0.00001	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
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
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

2020 Weekday VMT Mix - Beaumont TxDOT District (2018 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00451	0.00497	0.00506	0.00534	0.00442	0.00486	0.00489	0.00524	0.00465	0.00542	0.00512	0.00572	0.00381	0.00511	0.00458	0.00537
21_G	0.49630	0.54768	0.55696	0.58783	0.48677	0.53546	0.53819	0.57668	0.51222	0.59651	0.56394	0.62945	0.41938	0.56269	0.50471	0.59112
31_D	0.00391	0.00434	0.00394	0.00487	0.00366	0.00452	0.00372	0.00477	0.00368	0.00449	0.00385	0.00468	0.00311	0.00388	0.00316	0.00503
31_G	0.21354	0.23668	0.21495	0.26554	0.19969	0.24677	0.20308	0.26020	0.20090	0.24480	0.21010	0.25541	0.16986	0.21176	0.17259	0.27431
32_D	0.00288	0.00319	0.00290	0.00358	0.00269	0.00333	0.00274	0.00351	0.00271	0.00330	0.00283	0.00344	0.00229	0.00286	0.00233	0.00370
32_G	0.05251	0.05820	0.05285	0.06529	0.04910	0.06068	0.04994	0.06398	0.04940	0.06019	0.05166	0.06280	0.04177	0.05207	0.04244	0.06745
51_D	0.00156	0.00139	0.00110	0.00113	0.00156	0.00141	0.00128	0.00137	0.00117	0.00092	0.00085	0.00069	0.00131	0.00108	0.00096	0.00079
51_G	0.00044	0.00039	0.00031	0.00032	0.00044	0.00040	0.00036	0.00038	0.00033	0.00026	0.00024	0.00019	0.00037	0.00030	0.00027	0.00022
52_D	0.03363	0.02993	0.02366	0.02436	0.03370	0.03054	0.02769	0.02966	0.02537	0.02007	0.01843	0.01498	0.02897	0.02390	0.02131	0.01752
52_G	0.00943	0.00839	0.00663	0.00683	0.00945	0.00856	0.00776	0.00832	0.00711	0.00563	0.00517	0.00420	0.00812	0.00670	0.00598	0.00491
53_D	0.00173	0.00154	0.00122	0.00126	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00049	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00118	0.00105	0.00083	0.00086	0.00118	0.00107	0.00097	0.00104	0.00088	0.00070	0.00064	0.00052	0.00099	0.00082	0.00073	0.00060
54_G	0.00033	0.00029	0.00023	0.00024	0.00033	0.00030	0.00027	0.00029	0.00025	0.00020	0.00018	0.00015	0.00028	0.00023	0.00020	0.00017
41_D	0.00035	0.00132	0.00042	0.00058	0.00044	0.00061	0.00044	0.00049	0.00033	0.00016	0.00033	0.00029	0.00062	0.00017	0.00048	0.00026
42_D	0.00070	0.00265	0.00084	0.00117	0.00088	0.00122	0.00087	0.00099	0.00066	0.00032	0.00067	0.00057	0.00125	0.00034	0.00096	0.00053
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
43_D	0.00190	0.00723	0.00229	0.00318	0.00241	0.00334	0.00239	0.00270	0.00181	0.00088	0.00184	0.00156	0.00341	0.00093	0.00262	0.00144
43_G	0.00002	0.00007	0.00002	0.00003	0.00002	0.00003	0.00002	0.00003	0.00002	0.00001	0.00002	0.00002	0.00003	0.00001	0.00003	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
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
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

2020 Weekday VMT Mix - Houston TxDOT District (2018 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00621	0.00600	0.00644	0.00656	0.00570	0.00549	0.00604	0.00610	0.00632	0.00620	0.00653	0.00666	0.00541	0.00609	0.00644	0.00668
21_G	0.68339	0.66044	0.70943	0.72216	0.62768	0.60436	0.66537	0.67123	0.69622	0.68288	0.71912	0.73320	0.59585	0.67090	0.70932	0.73572
31_D	0.00306	0.00377	0.00341	0.00337	0.00318	0.00399	0.00358	0.00364	0.00296	0.00390	0.00342	0.00340	0.00237	0.00369	0.00306	0.00315
31_G	0.15818	0.19464	0.17626	0.17390	0.16437	0.20626	0.18492	0.18772	0.15266	0.20147	0.17636	0.17566	0.12249	0.19047	0.15823	0.16271
32_D	0.00214	0.00263	0.00238	0.00235	0.00222	0.00278	0.00250	0.00253	0.00206	0.00272	0.00238	0.00237	0.00165	0.00257	0.00214	0.00220
32_G	0.03893	0.04791	0.04338	0.04280	0.04046	0.05077	0.04552	0.04621	0.03757	0.04959	0.04341	0.04324	0.03015	0.04688	0.03895	0.04005
51_D	0.00069	0.00095	0.00066	0.00062	0.00086	0.00132	0.00100	0.00101	0.00047	0.00065	0.00048	0.00047	0.00064	0.00073	0.00052	0.00045
51_G	0.00041	0.00057	0.00039	0.00037	0.00051	0.00079	0.00060	0.00060	0.00028	0.00039	0.00029	0.00028	0.00038	0.00043	0.00031	0.00027
52_D	0.01294	0.01788	0.01235	0.01169	0.01650	0.02543	0.01928	0.01941	0.00896	0.01253	0.00928	0.00901	0.01321	0.01496	0.01067	0.00920
52_G	0.00773	0.01068	0.00738	0.00698	0.00986	0.01520	0.01152	0.01160	0.00535	0.00748	0.00554	0.00538	0.00789	0.00893	0.00637	0.00550
53_D	0.00261	0.00361	0.00249	0.00236	0.00291	0.00449	0.00340	0.00343	0.00159	0.00223	0.00165	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00216	0.00149	0.00141	0.00174	0.00268	0.00203	0.00205	0.00095	0.00133	0.00099	0.00096	0.00077	0.00087	0.00062	0.00054
54_D	0.00052	0.00072	0.00050	0.00047	0.00065	0.00100	0.00076	0.00076	0.00035	0.00049	0.00037	0.00035	0.00048	0.00055	0.00039	0.00034
54_G	0.00031	0.00043	0.00030	0.00028	0.00039	0.00060	0.00045	0.00046	0.00021	0.00029	0.00022	0.00021	0.00029	0.00033	0.00023	0.00020
41_D	0.00026	0.00056	0.00048	0.00045	0.00028	0.00032	0.00030	0.00030	0.00022	0.00012	0.00035	0.00017	0.00024	0.00016	0.00035	0.00016
42_D	0.00052	0.00113	0.00096	0.00090	0.00057	0.00065	0.00060	0.00061	0.00045	0.00025	0.00070	0.00034	0.00048	0.00032	0.00069	0.00031
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
43_D	0.00142	0.00308	0.00263	0.00246	0.00155	0.00178	0.00163	0.00167	0.00122	0.00067	0.00190	0.00093	0.00131	0.00088	0.00190	0.00086
43_G	0.00001	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
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
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

APPENDIX D:
TXDOT DISTRICT AGGREGATE WEEKDAY VMT MIX

TxDOT District/HGB Counties

TxDOT District	HGB County
Beaumont	Liberty
	Chambers
Houston	Harris
	Galveston
	Fort Bend
	Brazoria
	Montgomery
	Waller

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 - Beaumont TxDOT District

SUT/FT	2010[1]	2015[2]	2020[3]
21_D	0.00216	0.00378	0.00486
21_G	0.53786	0.53624	0.53516
31_D	0.00306	0.00373	0.00395
31_G	0.21559	0.21575	0.21553
32_D	0.00301	0.00296	0.00291
32_G	0.05372	0.05294	0.05300
51_D	0.00122	0.00125	0.00122
51_G	0.00034	0.00035	0.00034
52_D	0.02662	0.02653	0.02662
52_G	0.00746	0.00744	0.00746
53_D	0.00105	0.00105	0.00105
53_G	0.00029	0.00029	0.00029
54_D	0.00092	0.00098	0.00092
54_G	0.00026	0.00028	0.00026
41_D	0.00147	0.00046	0.00046
42_D	0.00060	0.00093	0.00093
42_G	0.00000	0.00000	0.00000
43_D	0.00188	0.00255	0.00255
43_G	0.00002	0.00003	0.00003
61_D	0.03848	0.03848	0.03848
61_G	0.00381	0.00381	0.00381
62_D	0.09962	0.09962	0.09962
62_G	0.00000	0.00000	0.00000
11_G	0.00054	0.00054	0.00054

[1] 2011 activity scenario.
[2] 2017 activity scenario.
[3] 2018 activity scenario.

Aggregate Weekday VMT Mix - Houston TxDOT District

SUT/FT	2010[1]	2015[2]	2020[3]
21_D	0.00278	0.00487	0.00626
21_G	0.69244	0.69036	0.68897
31_D	0.00253	0.00308	0.00344
31_G	0.17786	0.17799	0.17763
32_D	0.00253	0.00240	0.00240
32_G	0.04427	0.04372	0.04372
51_D	0.00077	0.00079	0.00077
51_G	0.00046	0.00047	0.00046
52_D	0.01492	0.01487	0.01492
52_G	0.00891	0.00889	0.00891
53_D	0.00247	0.00246	0.00247
53_G	0.00148	0.00147	0.00148
54_D	0.00058	0.00062	0.00058
54_G	0.00035	0.00037	0.00035
41_D	0.00107	0.00034	0.00034
42_D	0.00044	0.00068	0.00068
42_G	0.00000	0.00000	0.00000
43_D	0.00138	0.00187	0.00186
43_G	0.00001	0.00002	0.00002
61_D	0.01936	0.01936	0.01936
61_G	0.00157	0.00157	0.00157
62_D	0.02313	0.02313	0.02313
62_G	0.00000	0.00000	0.00000
11_G	0.00070	0.00070	0.00070

[1] 2011 activity scenario.
[2] 2017 activity scenario.
[3] 2018 activity scenario.

