APPENDIX E

HOUSTON-GALVESTON-BRAZORIA 1997 EIGHT-HOUR OZONE NONATTAINMENT AREA VEHICLE MILES TRAVELED OFFSET ON-ROAD MOBILE SOURCE EMISSIONS INVENTORIES ANALYSIS

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HOUSTON-GALVESTON-BRAZORIA 1997 EIGHT-HOUR OZONE NONATTAINMENT AREA VEHICLE MILES TRAVELED OFFSET ON-ROAD MOBILE SOURCE EMISSIONS INVENTORIES ANALYSIS

Appendix E documents the development of the vehicle miles traveled (VMT) offset analysis for on-road mobile emissions inventories (EI) to support updates to the Houston-Galveston-Brazoria (HGB) 1997 Eight-Hour Ozone Standard Nonattainment Area Motor Vehicle Emissions Budgets (MVEB) Update State Implementation Plan (SIP) Revision.

The development of the VMT offset EIs was prepared by the Texas Transportation Institute (TTI) at the request and under the direction of the Texas Commission on Environmental Quality (TCEQ). The VMT offset on-road mobile source EIs reflect the most recent planning assumptions for the HGB transportation network. Complete documentation of the development and resulting VMT offset EIs is provided in the attached document, *VMT-Offset Emissions Inventories for the HGB Eight-Hour Ozone Nonattainment Counties*. The final emissions estimates are summarized in Table 2: *HGB Emissions Inventories for the VMT Offset Demonstration (Tons/Day)* of the Executive Summary on page 3 of the report. The supporting electronic documents for the development of the EIs, including Motor Vehicle Emission Simulator (MOVES) input and output files and the post processing spreadsheets, are available upon request in electronic format. Please contact the TCEQ, Air Quality Division, Mobile Source Programs Team if a copy of the electronic information is needed.

Since the adoption of the 2010 HGB SIP Revision[1] by the TCEQ, the United States Ninth Circuit Court of Appeals decision on January 27, 2012 addressed requirements for transportation control measures to offset VMT growth in SIP revisions for areas classified as severe and above. The United States Environmental Protection Agency (EPA) has prepared new guidance on what information must be included in a SIP revision in order to demonstrate that VMT offsets are not needed. Based upon the EPA guidance, *Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Travelled*[2] (August 2012), the inventory development for the HGB VMT offset analysis in this SIP revision includes the following scenarios:

- 2002 base year emissions;
- attainment year emissions assuming no new post-2002 measures with VMT growth from the base year to the attainment year;
- attainment year emissions assuming no new post-2002 measures and no VMT growth (2002 VMT); and
- actual attainment year emission controls and VMT growth between the base year and the attainment year.

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[1] 2010 HGB RFP SIP Revision (TCEQ Project No. 2009-018-SIP-NR, adopted March 10, 2010) Houston-Galveston-Brazoria Reasonable Further Progress State Implementation Plan Revision for the 1997 Eight-Hour Ozone Standard (http://www.tceq.state.tx.us/assets/public/implementation/air/sip/hgb/hgb_sip_2009/09018SIP_ado.pdf)

[2] EPA, 2012. "Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Travelled." Office of Transportation and Air Quality, U.S. Environmental Protection Agency; EPA-420-B-12-053, August 2012

The four inventories were developed maintaining consistency with the 2012 HGB Reasonable Further Progress (RFP) inventories and in accordance with the EPA 2012 VMT offset guidance using a special version of the EPA's mobile source emissions estimation model, MOVES2010bROP. The inventory methodology, activity inputs, and MOVES model inputs used were consistent with the proposed 2012 HGB RFP 2002 base year and 2018 attainment year control strategy analysis inventories.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

VMT-Offset Emissions Inventories for the HGB Eight-Hour Ozone Nonattainment Counties

Prepared by the Texas A&M Transportation Institute

January 2013

DEVELOPMENT OF ON-ROAD MOBILE SOURCE, VMT-OFFSET EMISSIONS INVENTORIES FOR THE HGB EIGHT-HOUR OZONE NONATTAINMENT COUNTIES

TECHNICAL REPORT

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EXECUTIVE SUMMARY

The Texas Commission on Environmental Quality (TCEQ) recently approved the Houston-Galveston-Brazoria (HGB) 1997 Eight-Hour Ozone Standard Nonattainment Area Motor Vehicle Emissions Budgets (MVEB) Update State Implementation Plan (SIP) Revision proposal (Proposal October 17, 2012). This MVEB Update SIP revision replaces the HGB area's MOBILE model-based on-road mobile inventories and MVEBs of volatile organic compounds (VOC) and oxides of nitrogen (NO_x) in the current SIP with inventories and MVEBs based on MOVES, the U.S. Environmental Protection Agency's (EPA) latest on-road emissions model. EPA requires additional emissions analysis for the vehicle miles traveled (VMT) offset demonstration portion. TCEQ has requested that the Texas A&M Transportation Institute (TTI) develop the additional inventories needed for the VMT offset analysis.

This updated VMT offset analysis requirement was EPA's response to satisfy a recent U.S. circuit court of appeals decision that addressed the requirements for transportation control measures in SIPs for severe nonattainment areas (essentially that the VMT increase does not trigger additional emissions controls). The EPA released its new VMT offset demonstration analysis guidance (August 2012) and a version of MOVES (MOVES2010bROP) modified specifically for performing VMT offset calculations. In consultation with TCEQ, following the EPA guidance and using MOVES2010bROP, TTI produced four HGB emissions inventories needed for the VMT offset demonstration analysis. As Table 1 shows, these four inventories include a base year and three attainment year scenarios, and are comprised of two activity input data sets and three emissions factor input data sets.

Table 1. HGB VMT Offset Demonstration Emissions Inventory Scenarios.

Inventory	Activity Input Year	Emissions Factor Input[1]
2002 Base Year	2002	2002 Base Year
2018 Fleet and Pre-2003 Controls with Growth	2018	2018 Fleet and Pre-2003 Controls[1]
2018 Fleet and Pre-2003 Controls without Growth	2002	
2018 Attainment Year Control Strategy	2018	2018 Fleet and Control Strategy

[1] MOVES2010bROP provides the capability to model this emissions rate scenario required for the VMT offset calculations under the EPA's 2012 VMT offset guidance in which fleet turnover is allowed to occur through 2018, while "freezing" emissions rates at a 2002 model year baseline for later model year vehicles.

The first and fourth inventories listed in Table 1, the 2002 base year and the 2018 attainment year control strategy inventories, were also previously developed using MOVES2010a. They are part of the set of reasonable further progress (RFP) inventories (*HGB MOVES-Based RFP On-Road Inventories and Control Strategy Reductions*, TTI, March 2012) developed for the HGB RFP SIP analyses, and contained in the TCEQ's proposed HGB MVEB Update SIP revision (as Appendix D). The base and attainment year 2012 HGB RFP SIP inventories (MOVES2010a-

based) provided the basis (methodology and input data) for development of the four MOVES2010bROP-based inventories produced for the VMT offset analysis.

The two "2018 fleet and pre-2003 controls" scenarios (second and third inventories in Table 1) provided estimates of the hypothetical emissions in 2018 assuming no changes in emissions factors for vehicle model years after 2002, with one inventory including estimated growth (2018 VMT) and the other inventory excluding growth (using 2002 VMT). The difference between these two inventories is the estimate of growth in emissions due solely to the growth in vehicle activity from the base year to the attainment year. The third inventory in Table 1 (2018 fleet with base year controls and activity) also establishes attainment year emissions "ceilings." Any increased VOC and NO_x emissions due to increased VMT have been adequately offset if the attainment year control strategy emissions estimates are not greater than their ceilings.

TTI developed the four inventories maintaining consistency with the 2012 HGB RFP inventories and in accordance with the EPA 2012 VMT offset guidance and MOVES2010bROP requirements. The inventory methodology, activity inputs, and MOVES model inputs used were consistent with, and mostly directly acquired from, the proposed 2012 HGB RFP 2002 base year and 2018 attainment year control strategy inventories analysis.

According to the EPA, the net impact of model changes at the county scale is very small ("EPA Releases MOVES2010b Mobile Source Emissions Model Update: Questions and Answers", EPA, April 2012). A comparison of the 2012 HGB RFP and the VMT offset analysis inventories developed using the MOVES2010a and the MOVES2010bROP models, respectively, provided a check on the magnitude of the emissions difference between the 2010a and 2010b versions. The differences for HGB base and attainment year aggregate VOC, NO_x, carbon monoxide (CO), and carbon dioxide (CO_2) estimates were very small, within the realm of rounding error.

The inventory method used was the detailed, hourly, MOVES rates-per-activity, traffic demand model (TDM) link-based method. Network link level (roadway segment) and off-network (e.g., parked vehicle) emissions estimates were calculated by hour, external to the MOVES model, as the product of activity estimates and MOVES emissions rates. The activity estimates were link-based VMT and operational speed estimates, and off-network source-hours-parked (SHP), starts, and source hours extended idling (SHI) for diesel long-haul combination trucks only. Post-processing MOVES emissions and activity output produced all rates in pollutant mass per activity unit (e.g., grams/mile, grams/shp, grams/start, grams/shi) as needed in the emissions calculations. (See *Update of On-Road Inventory Development Methodologies for MOVES Model Compatibility.* TTI, July 2011.)

The inventories were produced using utilities developed by TTI to process on-road vehicle activity (travel model link-based or Highway Performance Monitoring System [HPMS] roadway-based), off-network vehicle activity, and emissions rate data into spatially and temporally detailed emissions estimates. EPA's *Technical Guidance* (*Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b.* EPA, April 2012) and *Explanation of Special VMT Offset Version of MOVES* (technical sheet provided with MOVES2010bROP model, September 2012) were the primary technical references used for guidance on appropriate inputs to MOVES.

Table 2 shows the resulting HGB VMT offset inventories of VOC and NO_x.

Table 2. HGB Emissions Inventories for the VMT Offset Demonstration (Tons/Day).

Inventory[1]	VMT	Speed	VOC	NO_x
2002 Base Year	128,145,285	36.40	124.47	371.89
2018 with Pre-2003 Controls with Growth	184,065,162	35.87	87.32	414.80
2018 with Pre-2003 Controls without Growth	128,145,285	36.40	58.15	282.75
2018 Attainment Year Control Strategy	184,065,162	35.87	51.84	109.98

[1] Emissions estimates are based on EPA's MOVES2010bROP model (September 2012).

A comparison of the inventories in Table 2 shows that the estimated 2018 attainment year control strategy scenario emissions (last inventory in Table 2) are below the emissions "ceilings" estimated as the 2018 with pre-2003 controls and without growth scenario (third inventory in Table 2). According to the 2012 EPA guidance, this demonstrates that the increased emissions due to increased VMT are adequately offset.

These MOVES2010bROP-based VMT offset demonstration analysis SIP inventories developed by TTI for TCEQ in support of the proposed HGB SIP Update are summarized in more detail in the following sections, along with the descriptions of methodologies and details of input data sources, development and usage.

PURPOSE

The purpose of this work was to develop on-road mobile source emissions inventories to support VMT offset analysis for the eight HGB ozone nonattainment area counties, required for the development of the HGB SIP revision.

BACKGROUND

TCEQ works with local planning districts, the Texas Department of Transportation (TxDOT), and TTI to provide on-road mobile source emissions inventories of air quality pollutants. TxDOT typically funds transportation conformity determinations required under 40 Code of Federal Regulations (CFR) Part 93. TCEQ funds mobile source inventory work in support of the Federal Clean Air Act (CAA) requirements, such as attainment of the National Ambient Air Quality Standards (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 prepared a revision to the HGB SIP, which was proposed in October 2012. This proposed SIP revision was to update the current 2010 HGB SIP revision (with the main purpose of replacing current MOBILE6-based inventories and MVEBs with MOVES-based

counterparts). Since the 2010 HGB SIP revision, a January 27, 2012, U.S. Ninth Circuit Court of Appeals decision addressed requirements for transportation control measures (TCM) to offset VMT growth in SIP revisions for areas classified as serious and above. Although previous HGB SIP revisions have included VMT offset analyses that have been approved by the EPA, in response to the appeals court decision the EPA has prepared new guidance (Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Traveled, EPA, August 2012) on what information must be included in a SIP revision to adequately demonstrate that VMT offsets are not needed. The EPA's new VMT-offset demonstration guidance specifies that four on-road inventory scenarios are needed for the demonstration. The EPA has also produced a special version of the MOVES on-road inventory tool, MOVES2010bROP (EPA, September 2012), that must be used in the VMT offset calculations.

The four emissions inventories required in the VMT offset demonstration consist of one 2002 base year, and three 2018 attainment year scenarios. The base year inventory is based on VMT in that year and all controls in effect in that year. For the attainment year, two of the inventories are hypothetical emissions scenarios that provide the basis to identify the "growth in emissions" due solely to growth in VMT; and the third represents projected actual motor vehicle emissions after fully accounting for projected VMT growth and emissions reductions from all creditable controls to be in effect in the attainment year (i.e., the attainment year control strategy scenario). The two hypothetical attainment year emissions inventories consist of one set of emissions factors that reflect the 2018 attainment year fleet with pre-2003 controls (i.e., 2002 base year controls including no new control measures), and two VMT scenarios, i.e., 2002 base year VMT representing the no growth scenario, and 2018 attainment year VMT representing the growth scenario. The emissions difference in the attainment year pre-2003 controls with growth and without growth scenarios yields the estimated increase in emissions due to VMT growth; and the pre-2003 controls no growth scenario emissions estimate also establishes the "ceiling" on attainment year emissions. If the attainment year control strategy emissions levels are greater than this emissions ceiling, additional controls would be needed to offset the emissions growth due to VMT, otherwise any increased emissions due to VMT have been adequately offset and no additional controls would be needed.

TTI developed all four of the inventories needed for the HGB VMT offset demonstration analysis, consistent with the 2012 EPA VMT offset guidance, and using the MOVES2010bROP model. TTI determined and agreed upon the methods, scenarios, and input data for the inventory development in consultation with the TCEQ project manager. This work was conducted by and completed consistent with the list of references in the References section.

DEVELOPMENT OF ON-ROAD MOBILE SOURCE, VMT OFFSET EMISSIONS INVENTORIES FOR THE HGB EIGHT-HOUR OZONE NONATTAINMENT COUNTIES

TTI developed emissions estimates for the eight HGB ozone nonattainment counties for the analysis years consistent with the EPA's 2012 VMT offset demonstration guidance, including each control scenario required for the VMT offset demonstration. Following the EPA's 2012 guidance, TTI produced four HGB area inventories:

- 2002 base year;

- 2018 attainment year with pre-2003 controls with growth (2018 activity estimates);
- 2018 attainment year with pre-2003 controls without growth (2002 activity estimates); and
- 2018 control strategy (i.e., all controls to be in effect in 2018 and with growth).

TTI developed the VMT offset inventories for the HGB area consistent with inventory development for other SIP analyses. Since the FY 2012 HGB RFP SIP and attainment demonstration (AD) SIP inventories had already been completed, the activity information based upon travel demand modeling completed at the time of the RFP and AD inventory development were used. Other modeling inputs used were also consistent with the FY 2012 HGB RFP SIP inventories.

In conjunction with the VMT offset guidance, the EPA released a special version of the on-road mobile source emissions model, MOVES2010b, designed to develop emissions factors and inventories consistent with the VMT offset guidance. This special version of MOVES2010b is referred to as MOVES2010bROP. MOVES2010bROP was used to complete this work. The VMT offset inventories were produced based on methods agreed upon in consultation with the TCEQ project manager. The methods were consistent with the EPA's 2012 VMT offset guidance. Development is complete for the HGB RFP and AD SIP on-road inventories (produced with MOVES2010a) that are being used in the proposed HGB SIP revision. Although it is general practice to use the most recently available data for on-road SIP inventory development, for the VMT offset inventories to be as consistent as possible with the other HGB SIP inventories, some MOVES2010bROP inputs were the same as the recently developed RFP inventories as indicated in the following. The MOVES inputs for the FY 2012 HGB RFP on-road mobile inventories are documented in the project report *HGB MOVES-Based RFP On-Road Inventories and Control Strategy Reductions,* TTI, March 2012.

TTI adhered to the following:

- The emissions factor model used in developing inventories for this task was the special version of MOVES, named MOVES2010bROP (this model was said to be named MOVES2010b-VMTOffset, but instead was released by EPA in September 2012 with the name of MOVES2010bROP).
- The pollutants included are VOC, carbon monoxide CO, nitrogen oxides NO_x, and carbon dioxide CO_2.
- The day type is consistent with the HGB RFP inventory development from March 2012. The day type for all the inventories is ozone-season, daily. Activity levels were adjusted for summer season and for average weekday, Monday through Friday.
- The temperatures are consistent with the HGB RFP inventory development from March 2012. The temperatures are consistent with the eight-hour, ozone season temperatures as determined using the EPA guidance.
- The humidity input is consistent with the HGB RFP inventory development from March 2012. The humidity input was developed using the same methodology as the ozone season temperatures.

- The VMT mixes are consistent with the HGB RFP inventory development from March 2012. The VMT mixes are consistent with the EPA MOVES source use types.
- The locality-specific age distributions are consistent with the HGB RFP inventory development from March 2012. The age distributions used were the age distributions for the RFP analysis year that corresponds to the VMT offset analysis years.
- A link-based, time-of-day emissions analysis methodology was used for all of the referenced counties (the VMT Offset demonstration guidance did not state an alternative preferred methodology).
- Control program parameters, including Reid Vapor Pressure (RVP) and fuel settings, were determined based upon the VMT offset control scenarios documented in the VMT Offset demonstration guidance. TTI used fuel parameter inputs agreed upon in consultation with TCEQ.
- The Texas Low Emissions Diesel (TxLED) factors used were consistent with the HGB RFP inventory development from March 2012. The year-specific TxLED adjustment factors were developed using the benefit information described in the EPA Memorandum on Texas Low Emission Diesel Fuel Benefits.

Table 3 lists the VMT offset analysis inventory scenarios produced, along with the activity and emissions rate components comprising each inventory.

Table 3. HGB VMT Offset Demonstration Emissions Inventory Scenarios.

Inventory	Activity Input Year[1]	Emissions Factor Input[2]
2002 Base Year	2002	2002 Base Year
2018 Fleet and Pre-2003 Controls with Growth	2018	2018 Fleet and Pre-2003 Controls
2018 Fleet and Pre-2003 Controls without Growth	2002	
2018 Attainment Year Control Strategy	2018	2018 Fleet and Control Strategy

[1] Activity inputs (VMT mix; link VMT/speeds; and off-network activity: SHP, starts, SHI) were consistent with the FY 2012 HGB RFP SIP inventories.

[2] Emissions factors were based on the EPA's special model "MOVES2010bROP" provided to TCEQ for use in the VMT offset calculations. "Pre-2003 Controls" means attainment year emissions factors were modeled to reflect no new controls after the base year beyond those already credited.

The following activities were completed.

- Prepared county-level hourly and 24-hour day tables that provide roadway and source use type summaries of VMT, vehicle hours traveled (VHT), average speed, SHP, vehicle starts, SHI, and totals for the pollutants VOC, CO, NO_x, and CO_2 by associated emissions processes. These files are tab-delimited for ease of loading into spreadsheet software such as Microsoft® Excel.

- Prepared documentation, complete and self contained, including electronic data files.

TTI will maintain 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. The electronic file submission is described in Appendix A – Electronic Data Submittal.

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 (H-GAC) staff provided the HGB regional travel model data sets. White processed roadway based activity (VMT and speeds) and off-network vehicle activity estimates (and vehicle population estimates) needed for the emissions calculations. Boardman produced MOVES model and MOVES output post-processor set-ups, and the MOVES-based emissions factors with adjustments for TxLED fuel, where needed. Schrank produced the emissions run set-ups and performed the emissions runs. 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 elements. 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 discussion is organized in the following sections: Summary of Results, Overview of Methodology, Development of VMT Mix, Estimation of VMT, Estimation of Link Speeds, Estimation of Off-Network Activity, Estimation of Emissions Factors, Emissions Calculations, Quality Assurance, and References.

SUMMARY OF RESULTS

Table 4 summarizes the MOVES2010bROP-based VMT offset inventories (VMT and speed, and VOC, CO, NO_x, and CO_2 emissions) for the HGB region.

Table 4. HGB VMT Offset Ozone Season Weekday On-Road Mobile Source MOVES2010bROP-Based Emissions Inventories (Tons).

Inventory	VMT	Speed[1]	VOC	CO	NO_x	CO_2
2002 Base Year	128,145,285	36.40	124.47	1,414.97	371.89	72,346.11
2018 Pre-2003 Controls with Growth	184,065,162	35.87	87.32	1,261.23	414.80	106,368.48
2018 Pre-2003 Controls without Growth	128,145,285	36.40	58.15	858.28	282.75	73,305.65
2018 Attainment Year Control Strategy	184,065,162	35.87	51.84	663.10	109.98	97,995.85

[1] Average speed in miles-per-hour.

VMT offset inventory estimates with more detail (e.g., by county, SUT/fuel type, road type) may be found in the electronic data submittal (see description in Appendix A).

OVERVIEW OF METHODOLOGY

During FY 2012, TTI used MOVES2010a to develop the HGB RFP SIP emissions inventories (March 2012), which included the RFP 2002 base year and RFP 2018 attainment year control strategy inventories. To model the four inventories for the VMT offset analysis, TTI used the MOVES2010bROP model (provided by EPA specifically for VMT offset calculations), and the inventory methodology, activity inputs, and MOVES model inputs consistent with (e.g., mostly directly from) the FY 2012 HGB RFP 2002 base year and RFP 2018 attainment year control strategy inventories. Adjustments to inventory inputs were made to convert MOVES2010a-based inputs to MOVES2010bROP model input specifications, where needed, and as required specifically for VMT offset calculations.

The inventory method is the detailed, hourly, MOVES rates-per-activity-based, TDM link-based method. This method produces the hourly emissions estimates by MOVES SUT/fuel type (Table 5), pollutant, and emission process (Table 6) for each county inventory scenario (i.e., inventory analysis year, seasonal day-type and control scenario).

This new method is an adaptation of the previous TDM link-based emissions inventory method used with MOBILE6, which applied emissions rates for all emissions processes in terms of miles-traveled activity (e.g., grams/mile). This MOVES "rates-per-activity" method was first implemented during FY 2011 by TTI to produce the HGB base case and baseline emissions inventories (documented in *Development and Production of 2006 Base Case and 2008 Baseline On-road Mobile Source Emissions Inventories for the HGB Nonattainment Area*, TTI, July 2011).

In addition to the VMT-based calculations of roadway-based emissions estimates, the TTI MOVES emissions inventory process now uses off-network activity measures (i.e., starts, SHP, SHI) for off-network-based emissions estimates. "Rates-per-activity" is emphasized in the new process, because all emissions rates used are based in activity units, which is different than the standard MOVES look-up table output that provides mass-per-mile for roadway-based processes, and (only) mass-per-vehicle for off-network-based emissions processes. The TTI method used requires post-processing of MOVES output into rate tables with the off-network process emissions rates based in units of activity, rather than in units of vehicles.

Table 5. MOVES Source Use Type/Fuel Types.

Source Use Type ID	Source Use Type Description	Source Use Type 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 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).

Table 6. MOVES Model Emissions Processes.

Process ID	Process Name
1	Running Exhaust
2	Start Exhaust
9	Brake Wear
10	Tire Wear
11	Evaporative Permeation
12	Evaporative Fuel Vapor Venting
13	Evaporative Fuel Leaks
15	Crankcase Running Exhaust
16	Crankcase Start Exhaust
17	Crankcase Extended Idle Exhaust
18[1]	Refueling Displacement Vapor Loss
19[1]	Refueling Spillage Loss
90	Extended Idle Exhaust
99[1]	Well-to-Pump

[1] Not subject to on-road mobile emissions analysis.

Table 7 shows the emissions rate units with associated processes and activity factors used in this MOVES analysis.

Table 7. Emissions Rates by Process and Activity Factor.

Emission Processes	Activity[1]	Emissions Factor Units
Running Exhaust Crankcase Running Exhaust	VMT	grams/mile (g/mi)
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	VMT	g/mi
	SHP	g/shp
Start Exhaust Crankcase Start Exhaust	starts	g/start
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHI	g/shi

[1] The amount of travel on roads (VMT), SHP, vehicle starts, and SHI are the basic activity factors. SHI is for Combination Long-Haul Trucks only. Evaporative permeation, fuel vapor venting, and fuel leaks occur both during operation and while parked.

Major Components

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

- Area source use type (SUT)/fuel type VMT mix;
- County, hourly link fleet VMT and average speeds;
- County SUT/fuel type vehicle populations;
- County, hourly SUT/fuel type SHP;
- County, hourly SUT/fuel type starts;
- County, hourly SUT/fuel type SHI; and
- County, hourly SUT/fuel type emissions rates: g/mile, g/SHP, g/start, and g/SHI.

VMT Mix

The VMT mix designates the SUT/fuel types included in the analysis, and specifies the fraction of on-road fleet VMT attributable to each SUT/fuel type by MOVES road type.

The SUT/fuel type VMT mixes were estimated using TTI's SUT/fuel type mix method (*Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009). The VMT mix method sets Texas vehicle registration category aggregations for MOVES SUT categories to be used in developing the VMT mix estimates, as well as for developing other fleet parameter inputs needed in the process (e.g., SUT age distributions). The current VMT mix method produced a set of 24-hour average SUT/fuel type VMT allocations by MOVES road type, estimated for each TxDOT district associated with the eight-county HGB area (i.e., Houston and Beaumont districts). The data sources used were recent, multi-year TxDOT vehicle classification counts, year-end TxDOT/TxDMV registration data, along with MOVES default data where needed.

