Missouri
Department of
Natural Resources

Technical Support Document for the Amendment to
10 CSR 10-5.220 *Control of Petroleum Liquid Storage, Loading and Transfer*
Removal of Stage II Vapor Recovery Requirements

I.   Background and Purpose.
Missouri rule 10 CSR 10-5.220, *Control of Petroleum Liquid Storage, Loading and Transfer* regulates the emissions of volatile organic compounds (VOCs) from the petroleum product storage and distribution network. This rule includes requirements for control of VOC emissions from motor vehicle refueling in the St. Louis area using Stage II vapor recovery systems. Stage II systems capture displaced vapors from vehicle fuel tanks during refueling and return the vapors to the underground storage tanks at the gasoline dispensing facility. The Stage II requirements of this rule were promulgated in the late 1980's and were incorporated into Missouri's State Implementation Plan (SIP) as part of the control strategies for the one-hour ozone National Ambient Air Quality Standard (NAAQS).

Onboard refueling vapor recover (ORVR) is a second method of controlling the vapor displaced during motor vehicle refueling. The displaced vapors are captured before they exit the vehicle fill pipe and are stored in activated carbon canisters onboard the vehicle. When the vehicle's engine is started, the vapors are purged from the activated carbon into the engine where they are burned as fuel.

Automobile manufacturers began installing ORVR systems on new passenger vehicles in 1998. Currently, more than 75% of gasoline refueling nationwide occurs with ORVR-equipped vehicles, so Stage II programs have become largely redundant control systems and Stage II vapor recovery systems achieve an ever-declining emissions benefit as ORVR-equipped vehicles continue to enter the motor vehicle fleet.

In its final rule published in the May 16, 2012, *Federal Register* (77 FR 28772), the U.S. Environmental Protection Agency (EPA) has determined that ORVR technology is in widespread use throughout the motor vehicle fleet for purposes of controlling motor vehicle refueling emissions. This federal rule allows states to remove Stage II programs from their SIP if certain criteria are met.

Because the Stage II controls in 10 CSR 10-5.220 are part of Missouri's approved SIP, if the state decides to terminate the Stage II program, it must submit a SIP revision to EPA that includes the appropriate revisions to the Stage II regulations and an analysis of the emissions impact of eliminating the Stage II controls. This Technical Support Document (TSD) serves as the analysis of the emissions impact of eliminating Stage II requirements from the St. Louis area. It demonstrates that removal of State II controls will not

adversely affect the air quality in the St. Louis area and satisfies all Clean Air Act (CAA) requirements for removal of control measures from a SIP.

II.   Anti-Backsliding Requirements.
Section 110(l) of the CAA prohibits revision of a SIP that would interfere with attainment of a NAAQS, reasonable further progress toward attainment of a NAAQS, or any other applicable requirement of the CAA.

Furthermore, section 193 of the CAA prohibits modification of any control requirement in effect before November 15, 1990 in a current nonattainment area, unless the modification insures equivalent or greater emissions reductions.

The Stage II vapor recovery program in St. Louis was established in 1987, therefore the requirements of CAA sections 110(l) and 193 must be satisfied before removing Stage II controls in the St. Louis area.

III.   Demonstration.

   A.   EPA Guidance.
   On August 7, 2012, EPA released guidance for states that wish to remove Stage II requirements from their SIP titled *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, herein referred to as "the EPA guidance." This guidance presents the methodology and information needed for a state to conduct an emissions inventory analysis related to phasing out an existing Stage II program.

   To comply with CAA section 193 requirements, the EPA guidance recommends comparing the net Stage II efficiency to the net ORVR efficiency and presents an equation to calculate the difference between the two efficiencies.

   To comply with CAA section 110(l) requirements, the EPA guidance recommends computing the incremental emission control from Stage II installations as ORVR technology is phased into the motor vehicle fleet. This incremental emission control is calculated using an equation presented in the EPA guidance.

   The EPA guidance also presents a method to quantify the impact on the area-wide VOC emissions inventory from the incremental emissions that result from the removal of Stage II vapor recovery systems.

   B.   Input Parameters for the Equations in EPA's Guidance Document.
   The equations in the EPA guidance require appropriate area-specific values for the penetration of the ORVR in the motor vehicle fleet; in-use efficiencies of ORVR and Stage II systems; the proportion of gasoline dispensed by facilities equipped with Stage II controls; the projected gasoline consumption for the area

and time periods of interest; and the uncontrolled displacement refueling emission factor.

The values of the individual parameters for the St. Louis area are:

1.   **Penetration of ORVR in the Motor Vehicle Fleet, Q_{ORVR}.**
       Q_{ORVR} represents the proportion of annual gallons of highway motor gasoline dispensed to ORVR-equipped vehicles.

       Table A-1 of the EPA guidance, replicated in Appendix A, shows nationwide values for the percentage of ORVR-equipped vehicles (Column 2), the percentage of vehicle miles traveled by ORVR-equipped vehicles (Column 3), and the percentage of gasoline dispensed into ORVR-equipped vehicles (Column 4). As stated in section 3.3.3 of the EPA guidance, the nationwide values in Table A-1 may be adjusted to obtain area-specific values by comparing the area-specific fleet age to the national fleet age.

       A comparison of the age distribution of the St. Louis area's gasoline motor vehicle fleet, presented in Appendix B, to that of the national gasoline motor vehicle fleet, presented in Appendix C, shows them to be almost identical. The average age of passenger cars in the St. Louis fleet is just 0.1 years older than the national fleet. The average age of tier 1 light-duty trucks (gross vehicle weight rating less than 6,000 pounds) is 1.1 years newer in St. Louis than the national fleet. The average age of tier 2 light-duty trucks (gross vehicle weight rating between 6,000 pounds and 8500 pounds) is 1.4 years newer in St. Louis than the national fleet. The average age of heavy-duty vehicles in St. Louis is 0.2 years older than the nation, but this slight difference is more than offset by the newer age of light-duty trucks, since light-duty trucks are more than thirteen times more numerous than heavy-duty vehicles in the St. Louis fleet. The difference in the average age for motorcycles is irrelevant, since motorcycles are not required to have ORVR systems.

       Given the similarity in the age distributions of the St. Louis fleet and the nationwide fleet, the percentage of gasoline dispensed into ORVR-equipped vehicles for the national fleet presented in Table A-1 of the EPA guidance would be a conservative indicator of the percentage of gasoline dispensed into ORVR-equipped vehicles for the St. Louis fleet.

2.   **In-use control efficiency of ORVR, η_{ORVR}.**
       η_{ORVR} represents the in-use control efficiency of ORVR systems. Section 3.3.3 of the EPA guidance recommends using 98% for this control efficiency.

3.   **In-use control efficiency of Stage II vapor recovery systems, η_{iuSII}.**

η_{iuSII} represents the in-use control efficiency of Stage II vapor recovery systems. Section 3.3.3 of the EPA guidance recommends using a value consistent with field test data and advises against relying on prior EPA guidance, new system certification efficiency, or state regulation claims regarding efficiency. Since Missouri's inspection of Stage II-equipped installations does not include calculation of in-use efficiency, other test data must be used to establish the control efficiency.

In May 2000, the San Diego Air Pollution Control District released their report titled *Performance of Balance Vapor Recovery Systems at Gasoline Dispensing Facilities*. They studied balance vapor recovery systems in four air districts in California and used field tests and engineering calculations to estimate the in-use efficiency. Their report concluded that "American vacuum assist and balance vapor recovery systems averaged about 75% overall, with balance systems having the worst performance with efficiencies ranging from 63 to 68%." All Stage II vapor recovery systems in St. Louis are of the balance type and their in-use control efficiency is assumed to be 65%, which is approximately the middle of the range reported by the San Diego Air Pollution Control District.

4.   **Proportion of gasoline throughput covered by Stage II vapor recovery systems, Q_{SII}.**
     Q_{SII} represents the proportion of gasoline throughput dispensed by gasoline distribution facilities with Stage II vapor recovery systems. Section 3.3.3 of the EPA guidance recommends using the threshold for Stage II applicability to determine this proportion. The default values are 90% for states adopting the CAA exemption provisions and 95% to 97% for states that used a throughput of 10,000 gallons per month for all gasoline dispensing facilities.

     Paragraph (1)(C)4. of Missouri rule 10 CSR 10-5.220 *Control of Petroleum Liquid Storage, Loading and Transfer* sets 10,000 gallons per month as the applicability threshold for the Stage II vapor recovery requirements at gasoline dispensing facilities in the St. Louis area. Therefore, per section 3.3.3 of the EPA guidance, the recommended proportion of gasoline throughput dispensed by facilities with Stage II vapor recovery systems is assumed to be 96%, which is the middle of the range presented in the EPA guidance.

5.   **Projected gasoline consumption for the area and time periods of interest, GC.**
     GC represents the projected ozone season gasoline consumption for the St. Louis area for the years analyzed in this demonstration. Section 3.5.1 of the EPA guidance suggests using the Federal Highway Administration (FHA) to establish the baseline consumption for 2010 and then applying a

nationwide growth factor derived from the U.S. Department of Energy (DOE) in their national annual forecast of future gasoline consumption.

Table 1 summarizes the calculations for the projected St. Louis ozone-season gasoline consumption through 2020.

	Motor Gasoline (million barrels per day) [1]	Calculated Growth Factor	Ozone Season Nationwide Gasoline Comsumption (gallons)	GC, Ozone Season St. Louis Gasoline Consumption (gallons)
Year				
2010	9.02	---	82,697,384,000 [2]	642,062,489 [3]
2011	9.09	0.0078	83,339,159,707	647,045,236
2012	9.33	0.0264	85,539,533,561	664,128,939
2013	9.38	0.0054	85,997,944,780	667,688,043
2014	9.39	0.0011	86,089,627,024	668,399,864
2015	9.40	0.0011	86,181,309,268	669,111,685
2016	9.42	0.0021	86,364,673,756	670,535,327
2017	9.36	-0.0064	85,814,580,293	666,264,401
2018	9.29	-0.0075	85,172,804,585	661,281,655
2019	9.24	-0.0054	84,714,393,366	657,722,550
2020	9.19	-0.0054	84,255,982,146	654,163,445

Table 1
GC, Projected Ozone Season Gasoline Consumption for St. Louis

[1] U.S. Department of Energy's National Annual Forecasts of gasoline consumption. Projected consumption of Motor Gasoline for 2010 through 2020.
http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=11-AEO2011&region=0-0&cases=ref2011-d020911a

[2] National Highway Administration. Total national gasoline consumption for April through October of 2010.
http://www.fhwa.dot.gov/policyinformation/statistics/2010/33ga.cfm

[3] Gasoline consumption for St. Louis is 0.7764% of gasoline consumption for the 50 States, per Table A-4 of the EPA guidance.

Using the monthly nationwide gasoline consumption data for 2010 from the FHA report and adding the consumption for the months of April through October gives the 2010 nationwide gasoline consumption for Missouri's ozone season. The DOE report was used to calculate an annual growth factor for the national gasoline consumption for 2011 through 2020 by subtracting the previous year's consumption from the current year's consumption and dividing that difference by the previous year's consumption. The growth factor is then applied to the ozone-season national gasoline consumption to project the consumption for 2011

through 2020. As stated in Table A-4 of the EPA guidance, the Missouri portion of the St. Louis ozone nonattainment area accounts for 0.7764% of the nationwide gasoline consumption, which allows the St. Louis ozone-season gasoline consumption to be separated from the nationwide gasoline consumption.

6.   Uncontrolled Displacement Refueling Emission Factor, EF.
EF represents the uncontrolled displacement refueling emission factor. This emission factor depends on the Reid vapor pressure (RVP) of the fuel, the dispensed fuel temperature, and the difference between the tank fuel temperature and the dispensed fuel temperature.

The St. Louis ozone nonattainment area uses federally-controlled Reformulated Gasoline (RFG) throughout the year. This gasoline must meet specific formulation requirements that are designed to reduce VOC emissions and RFG fuel is not required to meet a specific RVP. The RVP for motor vehicle gasoline sold during the months of May through September in the Missouri portion of the St. Louis ozone nonattainment area is assumed to be 7.0 pounds per square inch (psi) as shown in Table A-7 of the EPA guidance, which is reproduced in Appendix D. Table A-7 does not include October, which is the final month of Missouri's ozone season. The RVP for October is also assumed to be 7.0 psi, which is a conservative estimate.

T_d is the dispensed fuel temperature and is presented in Table A-2 of the EPA Guidance, which is reproduced in Appendix E. The mean temperature for the ozone-season months in Missouri (April through October) is 73.57 ℉.

ΔT is the difference between the tank fuel temperature and the dispensed fuel temperature. This value is found in Table A-3 of the EPA guidance, which is reproduced in Appendix F. For April through September, the temperature difference is 11.7 ℉. For October, the temperature difference is -2.4 ℉. The weighted average temperature difference for Missouri's ozone season is 9.69 ℉.

The equation to calculate EF using the above parameters is presented in section 3.5.1 of the EPA guidance:

$$\text{EF(grams/gallon)} = e^{[-1.2798 - 0.0049(\Delta T) + 0.0203(T_d) + 0.1315(RVP)]}$$

Using the above values for RVP, T_d, and ΔT, the uncontrolled displacement refueling emission factor, EF, for the St. Louis ozone season is 2.965 grams of VOC per gallon of fuel dispensed.

C.   Section 193 Demonstration.

CAA section 193 requirements may be met by comparing the Stage II control efficiency to the ORVR control efficiency and demonstrating that the ORVR control program provides greater emission reduction benefits than the Stage II control program alone.   Section 3.3.2 of the EPA guidance recommends using the following equation to compare the two (2) emission reduction benefits:

$$\text{Delta}_i = (Q_{SII})(\eta_{iuSII}) - (Q_{SIIva})(CF_i) - (Q_{ORVRi})(\eta_{ORVR})$$

Where:
- Delta_i is the comparison between the Stage II efficiency and the ORVR efficiency for year i;
- Q_{SII} is the fraction of gasoline throughput covered by Stage II vapor recovery systems;
- η_{iuSII} is the in-use Stage II control efficiency;
- Q_{SIIva} is the fraction of gasoline throughput covered by traditional vacuum assist Stage II vapor recovery systems;
- CF_i is the compatibility factor for the increase in underground storage tank emissions over the normal breathing/emptying loss emissions when using vacuum assist Stage II vapor recovery systems for year i;
- Q_{ORVRi} is the fraction of annual gallons of highway motor gasoline dispensed to ORVR-equipped vehicles for year i; and
- η_{ORVR} is the ORVR in-use efficiency.

Since none of the Stage II systems in St. Louis are vacuum assist, Q_{SIIva} is zero and the product of Q_{SIIva} and CF_i is zero. Therefore, the equation can be simplified to:

$$\text{Delta}_i = (Q_{SII})(\eta_{iuSII}) - (Q_{ORVRi})(\eta_{ORVR})$$

Table 2 shows the calculated Delta for 2012 through 2020 using the parameter values in section III.B. of this TSD.

Table 2						
Comparison of ORVR and Stage II Control Efficiencies						
					Delta	
End of:	Q_{SII}	η_{iuSII}	Q_{ORVR}	η_{ORVR}	(decimal)	(%)
2012	0.960	0.65	0.777	0.98	-0.137	-13.7%
2013	0.960	0.65	0.810	0.98	-0.17	-17.0%
2014	0.960	0.65	0.840	0.98	-0.20	-19.9%
2015	0.960	0.65	0.865	0.98	-0.22	-22.4%
2016	0.960	0.65	0.886	0.98	-0.24	-24.4%
2017	0.960	0.65	0.903	0.98	-0.26	-26.1%
2018	0.960	0.65	0.919	0.98	-0.28	-27.7%
2019	0.960	0.65	0.932	0.98	-0.29	-28.9%
2020	0.960	0.65	0.943	0.98	-0.30	-30.0%

Negative Delta values indicate that ORVR has greater control efficiency than Stage II systems. Specifically for the years examined, ORVR provides between 13.7% and 30.0% greater emission reduction benefits than Stage II control systems. This additional emission reduction benefit for all future years satisfies the requirements of CAA section 193 for "equivalent or greater emissions reductions."

D.   Section 110(l) Demonstration.

CAA section 110(l) requirements may be met by calculating the incremental emission control from Stage II systems as ORVR technology is phased in, and demonstrating that any incremental emissions from the removal of Stage II systems will not interfere with attainment, or progress toward attainment, of any air quality standard. Section 3.3.1 of the EPA guidance recommends calculating the incremental emission control for Stage II systems using the following equation:

$$\text{Increment}_i = (Q_{SII})(1\text{-}Q_{ORVRi})(\eta_{iuSII}) - (Q_{SIIva})(CF_i)$$

Where:
- Increment_i is the incremental emission control for Stage II systems for year i;
- Q_{SII} is the fraction of gasoline throughput covered by Stage II vapor recovery systems;
- Q_{ORVRi} is the fraction of annual gallons of highway motor gasoline dispensed to ORVR-equipped vehicles for year i;
- η_{iuSII} is the in-use Stage II control efficiency;
- Q_{SIIva} is the fraction of gasoline throughput covered by traditional vacuum assist Stage II vapor recovery systems; and
- CF_i is the compatibility factor for the increase in underground storage tank emissions over the normal breathing/emptying loss emissions when using vacuum assist Stage II vapor recovery systems for year i.

Since none of the Stage II systems in the St. Louis area are vacuum assist, Q_{SIIva} is zero (0) and the product of Q_{SIIva} and CF_i is zero (0). Therefore, the equation can be simplified to:

$$\text{Increment}_i = (Q_{SII})(1\text{-}Q_{ORVRi})(\eta_{iuSII})$$

Table 3 shows the calculated Increment for 2012 through 2020 using the parameter values in section III.B. of this TSD.

Table 3 Incremental Emissions Control for Stage II				
End of:	Q_{SII}	Q_{ORVR}	η_{iuSII}	Increment (decimal)	(%)
2012	0.960	0.777	0.65	0.139	13.9%
2013	0.960	0.810	0.65	0.119	11.9%
2014	0.960	0.840	0.65	0.100	10.0%
2015	0.960	0.865	0.65	0.084	8.4%
2016	0.960	0.886	0.65	0.071	7.1%
2017	0.960	0.903	0.65	0.061	6.1%
2018	0.960	0.919	0.65	0.051	5.1%
2019	0.960	0.932	0.65	0.042	4.2%
2020	0.960	0.943	0.65	0.036	3.6%

The increment shows that the additional emissions control for Stage II over
ORVR diminishes over time as ORVR becomes more prevalent in the motor
vehicle fleet. The incremental emissions would approach zero as the percentage
of ORVR-equipped vehicles approaches 100%.