APPENDIX E:
CAPACITY FACTORS, SPEED FACTORS, AND SPEED REDUCTION FACTORS

Capacity Factors

Time of Day Assignment	Capacity Factor[1]
AM Peak	0.3333333
Mid-Day	0.1666667
PM Peak	0.2500000
Overnight	0.0909091

[1] To obtain hourly capacities, a single capacity factor for each time-of-day assignment is used for all area types and functional classifications.

Free-Flow (V/C=0) Speed Factors for Houston/Galveston Speed Model

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
1	Urban Interstate	1	CBD	50.85	56.40	1.10906
1	Urban Interstate	2	Urban	52.55	61.40	1.16842
2	Urban Other Freeway	1	CBD	N/A	58.00	1.21154
2	Urban Other Freeway	2	Urban	52.00	63.00	1.21154
3	Toll Road	1	CBD	N/A	34.50	0.62652
3	Toll Road	2	Urban	57.58	36.08	0.62652
3	Toll Road	3	Urban Fringe	61.69	36.14	0.58577
3	Toll Road	4	Suburban	64.34	37.99	0.59040
3	Toll Road	5	Rural	59.13	38.43	0.64991
4	Ramp	1	CBD	28.62	35.13	1.22734
4	Ramp	2	Urban	40.06	36.26	0.90509
4	Ramp	3	Urban Fringe	43.22	38.52	0.89119
4	Ramp	4	Suburban	44.82	45.71	1.01987
4	Ramp	5	Rural	55.16	52.11	0.94478
5	Urban Principal Arterial	1	CBD	24.72	26.52	1.07262
5	Urban Principal Arterial	2	Urban	35.78	29.69	0.82974
6	Urban Other Arterial	1	CBD	22.00	24.64	1.11996
6	Urban Other Arterial	2	Urban	34.57	27.31	0.79001
7	Urban Collector	1	CBD	20.94	24.17	1.15413
7	Urban Collector	2	Urban	35.36	25.78	0.72901
10	Rural Interstate	3	Urban Fringe	57.84	61.40	1.06152
10	Rural Interstate	4	Suburban	59.15	67.20	1.13613
10	Rural Interstate	5	Rural	62.00	68.57	1.10599
11	Rural Other Freeway	3	Urban Fringe	62.00	63.00	1.01613
11	Rural Other Freeway	4	Suburban	62.00	69.00	1.11290
11	Rural Other Freeway	5	Rural	64.00	71.00	1.10938
12	Rural Principal Arterial	3	Urban Fringe	40.23	33.75	0.83890
12	Rural Principal Arterial	4	Suburban	46.12	42.48	0.92125
12	Rural Principal Arterial	5	Rural	60.00	55.53	0.92536
13	Rural Other Arterial	3	Urban Fringe	39.05	30.51	0.78131
13	Rural Other Arterial	4	Suburban	43.03	39.85	0.92612
13	Rural Other Arterial	5	Rural	53.97	54.07	1.00194

Free-Flow (V/C=0) Speed Factors for Houston/Galveston Speed Model - Continued

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
14	Rural Major Collector	3	Urban Fringe	38.00	27.76	0.73061
14	Rural Major Collector	4	Suburban	41.00	49.22	1.20059
14	Rural Major Collector	5	Rural	53.00	54.06	1.02009
15	Rural Collector	3	Urban Fringe	36.00	24.07	0.66864
15	Rural Collector	4	Suburban	40.00	35.58	0.88938
15	Rural Collector	5	Rural	49.00	49.86	1.01762

[1] Based on 2012 TDM data.
[2] Calculated from detailed speed model runs by HGAC with link volumes set to 0 (V/C=0).
[3] When input speeds are not available, speed factors are taken from the nearest area type.

LOS E (V/C=1) Speed Factors for Houston/Galveston Speed Model

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
1	Urban Interstate	1	CBD	50.85	34.35	0.67549
1	Urban Interstate	2	Urban	52.55	34.35	0.65370
2	Urban Other Freeway	1	CBD	N/A	35.00	0.67308
2	Urban Other Freeway	2	Urban	52.00	35.00	0.67308
3	Toll Road	1	CBD	N/A	24.77	0.43011
3	Toll Road	2	Urban	57.58	24.77	0.43011
3	Toll Road	3	Urban Fringe	61.69	26.52	0.42983
3	Toll Road	4	Suburban	64.34	29.54	0.45920
3	Toll Road	5	Rural	59.13	29.70	0.50229
4	Ramp	1	CBD	28.62	31.68	1.10692
4	Ramp	2	Urban	40.06	30.03	0.74952
4	Ramp	3	Urban Fringe	43.22	33.24	0.76908
4	Ramp	4	Suburban	44.82	41.22	0.91979
4	Ramp	5	Rural	55.16	49.01	0.88861
5	Urban Principal Arterial	1	CBD	24.72	22.13	0.89529
5	Urban Principal Arterial	2	Urban	35.78	24.44	0.68294
6	Urban Other Arterial	1	CBD	22.00	20.80	0.94565
6	Urban Other Arterial	2	Urban	34.57	22.76	0.65833
7	Urban Collector	1	CBD	20.94	20.06	0.95782
7	Urban Collector	2	Urban	35.36	21.23	0.60033
10	Rural Interstate	3	Urban Fringe	57.84	39.25	0.67860
10	Rural Interstate	4	Suburban	59.15	49.08	0.82973
10	Rural Interstate	5	Rural	62.00	49.08	0.79157
11	Rural Other Freeway	3	Urban Fringe	62.00	40.00	0.64516
11	Rural Other Freeway	4	Suburban	62.00	50.00	0.80645
11	Rural Other Freeway	5	Rural	64.00	50.00	0.78125
12	Rural Principal Arterial	3	Urban Fringe	40.23	27.30	0.67871
12	Rural Principal Arterial	4	Suburban	46.12	32.64	0.70784
12	Rural Principal Arterial	5	Rural	60.00	38.32	0.63858
13	Rural Other Arterial	3	Urban Fringe	39.05	24.81	0.63540
13	Rural Other Arterial	4	Suburban	43.03	30.15	0.70070
13	Rural Other Arterial	5	Rural	53.97	38.46	0.71270

LOS E (V/C=1) Speed Factors for Houston/Galveston Speed Model - Continued

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
14	Rural Major Collector	3	Urban Fringe	38.00	22.22	0.58465
14	Rural Major Collector	4	Suburban	41.00	34.09	0.83151
14	Rural Major Collector	5	Rural	53.00	36.83	0.69499
15	Rural Collector	3	Urban Fringe	36.00	19.74	0.54845
15	Rural Collector	4	Suburban	40.00	26.40	0.65994
15	Rural Collector	5	Rural	49.00	34.33	0.70057

[1] Based on 2012 TDM data.
[2] Calculated from detailed speed model runs by HGAC with link volumes set to 0 (V/C=0).
[3] When input speeds are not available, speed factors are taken from the nearest area type.

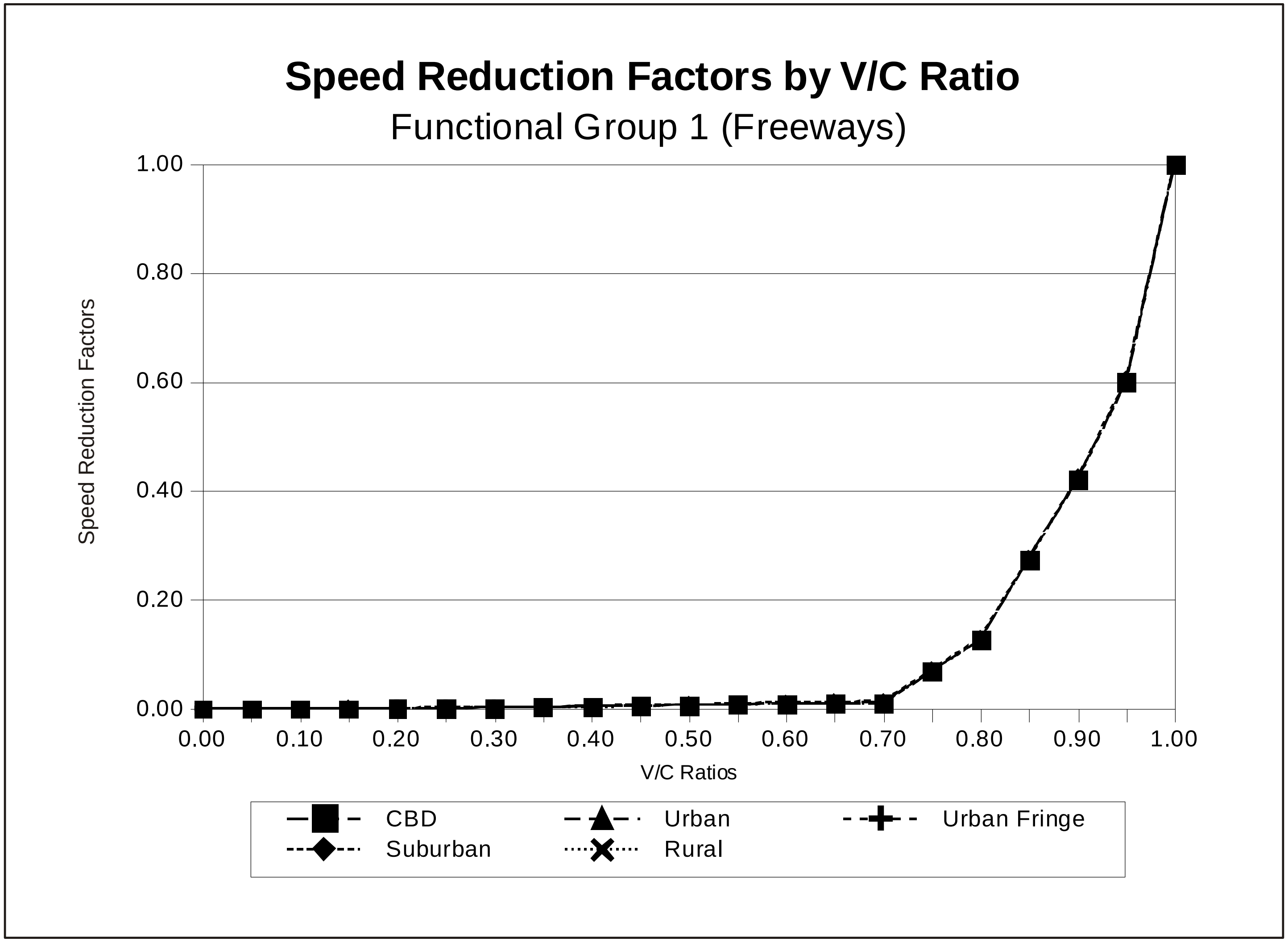


Figure 1. Freeway Speed Reduction Factors by V/C Ratio.