On-Road Fleet Link-VMT and Speeds

The TDM link-based method was used to estimate fleet VMT and speed inputs to the roadway-based emissions calculations (product of "mass per mile" emissions factors and VMT).

TTI post-processed directional, four-period time-of-day, TDM network traffic assignments and trip matrix data provided by H-GAC to produce the hourly, directional, link VMT (consistent with HPMS VMT) and associated average fleet speed estimates, of the ozone season weekday (i.e., average Monday through Friday during the June through August period). 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 travel-related emissions estimates (e.g., from vehicle starts, parked vehicle evaporative permeation and tank vapor venting, and SHI) were calculated as the product of the amount of associated activity and the pollutant mass per unit of activity (emission factor units as shown in Table 7). To estimate the SHP and vehicle starts activity, SUT/fuel type category population estimates were needed, whereas SHI was based on HGB county-specific actual estimates (*Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study*, ERG, August 2004).

SUT/Fuel Type Populations: TTI based vehicle population estimates on registration data, SUT/fuel type VMT mix-based vehicle population factors, and VMT-based growth estimates (for future years). For historical years, the SUT/fuel type vehicle population estimates are based solely on mid-year TxDOT (or Texas Department of Motor Vehicles [TxDMV]) county registrations data and regional, all roads-weekday SUT/fuel type VMT mix-based population factors for the analysis year. For the 2018 future year, SUT/fuel type populations were estimated as a function of base (e.g., latest available, mid-year) registrations, grown to the 2018 future value (growth as a function of base and future VMT), and all roads-weekday SUT/fuel type VMT mix-based population factors applicable to the analysis year.

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

Starts: Engine starts were based on the MOVES national default starts per vehicle, and the local, county SUT/fuel type vehicle 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 SUT/fuel type population estimates. This was performed for each analysis year by county and hour.

SHI: The SHI (for Combination Long-Haul Trucks) was estimated based on information from a TCEQ extended idling study, and additional scaling factors developed by TTI. The 2004 idle activity study produced 2004 summer weekday SHI estimates by Texas county. TTI used the HGB county summer weekday 24-hour 2004 base year SHI estimates from this study in combination with 2004 base year and analysis year link VMT and SUT/fuel type VMT mixes (for producing the SHI scaling factors) to estimate county, hourly SHI activity for each of the analysis years. SHI hourly factors (estimated as the inverse of the hourly VMT factors) were used to allocate the 24-hour SHI to each hour of the day.

MOVES Emissions Factors

TTI post-processed the MOVES2010bROP (emissions and activity) output to calculate the emissions rates in the needed "per activity" units (as summarized in Table 7). A fundamental aspect of the emissions rates modeling method is that the activity inputs used in MOVES are essentially MOVES defaults, which are later divided out (to unity) in the production of emissions

rates, via post-processing of the MOVES activity and emissions output (i.e., emissions divided by activity). The actual local, scenario-specific activity estimates for each county are then used in the emissions calculations outside of MOVES.

Look-up tables of MOVES emissions factors were developed (post-processed from "emissions rate calculation type" MOVES model output) by pollutant, process, speed (for roadway-based processes), hour, road type (including a category for off-network emissions processes), and average SUT/fuel type. MOVES outputs were post-processed in two ways: 1) to calculate the emissions rates from emissions and activity output, and 2) to extract the rates for only those pollutants needed in the emissions calculations, and to apply TxLED adjustments to each county's diesel vehicle NO_x emissions rates (depending on analysis scenario) as well as to combine the effects of two inspection and maintenance (I/M) test-types where the test-type change occurred in the preceding 12-month I/M cycle (i.e., only for the Harris County 2002 base year).

County-level emissions factors were developed for the MOVES weekday day type for each of the three scenarios: 2002 base year, 2018 with pre-2003 controls, and 2018 control strategy. Local emissions factor modeling input parameters were developed and used to produce emissions factors reflective of the local scenario conditions (e.g., weather and fleet characteristics, fuel properties, and I/M program).

Emissions Calculations

Emissions were calculated for each county and analysis control scenario using the major inputs as described previously, and summarized here: TxDOT district-level 24-hour SUT/fuel type VMT mix by MOVES road type; county, hourly on-road fleet link VMT and speed estimates; county hourly off-network activity estimates by SUT/fuel type of SHP, starts, and SHI; and the county-level look-up tables of activity-based hourly emissions rates by SUT/fuel type and emissions process.

For the VMT-based calculations, a MOVES road type to TDM network road type/area type designation was used to match the appropriate VMT mixes and link VMT. The VMT mixes by MOVES road type were multiplied by the link fleet VMT to distribute each link's VMT to the 23 different SUT/fuel type categories. Emissions rates for each link's average speed were interpolated (see procedure in Appendix B) from the appropriate set of look-up table emissions factors 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 SUT/fuel type and MOVES road type combination link speed-specific emissions factors for each pollutant process were then multiplied by the associated VMT to produce the link-based emissions estimates. This process was executed for each hour, analysis year and control scenario.

For the off-network emissions calculations, which are county level, the emissions factors by SUT/fuel type were multiplied by the appropriate county total activity estimate, as determined by the pollutant process. This process was executed for each hour, analysis year and control scenario.

The emissions estimates are organized in a tab-delimited output file for each county by pollutant/process, roadway type, and SUT/fuel type combination for each hour, and for the 24-hour period. This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity, VMT, VHT, and speed by roadway. Appendix A contains more detailed output definitions and specifications.

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.

DEVELOPMENT OF SUT/FUEL TYPE VMT MIX

The estimated SUT/fuel type VMT mix inputs to the emissions inventory calculations for the VMT offset demonstration analysis, developed as described again here, were acquired from the FY 2012 HGB RFP SIP inventories project.

The SUT/fuel type 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 SUT/fuel type. These hourly VMT estimates by SUT/fuel type are combined with the appropriate emissions factors in the link-emissions calculations.

TxDOT district-level, 24-hour average, weekday SUT/fuel type VMT mixes (for gasoline-powered and diesel-powered vehicles) were estimated by the four MOVES road-type categories following the methodology detailed in the report entitled, *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009. This methodology characterizes VMT by SUT/fuel type for a region (or district) as follows.

- TxDOT Classification Counts by County and TxDOT District — This is the standard TxDOT classification data assembled and used for determining the in-use road fleet mix (e.g., VMT mix under MOBILE).
- Redefine Roadway Functional Classifications from Federal Highway Administration (FHWA)/TxDOT to MOVES types — A straightforward transposition of FHWA/TxDOT roadway functional classifications in the classification count data into the five MOVES road types.
- Define MOVES vehicle categories. For example, PV21 – Passenger vehicles equivalent to FHWA C minus .001 for MCs.
- Define MOVES vehicle categories - Passenger and Light Commercial Trucks — Separates FHWA light-truck category (P) into passenger trucks and light commercial vehicles using approximate (rounded) MOVES default values. Note this disaggregation is similar to the MOBILE6 distinction between the two primary LDT categories (LDT12 and LDT34).
- Define MOVES vehicle categories – Single-Unit Trucks RTF51 — These are refuse trucks. These are currently assigned a nominal default value (.001) taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4). To be modified as improved or locally-specific data become available.

- Define MOVES vehicle categories – Single-Unit Trucks Short-Haul versus Long-Haul (SUSH52 and SULH53) per SUT_SSHX — Separates single-unit trucks into short-haul and long-haul based on local (TxDOT district) registrations versus observed vehicles from the classification counts. District allocations verified against statewide allocation.
- Define MOVES vehicle categories – Single-Unit Trucks MH54 — These are motor homes/recreational vehicles. These are currently assigned a nominal default value (.001) taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4). To be modified as improved or locally-specific data become available.
- Define MOVES vehicle categories - Buses (approximate MOBILE6 defaults) — To be modified as improved or locally-specific data become available.
- Define MOVES vehicle categories - Combination Trucks Short-Haul versus Long-Haul (CSH61 and CLH62) per SUT_HDX9 and SUT_CSHX — Separates combination trucks into short-haul and long-haul based on local (TxDOT district) registrations versus observed vehicles from the classification counts. District allocations verified against statewide allocation.
- Define MOVES vehicle categories - MCs — Nominal default value taken from passenger cars (FHWA C). To be modified as improved or locally-specific data become available.
- Fuel Type Allocation - PV and LDT fuel type allocation per TxDOT registration data and MOVES defaults (21, 31, and 32) per AgeReg9X and MF_Fuel — Other fuel types currently treated as *de minimus*. Additional fuel types can be incorporated as local or regional data become available, or from the MOVES national default database (though this latter option is not recommended). Note allocation of fuel type varies with analysis year.
- Fuel Type Allocation - Single Unit and Combination Trucks per TxDOT registration data per SUT_HDV9 — As with PV and LDT, other fuel types currently treated as *de minimus*.
- Aggregate and Calculate MOVES SUTs and apply day-of-week factors from urban area classification count data (Friday, Saturday, and Sunday).

TxDOT district-level weekday SUT/fuel type VMT mixes by MOVES road-type category (included as Appendix C) were 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 SUT/fuel type VMT mixes (used in the vehicle population estimation) were also produced and included as Appendix D. To ensure general applicability and consistency across all study areas, all VMT mixes were developed in five-year increments beginning with the year 2000 and applied to the analysis years based on Table 8.

Table 8. 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

ESTIMATION OF VMT

The estimated link VMT inputs to the emissions inventory calculations for the VMT offset demonstration analysis, developed as described again here, were acquired directly from the FY 2012 HGB RFP SIP inventories project.

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 summer ozone season (June through August) weekday (Monday through Friday). The TRANSVMT utility (see Appendix B for a description of the utility), the latest available HGB 2002 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 VHT summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

Data Sources

The latest available HGB 2002 (dated July 3, 2007) and 2018 (dated October 18, 2011) 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.

Several other data sources were used to adjust the VMT for HPMS consistency and to estimate the seasonal sub-period day types. 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 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 collected on a

continuous basis and 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 (2000 through 2010) 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 was combined from those stations with in the Houston TxDOT District for use with Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties. This data source was also used to product the time-of-day (hourly) allocation factors, in which the data from the ATR stations with in the eight-county region was combined.

VMT Adjustments

For each analysis year, the TDM VMT was adjusted for HPMS consistency and for seasonality (i.e., ozone season summer weekday). For 2002, which by definition is a historical year (i.e., HPMS VMT data exists for 2002), county-level VMT control totals were used. For the 2018 analysis year, which is considered a future year (i.e., HPMS VMT data does not exist), a regional HPMS factor and a seasonal weekday factor were used. Hourly travel factors were also applied to distribute this adjusted VMT over each hour of the day.

2002 Historical Year Analysis – VMT Control Totals and VMT Adjustments

To estimate the HPMS-consistent ozone season summer weekday for the 2002 historical year, 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 county-level HPMS AADT VMT for 2002 and an ozone season summer day-of-week (i.e., weekday) adjustment factor.

The ozone season summer weekday adjustment factors were developed using aggregated ATR data for the years 2000 through 2010. 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, 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. The same weekday adjustment factors were used for each historical year analysis. Table 9 shows the HGB weekday factors used in developing the VMT control totals.

Table 9. HGB Weekday Factors for Control Total Development.

TxDOT District	Weekday Adjustment Factor
Beaumont[1]	1.08998
Houston[2]	1.04160

[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 analysis year HPMS AADT VMT for each county by the appropriate ozone season summer weekday adjustment factors to produce eight VMT control totals (one for each county) for the 2002 historical analysis year. 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 analysis year 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 link-level HPMS consistent, period day-type-specific VMT estimates. Table 10 shows the weekday VMT control totals, the total TDM VMT, and the VMT adjustment factors for 2002.

Table 10. HGB 2002 Weekday VMT Control Totals and VMT Adjustment Factors.

County	VMT Control Total	TDM VMT[1]	VMT Adjustment Factor
Harris	93,380,035	94,641,477.08	0.986671361
Brazoria	5,564,463	5,871,848.97	0.947650906
Fort Bend	7,738,690	7,968,385.94	0.971174095
Waller	1,865,629	1,753,131.92	1.064169204
Montgomery	9,293,357	9,167,873.35	1.013687323
Liberty	2,301,454	2,228,487.13	1.032742781
Chambers	2,268,351	2,410,984.11	0.940840294
Galveston	5,733,306	4,820,989.76	1.189238370

[1] 2002 TDM, including intrazonal VMT.

2018 Future Year Analysis – HPMS Adjustment Factor

For the 2018 future year analysis, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) for HPMS consistency for the TDM. This factor was developed using the total TDM VMT from the 2005 travel model validation (dated November 16, 2011), the 2005 HGB HPMS VMT reported by TxDOT, and aggregated 2006 ATR data (to produce the annual non-summer weekday traffic [ANSWT] adjustment factor in the following equation). The 2006 ATR data was used instead of the 2005 ATR data because of data irregularities due to the possible effects of a hurricane on the traffic counters. The formula for the HPMS factor calculation is:

HPMS VMT (AADT) × ANSWT Adjustment Factor = HPMS VMT (ANSWT)
HPMS VMT (ANSWT) / Model VMT (ANSWT) = HPMS Factor

Applying the ANSWT adjustment to the HPMS AADT VMT (i.e., conversion from AADT to ANSWT) produces seasonal, day-of-week consistency between the TDM VMT and HPMS VMT components of the HPMS factor. The actual values for the HPMS factor are:

132,093,142 × 1.059088 = 139,898,261.5 (HPMS ANSWT VMT)
139,898,261.5 / 138,790,409.7 = 1.007982193 (HPMS Factor)

2018 Future Year Analysis – Seasonal Adjustment Factors

For the 2018 future year analysis, seasonal adjustment factors were used to adjust the TDM and estimated intrazonal VMT to ozone season summer weekday VMT. The seasonal adjustment factors were developed using aggregated ATR data for the years 2000 – 2010. 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 ANSWT traffic count. Table 11 shows the seasonal adjustment factors by TxDOT district.

Table 11. HGB Weekday Seasonal Adjustment Factors for Future Year Analysis.

TxDOT District	Weekday Seasonal Adjustment Factor
Beaumont[1]	1.06428
Houston[2]	0.96769

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

2018 Future Year Analysis – VMT Summary

The 2018 future year final HPMS-consistent, day-type specific 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 12 shows the TDM and ozone season weekday VMT summary.

Table 12. HGB 2018 VMT Summary.

County	2018	
	TDM	Weekday
Harris	132,292,219	129,039,721
Brazoria	8,841,141	8,623,775
Fort Bend	14,411,651	14,057,330
Waller	2,752,993	2,685,309
Montgomery	15,512,473	15,131,088
Liberty	3,377,161	3,622,935
Chambers	3,623,749	3,887,468
Galveston	7,194,417	7,017,537

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 (2000 through 2010) aggregated ATR station data for the eight-county HGB region. To maintain VMT proportions within each of the four assignment time periods (including those proportions produced specifically for the weekend day types as described previously), the hourly fractions were normalized within each time period. 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, ozone season summer weekday VMT estimates for each analysis year. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 13 shows the weekday hourly travel factors.

Table 13. Weekday Hourly Travel Factors.

Assignment	Hour	Weekday
AM Peak	6:00 a.m.	0.319975
	7:00 a.m.	0.368425
	8:00 a.m.	0.311600
Mid-Day	9:00 a.m.	0.160270
	10:00 a.m.	0.155898
	11:00 a.m.	0.162983
	12:00 p.m.	0.168764
	1:00 p.m.	0.171777
	2:00 p.m.	0.180308
PM Peak	3:00 p.m.	0.238603
	4:00 p.m.	0.259721
	5:00 p.m.	0.275395
	6:00 p.m.	0.226281
Overnight	7:00 p.m.	0.204604
	8:00 p.m.	0.159440
	9:00 p.m.	0.143563
	10:00 p.m.	0.113907
	11:00 p.m.	0.077553
	12:00 a.m.	0.043044
	1:00 a.m.	0.028404
	2:00 a.m.	0.026089
	3:00 a.m.	0.024941
	4:00 a.m.	0.044559
	5:00 a.m.	0.133896

ESTIMATION OF LINK SPEEDS

The estimated link speeds inputs to the emissions inventory calculations for the VMT offset demonstration analysis, developed as described again here, were acquired directly from the FY 2012 HGB RFP SIP inventories project.

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 travel model speed to a free-flow speed and an LOS E speed (i.e., application of these factors results in two speeds). These factors were grouped into seven functional groups. 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:

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

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 V/C ratio equal to 0.0;
- $S_{1.0}$ = estimated LOS E speed for V/C ratio equal to 1.0; and
- $SRF_{V/C}$ = speed reduction factor 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 model extension was used. The speed model extension is:

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

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

The estimated off-network (or parked vehicle) activity inputs to the emissions inventory calculations for the VMT offset demonstration analysis, developed as described again here, were acquired directly from the FY 2012 HGB RFP SIP inventories project.

To estimate the off-network (or parked vehicle) emissions using the grams per activity emissions rates (i.e., grams per SHP, grams per start, and grams per SHI), county-level estimates of the SHP, starts, and SHI are required by hour and SUT/fuel type for each analysis year and day type. One of the main components of the SHP and starts off-network activity estimation is the county-level vehicle population for each analysis year. Summaries of the vehicle population and 24-hour SHP, starts, and SHI off-network activity are included as Appendix F. Hourly SHP, starts, and SHI activity estimates are included with the detailed emissions inventory data provided (see inventory data file descriptions in Appendix A).

The county-level vehicle population estimates were developed using the MOVESpopulationBuild utility. The county-level SHP and starts by hour and SUT/fuel type estimates were developed using the ShpExtIdleStartActBld utility. The county-level SHI by hour and SUT/fuel type estimates were developed using the ExtIdleHrsCalc utility. Appendix B contains a description of the utilities.

Estimation of Vehicle Population

The vehicle population estimates (by SUT and fuel type) are needed to estimate the SHP and starts off-network activity. The vehicle population estimates (included as Appendix G) were

produced for each county and analysis year. The vehicle population estimates are a function of vehicle registration data (TxDOT registration data sets), population scaling factors (where applicable), and SUT/fuel type VMT mix.

For estimating vehicle populations, a historical analysis year is defined as any year where actual TxDOT registration data and HPMS VMT data (used in developing population scaling factors) exists. Therefore, the 2002 analysis year was considered a historical year and the vehicle population estimates were based on the TxDOT registration data for 2002. For the 2018 future analysis year, the vehicle population estimates were based on the most recent year (2010) TxDOT registration data set for which HPMS VMT data exists, and analysis 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 SUT/fuel type VMT mixes. The development of these VMT mixes are described in more detail in the "Development of SUT/Fuel Type VMT Mix" section and summaries are included in Appendix D.

Historical Vehicle Population Estimates

The county-level vehicle population estimates for the 2002 historical analysis year were calculated using the analysis year county-level, mid-year TxDOT vehicle registrations and the assigned aggregate SUT/fuel type VMT mix. The vehicle 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 estimation process: registration data category aggregation, calculation of the SUT/fuel type population factors, and estimation of the county-level vehicle population by SUT/fuel type.

The first step in the vehicle estimation process is the registration data category aggregation. For each county, the analysis year vehicle registrations were aggregated into five categories. Table 14 shows these five categories.

Table 14. 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 SUT/fuel type population factors. Using the assigned aggregate SUT/fuel type VMT mix, SUT/fuel type population factors were calculated for each SUT/fuel type combination. For the non-long-haul SUT categories, the SUT/fuel population

factors were calculated by dividing the SUT/fuel type VMT mix by the summed total of the SUT/fuel type 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 SUT/fuel 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 15 shows the vehicle registration aggregations and their associated MOVES SUT/fuel types.

Table 15. TxDOT Vehicle Registration Aggregations and Associated SUT/Fuel Types for Estimating SUT/Fuel Type Populations.

Vehicle Registration[1] Aggregation	Associated MOVES SUT/Fuel 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 TxDOT 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 population by SUT/fuel type. The non-long-haul SUT/fuel type vehicle populations were estimated by applying their SUT/fuel 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 vehicle population estimates for a future analysis year (e.g., 2018) is very similar to the historical vehicle population estimates except that instead of using the analysis year registration data sets, the most recent (2010) mid-year TxDOT registration data sets for which HPMS data exists were used. Using these registration data sets

and the assigned VMT mix, the base SUT/fuel type population for 2010 was calculated. To estimate the 2018 future analysis year county-level vehicle populations, 2018 future year county-level vehicle population scaling factors were applied to the base SUT/fuel type population for 2010. These future year county-level vehicle population scaling factors were calculated as the ratio of the county-level weekday VMT for the 2018 analysis year to the county-level weekday VMT for the year of the most recent (2010) mid-year TxDOT registration data (i.e., vehicle population estimates increase linearly with VMT).

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level weekday estimates of SHP by hour and SUT/fuel type for each analysis year. For each hour, the county-level SHP by SUT/fuel type was calculated by taking the difference between the total available hours minus the SHO by SUT/fuel type. Since this calculation was performed at the hourly level, the total available hours by SUT/fuel type is the same as the vehicle population by SUT/fuel type. The SHO was calculated using the link VMT and speeds and the TxDOT district-level SUT/fuel type VMT mixes by MOVES road-type category (see the "Development of SUT/Fuel 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 SUT/fuel type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Total Available Hours by SUT/Fuel Type

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

SHO by SUT/Fuel Type

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

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level weekday estimates of starts by hour and SUT/fuel type for each analysis year. The hourly default starts per vehicle by SUT/fuel type were multiplied by the analysis year county-level vehicle population by SUT/fuel type to estimate the county-level starts by hour and SUT/fuel type. Appendix F includes the 24-hour summaries of the county-level starts by hour and SUT/fuel type for each analysis year (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 and MOVES weekend run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES default starts per vehicle do not vary by year or geography (i.e., county), only by MOVES day type. Since the emissions inventories are for weekday, only the MOVES weekday default starts per vehicle were used.

Estimation of SHI

Unless otherwise stated, all activity factors referenced in the discussion of estimation of SHI pertain only to the CLhT_Diesel vehicle category.

The third activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level weekday estimate of SHI by hour and SUT/fuel type for each analysis year. These SHI estimates were for source type 62, fuel type 2 (CLhT_Diesel) only. The SHI was based on information from a TCEQ extended idling study, which produced 2004 summer weekday SHI estimates for each Texas county. SHI scaling factors (for 2002 and 2018) were applied to the base 2004 summer weekday SHI values from the study to estimate the 24-hour SHI by analysis year. SHI hourly factors were then applied to allocate the 24-hour SHI by analysis year to each hour of the day. To ensure valid hourly SHI values were used in the emissions estimation, the hourly SHI was compared to the hourly CLhT_Diesel SHP (i.e., hourly SHI values cannot exceed the hourly SHP values). Appendix F includes the 24-hour summaries of the county-level estimates of SHI by hour and SUT/fuel type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

SHI Scaling Factors

To estimate the county-level 24-hour SHI by analysis year, county-level SHI scaling factors were developed using county-level 2004 summer weekday link-level on-road fleet VMT and speeds, the TxDOT district-level base weekday SUT/fuel type VMT mix (by MOVES road type), the county-level analysis year weekday fleetwide link-level VMT and speeds, and the TxDOT district-level analysis year SUT/fuel type VMT mix (by MOVES road type). The 2004 summer weekday link-level on-road fleet VMT and speeds were developed using a process similar to the 2002 historical analysis year weekday link-level fleet VMT and speeds, using the HGB 2005 TDM (run date November 16, 2011) and a 2004 summer weekday county VMT control totals. The SUT/fuel type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Appendix C). For the base weekday SUT/fuel type VMT mix, the 2005 weekday SUT/fuel type VMT mix was used.

For each link in the 2004 summer weekday link-level fleetwide VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday SUT/fuel type VMT mix. This VMT allocation was performed for each link and hour in the 2004 summer weekday link-level fleet VMT and speeds, with the individual link VMT aggregated by hour to produce the hourly and 24-hour 2004 summer weekday CLhT_Diesel VMT estimates. Using a similar allocation process, the analysis year hourly and 24-hour CLhT_Diesel VMT was calculated using the analysis year weekday link-level on-road fleet VMT and speeds and the analysis year SUT/fuel type VMT mix. The county-level 24-hour SHI scaling factors for 2002 and 2018 were calculated

by dividing the analysis year and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2004 summer weekday VMT.

SHI Hourly Factors

To allocate the analysis year and weekday county-level 24-hour SHI to each hour of the day, SHI hourly factors were used. These SHI hourly factors were calculated as the inverse of the analysis year weekday CLhT_Diesel hourly VMT fractions. The analysis year weekday CLhT_Diesel hourly VMT fractions were calculated using the analysis year weekday CLhT_Diesel hourly VMT. The analysis year weekday CLhT_Diesel hourly VMT were converted to hourly fractions, therefore creating analysis year weekday 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 analysis year weekday SHI hourly factors.

County-Level CLhT_Diesel SHI by Hour Estimation

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

ESTIMATION OF EMISSIONS FACTORS

TTI developed the VMT offset inventory analysis MOVES emissions factors consistent in method and input with the FY 2012 HGB RFP SIP inventories project, adapting inputs where needed to account for input specification changes between MOVES model versions (MOVES2010a used for the RFP inventories and MOVES2010bROP used for this analysis), and using model set-ups needed for VMT offset calculations, as specified in EPA's 2012 VMT offset guidance materials. Although most of the MOVES model local inputs for this analysis were acquired directly from the FY 2012 HGB RFP inventory project, details on input data sources and development, post-processing procedure, etc., are included again here for completeness.