To quantify the effects of this incremental emission control for Stage II, the
additional VOC emissions from the removal of Stage II may be calculated using
the equation presented in section 3.5 of the EPA guidance:

$$\text{Tons}_i = (\text{Increment}_i)(GC_i)(EF)$$

Where:
- Tons_i is the overall effect of removing Stage II (tons) for year i;
- Increment_i is the incremental emissions gain from removal of
  Stage II systems for year i;
- GC_i is the projected gasoline consumption (gallons) for year i; and
- EF is the uncontrolled displacement refueling emission factor
  (grams/gallon).

Table 4 shows the calculated tons of VOC emissions per ozone-season day using
the parameter values from section III.B. of this TSD.

				VOC Emissions	
End of	Increment from Table 3 (decimal)	GC St. Louis Ozone Season from Table 1 (gallons)	EF (grams/ gallon)	(tons/ozone season)	(tons/ozone season day)
2012	0.139	664,128,939		302.0	1.4
2013	0.119	667,688,043		258.7	1.2
2014	0.100	668,399,864		218.1	1.0
2015	0.084	669,111,685		184.2	0.9
2016	0.071	670,535,327	2.965	155.9	0.7
2017	0.061	666,264,401		131.8	0.6
2018	0.051	661,281,655		109.2	0.5
2019	0.042	657,722,550		91.2	0.4
2020	0.036	654,163,445		76.0	0.4

Table 4 — St. Louis Incremental VOC Emissions per Ozone Season Day

The VOC emissions calculations include appropriate conversion factors for grams to pounds and pounds to tons. The ozone season in Missouri runs from April 1 through October 31, which is 214 days.

As Table 4 illustrates, removal of Stage II vapor recovery systems in the St. Louis area will result in minimal short-term increases in VOC emissions that rapidly diminish over time. As section 2.2 of the EPA guidance states, these short-term small emission increases may be consistent with the requirements of CAA section 110(l). A phase-out plan that would result in very small foregone emissions reductions in the near-term that continue to diminish rapidly over time as ORVR phase-in continues may result in temporary increases that are too small to interfere with attainment or progress toward attainment of a NAAQS.

To demonstrate noninterference of these short-term increases with progress of the St. Louis area toward attainment of the ozone NAAQS, the increases in VOC emissions from phase-out of Stage II will be compared to the mobile VOC emissions in the St. Louis area. This demonstration shows that the short term increases from the removal of Stage II are much smaller than the decreases in mobile source emissions and, therefore, do not affect the overall downward trend in mobile source VOC emissions.

The on-road vehicle VOC emissions for 2008 were estimated for a previous rulemaking using EPA's Motor Vehicle Emission Simulator (MOVES) 2010a. The on-road mobile source emissions for 2015, 2017, and 2022 were calculated using MOVES 2010b and applying a 1.5% annual growth factor to the 2008 vehicle miles traveled and source type population data. The 2011 mobile emissions were calculated for the purposes of the 2011 National Emissions Inventory using MOVES 2010b. The years 2008, 2011, 2015, 2017, and 2022 were chosen because these years are currently being studied by the Missouri Department of Natural Resources' Air Quality Planning Section for various other SIP actions and the use of these years reduced the modeling resources required for

this demonstration. Version 2010b of MOVES is an update to version 2010a that increases the software's functionality without significantly affecting the modeled emissions of criteria pollutants. EPA considers versions 2010a and 2010b to be the same model for SIP development purposes. Additional details regarding the development of the on-road mobile source VOC emissions inventories used in this demonstration can be found in Appendix G.

The nonroad vehicle emissions were projected for the same years using the NONROAD2008a model and do not include the aircraft, commercial marine vessel, and railroad locomotive source categories. Additional details regarding the development of the nonroad mobile source VOC emissions inventories used in this demonstration can be found in Appendix H.

The modeled mobile VOC emissions are shown in Table 5.

Table 5 Modeled Mobile VOC Emissions			
Year	Onroad (tons per ozone season day)	Non-road (tons per ozone season day)	Total Mobile (tons per ozone season day)
2008	60.9	44.1	105.0
2011	36.2	38.0	74.2
2015	32.7	29.5	62.2
2017	27.5	27.8	55.2
2022	20.9	26.7	47.6

Federal and state mobile source regulations have resulted in significant VOC emission reductions over the 2008-2022 time period covered by this analysis. In particular, the federal Tier 2 tailpipe emission standards, which apply to all passenger cars and light trucks starting in 2004, have generated substantial VOC reductions as the overall fleet turns over to these newer, cleaner vehicles. State measures include cleaner-burning reformulated gasoline and the Gateway Vehicle Inspection Program, which ensures vehicle emission control systems function properly.

To facilitate discussion of the mobile source VOC emissions for any year of interest in this demonstration, a cubic regression curve was fit to the modeled emissions in Table 5. The regression equation is:

$$y = -0.0457x^3 + 276.41x^2 - 557629x + 374991576$$

where y is the predicted mobile source VOC emissions for year x. The values for the coefficients and constant are rounded for convenience. The coefficient of determination for the regression is 0.995, indicating a very close agreement between actual and predicted values. A review of the residuals (the difference between the observed and predicted values) shows them to be randomly distributed with a sum that is close to zero, which indicates that a cubic regression

is appropriate for the data. The domain of the regression equation is [2008, 2022], meaning the regression equation is only valid for the years 2008 through 2022 and predictions should only be made in this timeframe.

Figure 1 shows the modeled mobile emissions from Table 5 and the cubic regression curve.

Figure 1

Mobile VOC Emissions (tons per ozone season day)

$$y = -0.0457x^3 + 276.41x^2 - 557629x + 4E+08$$
$$R^2 = 0.9946$$
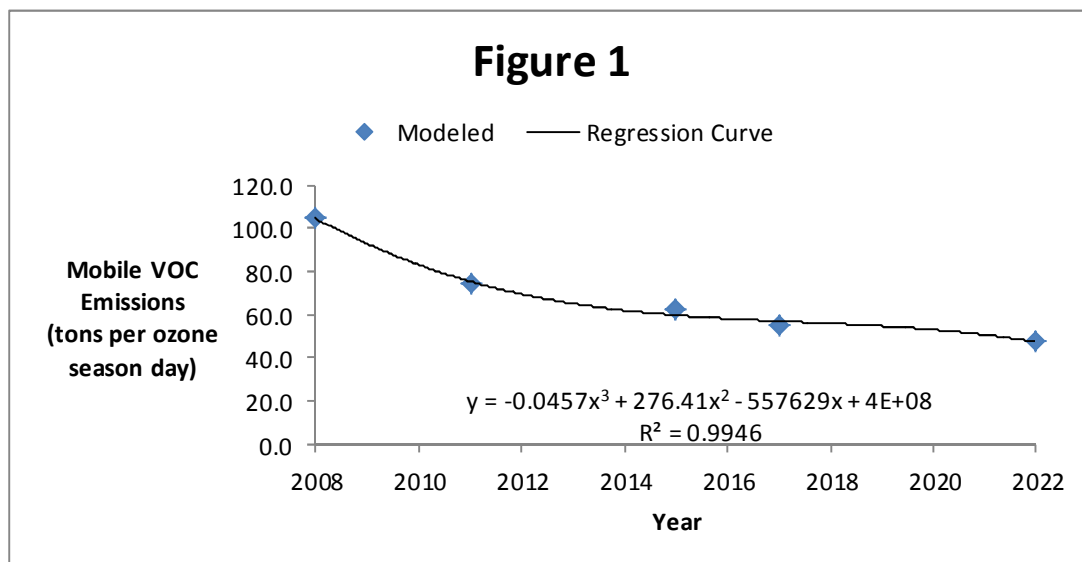
Table 6 shows the predicted mobile VOC emissions for all years of interest in this demonstration using the regression equation with unrounded values for the coefficients and constant. These predicted values will allow interpolation of mobile VOC emissions for years included in this demonstration but not actually modeled. Following proper statistical practices, all predictions are made within the bounds of the observed (modeled) values used to establish the regression equation.

Table 6	
Predicted Mobile VOC Emissions	
Year	Total Mobile (tons per ozone season day)
2012	69.5
2013	65.1
2014	62.0
2015	59.8
2016	58.2
2017	57.0
2018	56.0
2019	54.8
2020	53.1

Figure 2 shows the modeled mobile source VOC emissions, the regression curve, and the predicted mobile source VOC emissions.

Figure 2
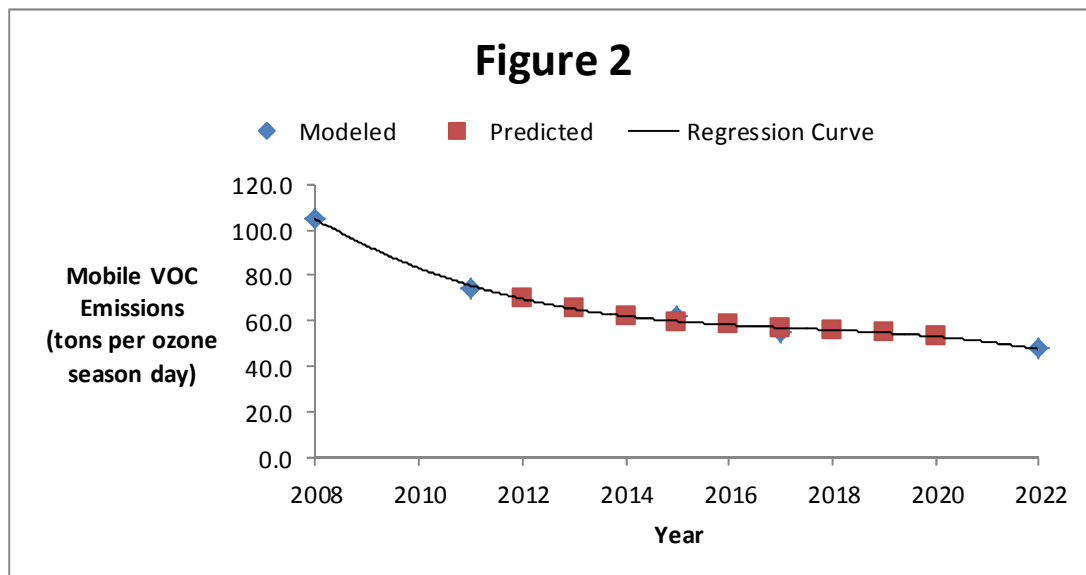
Table 7 shows the predicted mobile source VOC emissions using the regression equation, the yearly decrease in those emissions, the incremental emissions increase from the removal of Stage II controls, and the overall mobile emissions combined with the incremental increased emissions from Stage II removal. In keeping with proper statistical practices, the predicted mobile source emissions from the regression curve are used for 2015 and 2017 to avoid mixing predicted and observed values in the same analysis.

Table 7				
Impact of Removal of Stage II Controls on Mobile VOC Emissions				
Year	Mobile Projected VOC Emissions from Table 6 (tons per ozone season day)	Mobile Projected VOC Emissions Yearly Decrease (tons per ozone season day)	Incremental VOC Emissions Increase from Removal of Stage II from Table 4 (tons per ozone season day)	Mobile Projected VOC Emissions + Incremental VOC Emissions from Removal of Stage II (tons per ozone season day)
2012	69.5		1.4	70.9
2013	65.1	4.4	1.2	66.4
2014	62.0	3.2	1.0	63.0
2015	59.8	2.2	0.9	60.6
2016	58.2	1.6	0.7	58.9
2017	57.0	1.2	0.6	57.6
2018	56.0	1.1	0.5	56.5
2019	54.8	1.2	0.4	55.2
2020	53.1	1.7	0.4	53.5

Figure 3 shows the trend in mobile VOC emissions independent of the removal of Stage II controls (blue curve) and the trend in mobile emissions with the incremental emissions from the removal of Stage II controls included (red curve).

Figure 3
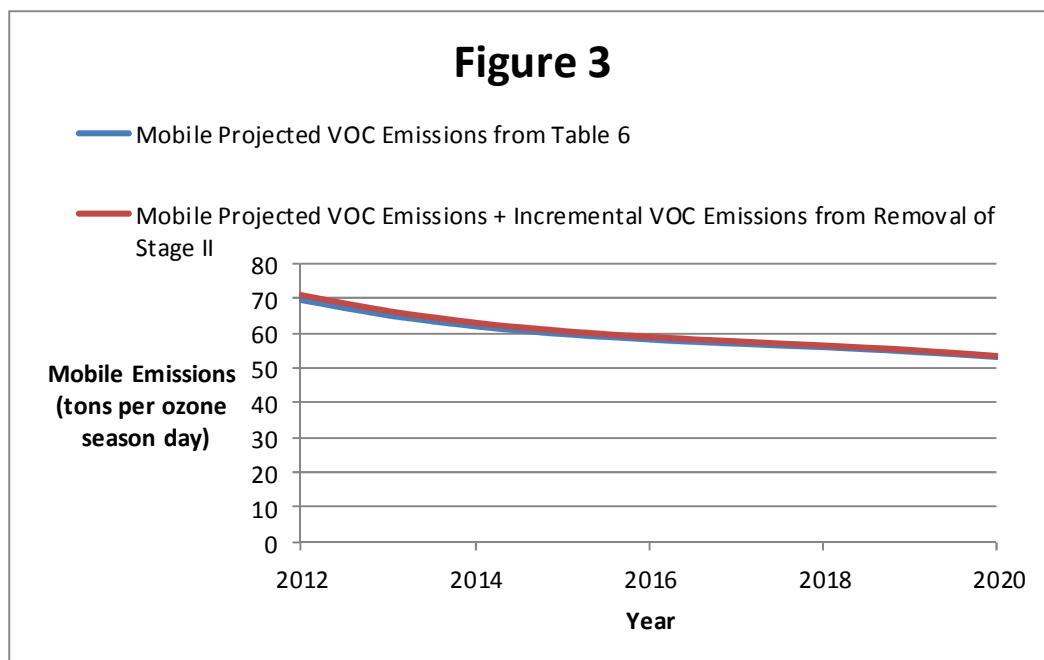
An analysis of the trend and decrement of the predicted mobile source emissions shows noninterference with progress of the St. Louis area toward attainment of the ozone NAAQS in two ways.

First, the yearly decrease in VOC emissions from mobile sources is always greater than the short-term increase in VOC emissions due to removal of Stage II controls. This is evidenced in Table 7 by a comparison between the column depicting the projected yearly decrease in mobile VOC emissions and the column depicting the incremental VOC emissions increase from removal of Stage II.

Second, the change in the overall downward trend in future VOC emissions from mobile sources is undetectable when the incremental emissions from the removal of Stage II controls are included.

E.   **Projected Mobile VOC Emissions in Federally-Approved SIP.**
The most-recent federally-approved ozone SIP is the Redesignation Demonstration and Maintenance Plan for the Missouri Portion of the St. Louis Ozone Nonattainment Area. This SIP revision, approved by EPA in May 2003 (68 FR 25418), projected mobile VOC emissions for 2000, 2004, and 2014 as shown in Table 8.

Table 8 Federally-Approved SIP Mobile VOC Emissions			
Year	Onroad (tons per ozone season day)	Non-road (tons per ozone season day)	Total Mobile (tons per ozone season day)
2000	103.79	38.58	142.37
2007	74.46	25.65	100.11
2014	47.14	21.79	68.93

To maintain consistency with the projected non-road emissions in section III.D. of this TSD, the non-road emissions in Table 8 do not include the aircraft, commercial marine vessel, and railroad locomotive source categories.

The timeframe in the SIP overlaps the timeframe in this TSD in years 2013 and 2014. Using interpolation to obtain the 2013 emissions in the SIP, a comparison of the mobile VOC emissions is shown in Table 9.

Table 9 Comparison of Mobile VOC Emissions			
Year	Federally-approved SIP (tons per ozone season day)	TSD [5] (tons per ozone season day)	Surplus (tons per ozone season day)
2013	73.38 [4]	65.1	8.3
2014	68.93	62.0	6.9

[4] Interpolating between 2007 and 2014, the mobile VOC emissions in the SIP would be 73.38 tons per ozone season day.
[5] Predicted values from Table 7.

As Table 9 shows, the projected mobile VOC emissions in this TSD for 2013 and 2014 are smaller than the emissions for the same years in the federally-approved SIP. This surplus is more than the incremental emissions from removal of Stage II, shown in Table 4, and provides further evidence, beyond that presented in section III.D., that removal Stage II controls in the St. Louis area will not interfere with attainment or progress toward attainment of an air quality standard. Furthermore, mobile source VOC reductions would not be needed to offset the small incremental increases in future SIPs for the St. Louis area, as there is more than enough surplus reduction to justify removal of Stage II controls.

IV.   Conclusion.

As shown in section III.C. of this TSD, the emissions reduction benefits from ORVR systems in the motor vehicle fleet are greater than the emissions reduction benefits from Stage II vapor recovery systems for all years of interest in this demonstration. Therefore, the requirements of section 193 of the CAA are satisfied for any year analyzed in the demonstration.

Section III.D. of this TSD shows the negligible impact of the small, short-term VOC emissions increases from Stage II removal on the overall progress of the St. Louis area toward attainment of the ozone NAAQS. All short-term emissions increases from the removal of Stage II requirements are smaller than the reductions in mobile source emissions for the years of interest in the demonstration. In addition, the downward trend of the mobile source VOC emissions is essentially unchanged if the incremental emissions from the removal of Stage II controls are included. Therefore, the requirements of section 110(l) of the CAA are satisfied for any year analyzed in the demonstration.

In conclusion, this Technical Support Document analyzed the impact on air quality in the St. Louis area by the removal Stage II vapor recovery systems. The analysis was conducted in accordance with EPA guidance and covers the years 2012 through 2020. All calculations in the TSD were made using parameter values that are nominal or conservative.

The analysis demonstrates that removal of Stage II controls may begin as early as 2013 without negatively impacting the St. Louis air quality or violating the Clean Air Act prohibition on backsliding. The Stage II equipment phase-out date depends on many factors that have yet to be determined (e.g., testing, permitting, and other logistical and practical issues). The Air Program will continue to work with the EPA, regulated industry, and other stakeholders to establish a reasonable phase-out date and process.