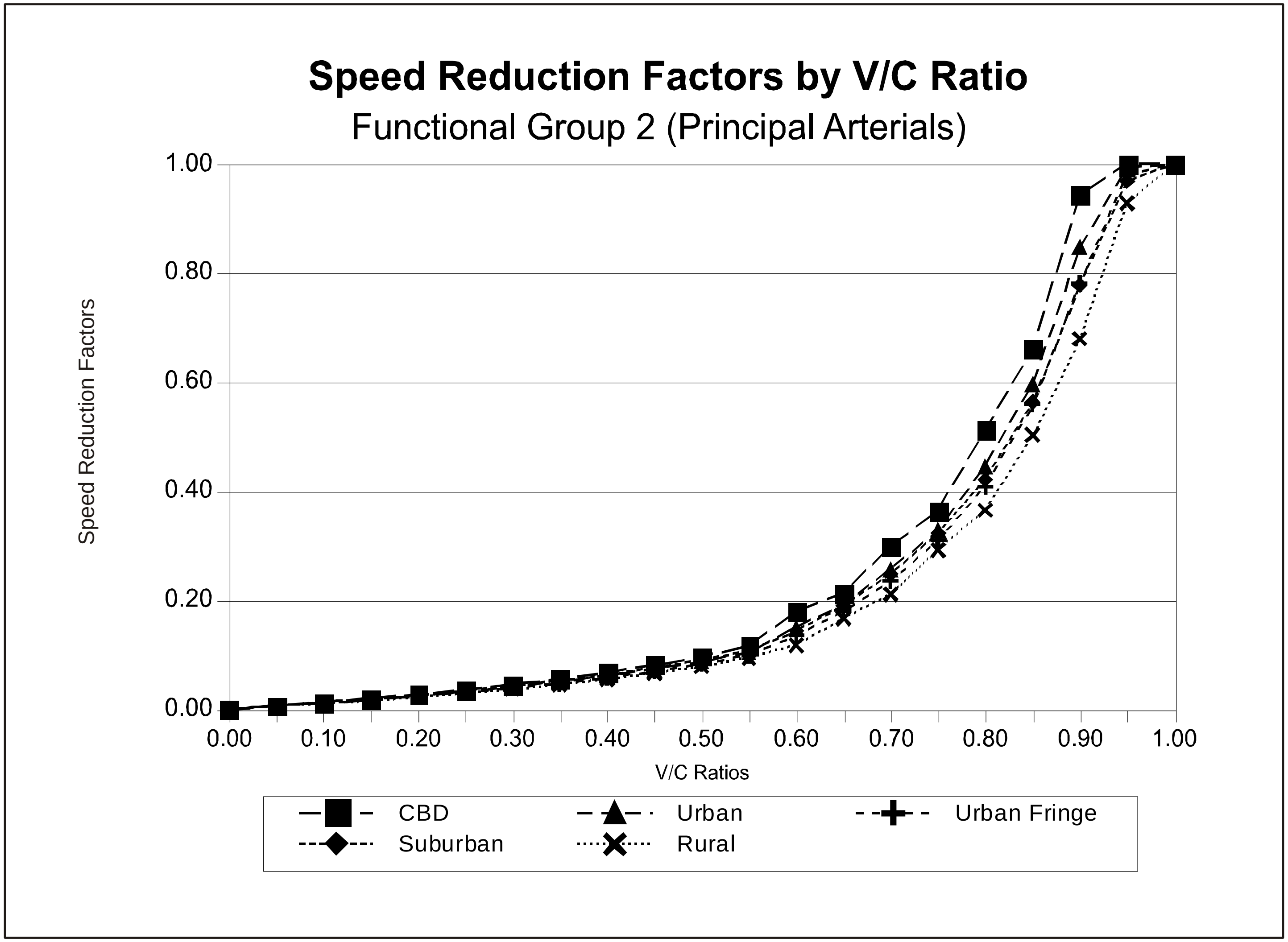


Figure 2. Principal Arterial Speed Reduction Factors by V/C Ratio.

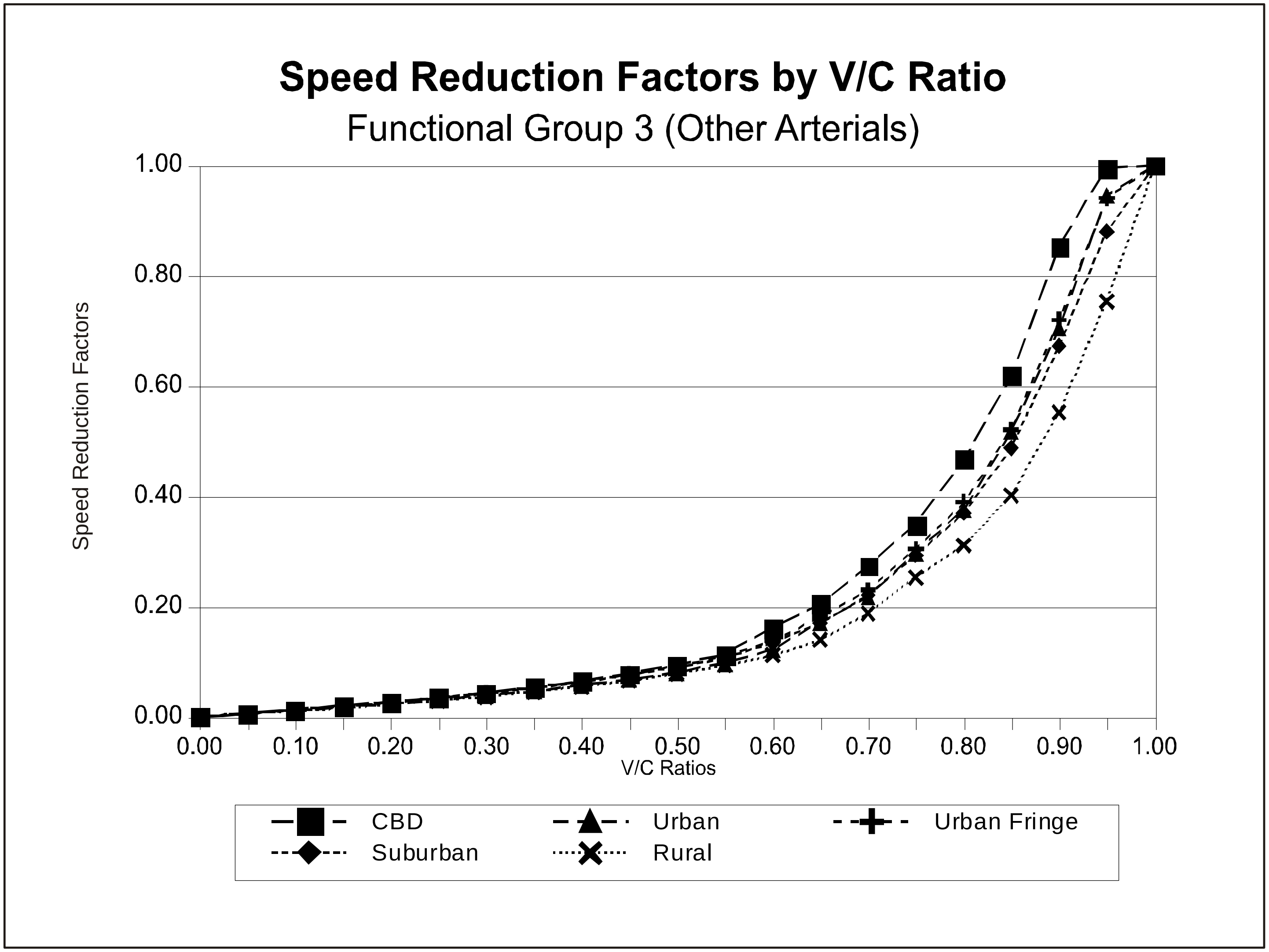


Figure 3. Other Arterial Speed Reduction Factors by V/C Ratio.