TTI developed the emissions factors using MOVES2010bROP, the special version of MOVES2010b modified by EPA especially for VMT offset calculations, and provided to TCEQ, September 2012. MOVES includes a feature (Strategies – Rate-of-Progress) that allows emission rates to be "frozen" after 1990 (i.e., disables all motor vehicle requirements of the 1990 Clean Air Act Amendments (CAAA). In MOVES2010bROP the Strategies – Rate-of-Progress function was modified to allow a different baseline year to be set at which later model year emissions rates are "frozen" (i.e., as in this analysis, 2002).

The emissions factors were developed based on EPA's 2012 VMT offset guidance and the EPA's current MOVES guidance. The EPA's 2012 VMT offset guidance is documented in

Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Travelled. EPA, August 2012, and in a one-page document entitled *Explanation of special VMT offset version of MOVES* (provided to TTI by TCEQ, September 2012, along with the MOVES2010bROP model). The current MOVES guidance is documented in *Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a, and 2010b*, EPA, April 2012. This MOVES emissions inventory *Technical Guidance* and EPA's 2012 VMT offset guidance, along with *Motor Vehicle Emission Simulator (MOVES) User Guide for MOVES1010b*, EPA, March 2012; and *Update Of On-Road Inventory Development Methodologies For Motor Vehicle Emissions Simulator (Moves) Model Compatibility Technical Report*, TTI, July 2011 (MOVES output post-processing utilities used are summarized in Appendix B of this Technical Report), are the main references where additional detail may be found, if desired.

The three sets of county-level emissions rates developed for input to the emissions calculations are:

- 2002 base year;
- 2018 attainment year with pre-2003 controls; and
- 2018 attainment year control strategy.

The 2002 base year and 2018 attainment year control strategy emissions rates were developed consistent with the FY 2012 HGB RFP inventory project emissions rate counterparts, and serve as a check between the MOVES model versions (as EPA has stated that "MOVES2010b does not significantly affect criteria pollutant emissions from MOVES2010"). In comparing the rates between the two projects, TTI found that the VOC, CO, NO_x, and CO_2 emissions rates for the scenarios are essentially the same, e.g., within rounding error.

The detailed link-based emissions inventory method of analysis requires emissions rates by speed in look-up table form; the MOVES Emission Rate calculation type was therefore selected to direct MOVES to output emissions rates, emissions, and activity data by MOVES speed bin average speed (2.5, 5, 10….. 75 mph). The emissions inventory method required that all rates be in terms of mass/activity (as opposed to the off-network rates in terms of mass/vehicle as output by MOVES) for the external emissions calculations. TTI post processed the MOVES emissions and activity output to produce all emissions rates in mass/activity terms (see Table 16, which was included in a previous section, but is provided again here for convenience).

Table 16. Emissions Rates by Process and Activity Factor.

Emission Processes	Activity[1]	Emissions Factor Units
Running Exhaust Crankcase Running Exhaust	VMT	grams/mile (g/mi)
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	VMT	g/mi
	SHP	g/shp
Start Exhaust Crankcase Start Exhaust	starts	g/start
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHI	g/shi

[1] The amount of travel on roads (VMT), SHP, vehicle starts, and SHI are the basic activity factors. SHI is for Combination Long-Haul Trucks only. Evaporative permeation, fuel vapor venting, and fuel leaks occur both during operation and while parked.

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions factors. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions. Where local data were available, MOVES defaults were replaced by local input values, via the MOVES Run Specifications file (RunSpec or MOVES Run Specifications [MRS]) and MOVES CDB (county input database). (The MOVES RunSpecs, CDBs, and MOVES default database provide the data for each local scenario model run.) Local inputs were developed and used to produce emissions factors characteristic of the June through August period peak ozone season average weather conditions, summer fuel properties, vehicle fleet characteristics, and emissions control programs (depending on the local control scenario). In the case of the activity input data to MOVES, the MOVES defaults were in general used, which is basic to the emissions rates method (default activity is divided out to unity in the rates calculation, and actual local activity estimates are applied later in the external emissions calculations).

MOVES Inputs, Outputs and Post-Processing

There is one RunSpec required per county and calendar year control scenario, and a corresponding number of county data bases (CDBs), and output databases (i.e., one output database per run). Therefore, for eight counties and three calendar year control scenarios (plus the additional I/M scenario for Harris 2002 needed for the I/M test-type switch modeling procedure) there are 25 each RunSpecs, CDBs, MOVES output databases, and MOVESRatesCalc runs; and 24 MOVESRatesAdj runs that produce the final emissions rates, by performing NO_x TxLED effect adjustments for attainment year control strategy scenario, and for the Harris 2002 I/M test-type switch effects combines two sets of rates into one, and extracts and stores the rates for the inventoried pollutants in a separate, smaller database for input to the emissions runs.

The utilities used to calculate the emissions rates from the MOVES emissions and activity output and to adjust the emissions rates are MOVESratescalc and MOVESratesadj, respectively (see descriptions in Appendix B).

Summary of Control Programs Modeled

Table 17 shows the control measures modeled (marked by a "√") in each of the calendar year control scenarios.

Table 17. Control Measure Modeling by Calendar Year Control Scenario.

Individual Control Measures[1]	Method	Calendar Year Control Scenario		
		2002 Base Year	2018 Pre-2003 Controls	2018 Control Strategy
Pre-2003 FMVCP Tier 0 Tier 1 National Low Emission Vehicle Program	MOVES	√	√	√
Post-2002 FMVCP[1] Tier 2 Heavy-Duty 2004 Diesel 2005 Gasoline 2007 Gasoline and Diesel Highway Motorcycle 2006	MOVES	N/A	N/A	√
RFG[1]	MOVES	√ (2002 fuel formulation)	√ (2002 fuel formulation)	√ (2011 fuel formulation)
Federal low-sulfur highway diesel (1993 rule 500 ppm maximum)	MOVES	√ (2002 fuel formulation)	√ (2002 fuel formulation)	N/A
Federal low-sulfur highway diesel (2006 rule 15 ppm maximum, with provisions)	MOVES	N/A	N/A	√ (2011 fuel formulation)
I/M Program[1]	MOVES	√ (2002 program)	√ (2002 program)	√ (latest program)
TxLED Fuel[1]	Post-process diesel vehicle NO_x rates	N/A	N/A	√

[1] RFG input parameters were based on Houston fuel survey data (summer 2002 and latest available summer 2011). Diesel sulfur values were based on historical fuel survey data (Houston 2003 survey for 2002 base year and pre-2003 scenario, and MOVES default for 2018 control strategy). The only I/M county in 2002 was Harris County, which was modeled for the 2002 base year and for the 2018 pre-2003 controls scenario; for the 2018 control strategy scenario, I/M was modeled for the five HGB counties under the current I/M program. TxLED effects were modeled as a post-processing procedure adjustment to diesel vehicle NO_x emissions for all counties, for the 2018 control strategy scenario only.

MOVES Emissions Factor Aggregation Levels

The summer weekday emissions factor look-up tables produced provide the MOVES emissions rates by:

- Up to 13 source types (i.e., vehicle types);
- Up to 4 fuel types;
- Up to 5 road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- 16 speed bins (i.e., 2.5, 5, 10, 15,…. 75 mph) (only included in miles-based rate tables);
- Up to 38 pollutants; and
- Up to 13 emissions processes.

The vehicle fleet was assumed to be powered only by the predominant on-road fuels of gasoline or diesel. The five road type categories in MOVES are Off-Network (not actually a road type), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access. Of the two rate tables produced (by post-processing) for input to the emissions calculations, one rate table contains off-network rates, and the other includes rates for each of the actual four MOVES road types, indexed by 16 speeds. The speeds index corresponds to the 16 MOVES speed bin average speeds: 2.5, 5, 10, 15,…. 75 mph.

MOVES Run Specifications

The MOVES Run Specifications (MRS) (XML file) defines place, time, vehicle, road, fuel, emissions producing process, and pollutant parameters for the modeling scenario. TTI developed the analysis MRS files by first creating an MRS template using the MOVES Graphical User Interface (GUI), then looping through the template with a file-building utility to create one MRS for each county, year, and control scenario. This process was used to produce the 25 MRSs for the analysis (three calendar year control scenarios x eight counties + one extra for the Harris County 2002 base year scenario needed for the I/M test-type switch effects modeling procedure).

Table 18 describes the MRS selections TTI used, with further details on the selections following the table.

Table 18. RunSpec Selections by MOVES2010bROP GUI Navigation Panel.

Navigation Panel	Detail Panel	Selection		
Scale	Domain/Scale; Calculation Type	County; Emissions Rates		
Time Spans[1]	Time Aggregation Level; Years – Months – Days – Hours	Hour; ***<YEAR>***[1] - July - Weekday - All		
Geographic Bounds[2]	Region; Selections; Domain Input Database	Zone and Link; ***<COUNTY>***[2]; ***<COUNTY INPUT DATABASE (CDB) NAME>***[2]		
On-Road Vehicle Equipment	SUT/fuel combinations	SUT	Gasoline	Diesel
		Motorcycle	X	-
		Passenger Car	X	X
		Passenger Truck	X	X
		Light Commercial Truck	X	X
		Intercity Bus	-	X
		Transit Bus	-	X
		School Bus	X	X
		Refuse Truck	X	X
		Single Unit Short-Haul Truck	X	X
		Single Unit Long-Haul Truck	X	X
		Motor Home	X	X
		Combination Short-Haul Truck	X	X
		Combination Long-Haul Truck	-	X
Road Type	Selected Road Types	Off-Network – Rural Restricted Access – Rural Unrestricted Access – Urban Restricted Access – Urban Unrestricted Access		
Pollutants and Processes[3]	VOC; CO; NO_x; Atmospheric CO_2	Depending on pollutant, processes may include: Running Exhaust, Start Exhaust, Extended Idle Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, or Fuel Leaks		
Manage Input Data Sets	Additional input database selections	None		
Strategies[4]	Rate-of-Progress	***"No Clean Air Act Amendments" box was checked only for the 2018 calendar year pre-2003 controls runs.***[4]		
General Output	Output Database; Units; Activity	***<MOVES OUTPUT DATABASE NAME>***; Pounds, KiloJoules, Miles; Distance Traveled, Source Hours, Source Hours Idling, Source Hours Operating, Source Hours Parked, Population, Starts		
Output Emissions Detail	Always; For All Vehicles/Equipment; On Road	Time: Hour – Location: Link – Pollutant; Fuel Type, Emissions Process; Source Use Type		
Advanced Performance Measures	Aggregation and Data Handling	All check boxes are to be "un-checked"		

[1] County scale allows one year and county per run. The years are 2002 (base year) and 2018 (for the attainment year pre-2003 controls and control strategy runs).

[2] The counties are Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller.

[3] 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 Total Energy Consumption).

[4] For 2018 pre-2003 controls, in addition to checking the Strategies Rate-of-Progress box, the modelyearcutpoints table was updated for a 2002 baseline, in accordance with EPA's instructions provided with MOVES2010bROP.

Scale, Time Spans, and Geographic Bounds

The MOVES Domain/Scale "County" was selected as is required for SIP inventory analyses. The MOVES Calculation Type "Emissions Rates" was selected for MOVES to produce the activity and emissions output needed for input to the post-processing algorithms that calculate the emissions rate look-up tables with speed bin indexing, as needed for the detailed link-based emissions estimation process (see MOVESratescalc utility description in Appendix B).

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 per run was selected, as MOVES allows only one "Years" selection for the County Domain Scale. For TTI's MOVES-based link emissions estimation process, which is for a single day, 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 user-produced 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, and 16 (speed bin) average speeds were modeled per run.

On-Road Vehicle Equipment and Road Type

All of the SUTs associated with gasoline and diesel fuels were specified. Note that for this analysis, the MOVES default fuel/engine fractions were replaced with local inputs, which showed no compressed natural gas (CNG) vehicles in the fleet (the MOVES default database includes some CNG Transit Buses), and no gasoline Transit Buses. (The local SUT/fuel type VMT mixes developed for the study define the SUT/fuel type combinations included in the MOVES runs.) For emissions rate calculations, all five MOVES road type categories were selected.

Pollutants and Processes

In MOVES, VOC is a "chained" pollutant, meaning that VOC emissions are calculated based on one or more other pollutants whose emissions must also be calculated. In addition to the pollutants called for in this analysis, the following pollutants were additionally required for MOVES to produce the VOC emissions rates: Total Hydrocarbons (THC), Non-Methane Hydrocarbons (NMHC) and Methane. Additionally, Total Energy Consumption (TEC) was required for MOVES to calculate CO_2 rates. All of the associated processes available by the selected pollutants were included, except for 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 2018 calendar year pre-2003 controls emissions rates modeling scenario. The check-box *Compute Rate-of-Progress "No Clean Air Act Amendments" Emissions* was selected for this scenario in combination with other required inputs (via modelyearcutpoints, imcoverage, and fuels tables in the input CDB,

discussed later), to set, or "freeze," emissions rates at a 2002 baseline by assigning 2002 model-year emissions rates to all post-2002 vehicles.

Output

The output units were pounds (converted in a later step to grams), kilojoules, and miles. All of the activity categories were chosen for inclusion in the output database. The activity output was needed along with the emissions output to calculate the rates/activity emissions rates look-up tables via post-processing. The output detail level was by hour, link (i.e., county/road type/speed bin combination), pollutant, process, 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 are entered through the CDB. Additional user input data may be entered through separate databases via the Manage Input Datasets feature, although this feature was not used.

TTI developed procedures to facilitate building and checking CDBs for large scale emissions inventory projects. The basic procedure was to write a CDB builder-MySQL script that was then converted to a template by replacing particular scenario-specific values (e.g., year, input file paths, county name/FIPS) with variables. The template was looped through for each scenario (in this case for each year, county, and control scenario) to produce the MySQL scripts needed to create all of the required CDBs. After building the CDBs, a CDB checker utility was run to verify that all CDB tables (listed in Table 19) were built and populated as intended.

To build all of the CDBs needed for the analysis, the required data were first prepared and organized. The input data for populating the CDBs includes local data from prepared text files and databases (e.g., for local fuels and weather data), and MOVES default data from MOVESDB20120410 (e.g., for default activity data), and some values provided directly in the CDB builder MySQL script.

Table 19 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 control scenarios.

Table 19. MOVES2010bROP County Database (CDB) Inputs.

MOVES Input Table	Data Category	Notes
year	Time	Sets analysis year, designates it as a base year (i.e., activity input to be supplied rather than forecast by MOVES), and sets fuelyearID value (2002 for base year/pre-2003 control scenarios, and 2012 for 2018 control strategy scenario).
state	Geography	Identifies the state (Texas) for the analysis.
county	Geography/ Meteorology	Identifies county of analysis and local altitude ("low") and barometric pressure (used input values from FY2012 HGB RFP inventories).
zonemonthhour	Meteorology	Contains local, hourly temperature and relative humidity data for the county (used input values from FY2012 HGB RFP inventories).
roadtype[1]	Activity	Lists MOVES road types with ramp activity fractions (which was set to 0).[1]
hpmsvtypeyear[2]	Activity (Defaults)	**Used MOVES defaults** – 1999 national annual VMT by HPMS vehicle category, except yearID was set to analysis year.
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 (Defaults)	**Used MOVES default** – 1999 national SUT populations, except yearID was set equal to the analysis year value.
sourcetypeage-distribution	Fleet	Used county SUT age fractions consistent with the FY2012 HGB RFP analysis, i.e., based on mid-year 2002 historical registrations for the 2002 base year, and on mid-year 2011 registrations for both 2018 analysis scenarios.
avft	Fleet	Used the Texas statewide fuel fractions inputs (i.e., diesel fractions) consistent with the FY2012 HGB RFP inventories, using the same local registration datasets for each scenario as used for the sourcetypeagdistributions.
zone	Activity	Start, idle, SHP zone allocation factors. County = zone; all factors set to 1.0.
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone; all factors set to 1.0.
fuelsupply	Fuel	Contains marketshare information for gasoline and diesel formulations. Used values consistent with the FY2012 HGB RFP inventories, 2002 base year data for the 2002 base year and the 2018 pre-2003 control scenarios, and the 2012 data (latest fuelyearID in MOVES) for the 2018 control strategy scenario.
fuelformulation	Fuel	Contains gasoline and diesel fuel formulations used, as specified by fuelformulationID in the fuelsupply records, and consistent with the FY2012 HGB RFP inventories. (Although T50 and T90 fields were added as required for MOVES2010b, the original E200 and E300 values were used).
imcoverage	I/M	Used I/M parameters consistent with the FY2012 HGB RFP inventory analysis, and modified inputs reflecting the Harris County program in place in 2002 as input for the 2018 attainment year pre-2003 control scenario run.
modelyearcutpoints	VMT Offset	Per EPA's 2012 VMT offset guidance, set model year at which to freeze FMVCP for all later model years (i.e., 2002), and set start and cutoff model years for particular fuel effects algorithms for consistency with the pre-2003 control scenario. Only used for the 2018 fleet pre-2003 control scenario.

[1] MOVES will not produce "ramp road type" rates in a single run with all road types. To calculate emissions for certain travel model links coded as ramps, MOVES Unrestricted Access road type emissions rates were used.

[2] Use of a default set of activity and population inputs for all MOVES runs is basic to the inventory method. The MOVES default activity is normalized in the emissions rates calculation post-processing procedure (i.e., MOVES activity output is divided into the MOVES emissions output to produce emissions rates in the desired "rates per activity" units), and actual local scenario-specific activity estimates are used in the external emissions calculations.

User Inputs to MOVES via CDB

All inputs discussed in this section are input via the CDB. Unless otherwise stated, the inputs apply to all counties, years, and control scenarios.

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.

StateID "48" (Texas) was inserted in the state table. 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 particular user-input fleet and activity data were to be used, rather than forecast by MOVES). As part of designating the appropriate fuel supply for the modeling scenario, the fuelyearid in the year table was set: for the 2002 base year and 2018 pre-2003 controls runs, fuelyearid was set to 2002, and for the 2018 control strategy run the fuelyearid was set to 2012 (i.e., currently the latest fuel year in MOVES which applies to 2012 an later analysis years). The county table identifies the county of analysis and contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data was selected from a prepared local "meteorology" database containing tables of weather data records (i.e., "county" and "zonemonthhour" tables) for the analysis.

Roadtype Table Inputs to MOVES

Currently the MOVES model contains "ramp" emissions rates, but not a road type for ramps specifically. 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, but with the ramp fractions 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; currently the MOVES Unrestricted Access road type rates are used with activity for particular ramp links in the external emissions calculations). The treatment of ramps for subsequent emissions inventory development projects will be updated to incorporate use of ramp rates.

Default Activity and Population CDB Inputs to MOVES

The activity and vehicle population input parameters under the methodology use the MOVES defaults. The tables are: hpmsvtypeyear, roadtpyedistribution, monthvmtfaction, dayvmtfraction, hourvmtfraction, avgspeeddistribution, and sourcetypeyear. Data for all of these tables were selected and inserted from the MOVES default database. For the two tables dependent on year (i.e., hpmsvtypeyear and sourcetypeyear include yearID), the 1999 default data were used, except the yearID value was updated to the analysis year value.

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.

Local Fleet Age Distributions and Fuel Fractions Inputs to MOVES

All of the age distributions and fuel fractions inputs used were from the FY 2012 HGB RFP SIP inventories analysis. The locality-specific fleet inputs to MOVES consist of county age distributions input datasets and statewide diesel fractions (or fuel/engine fractions) input datasets.

The age distributions and fuel 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 vehicle age distributions, and the AVFT table for fuel/engine fractions. The MOVESfleetInputBuild utility was used to produce these fleet inputs to MOVES in the required formats (see utility description in Appendix B), and MySQL scripts were used to populate the CDB input tables.

The age distributions and fuel fractions were based on TxDOT mid-year county registrations data and MOVES model defaults, where needed. The fuel/engine fractions were developed consistent with the SUT/fuel types in the VMT mix (e.g., no CNG vehicles are in the SUT/fuel type VMT mix resulting in fuel/engine fractions for CNG of zero). Locality-specific SUT age distributions were produced based on the TxDOT county vehicle registration category aggregations consistent with the vehicle registration category aggregations used in estimating the SUT/fuel type VMT mix (see Appendix B). The age distributions and diesel fractions summaries are included in Appendix G.

Table 20 summarizes the data sources and aggregation levels used to estimate the HGB county sourcetypeagedistributions and fuel/engine fractions.

Table 20. Data Sources and Aggregations for SUT Age Distributions and Fuel/Engine Fractions.

SUT Name	SUT ID	TxDOT 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 percent gas, no Fuel/Engine Fractions
Passenger Car	21	Passenger	County	MOVES default
Passenger Truck	31	Total Trucks<=8500	County	MOVES default
Light Commercial Truck	32	Total Trucks<=8500	County	MOVES default
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 percent diesel, no Fuel/Engine Fractions

[1] TxDOT mid-year 2002 and 2011(latest available) county vehicle registrations data (i.e., three-file data set: composite fuel light-duty categories; heavy-duty gas by eight weight categories; and heavy-duty diesel by eight weight categories) were used for developing local inputs for 2002 and 2018, respectively (weights are GVWR in units of lbs.). Based on the current MOVES2010a model and MOVESDB20100830 database, TTI updated the MOVES default age distributions from EPA's MOVES tools webpage, http://www.epa.gov/otaq/models/moves/tools.htm (which were based on the previous MOVES version), and used the default updates in this analysis.

[2] MOVES default fuel/engine fractions for transit buses were revised to exclude the CNG and gasoline-fueled components, consistent with the local SUT/fuel type VMT mixes.

Local Meteorological (County and Zonemonthhour Table) Inputs to MOVES

All of the meteorological inputs used were from the FY 2012 HGB RFP SIP inventories analysis. TCEQ provided the Houston peak-ozone season meteorological inputs values, which TTI processed into the MOVES input format, and loaded into the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These input data were developed by TCEQ as one set of hourly temperature and relative humidity, and 24-hour barometric pressure averages for the HGB region, using recent multiple year, June through August hourly

weather station data from the Houston George Bush Intercontinental Airport. Low altitude was designated for all counties. Table 21 summarizes the temperatures, relative humidity, and barometric pressure input values.

Table 21. Meteorological Inputs to MOVES.

Hour	Temperature (Degrees Fahrenheit)	Relative Humidity (Percent)	24-Hour Average Barometric Pressure (Inches of Mercury)
1	77.1	73.0	29.87
2	75.7	77.2	
3	75.2	78.7	
4	74.1	80.1	
5	72.7	83.6	
6	72.5	84.4	
7	72.4	84.5	
8	76.0	78.0	
9	79.6	68.9	
10	83.1	59.5	
11	85.6	52.1	
12	87.8	47.3	
13	89.0	43.0	
14	90.1	40.6	
15	91.2	39.3	
16	91.2	39.5	
17	91.4	40.3	
18	90.9	40.2	
19	88.8	44.3	
20	85.4	51.4	
21	82.7	57.7	
22	81.0	60.1	
23	80.3	62.0	
24	78.8	66.6	

Fuels Inputs to MOVES

The local fuels inputs to MOVES are input via the CDB in the fuelsupply and fuelformulation tables. These fuels inputs were consistent with the FY 2012 HGB RFP SIP inventories; and in the fuelformulation table, as required with MOVES2010b, the T50 and T90 fields were added. TTI prepared the HGB area-level input data for each year in spreadsheets, saved the input data to text files in the MOVES-required format. These data were then imported to the fuelsupply and fuelformulation tables in the appropriate MOVES scenario CDBs. The following describes the procedure used to populate the fuels tables.

- Selected and inserted into the CDB fuelsupply table all MOVES default fuelsupply records associated with the scenario (i.e., for the countyID, fuelyearID, monthgroupID) and set their marketshare field values to zero (to prevent MOVES from applying the default fuels data in addition to the desired local fuels input data).
- Loaded all local fuel formulations from the specified local fuels inputs text files into the CDB fuelformulation table (these were given fuelformulationIDs different than the set of IDs used as MOVES defaults). (Note that prior to loading, the new T50 and T90 fields were added as required for MOVES2010b, but were populated with zero values, which directed MOVES to give precedence to the original E200 and E300 field values.)
- Loaded the scenario (i.e., for the subject countyID, fuelyearID, monthgroupID) local fuel supply records (i.e., the marketshares of the specified fuel formulations) from the input data text files into the CDB fuelsupply table.

Data Sources – The EPA provided TTI with the Houston reformulated gasoline (RFG) retail outlet survey samples by fuel grade for 2002and 2011, collected by the RFG Survey Association (for more information see: http://www.epa.gov/otaq/regs/fuels/rfg/properf/perfmeth.htm). TTI processed the sample data to estimate the Houston summer season average RFG fuel property inputs by year, which were used for all counties. Some historical and future year MOVES default fuel properties for the HGB counties were also used. For average diesel sulfur content data sources include a TCEQ summer retail fuel survey summary and MOVES defaults. See the Table 22 and Table 23 footnotes for data source specifics.

Development of Fuel Formulations Inputs from RFG Survey Samples – On average, each summer period survey included 345 total samples taken during June 1 – September 15 (by grade: Regular – 291, Mid-grade – 19, and Premium – 36). The RFG sample data used were already in the units specified for MOVES, except for the 2002 MTBE and TAME values, which TTI converted from oxygenate weight percent to the required oxygenate volume percent form using appropriate conversion factors (i.e., vol% oxygenate-per-wt% oxygenate factors of 1.0162 for MTBE, and 0.9572 for TAME, based on conversion factors used in MOVES and provided by EPA OTAQ). TTI used the standard method of averaging the fuel properties by grade, and combining them into overall RFG averages using relative sales volumes by grade as weights. The relative sales volumes by grade were estimated using annual average sales volumes per day through retail outlets statistics for Texas, taken from the Energy Information Administration's (EIA) Petroleum Marketing Annuals (for 2002 and latest available 2009).