APPENDIX A

Table A-1 - Projected Penetration of ORVR in the National Gasoline Fueled Vehicle Fleet by Year
[Based on MOVES 2010(a)]

1	2	3	4
End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
2006	42.6%	51.2%	49.2%
2007	48.4%	57.3%	55.5%
2008	53.3%	62.3%	60.5%
2009	57.7%	66.8%	64.8%
2010	62.4%	71.6%	69.5%
2011	67.1%	76.0%	73.9%
2012	71.4%	80.0%	77.7%
2013	75.3%	83.4%	81.0%
2014	78.7%	86.3%	84.0%
2015	81.8%	88.8%	86.5%
2016	84.5%	90.9%	88.6%
2017	86.8%	92.5%	90.3%
2018	88.8%	93.9%	91.9%
2019	90.5%	95.0%	93.2%
2020	92.0%	95.9%	94.3%

See EPA Memorandum "Updated data for ORVR Widespread Use Assessment" February 29, 2012, in docket (number EPA-HQ-OAR-2010-1076) addressing details on values in this table and providing more calendar years.

Note: In this table, the columns have the following meaning.

1. Calendar year that corresponds to the percentages in the row associated with the year.
2. Percentage of the gasoline-powered highway vehicle fleet that have ORVR.
3. Percentage of gasoline-fueled vehicle miles traveled (VMT) by vehicles equipped with ORVR.
4. Amount of gasoline dispensed into ORVR-equipped vehicles as a percentage of all gasoline dispensed to highway motor vehicles.

Age of St. Louis Gasoline Motor Vehicle Fleet

Year	Age	Model Year	Motorcycle	Pass Cars	LDT1	LDT2	HDGV
2012	30	1982	0.005849	0.000514	0.000433	0.000221	0.001962
2012	29	1983	0.010773	0.000590	0.000681	0.000405	0.002973
2012	28	1984	0.005904	0.000755	0.000637	0.000609	0.003559
2012	27	1985	0.006665	0.001655	0.001273	0.001188	0.006148
2012	26	1986	0.007971	0.001746	0.001416	0.001563	0.007099
2012	25	1987	0.010692	0.002702	0.002625	0.002483	0.008393
2012	24	1988	0.005196	0.002621	0.002658	0.002658	0.007099
2012	23	1989	0.005468	0.004300	0.005082	0.003659	0.011629
2012	22	1990	0.005169	0.004838	0.004933	0.004170	0.012215
2012	21	1991	0.006883	0.007433	0.006105	0.005810	0.012640
2012	20	1992	0.005740	0.007845	0.007080	0.004669	0.008959
2012	19	1993	0.008515	0.012414	0.009465	0.010819	0.012903
2012	18	1994	0.010746	0.012875	0.010799	0.010832	0.014844
2012	17	1995	0.013766	0.020209	0.018149	0.022610	0.023945
2012	16	1996	0.013548	0.023339	0.016257	0.024642	0.033127
2012	15	1997	0.019534	0.028129	0.021574	0.022874	0.032864
2012	14	1998	0.017602	0.031585	0.027784	0.022934	0.041338
2012	13	1999	0.026063	0.043211	0.042466	0.029621	0.034502
2012	12	2000	0.029409	0.046299	0.041382	0.043546	0.058528
2012	11	2001	0.042142	0.061949	0.057056	0.046400	0.075375
2012	10	2002	0.045161	0.057337	0.055264	0.048624	0.066396
2012	9	2003	0.064423	0.069276	0.077376	0.062033	0.064009
2012	8	2004	0.066464	0.058587	0.065458	0.068759	0.070117
2012	7	2005	0.062111	0.066329	0.074564	0.082155	0.068216
2012	6	2006	0.069837	0.062476	0.078426	0.069376	0.054949
2012	5	2007	0.092064	0.066533	0.073422	0.072218	0.067771
2012	4	2008	0.088255	0.067333	0.067408	0.073934	0.047729
2012	3	2009	0.093914	0.067928	0.066432	0.080430	0.054342
2012	2	2010	0.078869	0.051581	0.041347	0.044662	0.026736
2012	1	2011	0.037789	0.054139	0.050754	0.059060	0.022732
2012	0	2012	0.043475	0.063474	0.071691	0.077035	0.046900

		Number of vehicles	36,757	830,970	447,630	234,763	49,446
		Average Age	8.1	8.1	7.8	7.5	9.8

APPENDIX C

Age of National Gasoline Motor Vehicle Fleet

Calendar Year	Age	Model Year	Motorcycle	Pass Cars	LDGT1	LDGT2	HDGV
2012	30	1982	0.001966	0.000668	0.002037	0.002037	0.005699
2012	29	1983	0.001689	0.000718	0.002178	0.002178	0.005426
2012	28	1984	0.002310	0.001094	0.003234	0.003234	0.006327
2012	27	1985	0.002585	0.001559	0.004318	0.004318	0.008814
2012	26	1986	0.003071	0.00217	0.004989	0.004989	0.011413
2012	25	1987	0.003696	0.002585	0.006043	0.006043	0.009350
2012	24	1988	0.003741	0.003538	0.007146	0.007146	0.011049
2012	23	1989	0.004419	0.004355	0.007774	0.007774	0.011843
2012	22	1990	0.005962	0.005407	0.008745	0.008745	0.010388
2012	21	1991	0.007355	0.006255	0.008972	0.008972	0.009462
2012	20	1992	0.00929	0.008232	0.011363	0.011363	0.011102
2012	19	1993	0.011102	0.011132	0.014774	0.014774	0.014453
2012	18	1994	0.013623	0.015221	0.018422	0.018422	0.020989
2012	17	1995	0.011840	0.018786	0.020574	0.020574	0.023061
2012	16	1996	0.015718	0.023545	0.024745	0.024745	0.025302
2012	15	1997	0.017935	0.028620	0.028422	0.028422	0.027497
2012	14	1998	0.018745	0.034619	0.034691	0.034691	0.032089
2012	13	1999	0.021968	0.044520	0.039503	0.039503	0.045460
2012	12	2000	0.029065	0.054649	0.047137	0.047137	0.048348
2012	11	2001	0.036410	0.056862	0.051960	0.051960	0.052218
2012	10	2002	0.042963	0.057388	0.056257	0.056257	0.047379
2012	9	2003	0.048226	0.056194	0.061399	0.061399	0.052367
2012	8	2004	0.056980	0.057747	0.066770	0.066770	0.058223
2012	7	2005	0.067163	0.060876	0.070393	0.070393	0.064607
2012	6	2006	0.076695	0.063183	0.068310	0.068310	0.063641
2012	5	2007	0.080950	0.062722	0.068566	0.068566	0.063843
2012	4	2008	0.089568	0.056968	0.046968	0.046968	0.048232
2012	3	2009	0.047643	0.051356	0.037902	0.037902	0.040547
2012	2	2010	0.067916	0.061669	0.054558	0.054558	0.052774
2012	1	2011	0.089591	0.070362	0.059917	0.059918	0.057786
2012	1	2012	0.109815	0.076999	0.061931	0.061930	0.060313
Average Age			6.9	8.0	8.9	8.9	9.6

APPENDIX D

Table A-7 - Five –Month (May-September) Uncontrolled Displacement (non-ORVR) Refueling Emission Factors (g/gal)

State	Number Counties	Area name	RVP (psi)	Emission Factor
ARIZONA	3	Phoenix	7.8	3.5
CALIFORNIA	58	All CA	7.0	3.4
CONNECTICUT	8	All CT	7.0	3.0
DELAWARE	3	All DE	7.0	3.0
DC	1	DC	7.0	3.0
GEORGIA	13	Atlanta	7.0	4.6
ILLINOIS	8	Chicago metro	7.0	3.0
INDIANA	4	Chicago-Gary metro	7.0	3.0
LOUISIANA	6	Baton Rouge	7.8	5.1
MAINE	3	Portland	7.8	3.3
MARYLAND	12	Baltimore and Wash DC areas	7.0	3.0
MASSACHUSETTS	14	All MA	7.0	3.0
MISSOURI	5	St. Louis	7.0	3.3
NEW HAMPSHIRE	4	Portsmouth Dover Rochester	7.0	3.0
NEW JERSEY	21	All NJ	7.0	3.0
NEW YORK	10	NYC metro	7.0	3.0
PENNSYLVANIA	12	Philadelphia metro	7.8	3.0
		Pittsburgh -Beaver Valley	7.0	3.3
RHODE ISLAND	5	All RI	7.0	3.0
TEXAS	16	All TX	7.0	3.5
VIRGINIA	17	All VA	7.0	3.0
VERMONT	14	All VT	9.0	3.9
WISCONSIN	6	Milwaukee-Racine	7.0	3.0
		Sheboygan, Manitowoc, Kewaunee	9.0	3.9

APPENDIX E

Table A-2 - Monthly Average Dispensed Liquid Temperature
Dispensed liquid temperature (°F)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Weighted Average | | |
													Summer (Apr-Sep)	Winter (Oct-Mar)	Annual Average
National Average	51	54	54	58	69	76	82	81	76	70	62	54	74	58	66
Region 1	43	45	48	53	66	74	78	78	72	66	59	46	70	51	61
Region 2	69	74	73	80	84	87	90	91	78	85	83	73	85	76	81
Region 3	54	57	61	67	76	82	83	84	79	76	67	54	79	62	70
Region 4	50	51	41	47	63	74	88	85	83	75	63	52	74	56	65
Region 5	54	NA	NA	NA	72	77	83	83	79	74	67	58	79	63	72
Region 6	NA	48	49	53	59	63	NA	73	71	60	49	42	64	50	57

Regional Boundaries
Region 1: ME, VT, NH, MA, CT, RI, NY, NJ, PA, DE, MD,VA,WV,DC, KY, OH, IN, IL, MI, WI
Region 2: NC, SC, GA, FL, AL, MS, AR, LA, TN
Region 3: OK, TX, NM, AZ
Region 4: MN, IA, MO, ND, SD, NE, KS, MT, WY, CO
Region 5: CA, NV, UT
Region 6: WA, OR, ID

Source: McNally Michael and Dickerman J.C., "Summary and Analysis of Data from Gasoline Temperature Survey," conducted by API, Radian Corporation, May, 1976.
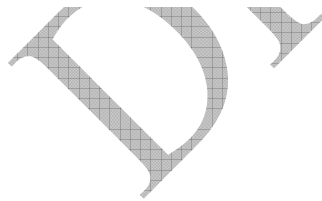
APPENDIX F

Table A-3 - Seasonal Variation In Temperature Difference Between Vehicle Fuel Tank and Dispensed Fuel

(

Temperature Difference (

	Average Annual	Summer (Apr – Sep)	Winter (Oct – Mar)	5-Month Ozone Season (May – Sep)	2-Month Ozone Season (Jul – Aug)
National Average	4.4	8.8	-0.8	9.44	9.9
Region 1	5.7	10.7	-0.3	11.5	12.5
Region 2	4.0	6.8	0.9	7.5	8.2
Region 3	3.7	7.6	-0.4	7.1	7.0
Region 4	5.5	11.7	-2.4	12.1	13.3
Region 5	0.1	3.9	-4.4	5.1	3.2
Region 6	Use Region 4 data				

Regional Boundaries
Region 1: ME, VT, NH, MA, CT, RI, NY, NJ, PA, DE, MD,VA,WV,DC, KY, OH, IN, IL, MI, WI
Region 2: NC, SC, GA, FL, AL, MS, AR, LA, TN
Region 3: OK, TX, NM, AZ
Region 4: MN, IA, MO, ND, SD, NE, KS, MT, WY, CO
Region 5: CA, NV, UT
Region 6: WA, OR, ID

Source: Rothman, Dale and Johnson, Robert, Technical Report, "Refueling Emissions from Uncontrolled Vehicles," EPA OMS, EPA-AA-SDSB-85-6. June 1985.

APPENDIX G

Stage II Removal Demonstration – Documentation of On-Road Mobile Source VOC Emissions Calculations in the St. Louis Ozone Nonattainment Area

Section 1: St. Louis Nonattainment Area On-Road Mobile Source VOC Emissions Calculations

For this demonstration, on-road mobile source emissions for 2008 were calculated using the EPA's Motor Vehicle Emissions Simulator (MOVES) version 2010a and the on-road mobile source emissions for 2011, 2015, 2017, and 2022 were calculated using MOVES version 2010b. The inputs to the models for 2015, 2017, and 2022 were developed using 2008 as the base year. Both vehicle miles traveled (VMT) data and source type population data for these three years, were grown annually by 1.5% from the 2008 data. The 2011 emissions data was calculated with all MOVES inputs developed independently from the 2008 data inputs. The 2011 mobile emissions were calculated for the purposes of the 2011 National Emissions Inventory; however they are displayed in this demonstration in order to provide a broad range of years demonstrating the continual decline of mobile source VOC emissions in the St. Louis area. Additional details about the development of the 2011 mobile source VOC emissions can be found in Attachment 1 of Appendix G.

The emissions for 2008 were calculated using 2008 VMT data provided by the East West Gateway Council of Governments. The 2008 VMT data was originally generated from the Missouri Department of Transportation for state-owned roads, and then East-West Gateway used their Traffic Demand Model to calculate the actual local VMT data for each of the five counties on the Missouri side of the St. Louis Ozone nonattainment area.

The road type distribution input used in 2008 was developed from the National County Database (NCD) to distribute the county level VMT to road type. EPA's VMT converter workbook was then used to produce MOVES input tables. The same road type distribution data that was used for 2008 was also used for 2015, 2017, and 2022. A vehicle registration distribution for 2008 was originally created for the National Mobile Inventory Model (NMIM) using registration data from Missouri's Department of Revenue. The vehicle distribution was converted to a MOVES age distribution table using EPA's VMT converter workbook. The same age distribution table was used for 2015, 2017, and 2022. The registration data was also used to create the MOVES vehicle population input tables for 2008. Vehicle counts were converted from Mobile 6.2 vehicle classes to MOVES source types using the source type fractions from the Source Type Pop Fractions table in EPA's VMT converter workbook. The meteorology data used for 2008 was developed by EPA from National Weather Service data. The 2008 meteorology data was also used for the projected emissions in 2015, 2017, and 2022. Inspection and Maintenance (I/M) input tables were developed to characterize the Gateway Vehicle Inspection Program (the I/M program in place in the St. Louis Ozone nonattainment area). Additional details regarding the development of the I/M input can be found in the I/M input table development protocol in Attachment 2 of Appendix G.

MOVES base data was used for all other inputs to calculate the 2008, 2015, 2017, and 2022 mobile source emissions, after reviewing the data to ensure accuracy. The base fuel supply tables in MOVES were used for the runs, as they already took into account the reformulated gasoline used in the St. Louis nonattainment area. A separate input database was created for each county, using county specific data where possible. All of the data used to develop the county database manager inputs for the MOVES runs performed for 2008, 2015, 2017, and 2022, other than the data for county database manager inputs where EPA default data was used, can be found in Section 2 of this document.

The MOVES model runs were set up selecting all available gasoline and diesel fuel vehicle type combinations, all months, days, hours, and all road types. A separate run was set-up for each pollutant and each county. The emissions were post-aggregated to the month level using MOVES.   Once the MOVES input tables had been created, MOVES was ran and all months for each year displayed in this demonstration were selected to create an annual emissions profile. The VOC emissions for the months of April through October were totaled and divided by 214, the number of days in those months, to give average ozone season day VOC emissions for each year in which the emissions were calculated.

Section 2: Data Used to Develop the MOVES County Database Manager Inputs for the St. Louis Nonattainment Area for 2008, 2015, 2017, and 2022

When using MOVES to calculate the on-road mobile source VOC emissions, default data was used in the county database manager for Average Speed Distribution, Fuel Supply, Fuel Formulation, VMT Monthly Distribution, VMT Daily Distribution, and VMT Hourly Distribution input tables for all five counties. Meteorology Data, Road Type Distribution, and Age Distribution Inputs are the same for 2008, 2015, 2017, and 2022. For all county database manager input tables developed by the Air Program for these four years, the data used to develop the input tables is listed in Tables 1 – 24 below.

2008 MOVES Inputs

Table 1 – 2008 Source Type Population (MOVES Inputs for 2008 On-Road Mobile Source VOC Emissions)

YearID	SourceTypeName	SourceTypeID	Source Type Population by County				
			Franklin	Jefferson	St Charles	St Louis County	St Louis City
2008	Motorcycle	11	6,067	13,018	11,151	19,243	3104
2008	Passenger Car	21	46,568	98,009	144,441	527,148	125,776
2008	Passenger Truck	31	45,890.24	82,509.19	110,385.78	303,295.72	59,405.61
2008	Light Commercial Truck	32	16,768.76	28,420.81	35,913.22	97,845.28	20,194.39
2008	Refuse Truck	41	8.25	41	35.5	93.5	69.5
2008	Single Unit Short-haul Truck	42	24.75	123	106.5	280.5	208.5
2008	Single Unit Long-haul Truck	43	302.08	541.2	549.04	2,709.24	661
2008	Motor Home	51	21.53	19.34	19.44	50.14	16.25
2008	School Bus	52	813.93	900.99	1,019.79	3,623.55	1,249.2
2008	Transit Bus	53	61.05	66.99	76.07	270.27	92.6
2008	Intercity Bus	54	44.26	71.09	82.23	378.69	143.45
2008	Combination Short-haul Truck	61	370.31	324.37	327.86	791.19	247.5
2008	Combination Long-haul Truck	62	306.84	257.02	257.57	544.92	160

Table 2 – 2008 Annual VMT by HPMS Vehicle Type, County, and Year (MOVES Inputs for 2008 On-Road Mobile Source VOC Emissions)

HPMSVtypeID	HPMSVtypeName	YearID	HPMSBaseYearVMT by County				
			Franklin	Jefferson	St. Charles	St. Louis	St. Louis City
10	Motorcycles	2008	11,619,323	13,841,651	20,770,584	91,989,970	26,665,063
20	Passenger Cars	2008	707,169,172	811,173,607	1,171,243,667	5,115,865,231	1,477,495,621
30	Other 2 axle-4 tire vehicles	2008	799,130,600	924,394,839	1,342,595,411	5,875,722,138	1,702,465,533
40	Buses	2008	4,781,820	5,578,789	8,183,119	35,928,481	10,469,862
50	Single Unit Trucks	2008	29,351,955	33,386,793	47,634,481	207,228,073	59,856,119
60	Combination Trucks	2008	84,673,330	96,333,716	137,528,782	598,448,609	173,536,046

Table 3 – 2008 Inspection and Maintenance Data (MOVES Inputs for 2008 On-Road Mobile Source VOC Emissions)