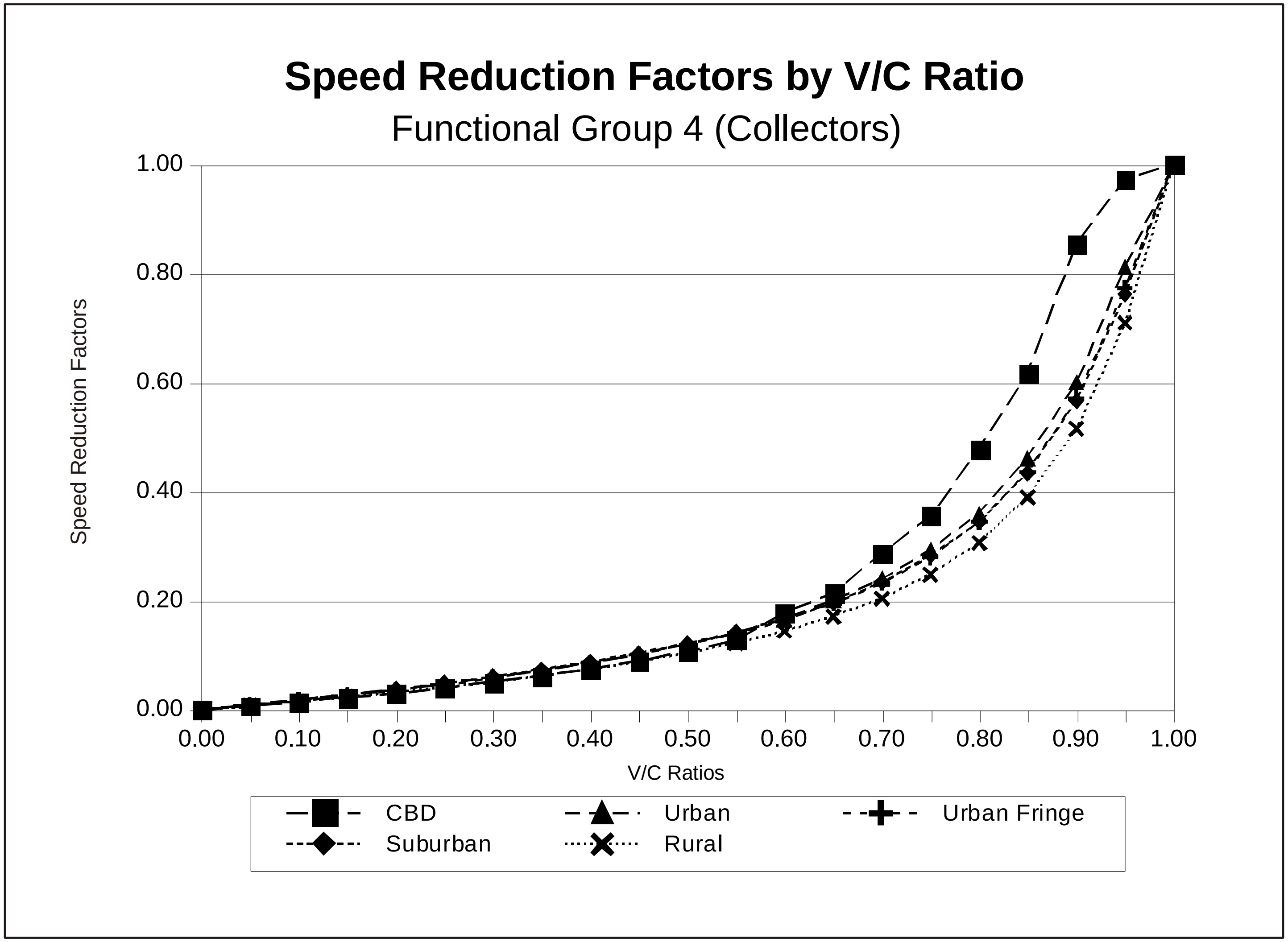


Figure 4. Collector Speed Reduction Factors by V/C Ratio.

Functional Classification to Functional Group Relationship for the Application of Speed Reduction Factors

Functional Group	Corresponding Network Functional Classifications
1. Freeways, Interstates	1. Urban Interstate Freeways 2. Urban Other Freeways 3. Toll Roads 10. Rural Interstate Freeways 11. Rural Other Freeways
2. Principal Arterials	5. Urban Principal Arterials 12. Rural Principal Arterials
3. Other Arterials, Major Collectors	6. Urban Other Arterials 13. Rural Other Arterials 14. Rural Major Collectors
4. Collectors	4. Ramps 7. Urban Collectors 15. Rural Collectors

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

2011 Vehicle Population Estimates

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	7,299	538	1,157	61	802	104	56	517
21_G	1,817,895	133,937	288,170	15,180	199,774	26,015	13,981	128,849
31_D	8,659	899	1,068	143	1,238	275	148	797
31_G	608,705	63,199	75,100	10,026	87,034	19,383	10,434	56,011
32_D	8,659	899	1,068	143	1,238	271	146	797
32_G	151,509	15,730	18,693	2,496	21,663	4,830	2,600	13,941
51_D	1,367	155	125	36	199	63	32	108
51_G	817	93	75	21	119	17	9	65
52_D	26,486	3,007	2,422	695	3,858	1,365	704	2,094
52_G	15,817	1,796	1,446	415	2,304	383	197	1,250
53_D	4,385	498	401	115	639	54	28	347
53_G	2,627	298	240	69	383	15	8	208
54_D	1,030	117	94	27	150	47	24	81
54_G	621	71	57	16	90	13	7	49
41_D	1,899	216	174	50	277	75	39	150
42_D	781	89	71	20	114	31	16	62
42_G	0	0	0	0	0	0	0	0
43_D	2,450	278	224	64	357	96	50	194
43_G	18	2	2	0	3	1	1	1
61_D	16,180	853	1,134	197	1,165	373	146	519
61_G	1,312	69	92	16	95	37	14	42
62_D	19,331	1,019	1,355	235	1,392	966	377	620
62_G	0	0	0	0	0	0	0	0
11_G	47,961	7,223	7,748	870	10,976	1,829	1,010	7,923

2017 Vehicle Population Estimates

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	16,073	1,387	3,266	113	2,069	236	133	1,066
21_G	2,278,368	196,584	462,896	15,962	293,257	33,520	18,847	151,069
31_D	11,945	1,480	1,838	174	2,004	407	220	1,031
31_G	690,285	85,543	106,216	10,037	115,813	23,523	12,725	59,570
32_D	9,308	1,153	1,432	135	1,562	323	175	803
32_G	169,556	21,012	26,090	2,465	28,447	5,772	3,122	14,632
51_D	1,908	300	250	47	408	109	62	154
51_G	1,135	178	149	28	243	31	17	91
52_D	35,912	5,644	4,701	883	7,684	2,322	1,306	2,893
52_G	21,470	3,374	2,811	528	4,594	651	366	1,730
53_D	5,941	934	778	146	1,271	92	52	479
53_G	3,550	558	465	87	760	25	14	286
54_D	1,497	235	196	37	320	86	48	121
54_G	894	140	117	22	191	25	14	72
41_D	821	129	107	20	176	40	23	66
42_D	1,642	258	215	40	351	81	46	132
42_G	0	0	0	0	0	0	0	0
43_D	4,516	710	591	111	966	223	126	364
43_G	48	8	6	1	10	3	1	4
61_D	17,705	1,304	1,777	238	1,915	498	292	578
61_G	1,436	106	144	19	155	49	29	47
62_D	21,153	1,558	2,124	284	2,288	1,289	756	691
62_G	0	0	0	0	0	0	0	0
11_G	52,987	9,183	11,164	833	14,066	1,973	1,160	8,099

2018 Vehicle Population Estimates

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	20,970	1,822	4,327	146	2,773	318	175	1,384
21_G	2,307,871	200,478	476,243	16,097	305,163	35,030	19,227	152,317
31_D	13,541	1,689	2,116	196	2,334	451	238	1,163
31_G	699,218	87,237	109,277	10,121	120,514	24,607	12,993	60,062
32_D	9,447	1,179	1,476	137	1,628	332	175	812
32_G	172,098	21,472	26,896	2,491	29,662	6,051	3,195	14,783
51_D	1,889	299	251	46	415	112	61	152
51_G	1,129	179	150	28	248	31	17	91
52_D	36,611	5,793	4,868	896	8,047	2,440	1,340	2,936
52_G	21,863	3,460	2,907	535	4,806	684	376	1,753
53_D	6,061	959	806	148	1,332	96	53	486
53_G	3,632	575	483	89	798	27	15	291
54_D	1,423	225	189	35	313	84	46	114
54_G	859	136	114	21	189	24	13	69
41_D	834	132	111	20	183	42	23	67
42_D	1,669	264	222	41	367	85	47	134
42_G	0	0	0	0	0	0	0	0
43_D	4,564	722	607	112	1,003	234	128	366
43_G	49	8	7	1	11	3	2	4
61_D	17,971	1,333	1,832	240	1,997	522	299	584
61_G	1,457	108	149	19	162	52	30	47
62_D	21,470	1,592	2,189	287	2,385	1,350	773	698
62_G	0	0	0	0	0	0	0	0
11_G	53,781	9,384	11,509	842	14,666	2,066	1,186	8,182

2011 24-Hour Weekday SHP Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	166,473	12,521	26,983	1,366	18,473	2,399	1,254	12,006
21_G	41,464,639	3,118,681	6,720,765	340,187	4,601,268	597,454	312,132	2,990,430
31_D	200,138	21,218	24,939	3,330	28,991	6,442	3,418	18,758
31_G	14,068,941	1,491,563	1,753,103	234,062	2,037,967	453,838	240,785	1,318,650
32_D	200,134	21,217	24,938	3,330	28,990	6,337	3,362	18,758
32_G	3,501,803	371,255	436,353	58,259	507,257	113,086	59,998	328,217
51_D	30,720	3,619	2,808	830	4,568	1,446	713	2,493
51_G	18,354	2,162	1,678	496	2,729	403	199	1,490
52_D	595,370	70,132	54,419	16,091	88,526	31,551	15,570	48,314
52_G	355,537	41,881	32,497	9,609	52,865	8,842	4,363	28,852
53_D	98,382	11,603	8,991	2,663	14,641	1,242	613	7,990
53_G	58,957	6,953	5,388	1,596	8,774	343	169	4,788
54_D	23,137	2,726	2,115	625	3,441	1,090	538	1,878
54_G	13,970	1,645	1,277	378	2,077	308	152	1,134
41_D	42,781	5,055	3,925	1,164	6,388	1,736	866	3,477
42_D	17,586	2,078	1,613	479	2,626	708	353	1,429
42_G	0	0	0	0	0	0	0	0
43_D	55,186	6,520	5,063	1,501	8,240	2,220	1,107	4,484
43_G	390	47	36	11	59	24	12	32
61_D	346,568	17,945	23,405	3,593	23,207	7,854	1,414	10,515
61_G	28,102	1,455	1,898	291	1,882	778	140	853
62_D	412,025	21,288	27,810	4,149	27,444	20,237	3,339	12,479
62_G	0	0	0	0	0	0	0	0
11_G	1,148,887	173,256	185,756	20,856	263,230	43,869	24,217	190,049