The fuel supply value for each fuel formulation used was 1.0, which means that for each modeling scenario there was only one diesel and one RFG fuel formulation used. Table 22 and Table 23 show the RFG and diesel fuel formulations used.

Table 22. MOVES Gasoline Inputs – HGB Summer Emissions Rates Analysis.

Fuel Formulation Field[1]	2002 Base Year; and 2018 pre-2003 Controls	2018 Control Strategy
fuelFormulationID	10002	10005
fuelSubtypeID	11	12
RVP	6.85	7.06
sulfurLevel	131.11	29.42
ETOHVolume	0	10
MTBEVolume	11.13	0
ETBEVolume	0	0
TAMEVolume	0.81	0
aromaticContent	20.49	14.65
olefinContent	11.24	13.27
benzeneContent	0.601	0.55
e200	48.51	49.32
e300	83.27	84.61
volToWtPercentOxy	0.1786	0.3488
BioDieselEsterVolume	\N	\N
CetaneIndex	\N	\N
PAHContent	\N	\N
T50	0	0
T90	0	0

[1] Data sources: 2002 – based on EPA Houston Summer 2002 retail outlet RFG survey data; 2018 future year – all values are based on latest available summer (2011) Houston RFG survey data, except for benzene and ethanol, which are MOVES defaults for July 2012 (latest fuel year in MOVES).

Table 23. MOVES Diesel Inputs – HGB RFP Summer Emissions Rates Analysis.

Fuel Formulation Field[1]	2002 Base Year; and 2018 pre-2003 Controls	2018 Control Strategy
fuelFormulationID	30307	30011
fuelSubtypeID	20	20
RVP	0	0
sulfurLevel	306.7	11
ETOHVolume	0	0
MTBEVolume	0	0
ETBEVolume	0	0
TAMEVolume	0	0
aromaticContent	0	0
olefinContent	0	0
benzeneContent	0	0
e200	0	0
e300	0	0
volToWtPercentOxy	0	0
BioDieselEsterVolume	\N	\N
CetaneIndex	\N	\N
PAHContent	\N	\N
T50	0	0
T90	0	0

[1] Diesel "sulfurLevel" data sources for the 2002 and 2018 analyses, respectively, are TCEQ Summer diesel survey data for Houston from 2003 and the July 2012 MOVES default.

Local I/M Inputs to MOVES

The current I/M program is administered to reduce vehicle emissions in five of the eight HGB counties. In 2002, only Harris County administered an I/M program. MOVES calculates county emissions rates that reflect the emissions-reducing benefits of the I/M program designs reflected in parameters specified in the MOVES IMcoverage table. These I/M input parameters are consistent with the FY 2012 HGB RFP SIP inventories I/M inputs. TTI produced a set of Texas I/M county MOVES imcoverage records to replace the MOVES default imcoverage table

records for Texas (that were populated using information from the EPA's 2005 National Emissions Inventory).

The imcoverage table data parameters (by field headers) are:

- polProcessID (pollutant and emissions process affected by the program);
- stateID (state subject to the I/M program);
- countyID (county number);
- yearID (year administered);
- sourceTypeID (SUT covered);
- fuelTypeID (fuel type subject to the program);
- IMProgramID (arbitrary ID number);
- begModelYearID (first model year covered);
- endModelYearID (last model year covered);
- 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 effects for compliance rate, waiver rates, or other adjustments).

TTI produced the set of Texas counties imcoverage table input records for all MOVES analysis years and stored them in a database for use in building the CDBs for emissions rates modeling. In addition to selecting the appropriate local user-input imcoverage records for the modeling scenario from the Texas imcoverage database, all MOVES default imcoverage records for the modeling scenario must be excluded. To prepare the appropriate county imcoverage inputs, the following two general steps were performed for all eight counties:

- Selected and inserted all MOVES default imcoverage records for the scenario's countyID and yearID into the CDB imcoverage table, and flagged them for non-use (i.e., set useIMyn = N) in the modeling run; and
- From the current, updated Texas MOVES imcoverage database, selected and inserted the imcoverage records for the scenario (excluding the 2018 pre-2003 control scenario) yearID and countyID into the CDB imcoverage table (with useIMyn = Y). For the 2018 pre-2003 control scenario, a special set of imcoverage records were produced and used for this VMT offset analysis, which reflected the I/M program in place for HGB in the 2002 base year that included only Harris County.

Data Sources – TTI produced the I/M coverage input parameters to best represent Texas I/M program designs as specified in the Texas I/M SIP and Texas rules (using current Texas I/M modeling protocol compliance and waiver rates), and where the pertinent I/M coverage modeling

parameters existed in MOVES (e.g., only for SUT and fuel type categories for which MOVES contained I/M effects). The HGB 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 on the vehicle class and model year, the vehicle emissions testing may utilize on-board diagnostics (OBD), the Accelerated Simulated Mode (ASM-2) test, or the Two-speed Idle (TSI) test. For additional Texas I/M program details, see the current I/M SIP, *Revision to the State Implementation Plan Mobile Source Strategies, Texas Inspection and Maintenance State Implementation Plan*, TCEQ, November 18, 2010.

Approach – Following is the general approach used to build the current Texas imcoverage tables.

- Identified the MOVES I/M test standards applicable to Texas (see Table 24, column 5, which lists the five I/M test standards pertinent to this HGB analysis).
- Queried the MOVES default imfactor table (contains adjustments to emissions rates per various I/M scenarios by SUT/fuel type, age, etc.) on the Texas I/M test frequency and fuel type (i.e., annual and gasoline) and on the imteststandards applicable to Texas – from this query, listed the SUTs, test standards, pollutant, and emissions process combinations with non-zero MOVES imfactors and corresponding base rates with non-zero standard I/M difference (i.e., I/M effects) available in MOVES (see Table 24, note 4).
- Categorized counties and years in groups under the same MOVES test standards.
- Assigned MOVES improgramIDs such that: 1) all MOVES default improgramIDs were excluded, and 2) per MOVES User's Guide, for each yearID, each IMprogramID represented a unique combination of test standard, test frequency, begin model year, and end model year.

Table 24 and the associated table notes describe the MOVES imcoverage records developed by TTI and used for the HGB analyses. Note that a review of the pertinent MOVES data (IMfactors and mean base rates for non-I/M and reference-I/M) showed that in the current MOVES model there are no I/M effects included for heavy-duty vehicle categories (i.e., vehicles with GVWR > 8,500 pounds – see Table 24, note 4). Although the Texas I/M program design includes heavy-duty vehicles, the current version of MOVES provides no means to model a potential benefit.

Table 24. MOVES IMCoverage Table Input Descriptions for HGB I/M Counties.

YearID[1]	IMprogamID[2]	begModel YearID[3]	endModel YearID[3]	testStandardsID	Sourcetypeid[4]
Harris County					21 (PC – Passenger Car) 31 (PT – Passenger Truck) 32 (LCT – Light Commercial Truck)
1999 through 4/2002	20	X	X	12 (2500 RPM/Idle)	
	50	X	X	41 (Evp Cap)	
Harris, Brazoria, Fort Bend, Galveston, Montgomery Counties					
5/2003 (5/2002, for Harris) through 2019	30	X	1995	23 (A2525/5015 Phase)	
	51	X	1995	41 (Evp Cap)	
	40	1996	X	51 (Exh OBD)	
	60	1996	X	45 (Evp Cap, OBD)	
2020 through 2050	41	X	X	51 (Exh OBD)	
	61	X	X	45 (Evp Cap, OBD)	

[1] County I/M implementation dates: Harris – 1/1/1997 with transition to the new I/M test types on 5/1/2002; Brazoria, Fort Bend, Galveston, Montgomery – 5/1/2003.

[2] Common parameters for Texas MOVES imcoverage records not shown include: annual test cycle, gasoline fuel type, use IMyn = Y. Aside from any non-standard adjustments, the compliancefactor values are common across areas: PC – 93.12%; PT – 87.53%; and LCT – 81.95%. Using the MOVES Emissions Inventory Technical Guidance compliance factor equation (Section 3.10.6), compliance factors were calculated as the product of the percent compliance rate, 100% percent waiver rate, and the regulatory class coverage adjustment. The current Texas I/M program modeling protocol compliance and waiver rates are 96% and 3%. The regulatory class adjustments used were taken directly from the MOVES Emissions Inventory Technical Guidance, and for PC, PT, and LCT, respectively are 100%, 94%, and 88%.

[3] begmodelyearid and endmodelyearid, which define the range of vehicle model years covered, where represented by "x" are calculated as YearID – 24, and YearID – 2, respectively.

[4] For heavy-duty gasoline vehicles (i.e., > 8,500 pounds GVWR), MOVES does not contain any combinations of I/M factors and mean base rates that yield I/M effects; for light-duty gasoline vehicles, MOVES includes both exhaust and evaporative I/M factors and mean base rates with I/M effects, therefore, only light-duty gasoline vehicles (SUTs 21, 31, and 32) were included in the user input imcoverage records. The processes/pollutants affected by I/M are exhaust running and exhaust start THC, CO, NO_x, and tank vapor venting THC.

Model Year Cut Points

Per EPA's 2012 VMT offset guidance, TTI set the model year at which to freeze FMVCP for all later model years (i.e., 2002), and set start and cutoff model years for particular fuel effects algorithms for consistency with the pre-2003 control scenario. These set ups provided by EPA (see item 3 in Table 25, which is EPA's technical sheet explaining the VMT offset version of MOVES, MOVES2010bROP) were applied only for the 2018 fleet pre-2003 control scenario.

Table 25. Explanation of Special VMT Offset Version of MOVES (Provided by EPA with the MOVES2010bROP Model, August 2012)

Explanation of special VMT offset version of MOVES

This version of MOVES, which will be referred to as MOVES2010bROP, is to be used only for VMT offset calculations according to EPA's 2012 VMToffset guidance. It should not be used for reasonable further progress calculations or for any other regulatory purpose.

As background, MOVES includes the option to disable all motor vehicle requirements of the 1990 Clean Air Act Amendments. This option was created to calculate adjusted base year emissions for the reasonable further progress provisions of the Clean Air Act. This option is selected in the MOVES RunSpec by checking the box in the Rate of Progress panel. When this box is checked, emissions rates are frozen after 1990 although activity inputs in MOVES continue to change.

MOVES2010bROP includes both code and database changes that allow the user to set a baseline year other than 1990. For the analysis described in EPA's 2012 VMT offset guidance, the new baseline year should be 2002. Following are the steps needed to make this change:

1. Complete the local RunSpec as you normally would, but check the box in the Rate of Progress Panel.
2. Enter all appropriate activity inputs in the County Data Manager for the local area in the calendar year of analysis. I/M program inputs should reflect the program in place in 2002. In addition, select the tab labeled "Generic" and the table labeled "modeIYearCutPoints."
3. Export the default table, open it in Excel, and modify it so that it appears like this:

cutPointName	modelYearlD
RateOfProgress	2002
HighestFuelPredictiveModelYear	2050
sulfurModelTHCNOxStart	1975
sulfurModelTHCNOxEnd	2050
sulfurModelCOStart	1975
sulfurModelGPAPhaselnStart	2004
sulfurModelGPAPhaselnEnd	2006

4. Save the file, browse for it, select the modelYearCutPoints table, and import.

Run MOVES2010bROP. The results will be the hypothetical emissions in the calendar year of analysis assuming no changes in emission factors after 2002.

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 19 tables (or 20 tables for the "pre-2003 controls" runs) were in the appropriate CDBs and the tables were populated with data as intended. The MOVES RunSpecs were executed in batches using the MOVES command line tool. The batches were set up to write each MOVES run log to a text file for later access. After completion, TTI searched the MOVES run logs for error and warning messages, for which none were found. The MOVES run summaries are included as Appendix H.

Post-Processing Runs

- *Rates Per Activity*: Using the MOVESratescalc utility, TTI calculated "rates-per-activity" for each county from the MOVES output (i.e., emissions divided by activity, using the movesoutput [emissions] and movesactivityoutput [activity] tables). The process created two emissions rate tables (per run) that were added to the MOVES output database: "ttirateperdistance" containing mass/mile emissions rates, and "ttirateperactivity" containing mass/SHP, mass/SHI, and mass/start emissions rates. This was performed for each county, year, and control scenario. See MOVESratescalc utility description in Appendix B for more details.
- *Rates Adjustments*: From the two calculated rate tables output from each MOVESratescalc run, emissions rates were extracted for only those pollutants needed in the emissions calculations. For the Harris County 2002 base year scenario, the pre-May and post-April I/M scenario rates were combined using factors representing the portion of the fleet estimated to have been tested under the previous and current I/M tests, during the prior complete I/M cycle (12 months). Using a July 1, 2002 evaluation reference, the proportions used were 10/12 for the pre-May I/M and 2/12 for the post-April I/M scenarios. For the 2018 control strategy scenario, TxLED adjustments were applied to all diesel vehicle NO_x emissions rates and the extracted and adjusted rate tables for each county and calendar year control scenario (i.e., 24) were placed in a separate database for input to the emissions calculations. Table 26 shows the TxLED factors used (provided by TCEQ). TCEQ produced these average diesel SUT NO_x adjustments using 4.8 percent and 6.2 percent reductions for 2002 and later, and 2001 and earlier model years, respectively. More details on TCEQ's TxLED factors analysis may be found at, ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/TxLED/, in the file:
    - *mvs10a-statewide-txled-2011-analysis-11-14-17-18-19-21.zip.*

Table 26. 2018 Analysis Year TxLED Adjustment Factor Summary.

Diesel Fuel Source Use Type	NOx Adjustment Factor
Passenger Car	0.9516
Passenger Truck	0.9496
Light Commercial Truck	0.9491
Intercity Bus	0.9438
Transit Bus	0.9447
School Bus	0.9444
Refuse Truck	0.9461
Single Unit Short-Haul Truck	0.9510
Single Unit Long-Haul Truck	0.9507
Motor Home	0.9465
Combination Short-Haul Truck	0.9483
Combination Long-Haul Truck	0.9488

Source: TCEQ, Fall 2011. See ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/TxLED/ for TCEQ's TxLED analysis spreadsheets and other information.

Appendix A describes the electronic data submittal for this VMT offset inventory analysis, which includes the TxLED and I/M test-type switch adjustment factor files used in the MOVESratesAdj utility runs that produced the final emissions rate look-up table inputs to the emissions calculations.

The emissions factor MOVES set-ups used (MRS files and CDBs) and final adjusted emission rate look-up table databases were provided as a part of the electronic data submittal (see Appendix A).

EMISSIONS CALCULATIONS

TTI calculated hourly, ozone season weekday, link-based emissions inventories by county for each VMT offset demonstration analysis inventory scenario using the MOVESemscalc utility. The emissions calculations fall into two categories: VMT-based emissions calculations and off-network emissions calculations. The VMT-based emissions calculations use the TDM VMT and speeds to estimate emissions at the TDM link (or roadway segment) level. The off-network emissions process calculations use off-network activity (SHP, starts, and SHI) to estimate emissions at the county level.

Hourly Link-Based Emissions Calculations

The ozone season weekday, hourly link-based emissions, by county, for each analysis year and inventory type, were calculated with the MOVESemscalc utility using the following major inputs:

- TxDOT district-level SUT/fuel type VMT mix by MOVES roadway type;
- TDM link and intrazonal link VMT and speeds estimates, which contain the 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;
- County-level hourly SUT/fuel type off-network activity estimates (SHP, starts, and SHI);
- MOVES-based off-network emissions factors by pollutant, process, hour, SUT, and fuel type;
- MOVES-based "on-network" (VMT-based) emissions factors by pollutant, process, hour, average speed, MOVES roadway type, SUT, and fuel type; and
- TDM road type/area type code combinations to MOVES road type designations (and VMT mix road type and rates road type designations) (see Table 27).

The VMT-based emissions were calculated for each hour using the TxDOT district-level SUT/fuel type VMT mix, the TDM link and intrazonal link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the TDM road type/area type to MOVES road types designations. For each link, the link was assigned a MOVES road type (and VMT mix and rates road types, which for this analysis were the same as MOVES road type) based on the link's road type and area type. The link VMT was then distributed to each SUT/fuel type using the VMT mix, based on the link's designated VMT mix road type and its associated TxDOT district.

The emissions factors for each SUT/fuel type were selected based on the link's designated rates road type code (same as MOVES road type code) 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 g/mi rates were multiplied by the link SUT/fuel type VMT producing the link-level emissions estimates.

Table 27. 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]
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.

The off-network emissions were calculated for each hour using the hourly MOVES-based off-network emissions factors by SUT/fuel type and the county-level hourly SUT/fuel type off-network activity estimates (SHP, starts, and SHI). The off-network emissions were calculated at the county level by multiplying the hourly MOVES-based off-network emissions factors by the appropriate county-level hourly SUT/fuel type off-network activity, which was determined by the pollutant process.

The MOVESemscalc utility outputs for this HGB VMT offset inventory project consist of a listing file (summarizing all pertinent information regarding the execution of the utility), and a tab-delimited emissions report summary file for each run including both hourly and 24-hour activity and emissions estimates by SUT/fuel type and TDM road type, with emissions tables of pollutant composites and individual emissions process totals.

Table 28 (shown in a previous section, but provided again here for convenience) lists the activity and emissions rate input data components used in calculating each of the four VMT offset analysis inventories.

Table 28. HGB VMT Offset Demonstration Emissions Inventory Scenarios.

Inventory	Activity Input Year[1]	Emissions Factor Input[2]
2002 Base Year	2002	2002 Base Year
2018 Fleet and Pre-2003 Controls with Growth	2018	2018 Fleet and Pre-2003 Controls
2018 Fleet and Pre-2003 Controls without Growth	2002	
2018 Attainment Year Control Strategy	2018	2018 Fleet and Control Strategy

[1] Activity inputs (VMT mix; link VMT/speeds; and off-network activity: SHP, starts, SHI) were consistent with the FY 2012 HGB RFP SIP inventories.

[2] Emissions factors were based on the EPA's special model "MOVES2010bROP" provided to TCEQ for use in the VMT offset calculations. "Pre-2003 Controls" means attainment year emission factors were modeled to reflect no new controls after the base year beyond those already credited.

See Appendix A (Electronic Data Submittal) for the listing of emissions inventory data files submitted as a part of this project report. See Appendix B for additional MOVESemscalc utility information and the emissions calculation process flow diagram.

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 ANSI/ASQ E4-2004: *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs* and the TCEQ Quality Management Plan.

Quality Assurance Project Plan (QAPP) Category II (Modeling for NAAQS Compliance) is the QAPP category that most closely matches these objectives and establishes QAPP requirements for projects involving applied research or technology evaluations. Internal review and quality control measures consistent with applicable NRML QAPP requirements, along with appropriate audits or assessments of data and reporting of findings, were employed. These include, but are not limited to, the elements outlined 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 for use in the HGB VMT-offset demonstration analysis to be included in the TCEQ's SIP Revision), in accordance with 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 were as specified, to include:

- The product met the purpose of the emissions analysis (e.g., photochemical modeling, reasonable further progress, transportation conformity, model comparison);
- The full extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, days, sources, pollutants) was included;
- Agreed methods, models, tools, and data were used (e.g., as listed in the Grant Activities Description, and as listed in the more detailed pre-analysis plan – any change from this plan, if needed, was made in consultation with the TCEQ project manager);
- 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 Section D) were corrected; and
- Aggregate emissions estimate results assessed for comparability with available, similarly produced emissions estimates.

B. Data Generation and 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 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 the Texas Department of Transportation (TxDOT), a Metropolitan Planning Organization (MPO) or Council of Governments (COG), TCEQ, and/or the EPA, and in most cases were QA'd by the providing agency. The data needed may include: Highway Performance Monitoring System (HPMS) data (from TxDOT's Roadway Inventory Functional Classification Record [RIFCREC] report); regional travel demand model data; speed model data; vehicle registration data; automatic traffic recorder data; vehicle classification count data; meteorological data; fuels data; MOVES emissions model data; extended idling activity data; and vehicle inspection and maintenance program design data.

Any significant problems found during data review, verification, and/or validation (see QA criteria and methods discussion in section D) were to be 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 and run log text files were (for cluster runs first copied to an individual workstation), archived and processed further in preparation for input to the emissions calculations.

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 input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan; and
- 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% 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

Development of the detailed on-road mobile source emissions estimates is a multi-staged process that involves many data sets and data processing steps. In the interest of product quality and process efficiency, thorough quality assurance checks were performed during emissions inventory development.

Data for the project, whether provided for direct use or processed by TTI, were reviewed, verified, and validated to ensure that they conform to their particular specifications and TCEQ's requirements for the intended use. The data specifications and requirements where not stated specifically, are included in the documents listed in the References section, or are outlined or referenced in the detailed pre-analysis plan.

The criteria for passing quality checks and the checks typically performed on each major inventory input component (i.e., estimates of source activity, activity distributions, and emissions factors) as well as on the resulting emissions estimates, are summarized in the following lists.

These QA guidelines were used to ensure the development of emissions inventory estimates that are as accurate as possible and meet the requirements of TCEQ's intended use.

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 (e.g., photochemical modeling, reasonable further progress, transportation conformity, model comparison);
- Extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, 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.

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; check 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 – if 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 (e.g., commands, input values, input and output file paths, output options) for the application per applicable user guide.
- 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 (e.g., utility listing files or model execution logs that contain error and warning records) for warnings/errors.
- Checked the summary information provided in output listing files for any unusual results.

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 (e.g., activity distributions between weekends/weekdays, vehicle mix by day-type, or average speeds between road types or time periods), compared and noted whether directional differences were as expected.
- 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 if available.
- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns, e.g., between gasoline versus diesel, heavy versus light.
- Verified summed link emissions output against tabular emissions output summaries – differences should be within rounding error (N/A).

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.

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APPENDIX A:
HGB VMT OFFSET ON-ROAD INVENTORIES ELECTRONIC DATA SUBMITTAL

HGB VMT Offset MOVES2010bROP-Based, County-Level, Emissions Inventories – Electronic Data Submittal

This appendix contains a description of the electronic data package that TTI submitted to TCEQ, per Proposal for Grant Activities No. 582-11-11226-FY13-08.

The MOVES rates-per-activity, TDM link-based method was used to produce ozone season weekday emissions inventories of VOC, CO, NO_x, and CO_2. The four HGB emissions inventories submitted consist of one base year and three attainment year scenarios (i.e., 32 county-level emissions inventories), described by activity and emission factor components in the following table.

Table 29. HGB VMT Offset Demonstration Emissions Inventory Scenarios.

Inventory	Activity Input Year	Emissions Factor Input[1]
2002 Base Year	2002	2002 Base Year (CSS)
2018 Attainment Year Fleet and Pre-2003 Controls with Growth	2018	2018 Fleet and Pre-2003 Controls (P03)
2018 Attainment Year Fleet and Pre-2003 Controls without Growth	2002	
2018 Attainment Year Control Strategy	2018	2018 Fleet and Control Strategy (CSS)

[1] Emissions factors were based on the EPA's special model "MOVES2010bROP" provided to TCEQ for use in the VMT offset calculations. "Pre-2003 Controls" means attainment year emissions factors were modeled to reflect no new controls after the base year beyond those already credited.

Electronic Media

The electronic data submittal files and databases, summarized in the following, were compressed and submitted on one CD-ROM, entitled:

"*HGB MOVES2010bROP- Based On-Road Mobile Source Emissions Inventories for VMT Offset Analysis – TTI FY2013.*"

- Emissions Files:
  - Emissions calculator output – MOVESemscalc utility TAB-delimited, hourly/24-hour emissions inventory report summary files;
  - 24-hour aggregate inventory extracts – 24-hour totals summaries extracted from MOVESemscalc emissions inventory data files listed in previous bullet; and
  - Emissions summary spreadsheet produced from inventory extracts listed in previous bullet, and used to produce inventory summaries in report;
- MOVES inputs (MOVES run specifications and county domain input databases); and
- Final, MOVES-based, rate-per-activity emissions factors (emissions factor database inputs to the emissions calculations, produced with TTI MOVES output post-processors), and TxLED adjustment factor file.

File-Naming Conventions
In the file and database names:

- ***SSSS*** is: BYR, AYR (or inventory type where BYR and AYR are base year [2002] and attainment year [2018], respectively);
- ***YYYY***: is 2002, 2018 (calendar or analysis year value for HGB base year and attainment year);
- ***QQQQ*** is: CSS, P03 (control scenario where CSS and P03 are analysis year control strategy scenario and pre-2003 control scenario, respectively);
- ***KKKK*** is: 2002, 2018 (year of VMT inputs to the inventory runs); and
- ***FFFF*** is: 48039, 48071…. (or county FIPS code for each of the eight counties).

Note: databases are MySQL databases. Each MySQL database consists of one "db.opt" file and a set of tables, where each table is composed of three files of the type: *.frm, *.MYD, and *.MYI.