Pol Process ID	State ID	Year ID	Source Type ID	Fuel Type ID	IM Program ID	Inspect Freq	Test Standards ID	Beg Model Year ID	End Model Year ID	Use IM Y/N	Compliance Factor
101	29	2008	21	1	1	1	11	1971	1995	N	93.12
101	29	2008	21	1	10	2	51	1996	2006	Y	97.94
101	29	2008	31	1	1	1	11	1971	1995	N	93.12
101	29	2008	31	1	10	2	51	1996	2006	Y	92.06
101	29	2008	32	1	1	1	11	1971	1995	N	93.12
101	29	2008	32	1	10	2	51	1996	2006	Y	86.18
102	29	2008	21	1	1	1	11	1971	1995	N	93.12
102	29	2008	21	1	10	2	51	1996	2006	Y	97.94
102	29	2008	31	1	1	1	11	1971	1995	N	93.12
102	29	2008	31	1	10	2	51	1996	2006	Y	92.06
102	29	2008	32	1	1	1	11	1971	1995	N	93.12
102	29	2008	32	1	10	2	51	1996	2006	Y	86.18
112	29	2008	21	1	7	1	41	1971	1995	N	93.12
112	29	2008	21	1	8	2	43	1996	2006	Y	97.94
112	29	2008	31	1	7	1	41	1971	1995	N	93.12
112	29	2008	31	1	8	2	43	1996	2006	Y	92.06
112	29	2008	32	1	7	1	41	1971	1995	N	93.12
112	29	2008	32	1	8	2	43	1996	2006	Y	86.18
113	29	2008	21	1	7	1	41	1971	1995	N	93.12
113	29	2008	21	1	8	2	43	1996	2006	Y	97.94
113	29	2008	31	1	7	1	41	1971	1995	N	93.12
113	29	2008	31	1	8	2	43	1996	2006	Y	92.06
113	29	2008	32	1	7	1	41	1971	1995	N	93.12
113	29	2008	32	1	8	2	43	1996	2006	Y	86.18

2015 MOVES Inputs

Table 4 – 2015 Source Type Population (MOVES Inputs for 2015 On-Road Mobile Source VOC Emissions)

YearID	SourceTypeName	SourceTypeID	Source Type Population by County				
			Franklin	Jefferson	St Charles	St Louis County	St Louis City
2015	Motorcycle	11	6,733	14,448	12,376	21,357	3,445
2015	Passenger Car	21	51,683	108,775	160,307	585,053	139,592
2015	Passenger Truck	31	50,931	91,572	122,511	336,611	65,931
2015	Light Commercial Truck	32	18,611	31,543	39,858	108,593	22,413
2015	Refuse Truck	41	9	46	39	104	77
2015	Single Unit Short-haul Truck	42	28	137	118	311	231
2015	Single Unit Long-haul Truck	43	335	601	609	3,007	734
2015	Motor Home	51	24	21	22	56	18
2015	School Bus	52	903	1,000	1,132	4,022	1,386
2015	Transit Bus	53	68	74	84	300	103
2015	Intercity Bus	54	49	79	91	420	159
2015	Combination Short-haul Truck	61	411	360	364	878	275
2015	Combination Long-haul Truck	62	341	285	286	605	178

Table 5 – 2015 Annual VMT by HPMS Vehicle Type, County, and Year (MOVES Inputs for 2015 On-Road Mobile Source VOC Emissions)

| HPMSVtypeID | HPMSVtypeName | YearID | HPMSBaseYearVMT by County | | | | |
			Franklin	Jefferson	St. Charles	St. Louis	St. Louis City
10	Motorcycles	2015	12,895,647	15,362,086	23,052,127	102,094,600	29,594,085
20	Passenger Cars	2015	784,848,108	900,276,901	1,299,898,826	5,677,817,002	1,639,790,999
30	Other 2 axle-4 tire vehicles	2015	886,911,031	1,025,934,909	1,490,072,687	6,521,140,324	1,889,472,711
40	Buses	2015	5,307,079	6,191,590	9,081,993	39,875,042	11,619,923
50	Single Unit Trucks	2015	32,576,118	37,054,162	52,866,886	229,991,023	66,431,009
60	Combination Trucks	2015	93,974,265	106,915,484	152,635,619	664,185,145	192,598,098

Table 6 – 2015 Inspection and Maintenance Data (MOVES Inputs for 2015 On-Road Mobile Source VOC Emissions)

Pol Process ID	State ID	Year ID	Source Type ID	Fuel Type ID	IM Program ID	Inspect Freq	Test Standards ID	Beg Model Year ID	End Model Year ID	Use IM Y/N	Compliance Factor
101	29	2015	21	1	1	1	11	1971	1995	N	93.12
101	29	2015	21	1	10	2	51	1996	2013	Y	97.94
101	29	2015	31	1	1	1	11	1971	1995	N	93.12
101	29	2015	31	1	10	2	51	1996	2013	Y	92.06
101	29	2015	32	1	1	1	11	1971	1995	N	93.12
101	29	2015	32	1	10	2	51	1996	2013	Y	86.18
102	29	2015	21	1	1	1	11	1971	1995	N	93.12
102	29	2015	21	1	10	2	51	1996	2013	Y	97.94
102	29	2015	31	1	1	1	11	1971	1995	N	93.12
102	29	2015	31	1	10	2	51	1996	2013	Y	92.06
102	29	2015	32	1	1	1	11	1971	1995	N	93.12
102	29	2015	32	1	10	2	51	1996	2013	Y	86.18
112	29	2015	21	1	7	1	41	1971	1995	N	93.12
112	29	2015	21	1	8	2	43	1996	2013	Y	97.94
112	29	2015	31	1	7	1	41	1971	1995	N	93.12
112	29	2015	31	1	8	2	43	1996	2013	Y	92.06
112	29	2015	32	1	7	1	41	1971	1995	N	93.12
112	29	2015	32	1	8	2	43	1996	2013	Y	86.18
113	29	2015	21	1	7	1	41	1971	1995	N	93.12
113	29	2015	21	1	8	2	43	1996	2013	Y	97.94
113	29	2015	31	1	7	1	41	1971	1995	N	93.12
113	29	2015	31	1	8	2	43	1996	2013	Y	92.06
113	29	2015	32	1	7	1	41	1971	1995	N	93.12
113	29	2015	32	1	8	2	43	1996	2013	Y	86.18

2017 MOVES Inputs

Table 7 – 2017 Source Type Population (MOVES Inputs for 2017 On-Road Mobile Source VOC Emissions)

YearID	SourceTypeName	SourceTypeID	Source Type Population by County				
			Franklin	Jefferson	St Charles	St Louis County	St Louis City
2017	Motorcycle	11	6,937	14,885	12,750	22,002	3,549
2017	Passenger Car	21	53,245	112,063	165,152	602,736	143,811
2017	Passenger Truck	31	52,470	94,340	126,214	346,785	67,924
2017	Light Commercial Truck	32	19,174	32,496	41,063	111,875	23,090
2017	Refuse Truck	41	9	47	41	107	79
2017	Single Unit Short-haul Truck	42	29	141	122	321	238
2017	Single Unit Long-haul Truck	43	345	619	628	3,098	756
2017	Motor Home	51	25	22	22	57	19
2017	School Bus	52	931	1,030	1,166	4,143	1,428
2017	Transit Bus	53	70	77	87	309	106
2017	Intercity Bus	54	50	81	94	433	164
2017	Combination Short-haul Truck	61	423	371	375	905	283
2017	Combination Long-haul Truck	62	351	294	295	623	183

Table 8 – 2017 Annual VMT by HPMS Vehicle Type, County, and Year (MOVES Inputs for 2017 On-Road Mobile Source VOC Emissions)

HPMSVtypeID	HPMSVtypeName	YearID	HPMSBaseYearVMT by County				
			Franklin	Jefferson	St. Charles	St. Louis	St. Louis City
10	Motorcycles	2017	13285,417	15,826,405	23,748,877	105,180,410	30,488,566
20	Passenger Cars	2017	808,570,142	927,487,770	1,339,188,268	5,849,429,021	1,689,353,682
30	Other 2 axle-4 tire vehicles	2017	913,717,917	1,056,943,792	1,535,110,134	6,718,241,791	1,946,582,024
40	Buses	2017	5,467,485	6,378,731	9,356,496	41,080,266	11,971,135
50	Single Unit Trucks	2017	33,560,731	38,174,124	54,464,788	236,942,502	68,438,886
60	Combination Trucks	2017	96,814,637	110,147,005	157,249,031	684,260,141	198,419,375

Table 9 – 2017 Inspection and Maintenance Data (MOVES Inputs for 2017 On-Road Mobile Source VOC Emissions)

Pol Process ID	State ID	Year ID	Source Type ID	Fuel Type ID	IM Program ID	Inspect Freq	Test Standards ID	Beg Model Year ID	End Model Year ID	Use IM Y/N	Compliance Factor
101	29	2017	21	1	1	1	11	1971	1995	N	93.12
101	29	2017	21	1	10	2	51	1996	2015	Y	97.94
101	29	2017	31	1	1	1	11	1971	1995	N	93.12
101	29	2017	31	1	10	2	51	1996	2015	Y	92.06
101	29	2017	32	1	1	1	11	1971	1995	N	93.12
101	29	2017	32	1	10	2	51	1996	2015	Y	86.18
102	29	2017	21	1	1	1	11	1971	1995	N	93.12
102	29	2017	21	1	10	2	51	1996	2015	Y	97.94
102	29	2017	31	1	1	1	11	1971	1995	N	93.12
102	29	2017	31	1	10	2	51	1996	2015	Y	92.06
102	29	2017	32	1	1	1	11	1971	1995	N	93.12
102	29	2017	32	1	10	2	51	1996	2015	Y	86.18
112	29	2017	21	1	7	1	41	1971	1995	N	93.12
112	29	2017	21	1	8	2	43	1996	2015	Y	97.94
112	29	2017	31	1	7	1	41	1971	1995	N	93.12
112	29	2017	31	1	8	2	43	1996	2015	Y	92.06
112	29	2017	32	1	7	1	41	1971	1995	N	93.12
112	29	2017	32	1	8	2	43	1996	2015	Y	86.18
113	29	2017	21	1	7	1	41	1971	1995	N	93.12
113	29	2017	21	1	8	2	43	1996	2015	Y	97.94
113	29	2017	31	1	7	1	41	1971	1995	N	93.12
113	29	2017	31	1	8	2	43	1996	2015	Y	92.06
113	29	2017	32	1	7	1	41	1971	1995	N	93.12
113	29	2017	32	1	8	2	43	1996	2015	Y	86.18

2022 MOVES Inputs

Table 10 – 2022 Source Type Population (MOVES Inputs for 2022 On-Road Mobile Source VOC Emissions)

Year ID	Source Type Name	Source Type ID	Source Type Population by County				
			Franklin	Jefferson	St Charles	St Louis County	St Louis City
2022	Motorcycle	11	7,473	16,035	13,735	23,703	3,823
2022	Passenger Car	21	57,360	120,723	177,916	649,318	154,925
2022	Passenger Truck	31	56,525	101,631	135,968	373,586	73,173
2022	Light Commercial Truck	32	20,655	35,007	44,236	120,521	24,875
2022	Refuse Truck	41	10	51	44	115	86
2022	Single Unit Short-haul Truck	42	31	152	131	346	257
2022	Single Unit Long-haul Truck	43	372	667	676	3,337	814
2022	Motor Home	51	27	24	24	62	20
2022	School Bus	52	1,003	1,110	1,256	4,463	1,539
2022	Transit Bus	53	75	83	94	333	114
2022	Intercity Bus	54	54	88	101	466	177
2022	Combination Short-haul Truck	61	456	400	404	975	305
2022	Combination Long-haul Truck	62	378	317	317	671	197

G-12

Table 11 – 2022 Annual VMT by HPMS Vehicle Type, County, and Year (MOVES Inputs for 2022 On-Road Mobile Source VOC Emissions)

HPMS Vtype ID	HPMS Vtype Name	Year ID	HPMS Base Year VMT by County				
			Franklin	Jefferson	St. Charles	St. Louis County	St. Louis City
10	Motorcycles	2022	14,312,168	17,049,533	25,584,286	113,309,173	32,844,844
20	Passenger Cars	2022	871,059,680	999,167,739	1,442,686,099	6,301,496,316	1,819,913,698
30	Other 2 axle-4 tire vehicles	2022	984,333,696	1,138,628,640	1,653,749,592	7,237,454,415	2,097,021,677
40	Buses	2022	5,890,034	6,871,705	10,079,604	44,255,113	12,896,313
50	Single Unit Trucks	2022	36,154,439	41,124,373	58,674,045	255,254,367	73,728,118
60	Combination Trucks	2022	104,296,860	118,659,606	169,401,866	737,142,504	213,754,019

G-13

Table 12 – 2022 Inspection and Maintenance Data (MOVES Inputs for 2022 On-Road Mobile Source VOC Emissions)

Pol Process ID	State ID	Year ID	Source Type ID	Fuel Type ID	IM Program ID	Inspect Freq	Test Standards ID	Beg Model Year ID	End Model Year ID	Use IM Y/N	Compliance Factor
101	29	2022	21	1	1	1	11	1971	1995	N	93.12
101	29	2022	21	1	10	2	51	1996	2020	Y	97.94
101	29	2022	31	1	1	1	11	1971	1995	N	93.12
101	29	2022	31	1	10	2	51	1996	2020	Y	92.06
101	29	2022	32	1	1	1	11	1971	1995	N	93.12
101	29	2022	32	1	10	2	51	1996	2020	Y	86.18
102	29	2022	21	1	1	1	11	1971	1995	N	93.12
102	29	2022	21	1	10	2	51	1996	2020	Y	97.94
102	29	2022	31	1	1	1	11	1971	1995	N	93.12
102	29	2022	31	1	10	2	51	1996	2020	Y	92.06
102	29	2022	32	1	1	1	11	1971	1995	N	93.12
102	29	2022	32	1	10	2	51	1996	2020	Y	86.18
112	29	2022	21	1	7	1	41	1971	1995	N	93.12
112	29	2022	21	1	8	2	43	1996	2020	Y	97.94
112	29	2022	31	1	7	1	41	1971	1995	N	93.12
112	29	2022	31	1	8	2	43	1996	2020	Y	92.06
112	29	2022	32	1	7	1	41	1971	1995	N	93.12
112	29	2022	32	1	8	2	43	1996	2020	Y	86.18
113	29	2022	21	1	7	1	41	1971	1995	N	93.12
113	29	2022	21	1	8	2	43	1996	2020	Y	97.94
113	29	2022	31	1	7	1	41	1971	1995	N	93.12
113	29	2022	31	1	8	2	43	1996	2020	Y	92.06
113	29	2022	32	1	7	1	41	1971	1995	N	93.12
113	29	2022	32	1	8	2	43	1996	2020	Y	86.18

MOVES Inputs Used for 2008, 2015, 2017, and 2022

Table 13 – Road Type Distribution (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

Source Type ID	Road Type ID	Road Type VMT Fraction	Source Type ID	Road Type ID	Road Type VMT Fraction
11	1	0	51	3	0.015096
11	2	0.00113	51	4	0.473646
11	3	0.011837	51	5	0.509786
11	4	0.460448	52	1	0
11	5	0.526585	52	2	0.001464
21	1	0	52	3	0.015054
21	2	0.001544	52	4	0.458621
21	3	0.015158	52	5	0.524861
21	4	0.459076	53	1	0
21	5	0.524222	53	2	0.001465
31	1	0	53	3	0.015061
31	2	0.001361	53	4	0.460904
31	3	0.01387	53	5	0.52257
31	4	0.46841	54	1	0
31	5	0.516359	54	2	0.001459
32	1	0	54	3	0.015026
32	2	0.001379	54	4	0.450614
32	3	0.014014	54	5	0.532901
32	4	0.467447	61	1	0
32	5	0.51716	61	2	0.001473
41	1	0	61	3	0.015102
41	2	0.001583	61	4	0.475707
41	3	0.015108	61	5	0.507719
41	4	0.496442	62	1	0
41	5	0.486867	62	2	0.001475
42	1	0	62	3	0.01511
42	2	0.001583	62	4	0.47878
42	3	0.015108	62	5	0.504636
42	4	0.496442			
42	5	0.486867			
43	1	0			
43	2	0.001336			
43	3	0.013582			
43	4	0.495108			
43	5	0.489975			
51	1	0			
51	2	0.001472			

Table 14 –Vehicle Age Distribution (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

Age ID	Source Type ID												
	11	21	31	32	41	42	43	51	52	53	54	61	62
0	0.019	0.0248	0.016038	0.015215	0.006	0.006	0.03372	0.019407	0.022549	0.022677	0.024421	0.018826	0.017834
1	0.0646	0.0564	0.059034	0.058508	0.0045	0.0045	0.054157	0.048521	0.039325	0.03937	0.032671	0.049995	0.052613
2	0.1035	0.0666	0.063189	0.062229	0.0132	0.0132	0.092687	0.158149	0.129508	0.130555	0.106219	0.16227	0.169835
3	0.1096	0.0649	0.073971	0.073529	0.0144	0.0144	0.057163	0.057986	0.082002	0.084645	0.091592	0.052692	0.04403
4	0.1172	0.0653	0.081725	0.079405	0.0138	0.0138	0.098055	0.068814	0.07432	0.076743	0.07138	0.066656	0.063479
5	0.0874	0.0632	0.072225	0.07206	0.0291	0.0291	0.05743	0.075516	0.060754	0.062113	0.04642	0.077218	0.080584
6	0.0922	0.0633	0.075227	0.075017	0.0378	0.0378	0.060728	0.071294	0.059753	0.061551	0.046468	0.072242	0.074392
7	0.0713	0.0679	0.075731	0.074101	0.0258	0.0258	0.034794	0.048222	0.045101	0.04668	0.038418	0.04791	0.047775
8	0.061	0.0675	0.069095	0.069315	0.0249	0.0249	0.049567	0.050551	0.053801	0.053336	0.05744	0.050259	0.049622
9	0.0435	0.0652	0.059343	0.060606	0.039	0.039	0.065329	0.101607	0.075238	0.074281	0.059218	0.106403	0.114631
10	0.036	0.0604	0.056546	0.058019	0.0351	0.0351	0.065952	0.060365	0.052757	0.052173	0.04901	0.061907	0.064481
11	0.0255	0.0501	0.045379	0.044021	0.0309	0.0309	0.066337	0.035034	0.038694	0.038608	0.041544	0.03448	0.033479
12	0.0208	0.0488	0.040069	0.041299	0.0351	0.0351	0.042714	0.030037	0.038252	0.038379	0.043733	0.028628	0.026173
13	0.0189	0.039	0.031719	0.032547	0.083	0.083	0.048635	0.022609	0.033622	0.033505	0.041779	0.020871	0.017769
14	0.0171	0.042	0.029341	0.030746	0.0836	0.0836	0.033323	0.026945	0.032499	0.031744	0.038573	0.026434	0.025331
15	0.0122	0.0313	0.025132	0.025766	0.0492	0.0492	0.018302	0.014853	0.01522	0.015277	0.015313	0.014766	0.014626
16	0.0119	0.0274	0.020261	0.020238	0.0441	0.0441	0.01489	0.014543	0.016624	0.016485	0.018482	0.014281	0.013778
17	0.0073	0.0213	0.01591	0.015912	0.0267	0.0267	0.010657	0.011093	0.012019	0.01218	0.012215	0.010861	0.010491
18	0.0063	0.0184	0.014002	0.013972	0.0399	0.0399	0.009968	0.011696	0.014667	0.014636	0.016859	0.011229	0.010394
19	0.0063	0.0138	0.011117	0.011398	0.0609	0.0609	0.012691	0.012448	0.018417	0.017168	0.026192	0.012123	0.011221
20	0.0064	0.0121	0.014109	0.014268	0.0333	0.0333	0.018084	0.014903	0.019136	0.018141	0.024946	0.014734	0.014172
21	0.0054	0.0083	0.015761	0.015219	0.0558	0.0558	0.00363	0.01022	0.014831	0.014247	0.019752	0.009773	0.008829
22	0.0068	0.0065	0.011686	0.011205	0.054	0.054	0.00501	0.010636	0.017272	0.016478	0.024234	0.009966	0.008574
23	0.0097	0.0049	0.00791	0.008124	0.0351	0.0351	0.003627	0.006385	0.007661	0.00744	0.00919	0.006293	0.006072
24	0.013837	0.003694	0.00582	0.006825	0.022815	0.022815	0.003017	0.003218	0.003631	0.003569	0.004095	0.003185	0.003108
25	0.019738	0.002785	0.004029	0.004856	0.01483	0.01483	0.002668	0.001864	0.001955	0.001889	0.002204	0.001885	0.001903
26	0.006525	0.002099	0.002201	0.002308	0.009639	0.009639	0.002379	0.001137	0.001109	0.001082	0.001162	0.001156	0.001183
27	0	0.001582	0.001069	0.001073	0.006266	0.006266	0.00214	0.00071	0.000645	0.000647	0.000595	0.000721	0.000739
28	0	0.00044	0.000253	0.000245	0.004073	0.004073	0.001953	0.000417	0.000378	0.000362	0.000398	0.000432	0.000454
29	0	0	0.000147	0.000139	0.002647	0.002647	0.001784	0.00024	0.000223	0.000197	0.000282	0.000256	0.000278
30	0	0	0.001957	0.001836	0.064531	0.064531	0.028609	0.010581	0.018036	0.013841	0.035194	0.011546	0.012147