2017 24-Hour Weekday SHP Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	369,798	32,400	76,588	2,542	47,852	5,451	2,994	24,806
21_G	52,417,843	4,592,600	10,856,268	360,304	6,782,947	773,364	424,694	3,516,247
31_D	276,879	34,955	42,993	4,060	46,945	9,533	5,082	24,263
31_G	15,999,770	2,019,994	2,484,454	234,598	2,712,788	551,389	293,980	1,402,119
32_D	215,745	27,238	33,501	3,163	36,580	7,565	4,033	18,906
32_G	3,930,044	496,174	610,260	57,625	666,346	135,298	72,136	344,405
51_D	43,544	7,056	5,732	1,096	9,518	2,559	1,403	3,579
51_G	25,897	4,197	3,409	652	5,662	717	393	2,129
52_D	819,602	132,813	107,889	20,630	179,156	54,325	29,770	67,359
52_G	490,013	79,403	64,503	12,334	107,110	15,235	8,349	40,271
53_D	135,406	21,962	17,826	3,412	29,618	2,148	1,177	11,135
53_G	80,912	13,123	10,652	2,039	17,699	593	325	6,654
54_D	34,168	5,538	4,498	860	7,470	2,007	1,099	2,808
54_G	20,387	3,304	2,684	513	4,457	574	314	1,676
41_D	18,751	3,048	2,478	475	4,111	939	518	1,544
42_D	37,510	6,095	4,956	950	8,223	1,900	1,048	3,088
42_G	0	0	0	0	0	0	0	0
43_D	103,160	16,761	13,631	2,612	22,613	5,209	2,873	8,494
43_G	1,102	179	146	28	242	62	34	91
61_D	379,813	27,851	37,119	4,670	39,672	10,648	4,512	11,702
61_G	30,798	2,258	3,010	379	3,217	1,054	447	949
62_D	451,301	33,056	44,047	5,473	47,007	27,450	11,230	13,876
62_G	0	0	0	0	0	0	0	0
11_G	1,269,396	220,263	267,686	19,976	337,323	47,322	27,813	194,263

2018 24-Hour Weekday SHP Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	482,455	42,553	101,491	3,302	64,122	7,342	3,934	32,212
21_G	53,095,981	4,683,184	11,169,547	363,413	7,056,923	808,434	433,204	3,545,095
31_D	313,857	39,892	49,501	4,582	54,662	10,573	5,501	27,377
31_G	16,206,613	2,059,889	2,556,066	236,609	2,822,577	576,926	300,169	1,413,640
32_D	218,977	27,832	34,536	3,197	38,137	7,790	4,053	19,100
32_G	3,988,916	506,999	629,122	58,236	694,718	141,870	73,813	347,938
51_D	43,117	7,035	5,765	1,081	9,682	2,615	1,399	3,527
51_G	25,760	4,203	3,444	646	5,784	729	390	2,107
52_D	835,579	136,311	111,712	20,941	187,613	57,067	30,541	68,351
52_G	498,986	81,402	66,712	12,506	112,039	15,992	8,559	40,818
53_D	138,143	22,556	18,471	3,466	31,038	2,248	1,203	11,307
53_G	82,782	13,516	11,069	2,077	18,599	621	332	6,775
54_D	32,474	5,299	4,342	814	7,292	1,972	1,055	2,657
54_G	19,606	3,198	2,621	491	4,402	557	298	1,604
41_D	19,052	3,117	2,558	480	4,290	984	530	1,562
42_D	38,103	6,234	5,115	961	8,580	1,990	1,071	3,123
42_G	0	0	0	0	0	0	0	0
43_D	104,225	17,052	13,990	2,628	23,469	5,458	2,938	8,543
43_G	1,120	183	150	28	252	65	35	92
61_D	385,412	28,460	38,250	4,716	41,329	10,991	4,609	11,818
61_G	31,252	2,308	3,102	382	3,351	1,088	457	958
62_D	457,951	33,785	45,388	5,525	48,967	28,299	11,469	14,014
62_G	0	0	0	0	0	0	0	0
11_G	1,288,428	225,079	275,960	20,185	351,725	49,555	28,430	196,262

2011 24-Hour Weekday Starts Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	39,249	2,892	6,222	328	4,313	562	302	2,782
21_G	9,775,900	720,260	1,549,661	81,632	1,074,303	139,896	75,183	692,896
31_D	48,287	5,013	5,957	795	6,904	1,534	826	4,443
31_G	3,394,589	352,443	418,812	55,914	485,365	108,096	58,189	312,360
32_D	52,097	5,409	6,428	858	7,449	1,628	877	4,794
32_G	911,602	94,647	112,470	15,015	130,343	29,061	15,644	83,883
51_D	5,261	597	481	138	766	241	124	416
51_G	3,143	357	287	82	458	67	35	248
52_D	189,184	21,477	17,301	4,962	27,556	9,752	5,030	14,955
52_G	112,978	12,826	10,332	2,963	16,456	2,733	1,410	8,931
53_D	19,499	2,214	1,783	511	2,840	239	124	1,541
53_G	11,684	1,326	1,068	306	1,702	66	34	924
54_D	587	67	54	15	86	27	14	46
54_G	354	40	32	9	52	8	4	28
41_D	5,468	621	500	143	797	217	112	432
42_D	3,714	422	340	97	541	146	75	294
42_G	0	0	0	0	0	0	0	0
43_D	14,410	1,636	1,318	378	2,099	567	293	1,139
43_G	104	12	10	3	15	6	3	8
61_D	98,200	5,176	6,883	1,196	7,074	2,264	884	3,149
61_G	7,963	420	558	97	574	224	87	255
62_D	82,868	4,368	5,808	1,009	5,969	4,140	1,616	2,658
62_G	0	0	0	0	0	0	0	0
11_G	21,728	3,272	3,510	394	4,972	829	458	3,589

2017 24-Hour Weekday Starts Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	86,434	7,458	17,561	606	11,125	1,271	714	5,731
21_G	12,252,135	1,057,146	2,489,264	85,837	1,577,018	180,255	101,353	812,390
31_D	66,614	8,255	10,250	969	11,176	2,268	1,227	5,749
31_G	3,849,542	477,049	592,337	55,972	645,860	131,183	70,963	332,208
32_D	56,003	6,940	8,617	814	9,396	1,942	1,050	4,833
32_G	1,020,189	126,425	156,979	14,833	171,163	34,730	18,787	88,040
51_D	7,343	1,154	961	180	1,571	421	237	592
51_G	4,369	687	572	107	935	118	66	352
52_D	256,514	40,317	33,580	6,304	54,883	16,586	9,330	20,665
52_G	153,356	24,103	20,075	3,769	32,812	4,651	2,617	12,354
53_D	26,421	4,153	3,459	649	5,653	409	230	2,128
53_G	15,788	2,481	2,067	388	3,378	113	63	1,272
54_D	854	134	112	21	183	49	28	69
54_G	510	80	67	13	109	14	8	41
41_D	2,364	372	309	58	506	116	65	190
42_D	7,808	1,227	1,022	192	1,671	387	218	629
42_G	0	0	0	0	0	0	0	0
43_D	26,566	4,175	3,478	653	5,684	1,313	739	2,140
43_G	284	45	37	7	61	15	9	23
61_D	107,459	7,914	10,788	1,443	11,622	3,023	1,773	3,510
61_G	8,714	642	875	117	942	299	176	285
62_D	90,682	6,679	9,104	1,218	9,807	5,527	3,242	2,962
62_G	0	0	0	0	0	0	0	0
11_G	24,004	4,160	5,058	378	6,372	894	526	3,669

2018 24-Hour Weekday Starts Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	112,768	9,796	23,270	787	14,911	1,711	939	7,443
21_G	12,410,792	1,078,091	2,561,040	86,561	1,641,045	188,380	103,393	819,099
31_D	75,515	9,422	11,802	1,093	13,015	2,515	1,328	6,487
31_G	3,899,355	486,496	609,411	56,444	672,076	137,228	72,461	334,948
32_D	56,842	7,092	8,884	823	9,797	1,999	1,056	4,883
32_G	1,035,484	129,190	161,831	14,989	178,471	36,408	19,225	88,946
51_D	7,272	1,151	967	178	1,598	430	236	583
51_G	4,344	687	578	106	955	120	66	348
52_D	261,506	41,380	34,770	6,398	57,478	17,432	9,572	20,969
52_G	156,168	24,712	20,764	3,821	34,325	4,885	2,682	12,522
53_D	26,954	4,265	3,584	659	5,924	428	235	2,161
53_G	16,151	2,556	2,147	395	3,550	118	65	1,295
54_D	812	128	108	20	178	48	26	65
54_G	490	78	65	12	108	14	7	39
41_D	2,402	380	319	59	528	121	67	193
42_D	7,933	1,255	1,055	194	1,744	405	223	636
42_G	0	0	0	0	0	0	0	0
43_D	26,848	4,248	3,570	657	5,901	1,375	755	2,153
43_G	289	46	38	7	63	16	9	23
61_D	109,070	8,088	11,121	1,458	12,118	3,165	1,812	3,546
61_G	8,845	656	902	118	983	313	179	288
62_D	92,041	6,825	9,385	1,231	10,226	5,788	3,314	2,993
62_G	0	0	0	0	0	0	0	0
11_G	24,364	4,251	5,214	381	6,644	936	537	3,707

2011 and 2017 24-Hour Weekday SHI and APU Hours Summaries (CLhT_Diesel Only)