Emissions Data Files
Emissions inventory output – Four MOVESemscalc utility emissions inventory runs per county (see the previous table for four inventory types). Each run produced two output file types (i.e., *.TAB and *.LST files) compressed in: "HGBvo_mvs10brop_4EIs.zip":

- "HGBvo_mvs10brop_BYR_CSS2002swkd_***FFFF***_ems.TAB," "HGBvo_mvs10brop_AYR_P03***KKKK***swkd_***FFFF***_ems.TAB," and "HGBvo_mvs10brop_AYR_CSS2018swkd_***FFFF***_ems.TAB": 32 tab-delimited county emissions inventory data summary reports including hourly and 24-hour activity and emissions tables. For roadway-based processes by roadway and vehicle type (SUT/Fuel Type) – VMT, VHT (vehicle hours traveled), average speed (VMT/VHT), and pollutant/process emissions totals; for off-network-based processes by vehicle type – SHP, SHI, starts, and pollutant/process emissions totals (SHI for combination long-haul trucks only); and
- *.LST": 32 list files corresponding to the above *.TAB files and with the same file name prefixes as the *.TABs, listing run execution times; run script; file locations; data descriptions; and varied data summaries including hourly and 24-hour activity, pollutant/process emissions totals, and average speed (VMT/VHT).

24-Hour aggregate inventory extracts and spreadsheet – 24-hour emissions inventory totals by SUT/fuel type extracted from the MOVESemscalc tab-file output, used for emissions summaries. Four county total and four county-level by SUT/fuel type inventory extracts were provided compressed in "HGBvo_mvs10brop_4EIs.zip":

- "HGBvo_mvs10brop_BYR_CSS2002swkd_tabtots_ST.tab," "HGBvo_mvs10brop_AYR_P03***KKKK***swkd_tabtots_ST.tab," and "HGBvo_mvs10brop_AYR_CSS2018swkd_tabtots_ST.tab": Four inventory type tab-

delimited text file of 24-hour emissions inventory data summaries for the eight HGB counties, by SUT/fuel type, pollutant, and process;

- "HGBvo_mvs10brop_BYR_CSS2002swkd_tabtots.tab," "HGBvo_mvs10brop_AYR_P03***KKKK***swkd_tabtots.tab," and "HGBvo_mvs10brop_AYR_CSS2018swkd_tabtots.tab": Four inventory type tab-delimited text file of 24-hour emissions inventory data summaries for eight counties, by pollutant and process; and
- "HGBvo_mvs10brop_OverallSummaries.xls": spreadsheet file of 24-hour emissions inventory data summaries for eight counties, by pollutant and process.

Emissions Factors – MOVES Input Files (MRSs and CDBs)
MOVES Input Files: There were three rate analysis year/control scenario combinations (the 2002/CSS, 2018/P03, and 2018/CSS), for a total of 25 county level runs. The MOVES inputs used – run specification files (RunSpec or MRS) and county input databases (CDB) – were provided. (The modified MOVES default database made available with the MOVES2010bROP model by TCEQ, was not included in this submittal.):

- "MVS10BROP_HGBVO_2002SWKD_CSS_***FFFF***_ER.MRS," and "MVS10BROP_HGBVO_2018SWKD_***QQQQ_FFFF***_ER.MRS": 25 MRS files, i.e., three analysis year/control scenarios x eight counties + one extra Harris County 2002 base year MRS file for I/M test-type switch effects post-processing procedure [Harris County 2002CSS has an "IM1" and an "IM2" run], compressed in "HGBvo_mvs10brop_mrs25.zip;" and
- "*_CDB_IN" (25 MySQL database folders containing 1,474 total files, where each database corresponds to one of the MRS files and the "*" in the database name is the same as the MRS filename prefix). Along with "CDBchecker" utility files (three files – an LST and TAB output along with *.doc file listing of utility checks), the CDBs are compressed in "HGBvo_mvs10brop_CDB25.zip."

Emissions Factors – Final, Adjusted MOVES2010bROP-based Emissions Rates
Final MOVES-based, Emissions Factor Look-up Tables: The MOVESratesAdj utility performed adjustments as specified (e.g., NOx TxLED effects and I/M test-type switch effects), and produced the final emissions rate look-up table inputs to the emissions calculations – MySQL databases containing two emissions rate lookup tables, ttirateperdistance for roadway-based emissions processes, and ttirateperactivity for the "off-network" processes. The ttirateperactivity table fields are: pollutantID, processID, hourID, sourceTypeID, fuelTypeID, rateperactivity. The ttirateperdistance table fields are: pollutantID, avgSpeedBinID, processID, hourID, roadTypeID, sourceTypeID, fuelTypeID, ratePerDistance.

- "MVS10BROP_HGBVO_2002SWKD_CSS_***FFFF***_ER_outratesadj," and "MVS10BROP_HGBVO_2018SWKD_***QQQQ_FFFF***_ER_outratesadj": (24 MySQL database folders containing 168 total files). This is the set of 2002 base year control strategy and 2018 control strategy and 2018 pre-2003 control scenario rates database look-up tables for all counties, used in the four emissions inventories. Each database contains the ttirateperdistance and ttirateperactivity emissions rate look-up tables used in

the emissions calculations. They are compressed in "hgbvo_mvs10brop_MOVESratesadjDB24.zip;" and

- "tx_mvs10a_2018_txled_facts.txt" (TxLED adjustment factor file) and "48201im2002_hgbvo_adjfactspath.txt"(one I/M test-type switch factor file used for Harris County 2002 run) are compressed in "hgbvo_mvs10brop_adjfacts.zip."

Note that the MOVES output databases were post-processed in two main steps to calculate the final emissions rates used in the external emissions calculations:

1) Rate Calculations: Using the TTI's MOVESratesCalc utility, TTI calculated "rates-per-activity" as "emissions/activity" from the movesoutput (emissions) and movesactivityoutput (activity) tables, performed unit conversions, and added two new tables to the MOVES output database: "ttirateperdistance" with grams/mile rates, and "ttirateperactivity" with grams/SHP, grams/SHI, and grams/start rates.
2) Final Rates Adjustments: Using TTI's MOVESratesAdj utility, TTI-calculated rates were extracted for only those pollutants needed in the emissions calculations. The I/M test-type switch effects adjustment (post-processing of rates from two runs with different I/M test-types into a single set of rates with the combined I/M test-type effects) was performed for the Harris County 2002 base year, and TxLED adjustments were applied to diesel vehicle NO_x rates for the 2018 attainment year control strategy scenario, and the extracted and adjusted rate tables were placed in a separate database (by county/year/control scenario) for input to the emissions calculations.

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

TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES-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. 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 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, MOVESactivityInputBuild, MOVESpopulationBuild, MOVESfleetInputBuild, MOVESratesCalc, MOVESratesAdj, ShpExtIdleStartActBld, ExtIdleHrsCalc, MOVESemscalc, and MOVEStabcomb. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The MOVESactivityInputBuild, MOVESpopulationBuild, and MOVESfleetInputBuild utilities build inputs used in MOVES. The MOVESratesCalc utility calculates the emissions rates from the MOVES output in terms of grams per activity, rather than the grams per vehicle emissions rates produced by MOVES. The MOVESratesadj utility makes special adjustments to the emissions rates when required. The ShpExtIdleStartActBld utility builds the SHP and starts activity required to estimate emissions using the grams per activity emissions rates produced by the MOVESratesCalc utility. The ExtIdleHrsCalc utility builds the SHI activity required to estimate emissions using the grams per activity emissions rates produced by the MOVESratesCalc utility. The MOVESemscalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals) and hourly link emissions output files (optional). The MOVEStabcomb utility combines multiple MOVESemscalc tab-delimited output files into one regional tab-delimited output file.

A process flow diagram follows the utility descriptions.

TRANSVMT

The TRANSVMT utility post-processes 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.

VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS AADT VMT, centerline miles, and lane miles by functional classification and area type (from TxDOT's annual RIFCREC report) 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 emissions 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 county-level VMT control total-to-AADT ratios 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 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.

MOVESactivityInputBuild

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeyear, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction 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 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;
- Link/MOVES roadway type designations, which lists associations of the link roadway types/area type combination to the MOVES roadway types (same as used with the MOVESemscalc utility);
- VMT mix by MOVES roadway type, MOVES source type, and MOVES fuel type (same as used with the MOVESemscalc 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; and
- MOVES default database.

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, then the VHT is also saved in the ramp segment of the road type VHT array.

A MOVES roadway type array (by MOVES roadway type) is also formed using the data in the VMT summary array and the link/MOVES roadway type designations. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the link/MOVES roadway type designations, and the VMT mix. 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 hour VMT array is aggregated by hour to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is then 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. Using the appropriate MySQL code, the roadtypedistribution database table is written. A tab-delimited version is also written (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. Using the appropriate MySQL code, the hourvmtfraction database table is written. 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. A tab-delimited version is also written (optional).

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. Using the appropriate MySQL code, the avgspeeddistribution database table is written. 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. A tab-delimited version is also written (optional).

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. Using the appropriate MySQL code, the road type database table is written using the proportions from the road type VHT array. A tab-delimited version is also written (optional).

The VMT in the hourly VMT array is aggregated to form the HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUT 21 is HPMS vehicle type 20; SUTs 31 and 32 are HPMS vehicle type 30; 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). Using the appropriate MySQL code, the hpmsvtypeyear database table is written using the VMT from the HPMS vehicle type VMT array, along with the user supplied year ID, the VMT growth factor (automatically set to "Null"), and the base year Off-Network VMT (automatically set to 0). A tab-delimited version is also written (optional).

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

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 outputs five other database tables (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction) using the appropriate MySQL code and the user-supplied inputs. For the state database table, a new state database table is created and the data from the MOVES default state database table is copied to the new table for the state ID of 48. For the zone database table, a new zone database table is created and the data from the MOVES default zone data base table is copied to the new table for the county ID greater than 48000 and county ID less than 49000. The start allocation factors, idle allocation factors, and SHP allocation factors are all then replaced with values of 1 in the new table.

For the zoneroadtype database table, a new zoneroadtype database table is created and the data from the MOVES default zoneroadtype data base table is copied to the new table for the zone ID greater than 480000 and zone ID less than 490000. The SHO allocation factors are all then replaced with values of 1 in the new table. For the monthvmtfraction database table, a new monthvmtfraction database table is created and the data from the MOVES default monthvmtfraction database table is copied to the new database table and the month VMT fraction is set to 1 for the user-supplied month ID and 0 for all other months. For the dayvmtfraction database table, a new dayvmtfraction database table is created and the data from the MOVES default dayvmtfraction database table is copied to the new and the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

MOVESpopulationBuild

The MOVESpopulationBuild utility builds the sourcetypeyear MOVES input database table and the source type/fuel type population input file used with the MOVESemscalc utility to estimate emissions using the VMT mix and the TxDOT registration data sets. The TxDOT registration data sets are three sets of registration data (an age registration data file, a gasoline 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;
- Gasoline 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 gasoline 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 source type, 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 gasoline truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gasoline truck categories) are saved in the gasoline truck section of the diesel/gasoline 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/gasoline registration data array. The age registration data array and the diesel/gasoline registration data array are combined to form the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 30.

Table 30. 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 everything except the 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 31 shows the SUTs and their associated registration category in the registration category data array.

Table 31. 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 SUTs42, 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 source type 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 to 1. A text format of this database table is written by the utility as well. The source type/fuel type population input file used with the MOVESemscalc utility is written using the SUT population array.

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 gasoline 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;
- Gasoline 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 gasoline 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 souretypeagedistribution 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 keeps 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 gasoline truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gasoline truck categories) are saved in the gasoline truck section of the diesel/gasoline 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/gasoline registration data array.

The age registration data array and the diesel/gas registration data array are combined to form the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 32 (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 33 shows the source types and their corresponding registration categories.

Table 32. 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 33 shows the SUTs and their corresponding registration categories.

Table 33. SUTs/Registration Categories Correlation for Fuel/Engine Fractions.

SUT	Fuel Type	Registration Category
52, 53	Diesel	4
	Gasoline	6
61	Diesel	5
	Gasoline	7
62	Diesel	5 + 7
	Gasoline	None – all are assumed diesel

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 gasoline 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.

MOVESratesCalc

The MOVESratesCalc utility estimates emissions rates in terms of grams per activity (i.e., grams per mile, grams per SHP, grams per start, and grams per SHI) using the data in the movesoutput (emissions output) and movesactivityoutput (activity output) database tables produced by a MOVES emissions rate run. The utility also has the option of calculating the SHP, starts, and SHI activity per vehicle using the movesactivityoutput database table. If not specified, emissions rates are calculated for each pollutant and process combination (excluding total energy) in the movesoutput database table. The utility also uses the movesrun database table to determine the units of the emissions in the movesoutput table, which will then be converted to grams per activity during the emissions rate calculations; therefore allowing 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 34 shows.

Table 34. MOVES2010a Emissions Process and Corresponding Activity for Grams per Activity Emissions Rates.

MOVES2010a Emissions Process	Activity	Emissions Rate Units
Running Exhaust	Miles Traveled	Grams/Mile
Crankcase Running Exhaust	Miles Traveled	Grams/Mile
Start Exhaust	Starts	Grams/Start
Crankcase Start Exhaust	Starts	Grams/Start
Extended Idle Exhaust	Extended Idle Hours	Grams/Extended Idle Hour
Crankcase Extended Idle Exhaust	Extended Idle Hours	Grams/Extended Idle Hour
Evaporative Permeation	Miles Traveled Source Hours Parked	Grams/Mile Grams/ Source Hour Parked
Evaporative Fuel Vapor Venting	Miles Traveled Source Hours Parked	Grams/Mile Grams/ Source Hour Parked
Evaporative Fuel Leaks	Miles Traveled Source Hours Parked	Grams/Mile Grams/ Source Hour Parked
Brake Wear	Miles Traveled	Grams/Mile
Tire Wear	Miles Traveled	Grams/Mile

For the distance based emissions rates (i.e., grams per mile), the utility extracts the emissions data (by pollutant, pollutant process, roadway type, average speed bin, SUT, and fuel type) from the movesoutput database for the specified pollutants (or all of the pollutants if not specified) and the corresponding miles traveled activity (MOVES activityTypeID = 1) from the movesactivityoutput database table. The utility divides the emissions data by the corresponding activity data, applies the appropriate units conversion factors and saves the emissions rates in the ttirateperdistance database table.

For the off-network emissions rates (i.e., grams per SHP, grams per start, and grams per SHI) the utility calculates the emissions rates based on the pollutant process. For processID = 12 (evaporative fuel vapor venting), the utility extracts the emissions data (by hour, pollutant, pollutant process, source type, and fuel type) from the movesoutput database table for the specified pollutants pollutants (or all of the pollutants if not specified) where roadTypeID = 1 ("off-network" emissions) and the corresponding SHP activity (activityTypeID = 5) from the movesactivityoutput database table. The utility divides the emissions data by the corresponding activity data, applies the appropriate units conversion factor and saves the emissions rates in the ttirateperactivity database table.

Using the same calculation process, the utility also calculates the emissions rates for processID = 17 (crankcase extended idle exhaust) and processID = 90 (extended idle exhaust) using the corresponding SHI activity (activityTypeID = 3), for processID = 11 (evaporative permeation) and processID = 13 (evaporative fuel leaks) using the corresponding SHP activity (activityTypeID = 5), and for processID = 2 (start exhaust) and processID = 16 (crankcase start exhaust) using the corresponding starts activity (activityTypeID = 7).

For the SHP, starts, and SHI activity per vehicle, the utility extracts the SHP, starts, SHI, and population activity data (by hour, SUT, and fuel type) from the movesactivityoutput database table. The utility divides the SHP activity by the population and saves the SHP per vehicle in the ttiactpervehicle database table. Using the same calculation process, the utility also calculates the starts per vehicle and SHI per vehicle using the starts and SHI activity data.

MOVESratesAdj

The MOVESratesAdj utility applies emissions rate adjustments to an emissions rate database table produced by MOVES (rateperdistance, ratepervehicle, rateperprofile), the MOVESratesCalc utility (ttirateperdistance, ttirateperactivity) 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. Otherwise, all of the pollutants in the input emissions rate database table will be in the new emissions rate database table. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, provided that 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 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. A tab-

delimited form of this database table may also be output that includes the text description of the pollutant, process, and roadway type instead of the MOVES codes that are included in the database tables.

ShpExtIdleStartActBld

The ShpExtIdleStartActBld utility calculates the SHP and starts activity by hour, SUT, and fuel type used to estimate emissions using the MOVESratesCalc emissions rates. The SHP is calculated using the either the TDM or virtual link based link VMT and speeds (same as used in the distance-based emissions estimation), the VMT mix (by roadway type), and the SUT/fuel type population (from the MOVESpopulationBuild). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically from the ttiactpervehicle database table created by the MOVESratesCalc utility). The utility also has the option of calculating the SHI activity used to estimate emissions using the MOVESratesCalc emissions rates. However, this method of estimating the extended idle hours is a direct function of the SHO and does not consider the availability of locations where extended idling may occur. The suggested method for estimating the SHI is discussed in the "ExtIdleHrsCalc" section.

For each link in the first VMT and speeds input with the desired county code, the utility applies the appropriate VMT mix to distribute 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 VMT and speeds input; therefore producing 24-hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The 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 by are calculated subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours.

The hourly SUT/fuel type starts are calculated using the hourly starts per vehicle and the SUT/fuel type population. For each hour, the hourly SUT/fuel type starts are calculated by multiplying the hourly starts per vehicle by the SUT/fuel type population.

The hourly SUT/fuel type SHIs are calculated for source type 62, fuel type 2 (CLhT_Diesel) only. The CLhT_Diesel 24-hour SHI is calculated by multiplying the CLhT_Diesel 24-hour VHT (from the SHP calculation process) by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. The hourly CLhT_Diesel VHT (from the SHP calculation process) is converted to hourly VHT fractions. The hourly SHI fractions are calculated as the inverse of the hourly VHT fractions. The hourly SHI fractions are then applied to the CLhT_Diesel 24-hour SHI to calculate the hourly SUT/fuel type SHI.

ExtIdleHrsCalc

The ExtIdleHrsCalc utility calculates the SHI activity by hour for SUT 62, fuel type 2 (CLhT_Diesel) used to estimate emissions using the MOVESratesCalc emissions rates. This hourly SHI is calculated using a 24-hour base SHI for a specific year and day type, base link

VMT and speeds, base VMT mix, future link VMT and speeds, future VMT mix, and the future tab-delimited hourly SHP by SUT/fuel type. All of the base data should be from the same year and day-type. Although the term future data is used, the future data can be a year previous to the base data (i.e., historical year) and should be from the same year and day type. The tab-delimited hourly SHP by SUT/fuel type is typically the output from the ShpExtIdleStartActBld utility.

For each link in the first base VMT and speeds input with the desired county code, the utility applies the appropriate base VMT mix for CLhT_Diesel to the link VMT to calculate the link CLhT_Diesel VMT, which is added to the hourly CLhT_Diesel VMT. The link CLhT_Diesel VMT is divided by the link speed to calculate the link CLhT_Diesel VHT, which is added to the hourly CLhT_Diesel VHT. This calculation process is repeated for each base VMT and speeds input; therefore producing 24-hourly values for base CLhT_Diesel VMT and for base CLhT_Diesel VHT by SUT/fuel type. The same calculation process is performed for the future data (future VMT and speeds, future VMT mix) to calculate the hourly future CLhT_Diesel VMT and the hourly future CLhT_Diesel VHT.

The 24-hour future SHI is calculated using the 24-hour base CLhT_Diesel VMT, the 24-hour future CLhT_Diesel VMT, and the 24-hour base SHI. The scaling factor is calculated by the dividing the 24-hour future CLhT_Diesel VMT by the 24-hour base CLhT_Diesel VMT. The scaling factor is multiplied by the 24-hour base SHI to estimate the 24-hour future SHI.

The 24-hour future SHI is distributed to each hour using SHI hourly factors. The SHI hourly factors are calculated using the hourly CLhT_Diesel VMT. The hourly CLhT_Diesel VMT is converted hourly CLhT_Diesel VMT fractions. The SHI hourly factors are calculated by taking the inverse of the hourly CLhT_Diesel VMT fractions (i.e., more VMT implies less SHI). The SHI hourly factors are applied to the 24-hour future SHI to calculate the initial hourly future SHI, therefore distributing the 24-hour future SHI to each hour of the day.

To form the final SHI activity by hour, the initial hourly future SHI is compared to the hourly CLhT_Diesel SHP. If the initial hourly future SHI is greater than the hourly CLhT_Diesel SHP, then the final SHI activity for that hour is set to the hourly CLhT_Diesel SHP. Otherwise, the final SHI activity for that hour is set to the initial hourly future SHI. This comparison is performed for each hour.

MOVESemscalc

The MOVESemscalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from MOVES, MOVES ratesCalc or MOVESratesAdj), the VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (either vehicle population or 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 MOVESemscalc are:

- Emissions factors from MOVES, MOVES ratesCalc or MOVESratesAdj;

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility. For each link, the following information is input to MOVESemscalc: link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;
- VMT mix by MOVES roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity. If the emissions factors are in the MOVES format, vehicle population by SUT/fuel type is required. If the emissions factors are in the MOVESratesCalc format, the SHP, starts, SHI by hour, and SUT/fuel type are required; and
- Link/MOVES roadway type designations, which associates the link roadway/area type combination to the appropriate MOVES roadway type.

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the VMT-based emissions and the off-network emissions. For the VMT-based emissions (rateperdistance or ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by MOVES roadway type (as designated in the link/MOVES roadway type designations). The emissions factors are selected based on the MOVES roadway type 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.

The off-network emissions calculation depends on the format of the input emissions factors. If the emissions factors are in the MOVES format (rateperprofile and ratepervehicle), the emissions factors by SUT/fuel type are multiplied by their associated vehicle population to estimate emissions. If the emissions factors are in the MOVESratesCalc format, the emissions factors by SUT/fuel type are multiplied by the appropriate activity, which is determined by the pollutant process (see Table 34).

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, 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. This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by roadway. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination.

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:

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

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.

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

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

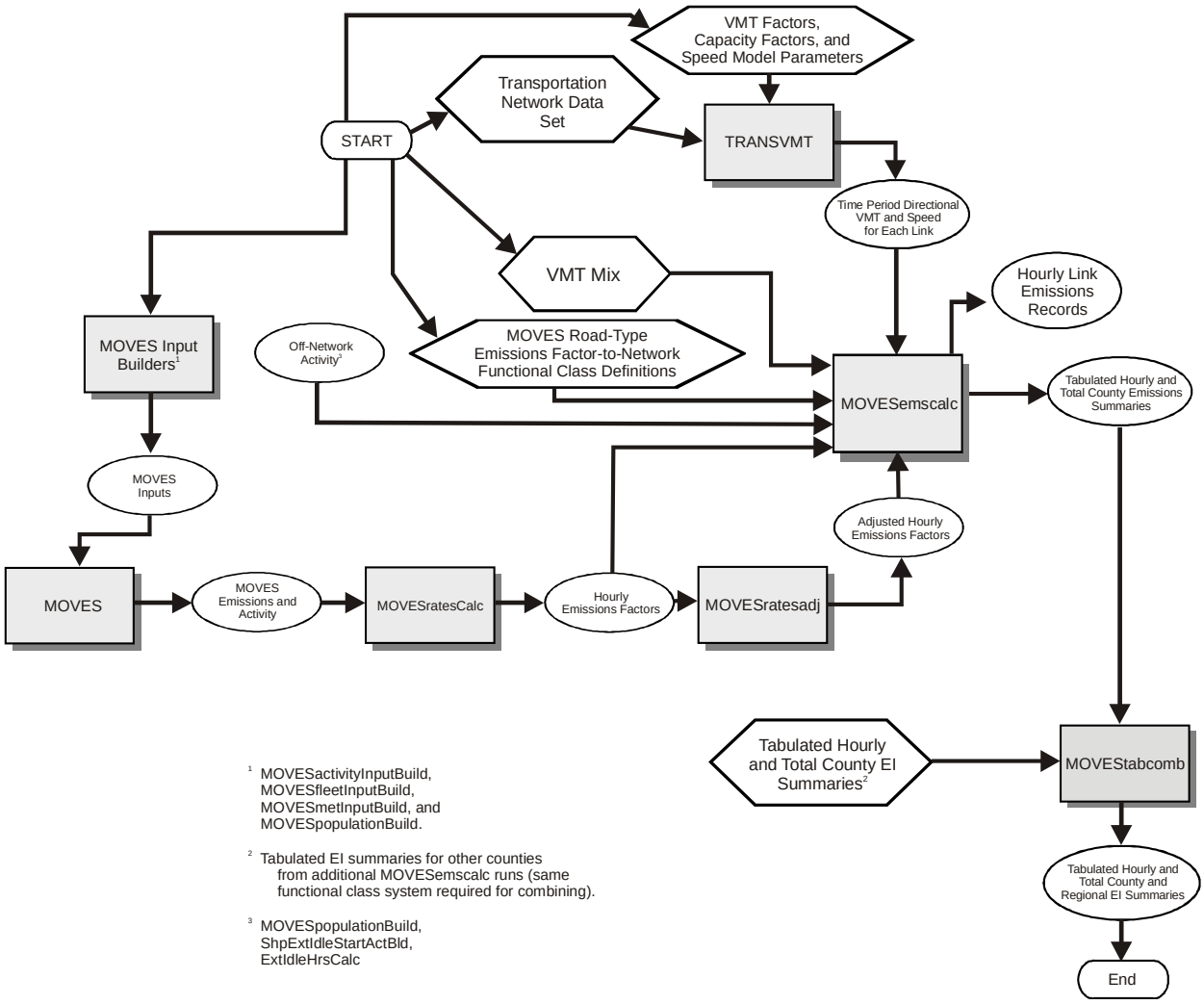
$$= 0.7377 \text{ g/mi}.$$

MOVEStabcomb

The MOVEStabcomb utility combines the tab-delimited output from multiple runs of the MOVESemscac utility to produce a regional summary of the VMT, VHT, speed (VMT/VHT), off-network activity, and emissions for each hour along with a 24-hour summary. A maximum of 1,000 tab files can be combined in one run of the MOVEStabcomb utility. However, each tab file must have the same roadway types or the utility will not function properly.