Table 15 – Average Monthly Temperatures by Hour of the Day for Franklin County in Fahrenheit (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25.8	29	39.1	48.4	55.9	68.2	70.9	67.1	60.6	49	38.4	24.7
2	24.8	27.4	37	46.4	54.7	67.1	69.6	66.2	60.8	47.9	38.4	24.7
3	23.8	26.3	35.8	45	53.6	66	68.8	65.4	60	47.1	37.5	24
4	22.8	25.3	34.5	44.1	52.6	65	68.1	64.8	59.1	46.5	36.8	23.5
5	22	24.9	33.5	43.2	51.7	64.1	67.5	63.9	58.6	45.7	36	23
6	21.4	24.2	32.6	42.7	51.1	63.5	66.8	63.4	58.2	45.1	35.3	22.5
7	21.2	23.8	32.1	42.7	52.6	65.7	68.2	63.9	57.9	44.6	34.7	22.8
8	21	23.4	32.4	45.3	56.2	69.3	71.4	67.6	60	45.9	34.2	22.3
9	22.2	24.9	36.4	48.9	59.6	72.9	75.2	71.7	63.8	50.9	37.1	23.8
10	26.6	27.8	40.5	52.5	63.2	76.2	78.5	75.7	67.8	56	41.5	27.4
11	31.2	31.1	44.7	55.7	66.4	79	81.3	78.9	71.4	60.5	45.6	31.7
12	36	34.3	48.5	58.5	68.8	81.3	83.6	81.2	74.4	63.9	49.3	36.1
13	39.6	37.2	51.7	61.5	70.6	83	85.6	82.9	76.5	66.1	51.9	39.7
14	42.4	39.5	53.9	63.3	72.1	84.3	87	84.1	77.9	67.5	54	42.2
15	44	41	55.6	64.9	73.6	85.1	88	84.9	78.7	68.4	55.1	43.9
16	44.4	41.6	56.3	65.8	74.3	85.5	88.1	85.1	78.7	68.5	55.1	44.1
17	43.2	41.4	56.1	65.6	74.3	85.2	87.7	84.7	77.9	67.4	53.7	42.2
18	39.4	39.9	54.8	64.6	73.3	84.1	86.7	83.3	75.8	64.2	50.1	37.8
19	35.2	37	51.7	62.1	71.3	82.3	84.6	80.4	71.3	58.9	46.8	34.4
20	32.8	34.9	47.9	58.2	67.3	79	81	75.9	67	55.9	44.8	32
21	31	33.6	45.7	55.6	63.2	74.6	76.9	72.5	65.1	54.1	43.1	30.1
22	29.6	32.2	43.9	53.4	60.7	72.2	75	70.6	63.8	52.7	41.9	28.4
23	28.2	30.9	42.3	51.5	58.9	70.7	73.4	69.2	62.5	51.3	40.7	27.1
24	27.2	29.9	40.5	50	57.2	69.3	72.1	68.1	61.4	50.2	39.5	25.7

Table 16 – Average Monthly Percent Relative Humidity by Hour of the Day for Franklin County (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	68.3	76	71.8	70.6	77	78.3	83.9	86.1	88.2	77	68.9	69.9
2	69	77.2	72.8	72.9	77.2	80.2	84.4	86.9	88.5	78.7	70.3	71.8
3	70.1	78	73.9	74.5	78.2	81.6	85.3	87.5	89.2	79.8	71.7	72.9
4	70.9	78.3	75.3	75.3	79.3	82.4	86.1	88.1	90.1	80.4	72.8	73.8
5	71.8	78.3	76.8	76.1	80.5	83.8	86.4	89.3	90.4	81.6	73.9	75.1
6	72.3	78.9	77.6	77	81.1	84.4	87.3	89.6	90.4	82.5	75	75.7
7	72	78.8	78.2	77.6	80.3	83	85.8	89	90.4	83.4	75.9	76.1
8	72	78.8	78.3	74.5	76.2	77.9	81.4	84.9	89.5	83.2	76.5	76
9	71.2	77.6	74.8	69.8	71.5	72.4	74.9	77.5	84.7	76.8	74.3	75.2
10	66.9	74.3	69.7	64.8	65.8	66.9	69.3	70.2	77.2	67.7	68.4	72.4
11	62	70.4	63.5	61.1	61.1	62.1	64.5	64.2	70.5	59.4	62.1	68.4
12	56.8	67	58.7	58.2	58.1	58.2	60.9	60	64.6	53.3	56.5	64.8
13	53	63.8	54.8	55	56.3	55.4	57.9	57.2	60.9	49.9	52.7	62.1
14	50.2	61.5	52.6	53	55.1	53.7	55.8	55.4	58.3	47.7	49.4	60.2
15	48.4	60	51	51.1	53.1	52.2	54.6	54.2	56.8	46.3	47.6	58.7
16	47.3	59.4	50.7	49.7	52.5	51.5	54.4	54	56.6	46	47.1	58
17	47.9	59.8	50.7	49.1	51.7	51.5	55.1	54.9	58.1	47.2	48.4	59.2
18	51.2	61.6	52.5	49.9	52.1	52.8	56.7	57.6	62.8	52.3	52.9	62.9
19	55.5	65.4	56.2	52.8	54.6	55.5	61.1	63.5	72.5	61.5	57.2	65.6
20	58.3	68.2	61	57.5	60.3	61.6	68.4	72.7	80.5	66.9	60	67
21	60.6	70.1	63.9	60.8	66.3	68.8	75.3	78.4	83.9	69.6	62.5	67.6
22	62.8	72	66.3	63.9	70.3	72.8	78.3	81.9	85.3	71.9	64.4	68.3
23	64.5	73.7	68.2	66.4	73.1	75	80.7	83.8	86.4	73.7	65.9	68.7
24	66.1	75.1	70.3	68.3	75.4	77	82.3	85.2	87.6	75.6	67.6	69.1

Table 17 – Average Monthly Temperatures by Hour of the Day for Jefferson County in Fahrenheit (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25.6	28.3	38.5	47.4	55	68.3	70.1	67	60.2	48.6	37.5	24.2
2	24.7	26.8	36.3	45.5	53.8	67.3	68.8	66.1	60.4	47.7	37.3	24.2
3	23.7	25.7	35.2	44.3	52.8	66.3	68.1	65.3	59.5	46.9	36.4	23.2
4	22.5	24.8	34.2	43.3	51.8	65.2	67.5	64.6	58.9	46.3	35.8	22.8
5	22	24.2	33.3	42.6	50.9	64.5	66.8	63.9	58.2	45.4	35	22.3
6	21.2	23.5	32.3	42.3	50.5	63.8	66.2	63.4	57.9	44.8	34.3	21.8
7	20.8	23.1	31.8	42.3	52.1	66	67.6	63.9	57.6	44.3	33.7	22.1
8	20.8	22.9	32	44.9	55.7	69.6	70.8	67.6	59.9	45.6	33.5	21.6
9	22	24.2	35.7	48.4	58.9	73	74.5	71.6	63.7	50.7	36.6	23.2
10	26.2	27	39.5	51.7	62.4	76.3	77.6	75.6	67.6	55.8	41	27
11	30.7	30	43.6	54.7	65.5	78.9	80.3	78.7	71.3	60.2	45	31
12	35	33.2	47.1	57.1	67.7	81.1	82.5	80.8	74.2	63.7	48.6	35.2
13	38.3	35.7	50.1	59.7	69.3	82.8	84.3	82.5	76.4	65.8	51.1	38.8
14	41.2	37.9	52.3	61.6	70.4	83.9	85.6	83.7	77.7	67.2	53.2	41.1
15	42.9	39.2	53.7	62.9	71.7	84.6	86.6	84.4	78.5	68.1	54.3	42.8
16	43.3	40	54.5	63.8	72.6	84.9	86.9	84.4	78.6	68.1	54.3	43
17	42.1	39.8	54.3	63.5	72.6	84.6	86.5	84.2	77.8	67.1	52.9	41.1
18	38.5	38.3	53	62.6	71.6	83.6	85.4	82.7	75.6	63.9	49.1	36.9
19	34.4	35.7	50	60.1	69.7	81.8	83.4	79.9	71	58.7	45.7	33.8
20	32	33.6	46.8	56.8	65.8	78.6	79.9	75.6	66.7	55.6	43.7	31.5
21	30.3	32.1	44.6	54.1	62	74.4	76.1	72.3	64.7	53.7	41.9	29.8
22	29.1	31.2	42.7	52.2	59.7	72.2	74.1	70.4	63.3	52.3	40.7	27.9
23	28	29.9	41.4	50.3	57.6	70.7	72.6	69	62.1	50.9	39.5	26.8
24	27	29.1	39.7	48.9	56.2	69.4	71.3	68.1	61.1	49.7	38.4	25.1

Table 18 – Average Monthly Percent Relative Humidity by Hour of the Day for Jefferson County (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	67.9	75.6	72.4	70.8	76.6	76.7	83	85.5	87.6	77.2	68.8	69.6
2	69	77.1	73	73.1	76.8	78.3	83.8	86.6	87.6	78.3	70.2	71.1
3	70.1	78	74.1	74.4	77.6	79.9	84.6	86.9	88.5	80.1	71.3	72.5
4	71.2	78.2	75.2	75.5	78.7	81.2	85.2	87.8	88.8	80.7	72.1	73.1
5	71.8	78.2	76.1	76.1	79.5	82.3	85.8	88.4	89.4	81.9	73.2	74.4
6	72.3	78.8	77.6	76.9	80.1	83.2	86.3	88.7	89.4	82.8	74.3	75
7	72.6	78.8	78.2	77.3	79.3	81.3	85.2	88.4	89.4	83.4	75.2	75.3
8	72.3	78.4	78.5	73.9	75	76	80.5	84	88.2	83.2	75.5	75.6
9	71.1	77.2	75.4	69	70.7	70.4	73.8	76.7	83.2	77.1	73.4	74.8
10	67.1	74.2	70.2	64.4	65	64.8	68.5	69.4	76.1	67.5	67.5	71.7
11	62.2	70.5	64.4	60.9	60.3	60.1	63.7	63.8	69.5	58.9	61.3	68
12	57.2	67.1	59.9	58.5	57.6	56.1	60	59.5	63.9	52.9	56.2	64.6
13	53.7	64.7	56.4	55.6	56.1	53	57.4	56.9	60	49.3	52.6	62
14	50.9	62.1	54.1	53.4	54.8	51.8	55	55.1	57.9	46.8	49.5	59.8
15	48.8	60.8	53	51.6	53.4	50.2	53.7	54.1	56.4	45.5	47.7	58.3
16	47.7	59.9	52.5	50.1	52.4	49.5	53.5	54.1	56	45.4	47	57.9
17	48.1	60.1	52.7	49.7	52	49.5	53.9	54.8	57.5	46.4	48.3	59
18	51.3	61.6	54.4	50.7	52.1	50.5	55.6	57.6	62.3	51.7	52.9	62.7
19	55.6	65.2	58.2	54	54.5	53.5	59.7	63.5	71.7	61	57.3	65.3
20	58.2	68.3	62.5	58.4	60.3	59.2	67.1	71.6	79.3	66.7	59.9	66.6
21	60.5	70.2	65.3	61.8	66.2	66.5	73.7	77.6	82.9	69.6	62.9	67.3
22	62.5	71.9	67.5	64.5	70	70.6	77.2	81	84.6	71.8	64.5	68.2
23	64.2	73.6	69.5	67.3	73.2	72.7	79.5	83.2	85.8	73.7	66.3	68.4
24	65.8	74.7	71.3	68.7	75.3	74.9	81.1	84.3	86.7	75.8	67.8	69.1

Table 19 – Average Monthly Temperatures by Hour of the Day for St. Charles County in Fahrenheit (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	24.3	26.9	37.9	47.5	54.9	68.8	70.2	67.6	60.6	49.2	37.6	23.3
2	23.3	25.3	36.1	45.7	53.7	67.8	69	66.8	60.7	48.1	37.5	23.5
3	22.2	24.1	34.9	44.4	52.6	66.7	68.3	65.9	59.9	47.6	36.6	22.8
4	21.2	23.2	33.8	43.5	51.5	65.7	67.9	65.1	59.2	46.8	35.9	22
5	20.7	22.9	32.8	42.7	50.8	64.8	67.2	64.5	58.6	46	35	21.5
6	20.3	22.4	31.7	42.4	50.2	64.3	66.7	63.9	58.1	45.4	34.2	21.3
7	20.1	21.8	31.2	42.4	51.9	66.4	68	64.5	58	44.8	33.8	21
8	20.1	21.5	31.5	45	55.3	69.8	71	68	60.1	46.1	33.5	20.5
9	21.4	23.1	35.2	48.4	58.2	73	74.4	71.9	63.7	50.8	36.5	22.3
10	25.8	25.6	38.9	51.4	61.8	75.9	77.5	75.7	67.6	55.4	40.5	26
11	30.3	28.6	42.7	54.3	64.7	78.4	79.9	78.7	71.3	59.7	44.2	30.3
12	34.4	31.7	46.2	56.7	66.7	80.8	82.2	80.7	74.1	63.1	47.9	34.8
13	38	34.1	48.9	59.3	68	82.3	84.1	82.2	76.2	65	50.5	38.3
14	40.7	36.2	51	61.1	69.4	83.3	85.4	83.5	77.6	66.4	52.6	40.3
15	42	37.6	52.4	62.5	70.8	84	86.4	84.1	78.3	67.3	53.8	41.8
16	42	38.1	52.9	63.4	71.7	84.4	86.5	84.3	78.4	67.4	53.8	42.1
17	41.1	37.8	52.7	63.3	71.8	84.3	86	84	77.8	66.3	52.5	40.6
18	37.5	36.4	51.6	62.4	71	83.3	85	82.7	75.7	63.3	48.9	36.3
19	33.3	33.6	48.8	60.1	69.1	81.8	83	79.8	71	58.4	45.8	33.3
20	30.9	31.9	45.4	56.5	65.3	78.6	79.7	75.8	66.8	55.4	43.9	31
21	29	30.5	43.5	54	61.5	74.6	76	72.5	65	53.9	42.5	29.3
22	27.8	29.5	41.9	52.3	59.1	72.5	74	70.7	63.4	52.6	41.4	27.3
23	26.5	28.2	40.8	50.5	57.4	71.1	72.7	69.4	62.4	51.4	40	25.8
24	25.4	27.7	39	49.1	56	69.8	71.3	68.5	61.2	50.3	38.8	24.3

Table 20 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Charles County (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	67.5	75.8	71.7	70.5	76.6	77.3	83.3	85.5	87.9	76.1	68.8	69.8
2	68.2	77	72.1	72.8	76.5	78.9	84.1	86.4	88.2	77.8	70.2	71.3
3	69.6	77.5	73.5	74.4	77.9	80.5	84.9	86.9	88.8	78.9	71.6	72.5
4	70.7	78.1	74.9	75.3	79.3	82.1	85.2	88.1	89.4	79.5	72.4	73.4
5	71.6	78.1	76.4	75.8	79.8	82.9	86.4	88.4	90.1	81	73.8	74.9
6	71.9	78	77.5	76.3	81	84.1	86.7	89	90.4	81.9	75.3	75.6
7	71.6	78.7	78.2	77	79.9	81.9	85.2	88.1	90	83.1	76.2	76.5
8	71.6	78.3	78.2	73	75.5	76.3	80.2	84	88.8	82.6	76.4	76.2
9	70.5	76.7	74.7	67.9	71.4	70.6	73.8	76.5	83.8	76.8	73.9	75
10	66.2	73.8	69.8	63.9	64.7	65.5	68.2	69	76.3	67.9	68.3	72.2
11	61.3	70.1	63.8	60.2	59.8	60.5	63.5	62.9	69.2	59.8	62.4	68.5
12	56.4	66.7	58.8	57.5	57	55.9	59.5	58.5	63.9	53.4	56.9	65.4
13	52.5	64	55.1	54.7	55.9	53.1	56.6	55.9	59.8	49.9	53.2	62.7
14	49.9	61.3	53	52.7	54.3	51.7	54.4	54	57.3	47.6	49.8	61.2
15	48.1	59.5	51.6	50.9	52.7	50.1	53.1	52.9	56	46.3	47.8	59.6
16	47.1	58.9	51.4	49.5	51.7	49.2	52.9	53	55.6	46	47.1	59.2
17	47.3	59.5	51.8	49.1	50.8	49.2	53.8	53.9	57.1	47	48.6	60.2
18	50.9	61.1	53.5	50.3	50.7	50.3	55.5	56.4	61.6	52.2	53.3	64
19	55.7	65.2	57.5	53.3	53.1	53.2	60	62.4	71.9	61	57.6	66.6
20	58.6	68.1	62.3	58.2	59	59.3	66.8	71.2	80.5	66.9	60.4	67.7
21	61.1	70.6	64.9	61.5	65.4	66.9	74	77.6	83.5	69.3	62.2	67.8
22	62.6	72.3	67.1	63.7	70.2	71.1	77.4	81.3	85.6	71.1	63.9	68.1
23	64	73.7	68.6	66.6	72.9	73.5	79.2	83.3	86.1	72.9	65.5	68.5
24	65.6	74.9	70.7	68.2	75	76	81.1	84.7	87.6	74.7	67.3	69.3