County	2011			2017		
	Hotelling	SHI	APU	Hotelling	SHI	APU
Harris	20,219	19,849	370	21,921	18,476	3,445
Brazoria	168	165	3	235	198	37
Fort Bend	3,260	3,201	60	4,882	4,115	767
Waller	2,217	2,177	41	2,134	1,798	335
Montgomery	4,519	4,436	83	5,901	4,974	927
Liberty	477	469	9	574	484	90
Chambers	2,180	2,140	40	2,662	2,244	418
Galveston	477	468	9	528	445	83

2018 24-Hour Weekday SHI and APU Hours Summaries (CLhT_Diesel Only)

County	2018		
	Hotelling	SHI	APU
Harris	22,286	18,218	4,068
Brazoria	239	195	44
Fort Bend	5,047	4,126	921
Waller	2,169	1,773	396
Montgomery	6,146	5,024	1,122
Liberty	658	538	120
Chambers	2,722	2,225	497
Galveston	532	435	97

APPENDIX G:
SOURCE TYPE AGE AND FUEL ENGINE FRACTIONS INPUTS TO MOVES

Brazoria County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.029489	0.041465	0.025332	0.025332	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.035165	0.059996	0.041857	0.041857	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.084868	0.058323	0.038005	0.038005	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.097743	0.088039	0.069630	0.069630	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.113526	0.091720	0.077310	0.077310	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.102174	0.081450	0.069196	0.069196	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.078222	0.075970	0.063213	0.063213	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.059532	0.065633	0.070261	0.070261	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.071577	0.061826	0.073680	0.073680	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.064655	0.060152	0.075947	0.075947	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.049702	0.054189	0.069147	0.069147	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.033504	0.053452	0.056586	0.056586	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028243	0.043257	0.050776	0.050776	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.022290	0.034683	0.035564	0.035564	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015368	0.027046	0.036060	0.036060	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015921	0.020837	0.025890	0.025890	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.013014	0.019007	0.025506	0.025506	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.011076	0.013489	0.021554	0.021554	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007615	0.010277	0.013849	0.013849	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.007061	0.007808	0.011582	0.011582	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003323	0.006053	0.009291	0.009291	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.004015	0.004439	0.007457	0.007457	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003738	0.003324	0.006937	0.006937	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003600	0.002372	0.005215	0.005215	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002769	0.001837	0.002564	0.002564	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004984	0.001398	0.002973	0.002973	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003600	0.001450	0.002155	0.002155	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003600	0.001034	0.002329	0.002329	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003184	0.000647	0.001102	0.001102	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004430	0.000565	0.001028	0.001028	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.022013	0.008262	0.008002	0.008002	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Brazoria County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.034051	0.049888	0.026692	0.026692	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.058353	0.082092	0.050348	0.050348	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.051368	0.076969	0.045098	0.045098	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.037398	0.066351	0.048366	0.048366	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033469	0.060897	0.042381	0.042381	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.072905	0.052089	0.034989	0.034989	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.082800	0.076409	0.063810	0.063810	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.093277	0.075794	0.068950	0.068950	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.086147	0.065460	0.063712	0.063712	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.066938	0.060303	0.056247	0.056247	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.053842	0.050644	0.062244	0.062244	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.062427	0.045919	0.064202	0.064202	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.054424	0.043597	0.066490	0.066490	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.038271	0.037030	0.057875	0.057875	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.026193	0.035876	0.046175	0.046175	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.024447	0.027141	0.040423	0.040423	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.018626	0.020587	0.028099	0.028099	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.013097	0.016206	0.028393	0.028393	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.013242	0.011191	0.020022	0.020022	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.011496	0.010260	0.018614	0.018614	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.009313	0.006635	0.015628	0.015628	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005384	0.005164	0.009974	0.009974	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004220	0.003598	0.007979	0.007979	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.003783	0.003078	0.005936	0.005936	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.003929	0.002369	0.005054	0.005054	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003347	0.001822	0.004699	0.004699	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002474	0.001390	0.003525	0.003525	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001455	0.001188	0.001799	0.001799	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.002910	0.000769	0.001775	0.001775	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002328	0.000918	0.001493	0.001493	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.028085	0.008363	0.009007	0.009007	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Chambers County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.016832	0.043599	0.026411	0.026411	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.028713	0.062691	0.040891	0.040891	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.086139	0.063048	0.046444	0.046444	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.094059	0.103227	0.077431	0.077431	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.130693	0.098597	0.083433	0.083433	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.109901	0.091757	0.075180	0.075180	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.080198	0.077652	0.066627	0.066627	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.068317	0.062122	0.075405	0.075405	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.075248	0.052148	0.073980	0.073980	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.067327	0.055639	0.069928	0.069928	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.045545	0.048372	0.067977	0.067977	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.039604	0.045166	0.051170	0.051170	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.040594	0.037900	0.045618	0.045618	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.023762	0.028924	0.031813	0.031813	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.010891	0.025219	0.031438	0.031438	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.011881	0.019377	0.022209	0.022209	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.006931	0.017953	0.024010	0.024010	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008911	0.011968	0.020408	0.020408	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007921	0.010401	0.013205	0.013205	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003960	0.007053	0.010579	0.010579	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004950	0.007124	0.008929	0.008929	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.001980	0.005486	0.007428	0.007428	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003960	0.004203	0.006227	0.006227	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.002970	0.002208	0.004727	0.004727	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.001980	0.002636	0.002776	0.002776	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.001980	0.001781	0.002701	0.002701	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.001980	0.001781	0.002176	0.002176	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003960	0.001282	0.002326	0.002326	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.000000	0.000427	0.001050	0.001050	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.002970	0.000712	0.000975	0.000975	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.015842	0.009546	0.006528	0.006528	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Chambers County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.026205	0.056954	0.034963	0.034963	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.041929	0.098149	0.057648	0.057648	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.062893	0.095394	0.053231	0.053231	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.036688	0.071753	0.059444	0.059444	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.037736	0.063809	0.044546	0.044546	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080713	0.054904	0.042674	0.042674	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.070231	0.079185	0.070150	0.070150	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.094340	0.072202	0.073070	0.073070	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.106918	0.068038	0.064910	0.064910	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.068134	0.054328	0.054503	0.054503	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.057652	0.043308	0.059370	0.059370	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.064990	0.034595	0.059744	0.059744	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.045073	0.037927	0.056300	0.056300	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.032495	0.031136	0.052931	0.052931	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.039832	0.028894	0.041102	0.041102	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.028302	0.022551	0.035487	0.035487	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.016771	0.016849	0.024931	0.024931	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.012579	0.013582	0.022161	0.022161	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.014675	0.010827	0.016096	0.016096	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.006289	0.008393	0.017219	0.017219	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.009434	0.007111	0.012802	0.012802	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005241	0.005061	0.009882	0.009882	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.006289	0.003075	0.007112	0.007112	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.001048	0.002691	0.005465	0.005465	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.003145	0.002306	0.004567	0.004567	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003145	0.002306	0.003743	0.003743	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002096	0.001345	0.002770	0.002770	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001048	0.001217	0.001348	0.001348	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.001048	0.000641	0.001872	0.001872	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.004193	0.001217	0.002171	0.002171	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.018868	0.010250	0.007786	0.007786	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Fort Bend County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.043366	0.046518	0.029637	0.029637	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.048141	0.065960	0.053790	0.053790	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.102478	0.064906	0.044450	0.044450	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.101058	0.094485	0.079934	0.079934	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.120289	0.096165	0.088972	0.088972	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.103898	0.085778	0.072731	0.072731	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.079375	0.075541	0.066153	0.066153	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.059241	0.067667	0.078277	0.078277	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.067759	0.063112	0.078099	0.078099	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.056402	0.059721	0.078037	0.078037	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.043753	0.053351	0.065736	0.065736	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.032137	0.050441	0.050913	0.050913	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028653	0.038721	0.042448	0.042448	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.019489	0.031594	0.032045	0.032045	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.011745	0.024350	0.029011	0.029011	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.011874	0.017987	0.019202	0.019202	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.008776	0.015595	0.018680	0.018680	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.006324	0.010355	0.015689	0.015689	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007486	0.007780	0.010508	0.010508	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003098	0.006066	0.008235	0.008235	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.002710	0.004559	0.006130	0.006130	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.001678	0.003633	0.005494	0.005494	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.002194	0.002202	0.004555	0.004555	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.002323	0.001756	0.003357	0.003357	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002710	0.001362	0.002450	0.002450	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.002323	0.001013	0.002085	0.002085	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.002581	0.000971	0.001939	0.001939	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.002452	0.000847	0.001887	0.001887	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.002839	0.000591	0.001136	0.001136	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.003872	0.000505	0.001220	0.001220	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018973	0.006470	0.007203	0.007203	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Fort Bend County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.050696	0.058337	0.032080	0.032080	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.073662	0.090001	0.064914	0.064914	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.068043	0.083425	0.056273	0.056273	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.050452	0.073275	0.058103	0.058103	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.041656	0.066488	0.051514	0.051514	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080015	0.057682	0.038498	0.038498	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.074884	0.080274	0.070114	0.070114	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.096995	0.077799	0.074872	0.074872	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080625	0.066166	0.061161	0.061161	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.062790	0.056728	0.056222	0.056222	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.046787	0.048539	0.063535	0.063535	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.053872	0.043165	0.062248	0.062248	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.043000	0.038870	0.062761	0.062761	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.032861	0.033461	0.051736	0.051736	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.026631	0.030643	0.040127	0.040127	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.021500	0.022460	0.031838	0.031838	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.016003	0.017884	0.023579	0.023579	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.009406	0.013139	0.021809	0.021809	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.008307	0.008985	0.014224	0.014224	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.006719	0.007194	0.013731	0.013731	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.004520	0.004944	0.011025	0.011025	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005375	0.003593	0.007585	0.007585	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003298	0.002656	0.005553	0.005553	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.001832	0.002039	0.003953	0.003953	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.001344	0.001697	0.003802	0.003802	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.002077	0.001082	0.003159	0.003159	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002199	0.000933	0.002223	0.002223	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002443	0.000837	0.001418	0.001418	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.003176	0.000641	0.001398	0.001398	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.001099	0.000664	0.001207	0.001207	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.027730	0.006398	0.009335	0.009335	