The new regional tab-delimited file is in the same form as the individual county files taken as input, except that each time period includes the individual county data summaries plus the regional summary. The individual county summaries are taken directly from the input tab-delimited files. The regional data summaries are summations of the county data except for "speed," which is calculated as regional VMT/regional VHT.

Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates



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

[2] Tabulated EI summaries for other counties from additional MOVESemscalc runs (same functional class system required for combining).

[3] MOVESpopulationBuild, ShpExtIdleStartActBld, ExtIdleHrsCalc

APPENDIX C:
TXDOT DISTRICT WEEKDAY VMT MIX BY MOVES ROAD TYPE

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

2000 Weekday VMT Mix by TxDOT District (2002 Analysis Year)

SUT/FT	Beaumont				Houston			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00218	0.00228	0.00232	0.00258	0.00199	0.00191	0.00223	0.00216
21_G	0.54312	0.56709	0.57688	0.64189	0.66078	0.63605	0.74264	0.71796
31_D	0.00248	0.00328	0.00263	0.00333	0.00244	0.00299	0.00216	0.00257
31_G	0.15223	0.20141	0.16175	0.20477	0.14991	0.18374	0.13311	0.15782
32_D	0.00449	0.00594	0.00477	0.00603	0.00442	0.00541	0.00392	0.00465
32_G	0.04708	0.06229	0.05003	0.06333	0.04637	0.05683	0.04117	0.04881
51_D	0.00131	0.00157	0.00117	0.00111	0.00080	0.00109	0.00069	0.00082
51_G	0.00033	0.00040	0.00030	0.00028	0.00041	0.00056	0.00035	0.00042
52_D	0.03591	0.04302	0.03215	0.03053	0.02090	0.02822	0.01797	0.02124
52_G	0.00920	0.01103	0.00824	0.00783	0.01067	0.01441	0.00917	0.01085
53_D	0.00173	0.00207	0.00155	0.00147	0.00230	0.00310	0.00197	0.00233
53_G	0.00044	0.00053	0.00040	0.00038	0.00117	0.00158	0.00101	0.00119
54_D	0.00188	0.00225	0.00168	0.00160	0.00116	0.00156	0.00099	0.00118
54_G	0.00048	0.00058	0.00043	0.00041	0.00059	0.00080	0.00051	0.00060
41_D	0.00188	0.00176	0.00164	0.00128	0.00090	0.00099	0.00121	0.00127
42_D	0.00072	0.00067	0.00062	0.00049	0.00034	0.00038	0.00046	0.00048
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00215	0.00202	0.00188	0.00147	0.00103	0.00114	0.00138	0.00145
43_G	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
61_D	0.06570	0.03125	0.05171	0.01047	0.04660	0.02931	0.01915	0.01174
61_G	0.00738	0.00351	0.00581	0.00118	0.00362	0.00227	0.00149	0.00091
62_D	0.11873	0.05647	0.09345	0.01891	0.04295	0.02701	0.01765	0.01082
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00055	0.00057	0.00058	0.00065	0.00066	0.00064	0.00075	0.00072

2020 Weekday VMT Mix by TxDOT District (2018 Analysis Year)

SUT/FT	Beaumont				Houston			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00164	0.00171	0.00174	0.00193	0.00199	0.00191	0.00223	0.00216
21_G	0.54366	0.56766	0.57746	0.64254	0.66078	0.63605	0.74264	0.71796
31_D	0.00866	0.01146	0.00921	0.01165	0.00868	0.01064	0.00771	0.00914
31_G	0.14604	0.19323	0.15517	0.19645	0.14367	0.17608	0.12756	0.15124
32_D	0.00346	0.00457	0.00367	0.00465	0.00340	0.00417	0.00302	0.00358
32_G	0.04811	0.06366	0.05112	0.06472	0.04738	0.05807	0.04207	0.04988
51_D	0.00037	0.00044	0.00033	0.00031	0.00023	0.00031	0.00019	0.00023
51_G	0.00009	0.00011	0.00008	0.00008	0.00012	0.00016	0.00010	0.00012
52_D	0.03681	0.04410	0.03295	0.03130	0.02142	0.02893	0.01841	0.02177
52_G	0.00943	0.01130	0.00844	0.00802	0.01093	0.01477	0.00940	0.01112
53_D	0.00177	0.00213	0.00159	0.00151	0.00235	0.00318	0.00202	0.00239
53_G	0.00045	0.00054	0.00041	0.00039	0.00120	0.00162	0.00103	0.00122
54_D	0.00188	0.00225	0.00168	0.00160	0.00116	0.00156	0.00099	0.00118
54_G	0.00048	0.00058	0.00043	0.00041	0.00059	0.00080	0.00051	0.00060
41_D	0.00199	0.00186	0.00173	0.00136	0.00095	0.00105	0.00128	0.00134
42_D	0.00057	0.00054	0.00050	0.00039	0.00027	0.00030	0.00037	0.00039
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00219	0.00205	0.00191	0.00149	0.00104	0.00115	0.00140	0.00148
43_G	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001
61_D	0.06570	0.03125	0.05171	0.01047	0.04660	0.02931	0.01915	0.01174
61_G	0.00738	0.00351	0.00581	0.00118	0.00362	0.00227	0.00149	0.00091
62_D	0.11873	0.05647	0.09345	0.01891	0.04295	0.02701	0.01765	0.01082
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00055	0.00057	0.00058	0.00065	0.00066	0.00064	0.00075	0.00072

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

2000 Aggregate Weekday VMT Mix by TxDOT District (2002 Analysis Year)

SUT/FT	Beaumont	Houston
21_D	0.002280	0.002200
21_G	0.568760	0.732370
31_D	0.002820	0.002240
31_G	0.173240	0.137890
32_D	0.005110	0.004060
32_G	0.053580	0.042650
51_D	0.001320	0.000720
51_G	0.000340	0.000370
52_D	0.036230	0.018810
52_G	0.009280	0.009610
53_D	0.001750	0.002070
53_G	0.000450	0.001060
54_D	0.001890	0.001040
54_G	0.000490	0.000530
41_D	0.001720	0.001190
42_D	0.000660	0.000450
42_G	0.000000	0.000000
43_D	0.001970	0.001360
43_G	0.000020	0.000010
61_D	0.047110	0.020320
61_G	0.005290	0.001580
62_D	0.085140	0.018730
62_G	0.000000	0.000000
11_G	0.000570	0.000740

2020 Aggregate Weekday VMT Mix by TxDOT District (2018 Analysis Year)

SUT/FT	Beaumont	Houston
21_D	0.001710	0.002200
21_G	0.569330	0.732370
31_D	0.009860	0.007990
31_G	0.166190	0.132140
32_D	0.003930	0.003130
32_G	0.054750	0.043580
51_D	0.000370	0.000200
51_G	0.000090	0.000100
52_D	0.037130	0.019280
52_G	0.009520	0.009850
53_D	0.001790	0.002120
53_G	0.000460	0.001080
54_D	0.001890	0.001040
54_G	0.000490	0.000530
41_D	0.001820	0.001260
42_D	0.000520	0.000360
42_G	0.000000	0.000000
43_D	0.002000	0.001380
43_G	0.000020	0.000010
61_D	0.047110	0.020320
61_G	0.005290	0.001580
62_D	0.085140	0.018730
62_G	0.000000	0.000000
11_G	0.000570	0.000740

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

Freeflow (Volume = 1) Speed Factors for Houston/Galveston Speed Model

Functional Group	Area Type				
	CBD	Urban	Urban Fringe	Suburban	Rural
Freeways, Interstates	1.147400	1.177508	1.157272	1.197842	1.137903
Principal Arterials	1.136702	0.860413	0.887801	1.002511	1.018546
Other Arterials, Major Collectors	1.145946	0.811981	0.813370	0.813370	1.112661
Collectors	1.235367	0.857297	0.889344	0.974734	1.033400
Toll Roads	1.054545	1.100000	1.081379	1.057097	1.077846
Ramps	1.235367	0.857297	0.889344	0.974734	1.033400
Locals	1.000000	1.000000	1.000000	1.000000	1.000000

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

LOS E (V/C = 1.0) Speed Factors for Houston/Galveston Speed Model

Functional Group	Area Type				
	CBD	Urban	Urban Fringe	Suburban	Rural
Freeways, Interstates	0.700000	0.768691	0.737693	0.715108	0.645161
Principal Arterials	0.703191	0.578709	0.633464	0.750628	0.458973
Other Arterials, Major Collectors	0.677477	0.560596	0.613733	0.870193	0.517909
Collectors	0.727049	0.567228	0.642497	0.761987	0.554081
Toll Roads	0.636364	0.636364	0.689705	0.645161	0.615385
Ramps	0.727049	0.567228	0.642497	0.761987	0.554081
Locals	1.000000	1.000000	1.000000	1.000000	1.000000

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

Functional Group	Corresponding Network Functional Classifications
Freeways, Interstates	1. Urban Interstate Freeways 2. Urban Other Freeways 10. Rural Interstate Freeways 11. Rural Other Freeways
Principal Arterials	5. Urban Principal Arterials 12. Rural Principal Arterials
Other Arterials, Major Collectors	6. Urban Other Arterials 13. Rural Other Arterials 14. Rural Major Collectors
Collectors	7. Urban Collectors 15. Rural Collectors
Toll Roads	3. Toll Roads
Ramps	4. Ramps
Locals	8. Locals (Centroid Connectors) 40. Locals (Intrazonals)

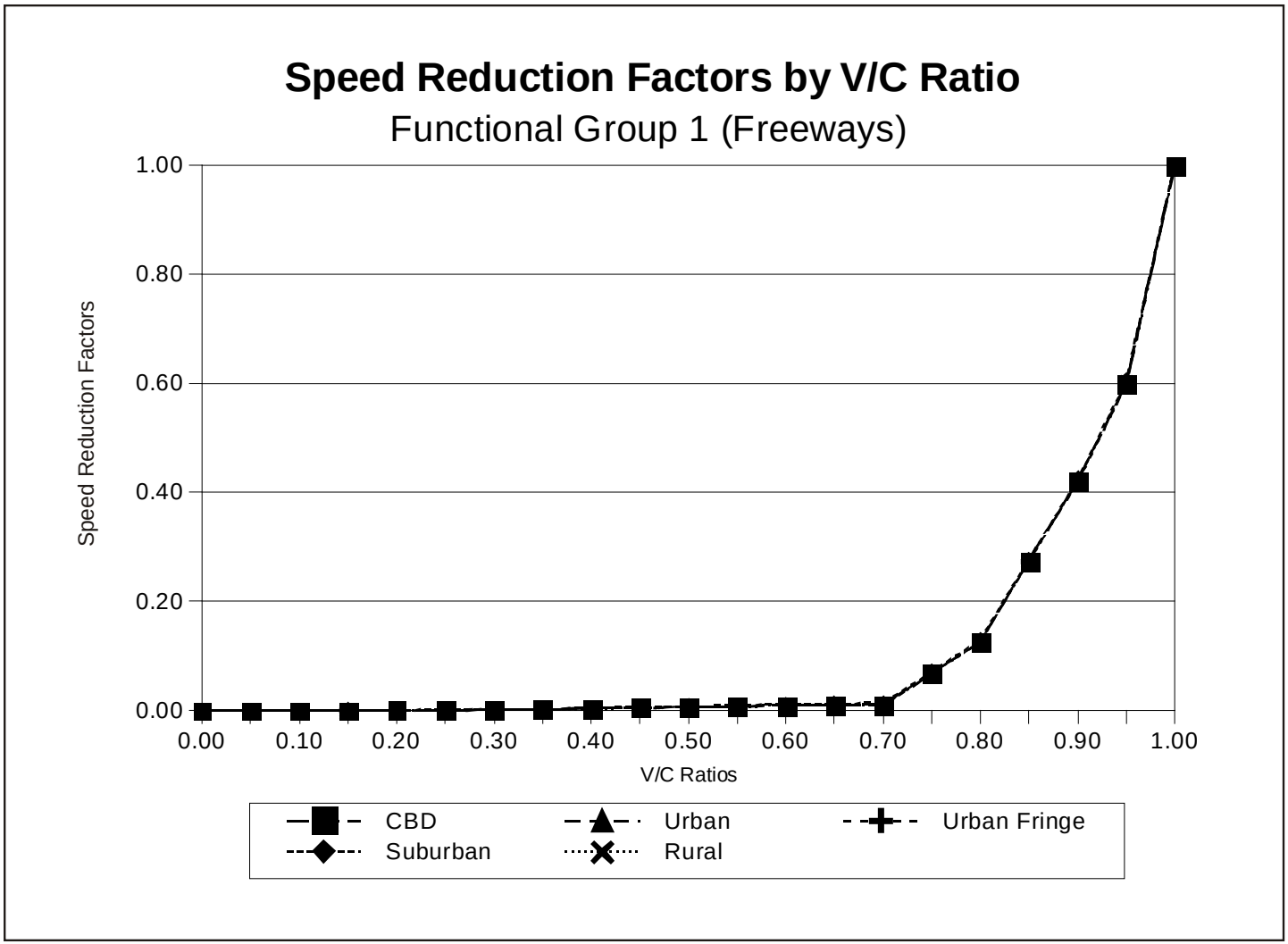


Figure 1. Freeway Speed Reduction Factors by V/C Ratio.

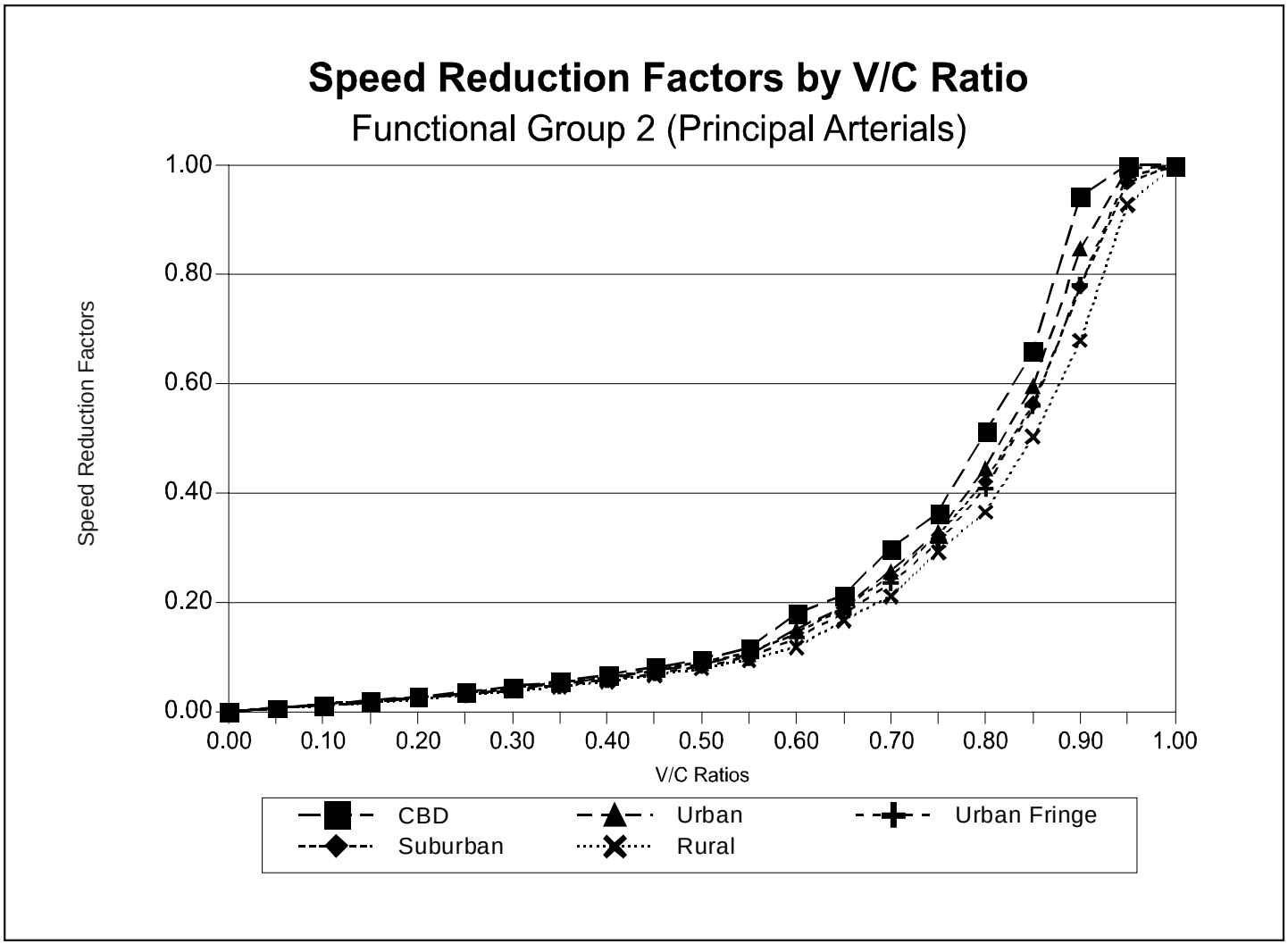


Figure 2. Principal Arterial Speed Reduction Factors by V/C Ratio.

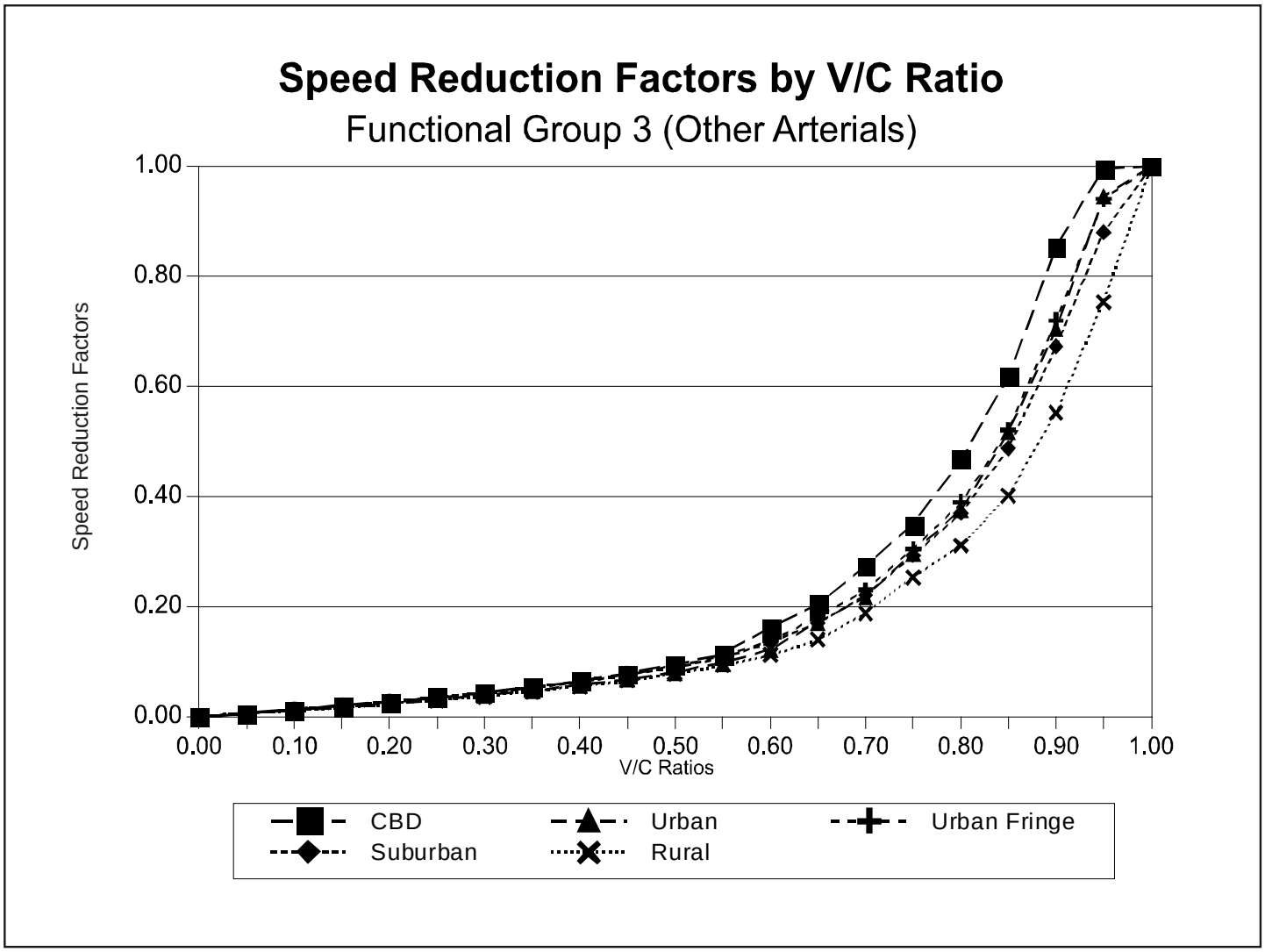


Figure 3. Other Arterial Speed Reduction Factors by V/C Ratio.

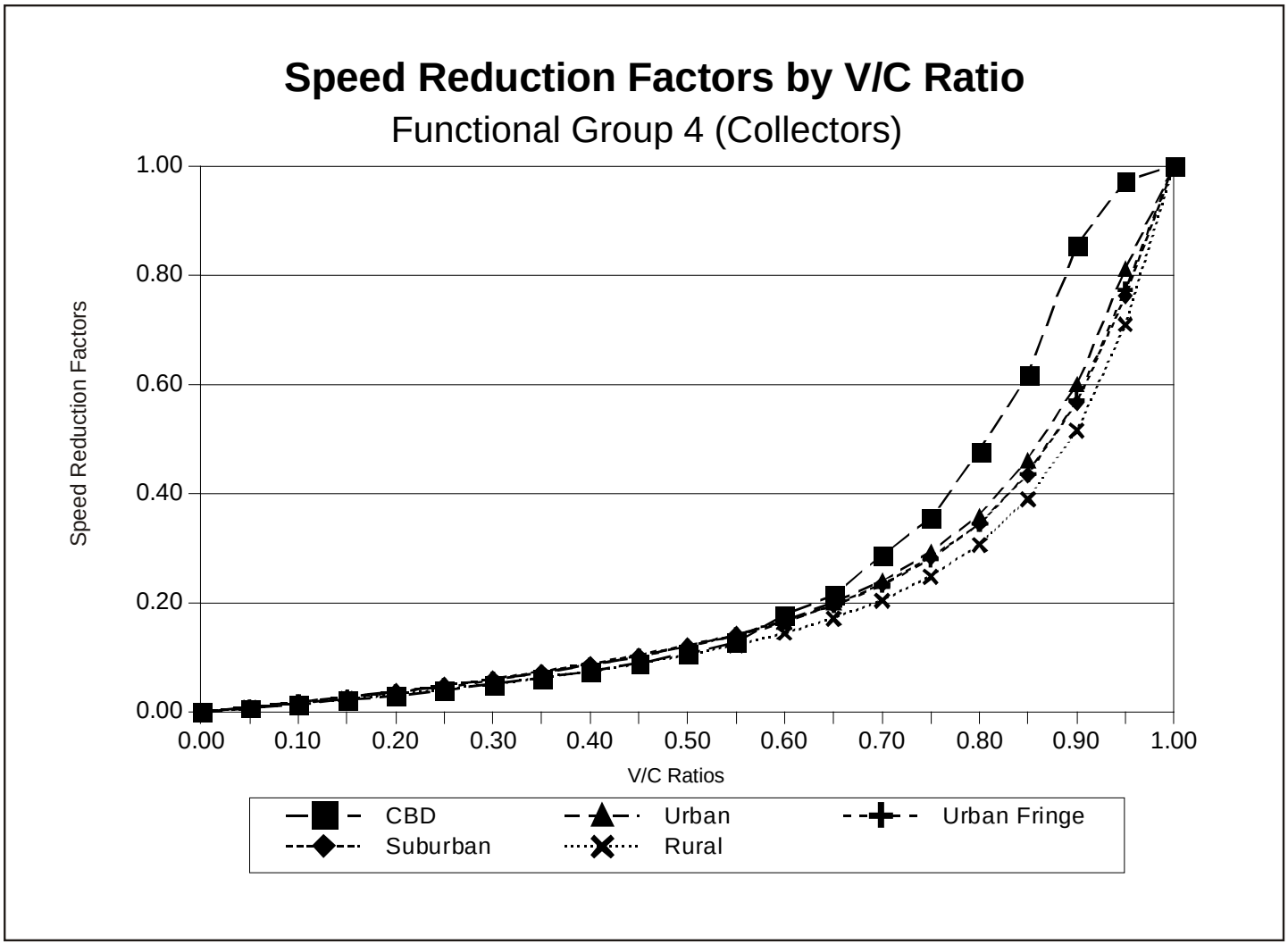


Figure 4. Collector Speed Reduction Factors by V/C Ratio.