Table 21 – Average Monthly Temperatures by Hour of the Day for St. Louis County in Fahrenheit (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25.5	28.1	39	48.2	56.2	70.2	71.8	68.8	62.4	50.7	38.8	24.4
2	24.5	26.6	37.3	46.2	55	69.1	70.6	68.1	62.5	49.8	38.6	24.6
3	23.6	25.2	36.1	45.1	53.8	68	69.9	67.2	61.6	49.1	37.8	23.9
4	22.7	24.5	35.1	44.3	52.8	67	69.6	66.5	60.9	48.4	37	23.2
5	21.9	23.9	34.2	43.6	52.1	66.1	68.9	65.9	60.4	47.6	36.3	22.5
6	21.4	23.4	33.1	43.3	51.6	65.6	68.4	65.3	59.9	47.1	35.6	22.5
7	21.2	23.1	32.6	43.3	53.2	67.7	69.7	65.8	59.8	46.6	35	22.5
8	21.2	22.7	32.9	45.7	56.5	70.9	72.5	69.4	61.9	47.9	34.9	22
9	22.5	24.1	36.4	48.9	59.4	73.9	75.7	72.8	65.2	52.2	37.8	23.9
10	26.6	26.7	39.8	51.8	62.5	76.8	78.5	76.6	68.7	56.7	41.5	27.2
11	30.8	29.5	43.3	54.6	65.2	79.3	81	79.5	72.2	60.7	45.1	31.1
12	34.9	32.5	46.7	56.8	67.1	81.6	83.1	81.4	74.8	63.9	48.4	35.1
13	38.2	35	49.4	59.3	68.4	83.1	84.8	83	76.8	65.8	50.9	38.7
14	41	37.1	51.3	61	69.4	84	86.2	84.1	78.3	67.2	52.8	40.8
15	42.5	38.5	52.7	62.4	70.8	84.8	87.2	84.8	79	67.9	54	42
16	42.5	39	53	63.2	71.6	85	87.3	84.9	79	68.1	54.1	42.5
17	41.6	38.6	53	63.1	71.9	84.9	86.8	84.6	78.4	67	52.8	40.8
18	38.1	37.2	51.7	62.4	70.9	84	85.9	83.2	76.3	64.2	49.5	37
19	34.2	34.6	49.1	60.1	69.3	82.5	83.9	80.5	72.3	59.9	46.6	34.4
20	31.8	32.9	46.3	56.8	65.6	79.5	80.7	76.8	68.5	57.1	44.8	32.3
21	30.1	31.6	44.4	54.4	62.5	76	77.4	73.9	66.6	55.5	43.4	30.6
22	29.2	30.8	42.6	52.8	60.2	73.9	75.8	72.1	65.2	54.1	42.2	28.4
23	27.9	29.5	41.7	51	58.4	72.4	74.4	70.8	64.1	52.9	41.1	27
24	26.8	28.8	40	49.6	57.2	71.2	73	69.8	63.1	51.7	39.9	25.3

Table 22 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Louis County (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	67.3	75.9	71.8	70	75.9	75.8	82.3	85	87.4	75.9	68.9	70.2
2	68.1	77.1	72.2	72.6	76	78.1	83.3	85.8	87.7	77.6	70.3	71.8
3	69.5	78.3	73.3	74.2	77.4	80	84.2	86.7	88.6	79.1	71.7	72.9
4	70.3	78.5	74.4	74.7	78.5	81.3	84.7	87	89.5	79.6	72.5	73.8
5	71.5	78.5	75.9	75.6	79.3	82.4	85.9	87.9	89.8	81.1	73.6	75.7
6	72	78.8	77.7	76.1	80.5	83.3	86.2	88.4	90.1	82	75.4	76.4
7	71.7	79.1	78	76.4	79.4	81.1	84.7	88.2	90.1	82.9	76.3	76.7
8	71.4	78.4	78.6	72.5	75	75.6	79.8	83.2	88.6	82.4	76.6	76.6
9	70.3	77.2	74.8	67.9	71	70	73.4	76.3	83.3	76.7	74.1	75.2
10	66	74.2	69.9	63.7	65	64.7	67.9	68.6	76.2	67.6	68.2	72.7
11	61.4	70.5	64.6	60.2	60	60	63.2	62.8	69.1	59.4	62.3	68.9
12	56.7	67.1	59.6	57.8	57.5	55.2	59.2	58.4	63.5	53.1	57.5	66
13	52.8	64.6	56	54.9	56.4	52.3	56.3	55.8	59.6	49.5	53.4	63.2
14	49.8	62	53.9	53.1	55.1	51.3	54.2	53.9	57	47.2	50.4	61.2
15	47.8	59.9	52.4	51.3	53.5	49.5	52.5	52.9	55.5	45.9	48.4	59.9
16	46.8	59	52.7	49.9	52.7	48.6	52.5	52.9	55.3	45.5	47.5	59.2
17	47.2	59.7	52.9	49.6	51.4	48.6	53.2	53.9	56.8	46.6	48.8	60.5
18	50.6	61.2	54.8	50.5	51.4	49.7	54.7	56.4	61.5	51.4	53.2	64.1
19	55.1	65.1	58.5	54	53.5	52.4	58.9	62	70.6	59.1	57.2	66.5
20	58.2	68.2	62.5	58.2	59	57.9	65.8	69.8	78.6	65.1	60	67.9
21	60.2	70.4	65.3	61.4	64.5	64.3	72.3	76.1	82.2	68.2	62.1	68.3
22	61.9	72.1	67.7	63.6	69.2	69	75.5	80	84.2	70.4	64	68.6
23	63.7	73.8	69.3	66.6	72.5	71.6	77.7	82.2	85.3	72.5	65.7	69
24	65.2	75	71.1	68.3	74.6	74.3	80.1	83.9	86.5	74.6	67.4	69.7

Table 23 – Average Monthly Temperatures by Hour of the Day for St. Louis City in Fahrenheit (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25.9	28.9	40.2	48.1	56	70.1	72.4	69.2	62.7	51.5	39.4	25.9
2	25	27.5	38.4	46.2	54.9	69.1	71.2	68.5	62.9	50.7	39.2	25.9
3	24	26.3	37.4	45.3	53.8	68	70.6	67.7	62.2	49.9	38.3	25
4	22.9	25.4	36.3	44.3	52.9	67	70.1	67	61.5	49.4	37.8	24.6
5	22.4	24.9	35.6	43.7	52.2	66.2	69.6	66.3	61	48.6	37.1	23.9
6	21.7	24.4	34.5	43.4	51.8	65.6	69.1	65.9	60.6	47.9	36.4	23.9
7	21.5	23.8	33.9	43.7	53.6	67.9	70.6	66.5	60.5	47.5	35.8	23.9
8	21.3	23.5	34.2	46	57	71.2	73.5	70.2	62.6	48.8	35.8	23.2
9	22.8	24.9	37.7	49.2	59.8	74.4	76.5	73.7	66	53.3	38.7	25.2
10	27	27.5	41	52.1	62.9	77.4	79.2	77.5	69.5	57.8	42.5	28.4
11	31	30.3	44.3	54.8	65.6	79.9	81.6	80.3	72.9	61.8	45.9	32
12	35	33	47.4	57	67.7	82.1	83.6	82.3	75.4	64.8	49.3	35.9
13	38.1	35.5	50.1	59.3	68.7	83.8	85.2	83.7	77.3	66.8	51.7	39.3
14	41.1	37.4	51.8	61	69.7	84.5	86.7	84.9	78.7	68.1	53.5	41.5
15	42.7	38.8	53.3	62.4	71.1	85.3	87.6	85.5	79.4	68.8	54.6	42.9
16	42.5	39.3	53.6	63.2	71.7	85.4	87.8	85.5	79.5	68.8	54.6	42.9
17	41.6	39.1	53.4	62.9	72	85.4	87.5	85.3	78.7	67.9	53.3	41.5
18	38.1	37.7	52.2	62.1	71.2	84.4	86.4	83.8	76.8	65.1	50	37.7
19	34.3	35.1	49.5	60.1	69.4	82.9	84.5	81.2	72.5	60.7	47.2	35
20	32.1	33.4	47	56.7	65.8	79.8	81.4	77.2	68.5	57.8	45.2	33.4
21	30.4	32.2	45	54.5	62.5	76	77.9	74.3	66.8	56.2	43.8	31.6
22	29.5	31.3	43.5	52.8	60.2	73.6	76.2	72.3	65.5	54.9	42.7	29.8
23	28.3	30.1	42.6	51	58.3	72.2	74.8	71.2	64.3	53.6	41.6	28.4
24	27.2	29.6	41.1	49.5	57.1	71	73.6	70.3	63.4	52.4	40.6	26.8

Table 24 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Louis City (MOVES Inputs for 2008, 2015, 2017, and 2022 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	68	76.6	72.6	71.4	77	76.6	83.4	85.9	87.7	76.9	69.3	69.8
2	69	78.1	73.2	73.8	76.9	78.7	84.2	86.5	87.7	78	71	71.3
3	69.8	79	74	74.8	78	80.8	85.4	87	88	79.7	72.1	72.7
4	70.9	79	75.2	75.9	79.1	81.9	85.6	87.6	88.9	80.3	72.3	73.6
5	72.1	78.9	76.3	76.5	79.9	82.7	86.5	88.5	89.5	81.5	73.4	75.2
6	72.4	79.2	78.4	77.4	80.5	83.9	86.8	88.5	89.8	82.7	75.2	75.8
7	72.7	79.5	79	77.1	79.4	81.7	85.1	88.2	89.5	83.3	76.3	76.2
8	72.3	79.1	79.4	73.4	75.1	75.9	80.1	83.3	88.3	83.1	76.3	76.4
9	70.9	77.9	75.6	68.3	71	70	74	76.4	83	77	73.6	75
10	66.7	74.9	70.6	64.2	64.8	64.5	68.4	68.9	75.7	67.4	68	72.5
11	61.9	71.5	65.5	60.7	60.1	59.6	63.7	63.1	68.9	59.1	62.4	69
12	57.4	68.3	60.7	58.5	57.1	55.3	59.7	58.7	63.6	52.8	57.2	66.1
13	53.7	65.5	57	55.7	56.4	52	57.1	56.3	59.7	48.9	53.8	63.1
14	50.6	63.3	55.1	53.7	55.1	51.2	54.6	54.2	57	46.4	50.7	61.1
15	48.4	61.4	53.4	51.7	53.7	49.5	53.1	53.5	55.5	45.5	48.5	59.5
16	47.8	60.3	53.4	50.4	52.9	48.9	52.7	53.5	55.1	45.3	47.8	59.1
17	48	60.7	53.8	50.2	51.8	48.9	53.4	54.2	56.8	46.4	48.9	60.1
18	51.2	62.1	55.8	51.4	51.4	49.9	55.2	57.1	61.6	51.3	53.3	63.6
19	55.9	66	59.7	54.8	53.9	52.4	59.2	62.6	71.1	59.4	57.3	66.2
20	58.7	69.2	63.6	59.6	59.7	58.2	66.3	71.1	79.7	65.7	60.6	67.5
21	60.8	71.1	66.4	62.1	65.5	65	73.6	77.5	83.4	68.8	62.6	68.4
22	62.5	73.1	68.7	64.8	70	70.2	76.8	81.4	84.8	71	64.5	68.7
23	64.3	74.8	70.2	67.7	73.6	72.8	79.1	83.1	86.2	73.1	66.3	68.9
24	66.1	75.7	71.8	69.4	75.7	75.3	81	84.8	87.1	75.5	67.8	69.6

Attachment 1 of Appendix G

**Documentation of On-Road Mobile Source VOC Emissions Calculations in the
St. Louis Ozone Nonattainment Area for 2011**

Section 1: St. Louis Area On-Road Mobile Source VOC Emissions Calculations for 2011

The 2011 on-road mobile source emissions inventory data used in this demonstration was calculated with MOVES 2010b. The 2011 mobile emissions were calculated for the purposes of the 2011 National Emissions Inventory; however they are displayed in this demonstration in order to provide a broad range of years demonstrating the continual decline of mobile source VOC emissions in the St. Louis area.

The emissions for 2011 were calculated with MOVES 2010b, using 2011 VMT data provided by the East West Gateway Council of Governments. The 2011 VMT data was originally generated from the Missouri Department of Transportation for state-owned roads, and then East-West Gateway used their Traffic Demand Model to calculate the actual local VMT data for each of the five counties on the Missouri side of the St. Louis Ozone nonattainment area.

The road type distribution input used in 2011 was developed from Missouri Department of Transportation traffic distribution data for state-owned roads. The road type distribution is an average of all five counties. The Source Type Population and Age Distribution tables were developed using 2011 motor vehicle registration data from the Missouri Department of Revenue. The list of vehicle identification numbers provided by the Missouri Department of Revenue was converted into Mobile6 vehicle classifications using a contractor to decode the VINs. The EPA provided excel conversion tables were used to convert the Mobile6 age distribution and vehicle population numbers into the MOVES formatted age distribution and source type population tables. The meteorology data used for 2011 was developed by EPA from National Weather Service data. The data was provided in the 2011 NEI MOVES County Database files, and each county has county specific meteorology data. Inspection and Maintenance (I/M) input tables were developed to characterize the Gateway Vehicle Inspection Program (the I/M program in place in the St. Louis Ozone nonattainment area). Additional details regarding the development of the I/M input can be found in the I/M input table development protocol (Attachment #2).

MOVES 2010b base data was used for all other inputs to calculate the 2011 mobile source emissions, after reviewing the data to ensure accuracy. The base fuel supply tables in MOVES were used for the runs, as they already took into account the reformulated gasoline used in the St. Louis nonattainment area. A separate input database was created for each county, using county specific data where possible. All of the data used to develop the county database manager inputs for the MOVES 2010b runs performed for 2011, other than the data for county database manager inputs where EPA default data was used, can be found in Section 2 of this document.

The MOVES model runs were set up selecting all available gasoline and diesel fuel vehicle type combinations, all months, days, hours, and all road types. A separate run was set-up for each pollutant and each county. The emissions were post-aggregated to the month level using MOVES. Once the MOVES input tables had been created, MOVES 2010b was ran and all

months for 2011 were selected to create an annual emissions profile. The VOC emissions for the months of April through October were totaled and divided by 214, the number of days in those months, to give average ozone season day VOC emissions for 2011
.

Section 2: Data Used to Develop the MOVES County Database Manager Inputs for the St. Louis Nonattainment Area Counties for 2011

When using MOVES 2010b to calculate the on-road mobile source VOC emissions, default data was used in the county database manager for Average Speed Distribution, Fuel Supply, Fuel Formulation, VMT Monthly Distribution, VMT Daily Distribution, and VMT Hourly Distribution for all five counties. For all county database manager input tables developed by the Air Program for 2011, the data used to develop these input tables is listed in Tables 1 – 15 below.