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Galveston County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.025243	0.043574	0.026319	0.026319	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.037738	0.058903	0.049632	0.049632	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.100719	0.063386	0.042001	0.042001	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.098574	0.088516	0.079627	0.079627	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.108166	0.090634	0.082367	0.082367	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.097816	0.083909	0.072569	0.072569	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.080020	0.075971	0.063120	0.063120	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.058437	0.064917	0.073910	0.073910	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.073457	0.062605	0.074861	0.074861	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.059447	0.059629	0.076888	0.076888	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044806	0.052487	0.068292	0.068292	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.034709	0.050206	0.051254	0.051254	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.030418	0.041696	0.045928	0.045928	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.020825	0.033502	0.032860	0.032860	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015777	0.026784	0.031798	0.031798	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.016534	0.020083	0.022671	0.022671	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.009719	0.018745	0.021832	0.021832	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008709	0.012337	0.017681	0.017681	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007952	0.010034	0.012957	0.012957	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004670	0.007490	0.008889	0.008889	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004039	0.005813	0.007785	0.007785	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003786	0.005017	0.007548	0.007548	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004670	0.003564	0.005996	0.005996	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.004670	0.002427	0.004025	0.004025	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.003155	0.002056	0.002376	0.002376	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004670	0.001778	0.002404	0.002404	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003155	0.001662	0.002111	0.002111	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.002524	0.001376	0.002264	0.002264	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003282	0.000873	0.001384	0.001384	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.005301	0.000657	0.001132	0.001132	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.027010	0.009369	0.007520	0.007520	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Galveston County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032675	0.050373	0.031659	0.031659	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.064163	0.084895	0.058659	0.058659	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.054941	0.076401	0.045384	0.045384	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.040580	0.065228	0.049650	0.049650	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033597	0.059393	0.045749	0.045749	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.083267	0.054553	0.038002	0.038002	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.079842	0.074858	0.068974	0.068974	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.091304	0.073456	0.072187	0.072187	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.081686	0.066351	0.062813	0.062813	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.064032	0.059954	0.054126	0.054126	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.049407	0.049882	0.063950	0.063950	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.060079	0.045968	0.064146	0.064146	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.048090	0.042939	0.064708	0.064708	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.035046	0.036829	0.057621	0.057621	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.031489	0.034073	0.041553	0.041553	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.024506	0.027557	0.037301	0.037301	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.020158	0.020845	0.025190	0.025190	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.015020	0.016188	0.024643	0.024643	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.012516	0.011650	0.017359	0.017359	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009486	0.010535	0.016980	0.016980	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.006192	0.006895	0.013360	0.013360	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005929	0.005043	0.008869	0.008869	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004480	0.003928	0.006217	0.006217	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.003162	0.003086	0.005080	0.005080	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002767	0.002490	0.005094	0.005094	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003557	0.002083	0.004182	0.004182	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002635	0.001557	0.002624	0.002624	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002240	0.001164	0.001431	0.001431	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004216	0.001108	0.001628	0.001628	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002899	0.000996	0.001473	0.001473	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.030040	0.009721	0.009388	0.009388	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Harris County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.035445	0.047178	0.027418	0.027418	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.042013	0.057736	0.040492	0.040492	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.102145	0.052988	0.035349	0.035349	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.098830	0.078010	0.069539	0.069539	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.117470	0.082164	0.077581	0.077581	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.098789	0.076988	0.066823	0.066823	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.077021	0.071964	0.064280	0.064280	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.055649	0.062982	0.073246	0.073246	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.068660	0.060872	0.076613	0.076613	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.057818	0.061481	0.079337	0.079337	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044703	0.058503	0.071480	0.071480	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.035425	0.057776	0.057650	0.057650	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028273	0.046624	0.051219	0.051219	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.020850	0.039183	0.038065	0.038065	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.014449	0.031811	0.035592	0.035592	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.013490	0.024008	0.023130	0.023130	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.011238	0.021505	0.023112	0.023112	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008924	0.015239	0.019319	0.019319	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.006484	0.011823	0.013504	0.013504	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004962	0.009001	0.010016	0.010016	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003419	0.006878	0.007798	0.007798	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003482	0.005110	0.006732	0.006732	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003336	0.003481	0.005890	0.005890	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003607	0.002469	0.004190	0.004190	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002877	0.001852	0.002588	0.002588	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004253	0.001431	0.002746	0.002746	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.004024	0.001468	0.002465	0.002465	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003440	0.001175	0.002283	0.002283	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.002648	0.000789	0.001410	0.001410	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.003982	0.000576	0.001734	0.001734	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.022289	0.006934	0.008398	0.008398	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Harris County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.041700	0.065600	0.031518	0.031518	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.074575	0.076227	0.050539	0.050539	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.064531	0.068965	0.043006	0.043006	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.043713	0.058501	0.045770	0.045770	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033668	0.055270	0.037853	0.037853	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080294	0.048562	0.033218	0.033218	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.076032	0.070340	0.064775	0.064775	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.094751	0.071820	0.071330	0.071330	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080786	0.066148	0.061027	0.061027	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.063717	0.060102	0.058713	0.058713	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.045983	0.051641	0.066065	0.066065	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.057506	0.048348	0.067479	0.067479	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.048853	0.046294	0.068120	0.068120	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.035232	0.041390	0.060118	0.060118	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.027479	0.039102	0.047321	0.047321	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.022403	0.030110	0.040584	0.040584	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.015785	0.023947	0.029053	0.029053	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011351	0.018569	0.027243	0.027243	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.010966	0.013123	0.017448	0.017448	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009274	0.010889	0.017264	0.017264	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.007068	0.007378	0.013932	0.013932	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005569	0.005564	0.009254	0.009254	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003641	0.004043	0.006578	0.006578	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002699	0.003098	0.005093	0.005093	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002741	0.002350	0.004350	0.004350	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.002420	0.001633	0.003927	0.003927	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002484	0.001253	0.002622	0.002622	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001928	0.001002	0.001749	0.001749	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.003491	0.000833	0.001985	0.001985	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002806	0.000826	0.001763	0.001763	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026558	0.007070	0.010301	0.010301	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Liberty County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.023510	0.031586	0.022295	0.022295	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.029524	0.046288	0.032190	0.032190	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.083652	0.045982	0.031827	0.031827	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.092947	0.079865	0.065471	0.065471	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.107709	0.080018	0.072378	0.072378	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.109896	0.074275	0.065269	0.065269	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.082559	0.070868	0.054768	0.054768	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.061236	0.056013	0.062038	0.062038	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.061782	0.054520	0.069147	0.069147	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.064516	0.052950	0.070883	0.070883	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.057408	0.057736	0.069712	0.069712	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.041006	0.056893	0.054606	0.054606	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.035539	0.051725	0.051133	0.051133	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.025150	0.042536	0.042974	0.042974	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.019683	0.038707	0.044428	0.044428	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015309	0.030476	0.030373	0.030373	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.009841	0.028294	0.032635	0.032635	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.007654	0.021134	0.027546	0.027546	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.006014	0.017191	0.017812	0.017812	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003827	0.013668	0.016156	0.016156	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.002734	0.011716	0.011753	0.011753	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.002734	0.008002	0.010663	0.010663	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004921	0.006394	0.009088	0.009088	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.004374	0.005054	0.007634	0.007634	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002187	0.002948	0.004241	0.004241	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.009841	0.002259	0.003918	0.003918	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003827	0.002106	0.003958	0.003958	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.004374	0.001646	0.003110	0.003110	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003827	0.000536	0.001494	0.001494	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.001640	0.000689	0.001535	0.001535	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.020776	0.007925	0.008966	0.008966	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Liberty County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.035294	0.045784	0.025960	0.025960	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.051393	0.072277	0.047689	0.047689	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.044582	0.065762	0.043050	0.043050	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.035913	0.055592	0.041626	0.041626	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.031579	0.051321	0.033407	0.033407	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.081115	0.041911	0.030843	0.030843	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.074303	0.068404	0.059774	0.059774	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092879	0.068006	0.061849	0.061849	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.085449	0.065364	0.061646	0.061646	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.078638	0.059428	0.050781	0.050781	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.052012	0.048136	0.057292	0.057292	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.050774	0.046797	0.064860	0.064860	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.060681	0.045277	0.062785	0.062785	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.043344	0.044915	0.061727	0.061727	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.029721	0.043540	0.047933	0.047933	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.023529	0.036518	0.042074	0.042074	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.022291	0.028882	0.035360	0.035360	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.014861	0.022367	0.035726	0.035726	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.016718	0.018277	0.024414	0.024414	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.008669	0.015201	0.024618	0.024618	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.012384	0.012052	0.020955	0.020955	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.004954	0.008578	0.013916	0.013916	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003715	0.007419	0.010295	0.010295	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002477	0.005718	0.007446	0.007446	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002477	0.003511	0.006266	0.006266	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.005573	0.003004	0.005656	0.005656	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003096	0.002316	0.004232	0.004232	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.000619	0.001810	0.002523	0.002523	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004334	0.001194	0.002319	0.002319	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.000619	0.001484	0.002075	0.002075	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026006	0.009157	0.010905	0.010905	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Montgomery County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.040452	0.047069	0.031806	0.031806	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.035805	0.066982	0.050435	0.050435	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.089468	0.060890	0.043266	0.043266	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.087281	0.093845	0.077591	0.077591	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.110787	0.092229	0.083330	0.083330	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.105047	0.083485	0.068758	0.068758	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.082088	0.074366	0.064179	0.064179	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.061771	