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

2002 Vehicle Population Estimates

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	4,763	309	510	35	395	93	39	342
21_G	1,585,418	102,754	169,889	11,507	131,650	23,256	9,636	113,876
31_D	8,220	849	846	122	1,024	270	120	750
31_G	506,003	52,259	52,086	7,537	63,018	16,578	7,378	46,144
32_D	14,899	1,539	1,534	222	1,855	489	218	1,359
32_G	156,509	16,164	16,110	2,331	19,492	5,127	2,282	14,273
51_D	577	44	31	10	54	19	8	31
51_G	297	23	16	5	28	5	2	16
52_D	15,079	1,148	812	267	1,415	517	206	801
52_G	7,704	586	415	136	723	133	53	409
53_D	1,659	126	89	29	156	25	10	88
53_G	850	65	46	15	80	6	3	45
54_D	834	63	45	15	78	27	11	44
54_G	425	32	23	8	40	7	3	23
41_D	954	73	51	17	90	25	10	51
42_D	361	27	19	6	34	9	4	19
42_G	0	0	0	0	0	0	0	0
43_D	1,090	83	59	19	102	28	11	58
43_G	8	1	0	0	1	0	0	0
61_D	15,514	888	888	153	892	468	85	495
61_G	1,206	69	69	12	69	53	9	39
62_D	14,300	818	818	141	822	847	153	457
62_G	0	0	0	0	0	0	0	0
11_G	28,919	3,284	3,252	319	4,133	747	431	3,940

2018 Vehicle Population Estimates

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	6,328	569	1,261	58	842	118	59	450
21_G	2,106,728	189,277	419,947	19,161	280,310	39,214	19,704	149,652
31_D	39,214	4,969	6,170	709	6,809	1,595	800	3,653
31_G	648,524	82,180	102,047	11,730	112,602	26,888	13,481	60,406
32_D	15,362	1,947	2,417	278	2,667	636	319	1,431
32_G	213,884	27,103	33,655	3,869	37,136	8,858	4,441	19,922
51_D	324	45	39	10	58	20	10	26
51_G	162	22	19	5	29	5	2	13
52_D	31,249	4,314	3,754	967	5,626	2,042	1,013	2,490
52_G	15,965	2,204	1,918	494	2,874	523	260	1,272
53_D	3,436	474	413	106	619	98	49	274
53_G	1,750	242	210	54	315	25	13	140
54_D	1,686	233	203	52	303	104	52	134
54_G	859	119	103	27	155	27	13	68
41_D	2,042	282	245	63	368	100	50	163
42_D	583	81	70	18	105	29	14	47
42_G	0	0	0	0	0	0	0	0
43_D	2,237	309	269	69	403	110	55	178
43_G	16	2	2	1	3	1	1	1
61_D	18,607	1,254	1,723	248	1,736	584	214	644
61_G	1,447	97	134	19	135	66	24	50
62_D	17,151	1,156	1,589	228	1,600	1,056	387	594
62_G	0	0	0	0	0	0	0	0
11_G	55,670	10,395	11,224	1,113	15,092	2,783	1,426	9,352

2002 24-Hour Weekday SHP Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	108,459	7,131	11,809	764	9,041	2,124	845	7,874
21_G	36,107,477	2,373,995	3,931,179	254,513	3,009,715	529,949	210,844	2,621,262
31_D	190,653	20,016	19,773	2,848	23,985	6,321	2,781	17,595
31_G	11,736,849	1,232,212	1,217,235	175,310	1,476,533	388,337	170,851	1,083,174
32_D	345,570	36,281	35,839	5,162	43,474	11,455	5,040	31,892
32_G	3,630,270	381,129	376,497	54,224	456,699	120,106	52,841	335,031
51_D	11,733	934	571	213	1,102	384	129	608
51_G	6,035	480	294	110	566	99	34	313
52_D	306,919	24,434	14,944	5,576	28,821	10,555	3,550	15,913
52_G	156,816	12,484	7,636	2,849	14,726	2,703	909	8,130
53_D	33,796	2,690	1,646	614	3,173	510	172	1,752
53_G	17,312	1,378	844	315	1,626	131	44	898
54_D	16,961	1,350	826	308	1,593	550	185	879
54_G	8,642	688	421	157	811	143	48	448
41_D	19,541	1,589	983	372	1,904	511	167	1,022
42_D	7,388	600	371	141	719	196	64	386
42_G	0	0	0	0	0	0	0	0
43_D	22,337	1,815	1,123	425	2,175	586	192	1,168
43_G	166	13	8	3	16	6	2	9
61_D	334,429	18,609	17,849	2,515	16,416	9,906	465	9,660
61_G	26,009	1,448	1,389	196	1,278	1,112	52	752
62_D	308,265	17,153	16,453	2,319	15,133	17,904	840	8,904
62_G	0	0	0	0	0	0	0	0
11_G	692,104	78,724	77,901	7,634	99,041	17,900	10,323	94,448

2018 24-Hour Weekday SHP Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	143,711	13,201	29,444	1,284	19,413	2,687	1,308	10,377
21_G	47,844,071	4,394,661	9,802,149	427,311	6,462,743	894,603	435,489	3,454,692
31_D	908,192	117,242	144,456	16,537	159,856	37,391	18,538	85,930
31_G	15,019,555	1,938,941	2,389,004	273,493	2,643,697	630,215	312,457	1,421,111
32_D	355,776	45,928	56,589	6,478	62,622	14,903	7,389	33,662
32_G	4,953,473	639,466	787,897	90,198	871,896	207,619	102,937	468,685
51_D	6,952	1,021	840	227	1,307	457	216	576
51_G	3,457	509	418	113	651	111	52	287
52_D	671,253	98,504	81,174	21,935	126,152	45,842	21,674	55,599
52_G	342,950	50,326	41,473	11,207	64,452	11,754	5,558	28,406
53_D	73,825	10,832	8,927	2,412	13,873	2,210	1,045	6,114
53_G	37,601	5,518	4,547	1,229	7,067	568	269	3,114
54_D	36,197	5,313	4,377	1,183	6,804	2,333	1,103	2,998
54_G	18,444	2,707	2,230	603	3,467	605	286	1,528
41_D	44,063	6,504	5,390	1,464	8,358	2,265	1,063	3,656
42_D	12,566	1,857	1,538	418	2,386	647	303	1,043
42_G	0	0	0	0	0	0	0	0
43_D	48,228	7,122	5,900	1,604	9,151	2,489	1,167	4,002
43_G	351	52	43	12	66	25	12	29
61_D	393,348	25,930	34,815	4,303	34,131	11,799	1,872	12,676
61_G	30,592	2,017	2,708	335	2,655	1,325	210	986
62_D	362,575	23,902	32,092	3,966	31,462	21,324	3,384	11,684
62_G	0	0	0	0	0	0	0	0
11_G	1,333,353	249,337	269,096	26,669	361,934	66,753	34,188	224,307

2002 24-Hour Weekday Starts Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	27,961	1,812	2,996	203	2,322	547	227	2,008
21_G	9,308,001	603,271	997,417	67,560	772,915	136,535	56,575	668,566
31_D	47,433	4,899	4,883	706	5,907	1,557	693	4,326
31_G	2,919,871	301,556	300,560	43,490	363,644	95,662	42,572	266,273
32_D	89,642	9,258	9,227	1,335	11,164	2,942	1,309	8,175
32_G	941,687	97,255	96,933	14,026	117,279	30,850	13,729	85,876
51_D	2,164	165	117	38	203	71	28	115
51_G	1,112	85	60	20	104	18	7	59
52_D	105,416	8,023	5,674	1,863	9,894	3,617	1,442	5,597
52_G	53,857	4,099	2,899	952	5,055	926	369	2,860
53_D	7,114	541	383	126	668	107	43	378
53_G	3,643	277	196	64	342	28	11	193
54_D	472	36	25	8	44	15	6	25
54_G	241	18	13	4	23	4	2	13
41_D	2,640	201	142	47	248	68	27	140
42_D	1,651	126	89	29	155	43	17	88
42_G	0	0	0	0	0	0	0	0
43_D	6,267	477	337	111	588	162	64	333
43_G	46	4	2	1	4	2	1	2
61_D	92,000	5,266	5,266	908	5,288	2,778	501	2,938
61_G	7,154	409	409	71	411	312	56	228
62_D	61,302	3,509	3,509	605	3,523	3,629	655	1,958
62_G	0	0	0	0	0	0	0	0
11_G	12,866	1,461	1,447	142	1,839	332	192	1,753

2018 24-Hour Weekday Starts Summaries

SUT/FT	Harris	Brazoria	Fort Bend	Waller	Montgomery	Liberty	Chambers	Galveston
21_D	37,154	3,338	7,406	338	4,944	691	347	2,639
21_G	12,368,612	1,111,249	2,465,509	112,493	1,645,704	230,224	115,684	878,605
31_D	226,282	28,674	35,606	4,093	39,289	9,205	4,615	21,077
31_G	3,742,289	474,216	588,860	67,689	649,769	155,154	77,792	348,573
32_D	92,428	11,712	14,544	1,672	16,048	3,826	1,918	8,609
32_G	1,286,906	163,074	202,498	23,277	223,444	53,297	26,722	119,868
51_D	1,216	168	146	38	219	76	38	97
51_G	608	84	73	19	109	19	9	48
52_D	218,462	30,160	26,246	6,759	39,333	14,274	7,079	17,410
52_G	111,611	15,409	13,409	3,453	20,095	3,660	1,815	8,895
53_D	14,730	2,034	1,770	456	2,652	422	209	1,174
53_G	7,504	1,036	902	232	1,351	108	54	598
54_D	954	132	115	30	172	59	29	76
54_G	486	67	58	15	88	15	8	39
41_D	5,651	780	679	175	1,017	277	137	450
42_D	2,671	369	321	83	481	131	65	213
42_G	0	0	0	0	0	0	0	0
43_D	12,857	1,775	1,545	398	2,315	632	314	1,025
43_G	93	13	11	3	17	6	3	7
61_D	110,346	7,436	10,221	1,469	10,294	3,465	1,271	3,818
61_G	8,580	578	795	114	800	389	143	297
62_D	73,526	4,955	6,810	979	6,859	4,526	1,661	2,544
62_G	0	0	0	0	0	0	0	0
11_G	24,767	4,625	4,993	495	6,714	1,238	634	4,161

24-Hour Weekday SHI Summaries (CLhT_Diesel Only)

County	2002	2008	2011	2014	2017	2018	2019
Harris	17,032	19,490	20,474	21,667	23,010	23,475	23,951
Brazoria	153	157	182	200	218	224	230
Fort Bend	3,072	3,415	4,214	4,663	5,147	5,320	5,498
Waller	1,560	1,835	1,905	2,046	2,205	2,260	2,318
Montgomery	4,242	4,357	5,248	5,283	5,771	5,943	6,121
Liberty	449	466	600	652	699	715	732
Chambers	840	1,575	2,138	2,272	2,420	2,471	2,523
Galveston	481	503	517	550	585	597	609

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

Brazoria County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.110231	0.056917	0.077390	0.077390	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.139160	0.083299	0.106849	0.106849	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.104446	0.097620	0.091753	0.091753	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.081912	0.086239	0.088335	0.088335	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.060901	0.078020	0.067279	0.067279	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.055116	0.074382	0.074891	0.074891	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.050244	0.065494	0.058156	0.058156	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.035932	0.070753	0.060415	0.060415	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.037454	0.058576	0.058029	0.058029	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.030146	0.055878	0.045078	0.045078	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.022838	0.044788	0.038469	0.038469	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.015834	0.042236	0.036803	0.036803	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.016748	0.034882	0.032086	0.032086	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.017052	0.033426	0.030857	0.030857	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.012485	0.023723	0.024615	0.024615	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.013398	0.018067	0.016565	0.016565	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.024665	0.015524	0.018232	0.018232	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.022838	0.013225	0.014814	0.014814	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.013398	0.010023	0.013572	0.013572	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.013398	0.005967	0.007513	0.007513	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.023752	0.004065	0.008050	0.008050	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.015225	0.003619	0.006044	0.006044	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.017966	0.002620	0.002994	0.002994	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.012485	0.002950	0.003658	0.003658	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.009744	0.002329	0.003305	0.003305	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.007308	0.001611	0.002528	0.002528	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.004066	0.001223	0.001447	0.001447	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.005082	0.000828	0.001345	0.001345	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.004193	0.000876	0.001289	0.001289	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.003304	0.000693	0.000684	0.000684	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.018678	0.010148	0.006956	0.006956	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Brazoria County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.029489	0.041465	0.025332	0.025332	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.035165	0.059996	0.041857	0.041857	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.084868	0.058323	0.038005	0.038005	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.097743	0.088039	0.069630	0.069630	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.113526	0.091720	0.077310	0.077310	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.102174	0.081450	0.069196	0.069196	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.078222	0.075970	0.063213	0.063213	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.059532	0.065633	0.070261	0.070261	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.071577	0.061826	0.073680	0.073680	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.064655	0.060152	0.075947	0.075947	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.049702	0.054189	0.069147	0.069147	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.033504	0.053452	0.056586	0.056586	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.028243	0.043257	0.050776	0.050776	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.022290	0.034683	0.035564	0.035564	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.015368	0.027046	0.036060	0.036060	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.015921	0.020837	0.025890	0.025890	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.013014	0.019007	0.025506	0.025506	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.011076	0.013489	0.021554	0.021554	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.007615	0.010277	0.013849	0.013849	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.007061	0.007808	0.011582	0.011582	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.003323	0.006053	0.009291	0.009291	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.004015	0.004439	0.007457	0.007457	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.003738	0.003324	0.006937	0.006937	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.003600	0.002372	0.005215	0.005215	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.002769	0.001837	0.002564	0.002564	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.004984	0.001398	0.002973	0.002973	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.003600	0.001450	0.002155	0.002155	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.003600	0.001034	0.002329	0.002329	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.003184	0.000647	0.001102	0.001102	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.004430	0.000565	0.001028	0.001028	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.022013	0.008262	0.008002	0.008002	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Chambers County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.118329	0.035245	0.050515	0.050515	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.139211	0.069871	0.099530	0.099530	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.146172	0.099845	0.098129	0.098129	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.090487	0.091266	0.091127	0.091127	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.078886	0.080517	0.076823	0.076823	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.044084	0.076176	0.083025	0.083025	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.062645	0.068320	0.059718	0.059718	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.041763	0.072351	0.063919	0.063919	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.027842	0.057778	0.061118	0.061118	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.034803	0.057364	0.046314	0.046314	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.020882	0.046305	0.041312	0.041312	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.009281	0.041240	0.037111	0.037111	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.011601	0.033592	0.032510	0.032510	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.013921	0.036072	0.026308	0.026308	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.011601	0.027390	0.023107	0.023107	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.000000	0.019018	0.014704	0.014704	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.009281	0.015917	0.016205	0.016205	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.020882	0.015090	0.015105	0.015105	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.013921	0.012610	0.014904	0.014904	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.011601	0.007235	0.008903	0.008903	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.023202	0.005478	0.008403	0.008403	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.013921	0.004651	0.007202	0.007202	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.009281	0.002791	0.003101	0.003101	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.016241	0.003824	0.004201	0.004201	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.004640	0.002687	0.003001	0.003001	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.004640	0.002481	0.002401	0.002401	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.000994	0.000986	0.001726	0.001726	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.001989	0.000807	0.001683	0.001683	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.001989	0.001435	0.001278	0.001278	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.000994	0.000717	0.000879	0.000879	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.014915	0.010939	0.005737	0.005737	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Chambers County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.016832	0.043599	0.026411	0.026411	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.028713	0.062691	0.040891	0.040891	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.086139	0.063048	0.046444	0.046444	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.094059	0.103227	0.077431	0.077431	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.130693	0.098597	0.083433	0.083433	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.109901	0.091757	0.075180	0.075180	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.080198	0.077652	0.066627	0.066627	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.068317	0.062122	0.075405	0.075405	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.075248	0.052148	0.073980	0.073980	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.067327	0.055639	0.069928	0.069928	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.045545	0.048372	0.067977	0.067977	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.039604	0.045166	0.051170	0.051170	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.040594	0.037900	0.045618	0.045618	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.023762	0.028924	0.031813	0.031813	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.010891	0.025219	0.031438	0.031438	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.011881	0.019377	0.022209	0.022209	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.006931	0.017953	0.024010	0.024010	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.008911	0.011968	0.020408	0.020408	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.007921	0.010401	0.013205	0.013205	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.003960	0.007053	0.010579	0.010579	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.004950	0.007124	0.008929	0.008929	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.001980	0.005486	0.007428	0.007428	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.003960	0.004203	0.006227	0.006227	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.002970	0.002208	0.004727	0.004727	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.001980	0.002636	0.002776	0.002776	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.001980	0.001781	0.002701	0.002701	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.001980	0.001781	0.002176	0.002176	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.003960	0.001282	0.002326	0.002326	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.000000	0.000427	0.001050	0.001050	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.002970	0.000712	0.000975	0.000975	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.015842	0.009546	0.006528	0.006528	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Fort Bend County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.151907	0.060388	0.093630	0.093630	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.141451	0.092442	0.123951	0.123951	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.107626	0.110740	0.111809	0.111809	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.091021	0.094678	0.100714	0.100714	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.069188	0.085928	0.076485	0.076485	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.046740	0.078293	0.075181	0.075181	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.045510	0.071256	0.053658	0.053658	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.037208	0.072659	0.056521	0.056521	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.036593	0.056825	0.051887	0.051887	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.031058	0.051550	0.040580	0.040580	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.019065	0.042365	0.032561	0.032561	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.014760	0.038568	0.028352	0.028352	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.011993	0.032265	0.024668	0.024668	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.013530	0.023938	0.022260	0.022260	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.010455	0.018644	0.018179	0.018179	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.011685	0.013797	0.012511	0.012511	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.017528	0.011080	0.013432	0.013432	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.013838	0.009930	0.012384	0.012384	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.011070	0.007435	0.010811	0.010811	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.016298	0.004378	0.005696	0.005696	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.018143	0.003421	0.006844	0.006844	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.012608	0.002430	0.005299	0.005299	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.010148	0.001831	0.002919	0.002919	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.008303	0.002171	0.004180	0.004180	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.009225	0.001755	0.003089	0.003089	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.004920	0.001291	0.002338	0.002338	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.005119	0.000776	0.001003	0.001003	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.006355	0.000784	0.001506	0.001506	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.003884	0.000542	0.001288	0.001288	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.004766	0.000537	0.000577	0.000577	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.018006	0.007302	0.005686	0.005686	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Fort Bend County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.043366	0.046518	0.029637	0.029637	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.048141	0.065960	0.053790	0.053790	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.102478	0.064906	0.044450	0.044450	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.101058	0.094485	0.079934	0.079934	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.120289	0.096165	0.088972	0.088972	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.103898	0.085778	0.072731	0.072731	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.079375	0.075541	0.066153	0.066153	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.059241	0.067667	0.078277	0.078277	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.067759	0.063112	0.078099	0.078099	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.056402	0.059721	0.078037	0.078037	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.043753	0.053351	0.065736	0.065736	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.032137	0.050441	0.050913	0.050913	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.028653	0.038721	0.042448	0.042448	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.019489	0.031594	0.032045	0.032045	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.011745	0.024350	0.029011	0.029011	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.011874	0.017987	0.019202	0.019202	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.008776	0.015595	0.018680	0.018680	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.006324	0.010355	0.015689	0.015689	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.007486	0.007780	0.010508	0.010508	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.003098	0.006066	0.008235	0.008235	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.002710	0.004559	0.006130	0.006130	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.001678	0.003633	0.005494	0.005494	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.002194	0.002202	0.004555	0.004555	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.002323	0.001756	0.003357	0.003357	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.002710	0.001362	0.002450	0.002450	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.002323	0.001013	0.002085	0.002085	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.002581	0.000971	0.001939	0.001939	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.002452	0.000847	0.001887	0.001887	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.002839	0.000591	0.001136	0.001136	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.003872	0.000505	0.001220	0.001220	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.018973	0.006470	0.007203	0.007203	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Galveston County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.118528	0.059071	0.086589	0.086589	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.127157	0.082439	0.107589	0.107589	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.102538	0.090599	0.088237	0.088237	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.091624	0.084523	0.087677	0.087677	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.061168	0.076398	0.068389	0.068389	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.041878	0.071276	0.072179	0.072179	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.052538	0.065498	0.053946	0.053946	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.039340	0.070488	0.059576	0.059576	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.034264	0.058099	0.056905	0.056905	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.027157	0.055543	0.045886	0.045886	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.015736	0.046219	0.039312	0.039312	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.013452	0.043049	0.034738	0.034738	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.019797	0.037236	0.031251	0.031251	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.013959	0.033200	0.030180	0.030180	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.013959	0.024593	0.023495	0.023495	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.014721	0.019270	0.016809	0.016809	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.024873	0.016652	0.017129	0.017129	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.021320	0.014577	0.015402	0.015402	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.016751	0.011846	0.015146	0.015146	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.020305	0.006260	0.008221	0.008221	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.019036	0.004614	0.008653	0.008653	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.013706	0.003380	0.006190	0.006190	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.018020	0.002863	0.003071	0.003071	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.011675	0.003450	0.004558	0.004558	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.010660	0.002793	0.003870	0.003870	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.006345	0.001821	0.002879	0.002879	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.004645	0.001285	0.001664	0.001664	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.007047	0.001049	0.001511	0.001511	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.005286	0.000865	0.001510	0.001510	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.005606	0.000821	0.000654	0.000654	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.026908	0.010225	0.006783	0.006783	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Galveston County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.025243	0.043574	0.026319	0.026319	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.037738	0.058903	0.049632	0.049632	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.100719	0.063386	0.042001	0.042001	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.098574	0.088516	0.079627	0.079627	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.108166	0.090634	0.082367	0.082367	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.097816	0.083909	0.072569	0.072569	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.080020	0.075971	0.063120	0.063120	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.058437	0.064917	0.073910	0.073910	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.073457	0.062605	0.074861	0.074861	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.059447	0.059629	0.076888	0.076888	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.044806	0.052487	0.068292	0.068292	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.034709	0.050206	0.051254	0.051254	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.030418	0.041696	0.045928	0.045928	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.020825	0.033502	0.032860	0.032860	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.015777	0.026784	0.031798	0.031798	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.016534	0.020083	0.022671	0.022671	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.009719	0.018745	0.021832	0.021832	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.008709	0.012337	0.017681	0.017681	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.007952	0.010034	0.012957	0.012957	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.004670	0.007490	0.008889	0.008889	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.004039	0.005813	0.007785	0.007785	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.003786	0.005017	0.007548	0.007548	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.004670	0.003564	0.005996	0.005996	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.004670	0.002427	0.004025	0.004025	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.003155	0.002056	0.002376	0.002376	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.004670	0.001778	0.002404	0.002404	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.003155	0.001662	0.002111	0.002111	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.002524	0.001376	0.002264	0.002264	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.003282	0.000873	0.001384	0.001384	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.005301	0.000657	0.001132	0.001132	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.027010	0.009369	0.007520	0.007520	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Harris County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.133995	0.076273	0.100452	0.100452	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.145925	0.093193	0.114137	0.114137	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.114043	0.092654	0.096030	0.096030	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.093503	0.080164	0.090982	0.090982	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.066704	0.074951	0.072659	0.072659	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.051592	0.070560	0.074424	0.074424	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.049483	0.064047	0.052854	0.052854	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.043293	0.069245	0.058809	0.058809	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.033507	0.055981	0.054443	0.054443	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.031087	0.052927	0.044816	0.044816	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.018742	0.046193	0.036332	0.036332	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.012656	0.042864	0.030902	0.030902	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.013140	0.037605	0.025900	0.025900	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.012241	0.031161	0.025331	0.025331	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.012449	0.024683	0.020578	0.020578	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.010685	0.018216	0.014423	0.014423	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.020263	0.014785	0.014715	0.014715	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.015664	0.012829	0.013796	0.013796	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.012794	0.009622	0.011971	0.011971	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.014074	0.005572	0.006788	0.006788	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.017808	0.004139	0.008045	0.008045	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.011515	0.003006	0.005852	0.005852	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.011169	0.002237	0.003099	0.003099	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.009267	0.002831	0.004308	0.004308	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.007089	0.002124	0.003630	0.003630	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.005913	0.001577	0.002999	0.002999	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.003569	0.001136	0.001504	0.001504	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.004734	0.000845	0.001815	0.001815	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.002977	0.000729	0.001364	0.001364	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.002903	0.000559	0.000656	0.000656	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.017215	0.007291	0.006386	0.006386	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Harris County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.035445	0.047178	0.027418	0.027418	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.042013	0.057736	0.040492	0.040492	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.102145	0.052988	0.035349	0.035349	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.098830	0.078010	0.069539	0.069539	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.117470	0.082164	0.077581	0.077581	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.098789	0.076988	0.066823	0.066823	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.077021	0.071964	0.064280	0.064280	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.055649	0.062982	0.073246	0.073246	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.068660	0.060872	0.076613	0.076613	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.057818	0.061481	0.079337	0.079337	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.044703	0.058503	0.071480	0.071480	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.035425	0.057776	0.057650	0.057650	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.028273	0.046624	0.051219	0.051219	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.020850	0.039183	0.038065	0.038065	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.014449	0.031811	0.035592	0.035592	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.013490	0.024008	0.023130	0.023130	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.011238	0.021505	0.023112	0.023112	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.008924	0.015239	0.019319	0.019319	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.006484	0.011823	0.013504	0.013504	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.004962	0.009001	0.010016	0.010016	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.003419	0.006878	0.007798	0.007798	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.003482	0.005110	0.006732	0.006732	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.003336	0.003481	0.005890	0.005890	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.003607	0.002469	0.004190	0.004190	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.002877	0.001852	0.002588	0.002588	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.004253	0.001431	0.002746	0.002746	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.004024	0.001468	0.002465	0.002465	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.003440	0.001175	0.002283	0.002283	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.002648	0.000789	0.001410	0.001410	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.003982	0.000576	0.001734	0.001734	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.022289	0.006934	0.008398	0.008398	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Liberty County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.096386	0.042443	0.079282	0.079282	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.129853	0.073665	0.103321	0.103321	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.115127	0.087241	0.082888	0.082888	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.100402	0.078119	0.081063	0.081063	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.065596	0.070581	0.067530	0.067530	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.048193	0.065527	0.075231	0.075231	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.058902	0.059960	0.054220	0.054220	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.048193	0.067926	0.058894	0.058894	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.038822	0.055848	0.053953	0.053953	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.029451	0.056876	0.043269	0.043269	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.020080	0.047240	0.038105	0.038105	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.010710	0.049081	0.035256	0.035256	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.009371	0.042614	0.029870	0.029870	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.010710	0.040558	0.031116	0.031116	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.014726	0.030622	0.026309	0.026309	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.014726	0.025440	0.016248	0.016248	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.022758	0.021628	0.019275	0.019275	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.021419	0.020686	0.019053	0.019053	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.010710	0.015033	0.017673	0.017673	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.018742	0.009422	0.011574	0.011574	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.020080	0.006467	0.011619	0.011619	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.021419	0.004411	0.008859	0.008859	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.016064	0.003041	0.003962	0.003962	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.004016	0.005097	0.007434	0.007434	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.004016	0.004668	0.005253	0.005253	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.005355	0.002398	0.003828	0.003828	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.001893	0.001305	0.002325	0.002325	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.006311	0.001395	0.002582	0.002582	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.007573	0.001080	0.001763	0.001763	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.006311	0.000720	0.000819	0.000819	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.022088	0.008907	0.007424	0.007424	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Liberty County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.023510	0.031586	0.022295	0.022295	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.029524	0.046288	0.032190	0.032190	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.083652	0.045982	0.031827	0.031827	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.092947	0.079865	0.065471	0.065471	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.107709	0.080018	0.072378	0.072378	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.109896	0.074275	0.065269	0.065269	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.082559	0.070868	0.054768	0.054768	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.061236	0.056013	0.062038	0.062038	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.061782	0.054520	0.069147	0.069147	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.064516	0.052950	0.070883	0.070883	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.057408	0.057736	0.069712	0.069712	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.041006	0.056893	0.054606	0.054606	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.035539	0.051725	0.051133	0.051133	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.025150	0.042536	0.042974	0.042974	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.019683	0.038707	0.044428	0.044428	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.015309	0.030476	0.030373	0.030373	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.009841	0.028294	0.032635	0.032635	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.007654	0.021134	0.027546	0.027546	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.006014	0.017191	0.017812	0.017812	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.003827	0.013668	0.016156	0.016156	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.002734	0.011716	0.011753	0.011753	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.002734	0.008002	0.010663	0.010663	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.004921	0.006394	0.009088	0.009088	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.004374	0.005054	0.007634	0.007634	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.002187	0.002948	0.004241	0.004241	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.009841	0.002259	0.003918	0.003918	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.003827	0.002106	0.003958	0.003958	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.004374	0.001646	0.003110	0.003110	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.003827	0.000536	0.001494	0.001494	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.001640	0.000689	0.001535	0.001535	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.020776	0.007925	0.008966	0.008966	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Montgomery County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.100411	0.058798	0.088606	0.088606	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.145899	0.091847	0.120742	0.120742	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.126301	0.102367	0.099240	0.099240	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.098476	0.088076	0.093396	0.093396	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.072103	0.079640	0.071707	0.071707	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.049117	0.074316	0.073276	0.073276	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.049601	0.065947	0.054375	0.054375	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.042342	0.070309	0.059036	0.059036	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.035325	0.056640	0.052114	0.052114	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.027583	0.052346	0.043073	0.043073	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.015485	0.042947	0.034196	0.034196	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.012098	0.039221	0.030835	0.030835	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.015727	0.033928	0.026268	0.026268	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.014759	0.029263	0.023856	0.023856	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.010888	0.023000	0.019675	0.019675	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.014275	0.017373	0.013550	0.013550	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.020082	0.013995	0.015377	0.015377	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.019114	0.012844	0.014627	0.014627	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.016211	0.009557	0.014053	0.014053	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.016453	0.005915	0.007718	0.007718	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.018872	0.004264	0.008514	0.008514	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.013549	0.003135	0.006324	0.006324	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.012098	0.002507	0.002939	0.002939	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.011130	0.003181	0.005446	0.005446	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.006049	0.002810	0.004345	0.004345	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.005081	0.001772	0.003115	0.003115	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.004757	0.001184	0.001721	0.001721	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.004272	0.000897	0.001642	0.001642	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.003592	0.000791	0.001323	0.001323	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.002815	0.000654	0.000714	0.000714	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.015534	0.010477	0.008197	0.008197	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Montgomery County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.040452	0.047069	0.031806	0.031806	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.035805	0.066982	0.050435	0.050435	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.089468	0.060890	0.043266	0.043266	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.087281	0.093845	0.077591	0.077591	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.110787	0.092229	0.083330	0.083330	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.105047	0.083485	0.068758	0.068758	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.082088	0.074366	0.064179	0.064179	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.061771	0.066269	0.073435	0.073435	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.074708	0.060237	0.076143	0.076143	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.056669	0.058257	0.073597	0.073597	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.047103	0.052050	0.068659	0.068659	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.038539	0.049792	0.050687	0.050687	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.028972	0.040304	0.044102	0.044102	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.019679	0.032307	0.033524	0.033524	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.015853	0.025846	0.032391	0.032391	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.015306	0.018497	0.023396	0.023396	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.011935	0.017126	0.021777	0.021777	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.008746	0.012005	0.017801	0.017801	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.008200	0.009174	0.012323	0.012323	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.006013	0.007304	0.009139	0.009139	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.003462	0.005529	0.007088	0.007088	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.003371	0.004268	0.006494	0.006494	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.003644	0.003410	0.005325	0.005325	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.003735	0.002438	0.003562	0.003562	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.003098	0.001875	0.002276	0.002276	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.004191	0.001436	0.002546	0.002546	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.004282	0.001256	0.002393	0.002393	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.003735	0.001077	0.002357	0.002357	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.003735	0.000858	0.001520	0.001520	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.004191	0.000653	0.001250	0.001250	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.018130	0.009169	0.008851	0.008851	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Waller County 2002 Age Distributions Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.081505	0.041587	0.074618	0.074618	0.057086	0.044226	0.054177	0.027706	0.101906	0.102260	0.051473	0.039361	0.033087
1	0.115987	0.068359	0.098903	0.098903	0.067160	0.052030	0.063738	0.029896	0.137869	0.143115	0.060557	0.067005	0.059279
2	0.094044	0.086294	0.084508	0.084508	0.074487	0.057706	0.070691	0.043169	0.139706	0.123935	0.067163	0.084079	0.078329
3	0.090909	0.070612	0.085879	0.085879	0.076013	0.058889	0.072140	0.050515	0.117981	0.115521	0.068539	0.091826	0.078564
4	0.056426	0.071391	0.066882	0.066882	0.060030	0.072023	0.059327	0.039893	0.054890	0.055213	0.041990	0.066096	0.066623
5	0.062696	0.067233	0.071582	0.071582	0.050385	0.067887	0.057010	0.033484	0.081717	0.073413	0.066692	0.050839	0.052283
6	0.053292	0.061601	0.058167	0.058167	0.043430	0.065192	0.051257	0.073919	0.044630	0.040436	0.043052	0.048257	0.050489
7	0.053292	0.061428	0.061105	0.061105	0.058246	0.055131	0.067565	0.087457	0.062570	0.053893	0.052418	0.077861	0.070480
8	0.031348	0.055623	0.055817	0.055817	0.046777	0.050144	0.034008	0.056440	0.041229	0.037105	0.052131	0.050170	0.048179
9	0.043887	0.054757	0.045339	0.045339	0.040161	0.043380	0.042359	0.050280	0.034536	0.029449	0.037417	0.049692	0.046822
10	0.006270	0.045833	0.036428	0.036428	0.030868	0.039299	0.035652	0.022238	0.025730	0.021518	0.034250	0.038213	0.033984
11	0.018809	0.046959	0.033000	0.033000	0.036500	0.041479	0.047487	0.063049	0.021725	0.022132	0.026585	0.046726	0.041654
12	0.021944	0.046266	0.028692	0.028692	0.042298	0.062690	0.055385	0.055438	0.021122	0.020865	0.035957	0.047587	0.040577
13	0.025078	0.035609	0.027810	0.027810	0.043797	0.049789	0.032989	0.045171	0.016925	0.017194	0.048492	0.040891	0.033233
14	0.028213	0.036475	0.024089	0.024089	0.042540	0.040918	0.040951	0.063457	0.015937	0.015593	0.044900	0.032570	0.029600
15	0.015674	0.028331	0.018606	0.018606	0.045676	0.039103	0.042849	0.052492	0.010451	0.012053	0.045301	0.025348	0.027100
16	0.012539	0.020880	0.017235	0.017235	0.040017	0.034406	0.039061	0.067697	0.009848	0.016246	0.034884	0.020278	0.026394
17	0.031348	0.020447	0.016843	0.016843	0.036115	0.030509	0.034656	0.036794	0.009848	0.015724	0.038270	0.021952	0.029982
18	0.028213	0.017848	0.018410	0.018410	0.029365	0.024575	0.027654	0.039478	0.008449	0.011020	0.040114	0.019944	0.025329
19	0.018809	0.011090	0.011653	0.011653	0.011980	0.024091	0.010443	0.011694	0.004992	0.006199	0.026863	0.008417	0.011549
20	0.015674	0.007971	0.012241	0.012241	0.010437	0.013429	0.007905	0.013460	0.007105	0.010204	0.016211	0.012961	0.017771
21	0.012539	0.005372	0.009792	0.009792	0.009369	0.006026	0.009592	0.012328	0.006172	0.008081	0.009213	0.013248	0.018511
22	0.015674	0.005285	0.005092	0.005092	0.012480	0.016749	0.009645	0.003160	0.003566	0.005448	0.001241	0.010617	0.014015
23	0.015674	0.006585	0.007736	0.007736	0.007676	0.005071	0.008149	0.003332	0.004800	0.007735	0.009806	0.012052	0.017132
24	0.009404	0.003726	0.006365	0.006365	0.006146	0.002264	0.007108	0.003312	0.004142	0.005370	0.013354	0.007987	0.010966
25	0.006270	0.002253	0.004015	0.004015	0.006667	0.000458	0.007229	0.000000	0.002935	0.005128	0.018503	0.004591	0.007815
26	0.009512	0.002779	0.003055	0.003055	0.002553	0.000881	0.004887	0.006886	0.000953	0.003182	0.011604	0.001016	0.004190
27	0.005945	0.001902	0.002788	0.002788	0.003150	0.000601	0.006086	0.002022	0.001215	0.002707	0.003020	0.001656	0.003073
28	0.003567	0.001243	0.002874	0.002874	0.003099	0.000582	0.000000	0.005149	0.001045	0.002035	0.000000	0.001889	0.003322
29	0.002378	0.001170	0.001145	0.001145	0.002572	0.000150	0.000000	0.000084	0.000657	0.001589	0.000000	0.001389	0.002952
30	0.013080	0.013092	0.009332	0.009332	0.002922	0.000320	0.000000	0.000000	0.005346	0.015638	0.000000	0.005481	0.016715