Table 1 – 2011 Source Type Population (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

YearID	SourceTypeName	SourceTypeID	Source Type Population by County				
			Franklin	Jefferson	St Charles	St Louis County	St Louis City
2011	Motorcycle	11	3,350	7,286	8,742	14,883	2,497
2011	Passenger Car	21	37,614	82,976	143,363	472,093	98,106
2011	Passenger Truck	31	41,668	76,955	112,323	287,935	51,525
2011	Light Commercial Truck	32	15,143	26,379	36,070	91,906	17,414
2011	Refuse Truck	41	12	44	36	74	28
2011	Single Unit Short-haul Truck	42	35	131	108	222	83
2011	Single Unit Long-haul Truck	43	258	490	504	1,994	322
2011	Motor Home	51	20	17	16	45	15
2011	School Bus	52	668	737	820	2,846	962
2011	Transit Bus	53	50	55	60	214	72
2011	Intercity Bus	54	38	61	73	299	110
2011	Combination Short-haul Truck	61	335	280	270	679	231
2011	Combination Long-haul Truck	62	276	219	210	456	151

Table 2 – 2011 Annual VMT by HPMS Vehicle Type, County, and Year (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HPMSVtypeID	HPMSVtypeName	YearID	HPMSBaseYearVMT by County				
			Franklin	Jefferson	St. Charles	St. Louis	St. Louis City
10	Motorcycles	2011	9,402,897	14,491,095	24,790,826	80,646,379	20,723,458
20	Passenger Cars	2011	665,926,569	1,026,279,979	1,755,721,576	5,711,491,339	1,467,664,806
30	Other 2 axle-4 tire vehicles	2011	255,497,009	393,754,323	673,620,235	2,191,336,137	563,101,077
40	Buses	2011	4,851,597	7,476,945	12,791,280	41,610,973	10,692,647
50	Single Unit Trucks	2011	43,124,442	66,460,408	113,697,992	369,867,925	95,043,852
60	Combination Trucks	2011	121,423,920	187,130,150	320,135,292	1,041,423,637	267,611,510

Table 3 – 2011 Inspection and Maintenance Data (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

Pol Process ID	State ID	Year ID	Source Type ID	Fuel Type ID	IM Program ID	Inspect Freq	Test Standards ID	Beg Model Year ID	End Model Year ID	Use IM Y/N	Compliance Factor
101	29	2011	21	1	1	1	11	1971	1995	N	93.12
101	29	2011	21	1	10	2	51	1996	2009	Y	97.94
101	29	2011	31	1	1	1	11	1971	1995	N	93.12
101	29	2011	31	1	10	2	51	1996	2009	Y	92.06
101	29	2011	32	1	1	1	11	1971	1995	N	93.12
101	29	2011	32	1	10	2	51	1996	2009	Y	86.18
102	29	2011	21	1	1	1	11	1971	1995	N	93.12
102	29	2011	21	1	10	2	51	1996	2009	Y	97.94
102	29	2011	31	1	1	1	11	1971	1995	N	93.12
102	29	2011	31	1	10	2	51	1996	2009	Y	92.06
102	29	2011	32	1	1	1	11	1971	1995	N	93.12
102	29	2011	32	1	10	2	51	1996	2009	Y	86.18
112	29	2011	21	1	7	1	41	1971	1995	N	93.12
112	29	2011	21	1	8	2	43	1996	2009	Y	97.94
112	29	2011	31	1	7	1	41	1971	1995	N	93.12
112	29	2011	31	1	8	2	43	1996	2009	Y	92.06
112	29	2011	32	1	7	1	41	1971	1995	N	93.12
112	29	2011	32	1	8	2	43	1996	2009	Y	86.18
113	29	2011	21	1	7	1	41	1971	1995	N	93.12
113	29	2011	21	1	8	2	43	1996	2009	Y	97.94
113	29	2011	31	1	7	1	41	1971	1995	N	93.12
113	29	2011	31	1	8	2	43	1996	2009	Y	92.06
113	29	2011	32	1	7	1	41	1971	1995	N	93.12
113	29	2011	32	1	8	2	43	1996	2009	Y	86.18

Table 4 – Road Type Distribution (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

Source Type ID	Road Type ID	Road Type VMT Fraction	Source Type ID	Road Type ID	Road Type VMT Fraction
11	1	0	52	1	0
11	2	0.017288	52	2	0.017288
11	3	0.074577	52	3	0.074577
11	4	0.616845	52	4	0.616845
11	5	0.29129	52	5	0.29129
21	1	0	53	1	0
21	2	0.017288	53	2	0.017288
21	3	0.074577	53	3	0.074577
21	4	0.616845	53	4	0.616845
21	5	0.29129	53	5	0.29129
31	1	0	54	1	0
31	2	0.017288	54	2	0.017288
31	3	0.074577	54	3	0.074577
31	4	0.616845	54	4	0.616845
31	5	0.29129	54	5	0.29129
32	1	0	61	1	0
32	2	0.017288	61	2	0.017288
32	3	0.074577	61	3	0.074577
32	4	0.616845	61	4	0.616845
32	5	0.29129	61	5	0.29129
41	1	0	62	1	0
41	2	0.017288	62	2	0.017288
41	3	0.074577	62	3	0.074577
41	4	0.616845	62	4	0.616845
41	5	0.29129	62	5	0.29129
42	1	0			
42	2	0.017288			
42	3	0.074577			
42	4	0.616845			
42	5	0.29129			
43	1	0			
43	2	0.017288			
43	3	0.074577			
43	4	0.616845			
43	5	0.29129			
51	1	0			
51	2	0.017288			
51	3	0.074577			
51	4	0.616845			
51	5	0.29129			

Table 5 –Vehicle Age Distribution (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

AgeID	11	21	31	32	41	42	43	51	52	53	54	61	62
0	0.0436	0.0639	0.076398	0.074052	0.0348	0.0348	0.013131	0.059681	0.068461	0.06768	0.077126	0.058628	0.056572
1	0.0379	0.0545	0.056036	0.052896	0.0246	0.0246	0.003494	0.034957	0.035371	0.036001	0.033854	0.034558	0.034019
2	0.0789	0.0518	0.038122	0.037103	0.0132	0.0132	0.036216	0.033113	0.035872	0.035904	0.037791	0.032638	0.031809
3	0.094	0.0677	0.066376	0.066571	0.0184	0.0184	0.069138	0.047342	0.047587	0.047801	0.047158	0.047186	0.04697
4	0.0883	0.0671	0.060881	0.060684	0.0405	0.0405	0.098013	0.136686	0.128434	0.129911	0.118171	0.137277	0.138705
5	0.0921	0.0667	0.07325	0.0735	0.0369	0.0369	0.056028	0.068436	0.076964	0.077734	0.080941	0.066623	0.063624
6	0.0699	0.0625	0.074895	0.073397	0.0231	0.0231	0.102831	0.076632	0.074017	0.075087	0.069021	0.076507	0.076564
7	0.0622	0.0663	0.069494	0.069842	0.0504	0.0504	0.120834	0.066117	0.056923	0.057919	0.047356	0.067119	0.069146
8	0.0665	0.0586	0.067393	0.067372	0.0575	0.0575	0.078472	0.067755	0.055622	0.056864	0.043202	0.069115	0.071837
9	0.0645	0.0693	0.072855	0.071667	0.0255	0.0255	0.040211	0.036375	0.03931	0.040733	0.037322	0.035149	0.033357
10	0.0451	0.0572	0.057108	0.058032	0.0306	0.0306	0.047493	0.047575	0.047842	0.047521	0.048973	0.047696	0.047828
11	0.0421	0.0618	0.052988	0.05455	0.0423	0.0423	0.066277	0.075638	0.060895	0.060468	0.051416	0.078298	0.08288
12	0.0294	0.0462	0.042401	0.044027	0.0287	0.0287	0.036229	0.046378	0.040119	0.039618	0.03702	0.047673	0.049829
13	0.026	0.0431	0.037305	0.036396	0.0211	0.0211	0.024733	0.034504	0.030644	0.030445	0.028417	0.035246	0.036504
14	0.0176	0.0315	0.027359	0.028988	0.0197	0.0197	0.020917	0.026129	0.032284	0.032271	0.036799	0.025117	0.023329
15	0.0195	0.028	0.024189	0.025117	0.0357	0.0357	0.024419	0.019853	0.024916	0.024896	0.028652	0.019026	0.017563
16	0.0135	0.0233	0.017828	0.019102	0.0291	0.0291	0.019666	0.021785	0.023893	0.023282	0.027185	0.021759	0.02155
17	0.0137	0.0201	0.017869	0.018499	0.0451	0.0451	0.016002	0.014999	0.013556	0.013504	0.012653	0.015267	0.015725
18	0.0107	0.0128	0.010756	0.010998	0.0456	0.0456	0.010873	0.012056	0.01322	0.013077	0.014467	0.011942	0.0117
19	0.0085	0.0124	0.010364	0.010483	0.0282	0.0282	0.008743	0.009118	0.00864	0.008691	0.008141	0.009172	0.009281
20	0.0057	0.0078	0.006807	0.006906	0.0527	0.0527	0.008974	0.008864	0.010739	0.010809	0.011895	0.008519	0.007928
21	0.0068	0.0074	0.00685	0.007057	0.0644	0.0644	0.014947	0.009824	0.014223	0.013313	0.020052	0.009571	0.008888
22	0.0051	0.0048	0.00685	0.006959	0.0367	0.0367	0.016863	0.009534	0.012041	0.011208	0.016262	0.009557	0.009379
23	0.0054	0.0042	0.009505	0.00924	0.0616	0.0616	0.002219	0.008127	0.010536	0.009934	0.014029	0.008044	0.00774
24	0.005718	0.003675	0.011175	0.010707	0.103394	0.103394	0.00104	0.007278	0.009543	0.008907	0.013027	0.007235	0.006993
25	0.006054	0.003216	0.002712	0.002851	0.030206	0.030206	0.000944	0.005649	0.008432	0.007738	0.012466	0.00555	0.005195
26	0.00641	0.002814	0.00084	0.000986	0	0	0.000942	0.003298	0.007172	0.006438	0.012116	0.003039	0.002391
27	0.006787	0.001296	0.00033	0.000461	0	0	0.00011	0.001451	0.001527	0.001481	0.001711	0.001463	0.001473
28	0.007186	0	0.000239	0.000311	0	0	7.60E-05	0.001052	0.001112	0.001089	0.001223	0.001055	0.001053
29	0.007609	0	0.00019	0.000219	0	0	4.67E-05	0.000785	0.000832	0.000836	0.000852	0.000775	0.000758
30	0.013236	0	0.000635	0.001027	0	0	0.060118	0.009009	0.009272	0.008839	0.010701	0.009196	0.00941

Table 6 – Average Monthly Temperatures by Hour of the Day for Franklin County in Fahrenheit (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	24.7	34.9	44.1	50.3	59.4	68.6	67.7	66.8	60.6	46.1	43.9	26.6
2	22.2	34.7	42	48.2	57.9	67.7	66.9	66.2	59.6	46.1	42.9	27
3	21.1	33.3	40.9	47.2	56.8	66.6	65.9	65.4	58.8	45.3	42	26.4
4	20.2	32.3	40.1	46.1	56	65.8	65.2	64.6	58	44.5	41.3	25.5
5	19	31	39.4	45.2	55	65.1	64.4	63.8	57.3	43.5	40.6	24.7
6	18.3	29.8	38.5	44.6	54.2	64.6	63.7	63.1	56.7	42.9	40.2	24.2
7	17.8	28.6	37.8	44.5	56	66.6	65.3	63.6	56.3	42.1	39.7	23.8
8	17.4	27.8	38.2	47.9	59.9	70.2	69	67.7	58.9	42.9	39.6	23.4
9	17.9	29.8	42.2	52.4	63.6	74	72.7	72.3	62.7	46	42.7	24
10	21.8	34	46.6	56.2	66.8	77.3	75.7	76.2	66.7	49.3	47.7	27.4
11	26.1	38.2	50.8	59.8	69.7	80	78.4	79.2	70.4	52.5	51.8	30.8
12	30.3	42.4	54.6	62.6	72	82.4	80.2	81.6	73.2	55.3	55.3	34.2
13	33.9	45.6	57.4	64.6	73.8	84.3	81.9	83.4	75.1	57.4	57.9	36.5
14	36.7	48.4	59.8	66.1	75.5	85.7	83	84.6	76.5	59	59.7	38.2
15	38.6	50.5	61.2	66.7	76.6	85.9	83.7	85.4	77.3	59.9	60.6	39.1
16	39.7	51.3	61.8	66.8	76.7	86.2	83.8	85.4	77.4	60.1	60.5	39.3
17	39.2	51	61.5	66.4	76.3	86.1	83.5	85	76.7	59.3	58.9	37.8
18	36	48.8	59.6	65.3	75.5	85	82.9	83.7	74.9	57.2	54.9	34
19	32.4	44.8	55.9	63.1	73.4	83.1	81.2	80.9	71.1	53.7	51.5	31.9
20	30.5	42.2	52.1	59.6	69.5	79.9	77.8	76.2	67.1	51.6	49.5	30.4
21	28.9	40.4	49.8	56.9	66.1	75.6	73.6	72.8	65.4	50.1	48.1	29.3
22	28	38.7	47.9	54.8	64	73.2	71.4	70.9	63.8	49	46.8	28.7
23	27	37.2	46.4	53	62.2	71.4	69.9	69.5	62.7	47.9	45.8	28.1
24	25.7	35.9	45.1	51.4	60.7	69.8	68.6	68	61.6	47.1	44.8	27.2

Table 7 – Average Monthly Percent Relative Humidity by Hour of the Day for Franklin County (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	68.4	68.5	65	69.7	78.7	82	84.3	86.1	83.9	80.7	72.9	75.1
2	69.9	69	67.4	70	80.7	83.4	84.9	87.2	84.7	81.6	75.2	76.1
3	70.4	70.3	69.2	71.3	82.1	84.8	86	87.8	85.6	83.2	76.3	76.4
4	71.3	71.1	70.5	72.6	82.9	86	86.6	88.7	86.5	83.8	77.5	77
5	72.1	72.8	71.9	73.9	83.8	86.9	87.5	89.6	87.4	84.7	78.7	77.9
6	72.3	73.6	73	75.1	84.7	87.5	88.1	90.3	88	85	79.2	78.2
7	72.6	74.1	73.8	75.6	83.3	85.7	87.2	90	88.7	85.6	80.2	78.5
8	72.9	74.6	74.1	72.8	77.3	79.9	81.5	85.5	86.9	85.3	80.8	78.5
9	72.9	72.9	69.9	66.5	69.9	73.5	74.7	78.4	81.6	81.6	78.5	77.8
10	69.6	67.5	63.5	61.4	63.9	68.2	68.7	71.5	74.9	77	71.1	74.6
11	64.8	62.4	57.8	56.7	58.9	64.4	64	65.9	67.9	71.6	64.7	70
12	60	57.3	52.9	53.1	55.3	60.6	60.7	61.7	62.4	67.4	59.4	65.9
13	56	53.9	48.8	50.8	52.6	58	58.1	58.7	59.2	64.4	55.7	63.5
14	52.8	50.9	45.6	49	50.4	55.8	56.6	56.4	56.7	62.2	52.7	61.4
15	50.9	49	43.8	48.2	48.9	55.1	55.7	55	55.2	60.9	51	60.2
16	49.6	48	42.8	48	48.6	54.6	55.7	54.6	55	60.5	50.8	60
17	50.1	48.1	42.6	48.3	49.1	54.5	56.1	55.1	56.3	61.5	52.3	61.6
18	53.8	50.8	44.7	49	50.4	56.1	57.4	57.3	59.6	65.1	57.3	65.3
19	58.3	56	48.9	51.8	53.9	59	61	62.7	67.7	70.9	62.4	67.8
20	61.1	59.4	53.6	56.2	60.8	64.8	67.8	71.2	75.8	74.3	65.2	70
21	63.8	62.2	57.2	60.3	67.2	71.9	75.8	77.1	78.4	76.5	66.8	71.1
22	65.1	64.6	59.8	63.3	71	75.8	79.7	79.9	81.1	77.5	68.8	72.2
23	66.1	66.3	61.7	66.1	74.2	78.3	81.6	82.1	81.9	78.7	69.8	73.1
24	67.7	68	63.6	68.2	76.8	80.1	83.5	84.3	83	79.5	71.3	74.6

Table 8 – Average Monthly Temperatures by Hour of the Day for Jefferson County in Fahrenheit (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25	33.3	42.6	49.7	60	69.5	67.9	66.8	61.9	47.2	44.9	27.6
2	22.6	33.2	40.6	47.8	58.9	68.6	67.3	66.1	61	47.2	44.1	28
3	21.6	32.2	39.5	46.9	57.9	67.8	66.3	65.3	60.2	46.3	43.4	27.2
4	20.8	31.2	38.9	45.9	56.9	67	65.6	64.5	59.5	45.8	42.6	26.6
5	19.9	30	38.3	45.2	56.2	66.3	64.9	63.8	58.8	44.9	42	25.7
6	18.9	28.7	37.5	44.7	55.3	65.8	64.3	63.3	58.2	44.2	41.7	25.3
7	18.3	27.5	36.8	44.7	57.2	67.9	65.8	63.8	57.9	43.4	41.3	24.9
8	17.8	26.7	37.5	47.8	60.6	71.2	69.2	67.7	60.4	44.3	41	24.7
9	18.4	28.7	41	51.8	64	74.8	72.7	71.9	64	47.2	44.1	25.5
10	22.1	32.7	45.2	55.3	66.8	77.7	75.5	75.8	68	50.6	48.9	28.7
11	26	36.6	49	58.5	69.3	80.2	77.9	78.5	71.4	53.7	52.8	32
12	29.5	40.5	52.6	61.2	71.2	82.4	79.7	80.7	73.8	56.1	55.9	35.1
13	32.5	43.6	55.2	62.9	72.7	84	81.4	82.4	75.5	58	58.3	37.4
14	34.9	46.2	57.2	64.2	74.1	85.2	82.4	83.7	76.8	59.4	60	39.1
15	36.7	48.1	58.7	64.8	75.1	85.5	82.9	84.4	77.6	60.4	60.9	39.9
16	37.5	48.9	59.4	64.9	75.2	85.6	83	84.4	77.7	60.6	60.8	40.1
17	37	48.6	59	64.2	74.7	85.5	82.9	83.7	77.1	59.8	59.1	38.4
18	34.3	46.6	57.2	63.4	73.8	84.2	82	82.4	75.5	57.7	55.4	34.9
19	31.3	42.6	53.8	61.4	72.1	82.8	80.6	79.7	71.9	54.3	52.1	32.6
20	29.5	40.1	50.2	58.2	68.6	79.8	77.5	75.3	68.2	52.5	50.3	31.2
21	28.2	38.5	47.9	55.8	65.7	76	73.7	72.3	66.5	51.1	49	30.3
22	27.6	37	46.1	54	63.8	73.8	71.6	70.5	65	50	47.8	29.5
23	26.8	35.8	44.6	52.3	62.5	72.1	70.1	69.1	63.9	49	46.8	28.9
24	26	34.5	43.4	50.8	61.1	70.6	68.8	67.7	62.9	48.1	45.8	28.2

G-36

Table 9 – Average Monthly Percent Relative Humidity by Hour of the Day for Jefferson County (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	68.8	69.2	65.1	70.2	79.4	81.8	84	85.5	83.3	80.1	73.9	75.2
2	70.3	69.7	67.2	70.3	80.7	83.2	84.3	86.9	84.5	81.4	75.6	76.2
3	71.1	70.2	68.8	71.5	82.5	84.3	85.7	87.5	85.1	83.2	76.7	76.8
4	71.6	71	70.1	72.9	83.6	85.5	86.3	88.4	86	83.2	78.2	77.1
5	71.9	72.4	71.2	73.9	84.2	86.6	86.9	89.3	86.9	84.1	79.1	78
6	72.4	73.1	72.3	74.8	85.4	87.2	87.2	89.9	87.5	84.7	79.7	78.3
7	72.6	73.3	73.4	75.4	83.9	85.2	86.3	89.6	88.1	85.3	80.3	78.9
8	73.2	74.2	73.1	72.5	77.7	79.4	80.9	85.2	86.3	85.1	81.2	78.6
9	73	72.5	69.2	66.5	70.4	72.8	74.2	78.1	81.1	81.7	78.6	78
10	69	67.4	63.3	61.2	64.1	67.8	68.5	70.9	74.2	76.2	71.2	74.7
11	64.5	62.2	57.8	56.9	59.3	63.7	64.1	65.3	67.5	70.9	64.6	70.5
12	60.1	57.7	53	53.3	56	60.2	60.4	61.2	62.5	67.2	59.5	66.3
13	56.3	54.3	48.6	51.2	53.2	57.7	58	57.9	59.3	64.2	55.8	63.6
14	53.4	51.4	45.6	49.4	51.1	55.6	56.3	55.7	56.9	62.2	53.1	61.7
15	51	49.9	43.4	48.4	49.8	54.8	55.6	54.5	55.5	60.5	51.2	60.6
16	50.1	48.4	42.1	48.1	49.3	54.3	55.6	54.1	55.1	60.1	50.8	60.4
17	50.8	48.9	42.2	48.7	49.9	54.3	56	55	56	60.9	53	62.2
18	54.2	51.7	44.5	49.1	51.3	56	57.5	56.9	59.3	64.7	58	65.7
19	59.1	56.9	49	51.9	54.7	58.6	60.6	62.4	67.1	70.7	63.2	68.5
20	62	60.6	54	56.7	61.8	64.1	67.3	70.9	75.1	73.8	66.3	70.4
21	64.5	63.2	57.6	60.8	68.1	71.2	74.8	76.5	78.2	76	68	71.5
22	65.9	65.4	60	63.7	71.7	75	78.9	79.6	80.6	77	69.7	72.6
23	66.9	66.9	62.2	66.5	74.5	78.1	81.3	81.8	82	78.4	71	73.8
24	67.7	68.4	64.1	68.7	77.4	79.9	83.2	84	82.5	79.3	72.3	74.7