0.066269	0.073435	0.073435	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.074708	0.060237	0.076143	0.076143	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.056669	0.058257	0.073597	0.073597	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.047103	0.052050	0.068659	0.068659	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.038539	0.049792	0.050687	0.050687	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028972	0.040304	0.044102	0.044102	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.019679	0.032307	0.033524	0.033524	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015853	0.025846	0.032391	0.032391	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015306	0.018497	0.023396	0.023396	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.011935	0.017126	0.021777	0.021777	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008746	0.012005	0.017801	0.017801	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.008200	0.009174	0.012323	0.012323	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.006013	0.007304	0.009139	0.009139	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003462	0.005529	0.007088	0.007088	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003371	0.004268	0.006494	0.006494	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003644	0.003410	0.005325	0.005325	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003735	0.002438	0.003562	0.003562	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.003098	0.001875	0.002276	0.002276	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004191	0.001436	0.002546	0.002546	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.004282	0.001256	0.002393	0.002393	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003735	0.001077	0.002357	0.002357	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003735	0.000858	0.001520	0.001520	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004191	0.000653	0.001250	0.001250	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018130	0.009169	0.008851	0.008851	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Montgomery County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.039192	0.062061	0.031242	0.031242	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.073451	0.096070	0.059737	0.059737	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.062945	0.084156	0.054686	0.054686	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.044034	0.068771	0.055112	0.055112	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033894	0.061796	0.046689	0.046689	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.072355	0.051148	0.037301	0.037301	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.076192	0.074088	0.066309	0.066309	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092363	0.070885	0.069620	0.069620	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080395	0.063575	0.059763	0.059763	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.065047	0.056213	0.055086	0.055086	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.050978	0.048773	0.062753	0.062753	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.061392	0.042868	0.062527	0.062527	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.047597	0.040514	0.061693	0.061693	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.037091	0.034744	0.055790	0.055790	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.027864	0.031977	0.041743	0.041743	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.023479	0.024845	0.034797	0.034797	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.015257	0.019141	0.025722	0.025722	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011785	0.014755	0.025244	0.025244	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.010963	0.010269	0.017516	0.017516	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009410	0.009168	0.015882	0.015882	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.007126	0.006100	0.012857	0.012857	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.006578	0.004421	0.008606	0.008606	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004202	0.003329	0.006537	0.006537	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002467	0.002654	0.004937	0.004937	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002832	0.002324	0.004485	0.004485	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003746	0.001832	0.003781	0.003781	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003289	0.001392	0.002747	0.002747	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002284	0.001157	0.001695	0.001695	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.002558	0.000918	0.001886	0.001886	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.003198	0.000814	0.001886	0.001886	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026037	0.009242	0.011370	0.011370	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Waller County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032184	0.023292	0.017334	0.017334	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.031034	0.039236	0.032092	0.032092	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.078161	0.041730	0.029125	0.029125	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.072414	0.072239	0.061138	0.061138	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.120690	0.071583	0.069415	0.069415	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.101149	0.070009	0.063012	0.063012	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.083908	0.068959	0.057469	0.057469	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.058621	0.055902	0.071133	0.071133	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.074713	0.054130	0.069806	0.069806	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.050575	0.059051	0.073007	0.073007	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044828	0.059839	0.069962	0.069962	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.042529	0.062594	0.050051	0.050051	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.032184	0.054721	0.052393	0.052393	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.025287	0.043435	0.042008	0.042008	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.013793	0.038843	0.044741	0.044741	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.016092	0.033134	0.031233	0.031233	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.018391	0.031560	0.033497	0.033497	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.009195	0.024014	0.026860	0.026860	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.011494	0.020471	0.017569	0.017569	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004598	0.016141	0.016710	0.016710	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004598	0.012204	0.010541	0.010541	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.005747	0.008792	0.009916	0.009916	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004598	0.007086	0.008745	0.008745	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.006897	0.005118	0.007340	0.007340	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.004598	0.004462	0.004919	0.004919	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.008046	0.001968	0.004216	0.004216	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.006897	0.002428	0.004216	0.004216	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.004598	0.002493	0.003904	0.003904	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.009195	0.001378	0.002342	0.002342	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004598	0.001115	0.002577	0.002577	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018391	0.012073	0.012727	0.012727	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Waller County 2014 Age Distribution Inputs to MOVES (2017 and 2018 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032768	0.039187	0.020653	0.020653	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.051977	0.063437	0.044613	0.044613	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.054237	0.062910	0.038365	0.038365	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.038418	0.048559	0.039247	0.039247	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.032768	0.049379	0.035352	0.035352	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.070056	0.042701	0.027561	0.027561	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.072316	0.061856	0.057695	0.057695	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092655	0.063730	0.059827	0.059827	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.067797	0.063730	0.059018	0.059018	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.074576	0.060918	0.050860	0.050860	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.049718	0.049965	0.066956	0.066956	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.056497	0.047680	0.065192	0.065192	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.055367	0.048676	0.064971	0.064971	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.041808	0.047856	0.062987	0.062987	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.035028	0.050199	0.049831	0.049831	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.036158	0.038425	0.045201	0.045201	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.023729	0.033271	0.033588	0.033588	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011299	0.027413	0.036601	0.036601	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.015819	0.020326	0.025503	0.025503	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.007910	0.017690	0.025062	0.025062	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.012429	0.011949	0.018668	0.018668	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.006780	0.009489	0.012568	0.012568	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003390	0.007146	0.011392	0.011392	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.005650	0.005858	0.007350	0.007350	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.004520	0.003925	0.007497	0.007497	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.004520	0.003222	0.005806	0.005806	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003390	0.003163	0.004777	0.004777	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.003390	0.002402	0.003454	0.003454	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004520	0.000879	0.002499	0.002499	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002260	0.001289	0.002278	0.002278	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.028249	0.012769	0.014626	0.014626	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Texas Statewide 2011 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
PC	Gas	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999
PC	Diesel	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001
PT	Gas	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981
PT	Diesel	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019
PT	Gas	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981
PT	Diesel	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019
LCT	Gas	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971
LCT	Diesel	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029
LCT	Gas	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971
LCT	Diesel	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958
RT	Gas	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012
RT	Diesel	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988
SUShT	Gas	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250	0.266	0.312	0.348	0.359	0.426	0.423	0.435
SUShT	Diesel	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750	0.734	0.688	0.652	0.641	0.574	0.577	0.565
SULhT	Gas	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250	0.266	0.312	0.348	0.359	0.426	0.423	0.435
SULhT	Diesel	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750	0.734	0.688	0.652	0.641	0.574	0.577	0.565
MH	Gas	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770
MH	Diesel	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230
CShT	Gas	0.046	0.071	0.047	0.053	0.026	0.059	0.048	0.050	0.050	0.078	0.077	0.083	0.102	0.131	0.152	0.146
CShT	Diesel	0.954	0.929	0.953	0.947	0.974	0.941	0.952	0.950	0.950	0.922	0.923	0.917	0.898	0.869	0.848	0.854
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2011 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981
PC	Gas	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987	0.991	0.966	0.956	0.923	0.893	0.924
PC	Diesel	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013	0.009	0.034	0.044	0.077	0.107	0.076
PT	Gas	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996	0.986	0.984	0.979	0.972	0.943	0.982
PT	Diesel	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004	0.014	0.016	0.021	0.028	0.057	0.018
PT	Gas	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996	0.986	0.984	0.979	0.972	0.943	0.982
PT	Diesel	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004	0.014	0.016	0.021	0.028	0.057	0.018
LCT	Gas	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986	0.956	0.958	0.948	0.933	0.892	0.929
LCT	Diesel	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014	0.044	0.042	0.052	0.067	0.108	0.071
LCT	Gas	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986	0.956	0.958	0.948	0.933	0.892	0.929
LCT	Diesel	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014	0.044	0.042	0.052	0.067	0.108	0.071
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265	0.327	0.484	0.615	0.676	0.674	0.736
SBus	Diesel	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735	0.673	0.516	0.385	0.324	0.326	0.264
RT	Gas	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106	0.062	0.051	0.054	0.099	0.090	0.040
RT	Diesel	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894	0.938	0.949	0.946	0.901	0.910	0.960
SUShT	Gas	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658	0.719	0.768	0.767	0.825	0.773	0.847	0.976
SUShT	Diesel	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342	0.281	0.232	0.233	0.175	0.227	0.153	0.024
SULhT	Gas	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658	0.719	0.768	0.767	0.825	0.773	0.847	0.976
SULhT	Diesel	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342	0.281	0.232	0.233	0.175	0.227	0.153	0.024
MH	Gas	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.306	0.112	0.123	0.164	0.161	0.153	0.124	0.170	0.148	0.250	0.239	0.284	0.384	0.311	0.626
CShT	Diesel	0.694	0.888	0.877	0.836	0.839	0.847	0.876	0.830	0.852	0.750	0.761	0.716	0.616	0.689	0.374
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995
SUShT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SUShT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
SULhT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SULhT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400
CShT	Gas	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077
CShT	Diesel	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
PC	Gas	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987
PC	Diesel	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013
PT	Gas	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996
PT	Diesel	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004
PT	Gas	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996
PT	Diesel	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004
LCT	Gas	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986
LCT	Diesel	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014
LCT	Gas	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986
LCT	Diesel	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735
RT	Gas	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106
RT	Diesel	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894
SUShT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SUShT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
SULhT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SULhT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
MH	Gas	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157	0.163
CShT	Diesel	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843	0.837
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2018 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2018 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988
PC	Gas	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000
PC	Diesel	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000
PT	Gas	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997
PT	Diesel	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003
PT	Gas	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997
PT	Diesel	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003
LCT	Gas	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952
LCT	Diesel	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048
LCT	Gas	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952
LCT	Diesel	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750
RT	Gas	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106
RT	Diesel	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894
SUShT	Gas	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640
SUShT	Diesel	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360
SULhT	Gas	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640
SULhT	Diesel	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360
MH	Gas	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157
CShT	Diesel	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

APPENDIX H:
MOVES RUN SUMMARIES

Appendix H is being transmitted electronically.