Waller County 2011 Age Distribution Inputs to MOVES (2018 Analysis Year)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032184	0.023292	0.017334	0.017334	0.069073	0.061049	0.067376	0.028802	0.100184	0.104789	0.066877	0.022568	0.021517
1	0.031034	0.039236	0.032092	0.032092	0.063576	0.056190	0.062014	0.027620	0.051441	0.054592	0.061554	0.023917	0.018938
2	0.078161	0.041730	0.029125	0.029125	0.061072	0.053977	0.059571	0.027681	0.054203	0.051380	0.059130	0.035695	0.033960
3	0.072414	0.072239	0.061138	0.061138	0.067253	0.059440	0.065601	0.031074	0.152909	0.148094	0.065115	0.047339	0.047549
4	0.120690	0.071583	0.069415	0.069415	0.068818	0.060823	0.067127	0.032867	0.091936	0.091287	0.066630	0.108389	0.100800
5	0.101149	0.070009	0.063012	0.063012	0.068082	0.060172	0.066409	0.054654	0.098539	0.100234	0.065917	0.079662	0.075154
6	0.083908	0.068959	0.057469	0.057469	0.067348	0.059523	0.065693	0.048848	0.085962	0.091233	0.065206	0.068333	0.065321
7	0.058621	0.055902	0.071133	0.071133	0.052749	0.046621	0.051452	0.038516	0.059676	0.063794	0.051071	0.051025	0.044275
8	0.074713	0.054130	0.069806	0.069806	0.041523	0.036699	0.040503	0.028087	0.050670	0.051239	0.040203	0.042259	0.037609
9	0.050575	0.059051	0.073007	0.073007	0.035696	0.031549	0.034819	0.028027	0.043809	0.040653	0.034561	0.043562	0.037406
10	0.044828	0.059839	0.069962	0.069962	0.040316	0.035632	0.039325	0.029033	0.044015	0.042649	0.039034	0.056600	0.052107
11	0.042529	0.062594	0.050051	0.050051	0.042925	0.037938	0.041871	0.040246	0.038221	0.034783	0.041560	0.064916	0.064101
12	0.032184	0.054721	0.052393	0.052393	0.041615	0.036780	0.040592	0.044739	0.032016	0.031295	0.040292	0.057678	0.056536
13	0.025287	0.043435	0.042008	0.042008	0.031537	0.043166	0.032034	0.033904	0.013503	0.014618	0.023687	0.044327	0.046019
14	0.013793	0.038843	0.044741	0.044741	0.025659	0.039441	0.029841	0.027586	0.018346	0.016614	0.036470	0.036010	0.035234
15	0.016092	0.033134	0.031233	0.031233	0.021215	0.036330	0.025734	0.058414	0.011306	0.009689	0.022582	0.030435	0.032591
16	0.018391	0.031560	0.033497	0.033497	0.027572	0.029773	0.032872	0.066975	0.012102	0.010658	0.026644	0.040685	0.040969
17	0.009195	0.024014	0.026860	0.026860	0.021230	0.025963	0.015864	0.041439	0.007387	0.006977	0.025405	0.025310	0.026449
18	0.011494	0.020471	0.017569	0.017569	0.017475	0.021535	0.018944	0.035394	0.005165	0.005036	0.017483	0.022433	0.024074
19	0.004598	0.016141	0.016710	0.016710	0.012872	0.018696	0.015280	0.015002	0.004240	0.003477	0.015336	0.016634	0.017590
20	0.004598	0.012204	0.010541	0.010541	0.014586	0.018911	0.019505	0.040761	0.004278	0.003744	0.011408	0.016184	0.019591
21	0.005747	0.008792	0.009916	0.009916	0.016370	0.027679	0.022031	0.034709	0.004124	0.003655	0.014943	0.014431	0.017397
22	0.004598	0.007086	0.008745	0.008745	0.016236	0.021057	0.012570	0.027090	0.003726	0.003071	0.019303	0.012723	0.013278
23	0.006897	0.005118	0.007340	0.007340	0.015106	0.016577	0.014946	0.036454	0.002698	0.002499	0.017121	0.009710	0.010967
24	0.004598	0.004462	0.004919	0.004919	0.015702	0.015336	0.015140	0.029193	0.001747	0.001536	0.016722	0.007013	0.009105
25	0.008046	0.001968	0.004216	0.004216	0.013171	0.012919	0.013214	0.036047	0.001824	0.001835	0.012329	0.004046	0.008763
26	0.006897	0.002428	0.004216	0.004216	0.011504	0.011086	0.011346	0.018960	0.000951	0.001467	0.013089	0.003462	0.008281
27	0.004598	0.002493	0.003904	0.003904	0.009052	0.008642	0.008761	0.019687	0.000784	0.001153	0.013278	0.003731	0.006291
28	0.009195	0.001378	0.002342	0.002342	0.003572	0.008196	0.003201	0.005641	0.000450	0.000748	0.008601	0.001349	0.002814
29	0.004598	0.001115	0.002577	0.002577	0.003011	0.004420	0.002344	0.006282	0.000642	0.001073	0.005022	0.001708	0.004440
30	0.018391	0.012073	0.012727	0.012727	0.004084	0.003881	0.004023	0.006268	0.003148	0.006131	0.003427	0.007867	0.020875

Texas Statewide 2002 Fuel/Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1900	1989	1988	1987
PC	Gas	0.996	0.996	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
PC	Diesel	0.004	0.004	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
PT	Gas	0.987	0.987	0.977	0.977	0.990	0.981	0.980	0.985	0.982	0.979	0.979	0.980	0.987	0.992	0.995	0.990
PT	Diesel	0.013	0.013	0.023	0.023	0.010	0.019	0.020	0.015	0.018	0.021	0.021	0.020	0.013	0.008	0.005	0.010
PT	Gas	0.987	0.987	0.977	0.977	0.990	0.981	0.980	0.985	0.982	0.979	0.979	0.980	0.987	0.992	0.995	0.990
PT	Diesel	0.013	0.013	0.023	0.023	0.010	0.019	0.020	0.015	0.018	0.021	0.021	0.020	0.013	0.008	0.005	0.010
LCT	Gas	0.843	0.827	0.877	0.833	0.962	0.864	0.911	0.881	0.898	0.915	0.930	0.932	0.916	0.907	0.923	0.939
LCT	Diesel	0.157	0.173	0.123	0.167	0.038	0.136	0.089	0.119	0.102	0.085	0.070	0.068	0.084	0.093	0.077	0.061
LCT	Gas	0.843	0.827	0.877	0.833	0.962	0.864	0.911	0.881	0.898	0.915	0.930	0.932	0.916	0.907	0.923	0.939
LCT	Diesel	0.157	0.173	0.123	0.167	0.038	0.136	0.089	0.119	0.102	0.085	0.070	0.068	0.084	0.093	0.077	0.061
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	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.266
SBus	Diesel	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.734
RT	Gas	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
RT	Diesel	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960
SUShT	Gas	0.202	0.265	0.346	0.330	0.413	0.450	0.456	0.703	0.492	0.493	0.504	0.517	0.570	0.606	0.723	0.775
SUShT	Diesel	0.798	0.735	0.654	0.670	0.587	0.550	0.544	0.297	0.508	0.507	0.496	0.483	0.430	0.394	0.277	0.225
SULhT	Gas	0.202	0.265	0.346	0.330	0.413	0.450	0.456	0.703	0.492	0.493	0.504	0.517	0.570	0.606	0.723	0.775
SULhT	Diesel	0.798	0.735	0.654	0.670	0.587	0.550	0.544	0.297	0.508	0.507	0.496	0.483	0.430	0.394	0.277	0.225
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	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	0.150
CShT	Gas	0.062	0.102	0.094	0.100	0.131	0.202	0.156	0.403	0.125	0.135	0.213	0.175	0.159	0.155	0.199	0.207
CShT	Diesel	0.938	0.898	0.906	0.900	0.869	0.798	0.844	0.597	0.875	0.865	0.787	0.825	0.841	0.845	0.801	0.793
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 2002 Fuel/Engine Fractions Summary[1] (Continued)

SUT	Fuel Type	Model Year														
		1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
PC	Gas	1.000	0.988	0.981	0.969	0.939	0.924	0.953	0.969	0.985	0.987	0.983	0.982	0.993	0.993	0.993
PC	Diesel	0.000	0.012	0.019	0.031	0.061	0.076	0.047	0.031	0.015	0.013	0.017	0.018	0.007	0.007	0.007
PT	Gas	0.978	0.983	0.985	0.979	0.960	0.982	0.988	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
PT	Diesel	0.022	0.017	0.015	0.021	0.040	0.018	0.012	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
PT	Gas	0.978	0.983	0.985	0.979	0.960	0.982	0.988	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
PT	Diesel	0.022	0.017	0.015	0.021	0.040	0.018	0.012	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
LCT	Gas	0.919	0.900	0.852	0.795	0.780	0.929	0.893	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958
LCT	Diesel	0.081	0.100	0.148	0.205	0.220	0.071	0.107	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
LCT	Gas	0.919	0.900	0.852	0.795	0.780	0.929	0.893	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958
LCT	Diesel	0.081	0.100	0.148	0.205	0.220	0.071	0.107	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
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	0.327	0.485	0.615	0.676	0.674	0.736	0.941	0.954	0.971	0.976	0.991	0.991	0.991	0.991	0.991
SBus	Diesel	0.673	0.515	0.385	0.324	0.326	0.264	0.059	0.046	0.029	0.024	0.009	0.009	0.009	0.009	0.009
RT	Gas	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
RT	Diesel	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960
SUShT	Gas	0.775	0.814	0.791	0.806	0.839	0.932	0.968	0.969	0.984	0.977	0.969	0.993	0.987	0.994	0.999
SUShT	Diesel	0.225	0.186	0.209	0.194	0.161	0.068	0.032	0.031	0.016	0.023	0.031	0.007	0.013	0.006	0.001
SULhT	Gas	0.775	0.814	0.791	0.806	0.839	0.932	0.968	0.969	0.984	0.977	0.969	0.993	0.987	0.994	0.999
SULhT	Diesel	0.225	0.186	0.209	0.194	0.161	0.068	0.032	0.031	0.016	0.023	0.031	0.007	0.013	0.006	0.001
MH	Gas	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	0.850	0.850
MH	Diesel	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	0.150	0.150
CShT	Gas	0.254	0.277	0.282	0.351	0.348	0.311	0.590	0.647	0.640	0.697	0.734	0.614	0.577	0.802	0.894
CShT	Diesel	0.746	0.723	0.718	0.649	0.652	0.689	0.410	0.353	0.360	0.303	0.266	0.386	0.423	0.198	0.106
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[1]

SUT	Fuel Type	Model Year															
		2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1900	1989	1988	1987
PC	Gas	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
PC	Diesel	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
PT	Gas	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.987	0.987	0.987
PT	Diesel	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.013	0.013	0.013
PT	Gas	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.987	0.987	0.987
PT	Diesel	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.013	0.013	0.013
LCT	Gas	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.913	0.921	0.891	0.819	0.867
LCT	Diesel	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.087	0.079	0.109	0.181	0.133
LCT	Gas	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.913	0.921	0.891	0.819	0.867
LCT	Diesel	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.087	0.079	0.109	0.181	0.133
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	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
SBus	Diesel	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.958
RT	Gas	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
RT	Diesel	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960
SUShT	Gas	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250
SUShT	Diesel	0.789	0.789	0.789	0.789	0.789	0.789	0.789	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750
SULhT	Gas	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250
SULhT	Diesel	0.789	0.789	0.789	0.789	0.789	0.789	0.789	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750
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	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.071	0.047	0.053	0.026	0.059	0.048	0.050	0.050
CShT	Diesel	0.954	0.954	0.954	0.954	0.954	0.954	0.954	0.954	0.929	0.953	0.947	0.974	0.941	0.952	0.950	0.950
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[1] (Continued)

SUT	Fuel Type	Model Year														
		1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
PC	Gas	0.996	0.996	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
PC	Diesel	0.004	0.004	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
PT	Gas	0.987	0.987	0.977	0.977	0.990	0.981	0.980	0.985	0.982	0.979	0.979	0.980	0.987	0.992	0.995
PT	Diesel	0.013	0.013	0.023	0.023	0.010	0.019	0.020	0.015	0.018	0.021	0.021	0.020	0.013	0.008	0.005
PT	Gas	0.987	0.987	0.977	0.977	0.990	0.981	0.980	0.985	0.982	0.979	0.979	0.980	0.987	0.992	0.995
PT	Diesel	0.013	0.013	0.023	0.023	0.010	0.019	0.020	0.015	0.018	0.021	0.021	0.020	0.013	0.008	0.005
LCT	Gas	0.843	0.827	0.877	0.833	0.962	0.864	0.911	0.881	0.898	0.915	0.930	0.932	0.916	0.907	0.923
LCT	Diesel	0.157	0.173	0.123	0.167	0.038	0.136	0.089	0.119	0.102	0.085	0.070	0.068	0.084	0.093	0.077
LCT	Gas	0.843	0.827	0.877	0.833	0.962	0.864	0.911	0.881	0.898	0.915	0.930	0.932	0.916	0.907	0.923
LCT	Diesel	0.157	0.173	0.123	0.167	0.038	0.136	0.089	0.119	0.102	0.085	0.070	0.068	0.084	0.093	0.077
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	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250
SBus	Diesel	0.958	0.958	0.958	0.958	0.958	0.958	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750
RT	Gas	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
RT	Diesel	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960
SUShT	Gas	0.266	0.312	0.348	0.359	0.426	0.423	0.435	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658
SUShT	Diesel	0.734	0.688	0.652	0.641	0.574	0.577	0.565	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342
SULhT	Gas	0.266	0.312	0.348	0.359	0.426	0.423	0.435	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658
SULhT	Diesel	0.734	0.688	0.652	0.641	0.574	0.577	0.565	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342
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	0.078	0.077	0.083	0.102	0.131	0.152	0.146	0.306	0.112	0.123	0.164	0.161	0.153	0.124	0.170
CShT	Diesel	0.922	0.923	0.917	0.898	0.869	0.848	0.854	0.694	0.888	0.877	0.836	0.839	0.847	0.876	0.830
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 Available Upon Request

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