Table 10 – Average Monthly Temperatures by Hour of the Day for St. Charles County in Fahrenheit (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	23.3	31.7	41.4	48.5	58.4	68.2	67	66	60.8	46.4	43.7	26.9
2	21.1	31.7	39.4	46.5	57	67.3	66.3	65.5	59.7	46.4	42.7	27.8
3	20	30.4	38.1	45.5	55.9	66.4	65.4	64.7	59	45.6	41.9	27.1
4	19.2	29.4	37.4	44.5	55	65.6	64.6	63.9	58.2	45.1	41.2	26.3
5	18	28	37	43.8	53.9	64.7	63.9	63.2	57.4	44.2	40.6	25.7
6	17.2	26.7	36	43.2	53.1	64.3	63.2	62.7	56.7	43.6	40.2	25
7	16.7	25.7	35.3	43.2	55	66.4	64.8	63.3	56.5	42.8	39.9	24.6
8	16.4	25	36	46.3	58.6	69.7	68.3	67.2	59.2	43.7	39.8	24.2
9	17	27	39.8	50.7	62.3	73.2	71.7	71.2	63.1	46.4	43	25
10	20.5	31.2	44.3	54.3	65.5	76.4	74.4	74.8	67.2	49.8	47.6	28.2
11	24.3	35.4	48.4	57.7	68.2	79	76.8	77.4	70.7	52.7	51.6	31.5
12	27.8	39.4	51.9	60.4	70.3	81.3	78.8	79.6	73.3	55.2	54.8	34.5
13	30.8	42.8	54.8	62.4	72.2	83	80.4	81.5	75	57.2	57.3	36.4
14	33.1	45.6	56.7	63.8	73.8	84.3	81.4	82.9	76.4	58.6	58.9	38.1
15	34.9	47.5	58.3	64.4	75	84.4	81.9	83.6	77.3	59.6	59.9	38.9
16	35.8	48.5	58.7	64.5	75.1	84.8	82.1	83.6	77.5	59.8	59.6	38.7
17	35.3	48	58.3	63.9	74.6	84.8	81.9	83	76.9	59	58	37.2
18	32.6	45.5	56.6	63.1	73.8	83.8	81	81.9	75.2	56.9	54.1	33.7
19	29.3	41.3	52.9	61	71.9	82.1	79.6	79.1	71.4	53.6	51	31.5
20	27.8	39.1	49.3	57.7	68.2	79.1	76.5	74.9	67.2	51.8	49	30.3
21	26.3	37.4	47	55.1	64.8	75	72.6	71.7	65.5	50.4	47.9	29.5
22	25.7	35.7	45.2	53	62.8	72.7	70.5	70	63.9	49.3	46.5	28.8
23	25.1	34.2	43.6	51.3	61.1	71	69.1	68.6	62.8	48.1	45.6	28.2
24	24.1	32.9	42.5	49.6	59.6	69.3	68	67.2	61.7	47.3	44.6	27.8

Table 11 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Charles County (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	68.6	69.6	65.2	69.8	77.2	81.7	84.3	86.6	83.9	81.3	74.7	76.5
2	70.4	69.8	67.3	70.1	79.1	83.4	84.8	87.5	85.3	82.6	77	77.2
3	70.9	70.9	69.1	71.4	80.8	84.8	85.7	88.1	85.9	84.5	78.1	77.5
4	71.5	71.4	70.5	72.4	82	85.7	86.9	89.6	87.1	84.4	79	78.4
5	72	73.1	71.3	73.5	83.1	86.9	87.1	90.3	88.1	85.7	80.2	79.3
6	72.2	73.9	72.7	74.6	84.3	87.5	88	90.9	89	86	81.2	80
7	72.5	74.4	73.5	75.2	82.6	85.4	86.9	90.3	89.3	86.6	81.8	80.3
8	72.8	75	73.3	72.3	75.8	79.3	81.1	85.5	87.5	85.7	82.1	80.6
9	72.8	73.3	69.1	65.6	68	72.9	74.1	78	81.6	82.6	79.2	79.3
10	69.7	67.8	62.7	60.2	61.4	67.6	68.1	70.8	74.4	77.3	72.2	75.6
11	65.2	62.3	57	55.5	56.6	63.8	63.5	65	67	71.9	65.2	70.7
12	60.7	57.6	52.3	52.2	53.2	59.8	59.9	60.6	61.6	67.9	60	66.5
13	56.8	53.9	47.6	49.7	50.5	57.4	57.2	57.4	58.1	65.1	56.5	64.5
14	53.6	50.9	44.8	47.9	48.5	55.2	55.6	54.8	55.9	62.9	54	62.6
15	51.6	49	42.8	47.1	46.8	54.5	55.1	53.6	54.2	61.3	52.3	61.2
16	50.4	47.4	42	46.9	46.5	53.8	54.9	53.1	53.7	60.7	51.9	61.4
17	51.2	48.1	42.1	47.4	47.2	53.6	55.3	53.7	55	61.5	53.8	63
18	54.9	51.7	44.4	48.1	48.5	55.2	57.1	55.7	58.2	65.3	59	66.6
19	59.9	57.1	49.2	50.9	51.7	57.9	60.2	61.6	66.3	71.4	64.1	69.5
20	62.8	60.5	54.5	56.1	58.7	63.6	67.2	70.3	75.8	74.6	67.2	71.2
21	65.4	63.1	57.7	60	65.3	71.3	75.7	76.4	78.9	76.8	68.1	72.3
22	66.5	65.8	60.1	63.1	69.3	75.2	79.6	79.3	82	78.2	70.4	73.8
23	67	67.6	62.1	65.9	72.8	78	81.5	81.7	82.5	79.6	71.4	74.7
24	68.1	68.8	63.7	68.3	75.3	79.8	83.2	84.6	83.3	80.1	73	75.6

Table 12 – Average Monthly Temperatures by Hour of the Day for St. Louis County in Fahrenheit (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	24.8	33.1	42.9	50.2	61	70.2	68.9	68.1	62.6	47.7	45.9	28
2	22.6	33.1	41.1	48.4	59.8	69.5	68	67.6	61.7	47.6	45	28.7
3	21.6	32	40	47.6	58.9	68.5	67.2	66.7	61	46.8	44.2	28
4	20.6	31	39.2	46.5	57.9	67.6	66.3	66	60.2	46.4	43.6	27.2
5	19.5	29.7	38.6	45.8	57.2	66.7	65.7	65.3	59.5	45.6	43	26.6
6	18.6	28.4	37.8	45.3	56.4	66.5	65.1	64.8	58.8	44.9	42.5	26.1
7	18.1	27.4	37.3	45.3	58.1	68.6	66.6	65.4	58.6	44.3	42.3	25.7
8	17.8	26.8	37.8	48.2	61.2	71.7	69.8	68.9	61.1	45.2	42	25.5
9	18.4	28.7	41.2	52.1	64.3	75	73	72.5	64.7	47.7	45.1	26.3
10	21.7	32.3	45.3	55.4	66.9	78	75.5	75.9	68.5	50.8	49.7	29.3
11	25.5	36.2	49.2	58.5	69.3	80.4	77.8	78.5	71.6	53.8	53.3	32.5
12	28.6	40	52.6	61.1	71.2	82.7	79.6	80.6	74.1	56	56.3	35.5
13	31.6	43.2	55.1	62.9	72.6	84.4	81.3	82.4	75.6	58.1	58.5	37.4
14	33.9	46	57	64.2	74	85.6	82.3	83.6	76.9	59.4	60.2	39.1
15	35.5	47.6	58.5	64.9	75.1	85.7	82.8	84.4	77.7	60.5	61	39.9
16	36.4	48.4	59	65	75.2	85.8	82.9	84.3	78	60.6	60.7	39.9
17	35.9	48.1	58.7	64.3	74.7	85.8	82.7	83.7	77.4	59.7	59.2	38.2
18	33.4	45.8	57	63.4	74	84.8	81.9	82.5	75.9	57.8	55.7	34.8
19	30.5	42.1	53.6	61.5	72.4	83.3	80.6	79.9	72.4	54.8	52.8	32.7
20	28.9	40	50.3	58.5	69.2	80.6	77.7	76.1	68.9	53	51.1	31.4
21	27.6	38.5	48.2	56.3	66.6	77	74.3	73.4	67.2	51.7	49.9	30.4
22	27.2	36.9	46.3	54.5	64.8	74.8	72.2	71.7	65.8	50.7	48.6	29.9
23	26.6	35.7	44.8	52.9	63.5	73.1	70.9	70.4	64.7	49.5	47.9	29.3
24	25.6	34.4	43.7	51.3	62.2	71.5	69.7	69	63.6	48.6	46.8	28.7

Table 13 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Louis County (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	69	70	65.1	70	77.4	80.7	82.9	84.9	82.8	80.5	74	75.9
2	70.6	70.3	67.3	70.3	79.3	81.8	83.7	86.1	84.2	82	76	76.6
3	71.4	71.1	68.5	71.3	81	83.5	84.9	87.3	85.1	83.9	77.4	76.9
4	72.3	71.6	70.1	72.6	82.2	84.9	86	88.5	86	84.2	78.3	77.8
5	72.5	72.9	71.2	73.7	83	86.4	86.3	89.4	87.2	85.1	79.5	78.7
6	73	74	72.3	74.8	84.5	86.7	86.9	90	88.1	85.8	80.7	79
7	72.9	74.3	73.1	75.4	82.8	84.4	86	89.7	88.4	86.1	81	79.7
8	73.2	75.1	73.2	72.5	76.1	78.6	79.8	85	86.7	85.1	82	79.7
9	73.3	73.5	69.2	66.2	68.4	72.3	73.7	77.9	80.9	82.1	79	78.4
10	70.2	68.5	63.1	61	62.5	67.1	67.8	70.5	73.5	76.8	71.6	74.8
11	65.3	62.9	57.4	56.5	57.6	63.1	63.2	64.4	66.8	71.5	64.9	70.5
12	61.3	58.6	52.6	52.9	54.2	59.4	59.6	59.9	61.2	67.7	59.7	66.6
13	57.4	54.7	48.2	50.8	51.5	56.8	56.8	56.7	58	64.5	56	64.4
14	54.2	51.8	45.4	48.9	49.5	54.6	55.1	54.4	55.8	62.3	53.4	62.5
15	52.1	50	43	47.9	47.8	53.9	54.6	52.8	54.1	60.8	52.1	61.3
16	51	48.5	42.1	47.5	47.3	53.4	54.7	52.6	53.4	59.9	51.6	61.1
17	51.8	49.1	42	48.2	48.1	53.4	55.2	53.5	54.5	60.9	53.6	63.2
18	55.5	52.6	44.7	49.1	49.3	54.7	56.7	55.4	57.6	64.4	58.5	66.2
19	60.3	57.7	49.1	51.9	52.6	57.4	59.7	61.3	65.5	70	63.6	69.1
20	63.3	61.4	54.2	56.9	59.5	62.5	66.1	69.3	73.5	73	66.4	70.7
21	65.6	63.7	57.7	60.4	65.3	69.1	73.3	75	76.9	75.7	67.8	72.1
22	66.4	66.5	60.2	63.3	69.2	73.1	77.6	78.1	79.8	77.1	69.8	73.3
23	67.2	67.7	62.3	66.3	72.5	76.3	79.9	80.5	81.2	78.5	70.5	74.1
24	68.2	69	64.2	68.8	75.3	78.3	82.1	83.2	82	79.3	72.1	75.3

Table 14 – Average Monthly Temperatures by Hour of the Day for St. Louis City in Fahrenheit (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	25.9	34.7	44.1	51.8	62.1	71.4	70	69.2	64	49	48.2	29.1
2	23.7	34.7	42.3	50.1	61	70.5	69.4	68.8	63.2	48.9	47.4	29.5
3	22.8	33.7	41.4	49.4	60.1	69.7	68.5	67.9	62.3	48.1	46.7	28.9
4	21.9	32.6	40.7	48.4	59.2	68.8	67.7	67.2	61.7	47.7	46	28.2
5	21	31.5	40.2	47.8	58.5	67.9	67.1	66.5	61	47	45.5	27.4
6	19.9	30.3	39.5	47.3	57.7	67.7	66.6	66.1	60.4	46.3	45	27
7	19.3	29.3	39	47.3	59.5	69.9	68.1	66.7	60.2	45.6	44.7	26.8
8	18.9	28.5	39.6	50	62.7	73.3	71.2	70.3	62.7	46.6	44.4	26.6
9	19.6	30.5	42.8	53.8	65.7	76.6	74.4	73.9	66.1	49.2	47.7	27.4
10	22.9	34	46.6	56.7	68.2	79.6	77	77.3	69.9	52.3	52.2	30.5
11	26.5	37.5	50	59.7	70.5	81.9	79.3	79.7	72.9	55	55.7	33.6
12	29.5	40.8	53.2	62	72.2	84.1	80.9	81.7	75.1	57.2	58.7	36.3
13	32.4	43.9	55.6	63.4	73.5	85.9	82.6	83.3	76.7	59	60.8	38.1
14	34.5	46.5	57.3	64.7	74.8	87	83.5	84.5	77.7	60.2	62.4	39.8
15	36	48	58.8	65.4	75.8	87.1	84	85.2	78.5	61.2	63.2	40.8
16	36.7	48.6	59.3	65.4	75.8	87.1	84	85.1	78.7	61.3	62.9	40.6
17	36.3	48.3	58.9	64.8	75.3	87.1	83.9	84.4	78.2	60.5	61.3	38.9
18	33.9	46.2	57.4	63.9	74.6	86	83.1	83.3	76.7	58.5	57.8	35.7
19	31.2	42.7	54.3	62.2	73.1	84.5	81.8	80.7	73.3	55.5	55.1	33.6
20	29.8	40.7	51.1	59.4	69.8	81.7	78.9	76.9	69.9	53.9	53.3	32.4
21	28.5	39.3	49	57.5	67.3	78	75.5	74.3	68.3	52.6	52	31.5
22	28.2	38.1	47.2	55.7	65.6	75.9	73.5	72.7	67	51.7	50.9	30.7
23	27.4	37.2	45.9	54.3	64.4	74.1	72	71.5	65.8	50.7	50	30.3
24	26.7	36	44.8	52.9	63.2	72.6	70.9	70.1	65	49.9	49.2	29.7

Table 15 – Average Monthly Percent Relative Humidity by Hour of the Day for St. Louis City (MOVES Inputs for 2011 On-Road Mobile Source VOC Emissions)

HourID	MonthID											
	1	2	3	4	5	6	7	8	9	10	11	12
1	69.2	70.2	65.5	71	78.7	81.1	83.6	85.3	83.2	80.6	74.8	76
2	71	70.5	67.4	70.5	80.6	82.5	83.8	86.5	84.3	81.8	76.5	77
3	71.6	71	69	71.8	82.3	83.9	85	87.3	85.2	83.7	77.6	77.3
4	72.4	71.7	70	72.8	83.5	85	86.1	88.8	86.1	84.3	78.8	77.9
5	72.6	72.8	71.1	74.2	84	86.4	86.4	89.8	87	84.9	79.7	79.1
6	72.8	73.9	72.2	75	85.5	86.7	86.7	90.4	88.2	85.5	80.9	79.1
7	73.1	74.4	73	75.6	83.8	84.5	85.5	89.8	88.5	86.5	81.5	79.8
8	73.4	75.3	73.1	72.7	77	78.5	80	85.1	86.4	85.5	82.1	79.4
9	73.1	73.3	68.9	66.2	69.4	72	73.6	77.7	80.7	81.8	79.2	78.8
10	69.7	68.4	63	61.4	63.1	67	67.7	70.4	73.4	76.1	71.8	74.9
11	65.2	63.1	57.7	56.9	58.2	63.1	63	64.3	67	71	65.2	70.9
12	61.5	59.2	52.7	53.6	54.9	59.4	59.8	60.1	61.6	67.4	60.1	67.2
13	57.5	55.2	48.3	51.8	52.4	57	56.7	57	58.4	64.1	56.6	65
14	54.7	52.5	45.4	49.9	50.3	54.7	55.3	54.7	56.3	62.1	53.9	62.9
15	52.4	50.7	42.9	48.7	48.8	54.1	54.6	53.3	54.6	60.6	52.6	61.5
16	51.4	49.3	41.9	48.5	48.5	53.7	54.8	53.1	54.1	60	52.2	61.7
17	52.3	49.7	42	49.2	49.5	53.7	55.4	53.9	55	61	54.1	63.5
18	55.8	53.4	44.4	50	50.6	55.3	57	55.9	58.2	64.5	59.5	66.6
19	60.4	58.5	49.1	52.8	54	57.8	59.9	62.1	65.9	70.6	64.1	69.2
20	63.1	62	54.3	57.7	61.1	63	66.3	70.1	74.2	73.7	67.2	71.1
21	66	64.4	58	61.3	66.8	69.9	73.4	75.9	77.5	75.8	69.1	72.2
22	66.5	66.6	60.9	64.2	70.9	73.7	77.9	79	80.2	77.2	70.6	74
23	67.6	67.6	62.7	67.3	73.9	77.2	80.3	81.1	81.8	78.6	71.6	74.5
24	68.4	69.2	64.6	69.5	76.5	79	82.8	83.6	82.4	79.4	72.9	75.4

Developing the I/M Input Tables for MOVES for the St. Louis Ozone nonattainment area

EPA has technical guidance on appropriate input assumptions and sources of data for the use of MOVES 2010 in State Implementation Plan (http://www.epa.gov/otaq/models/moves/420b10023.pdf). Section 3.10 of this guidance document explains the appropriate assumptions and methods to be used when developing the I/M input table for MOVES 2010. This guidance has been followed in the development of I/M input Tables 2 – 6 at the end of this document. This document outlines the approach used to develop each parameter of these I/M input tables in MOVES. The goal in developing these I/M input tables is to accurately reflect the actual I/M program being implemented in the St. Louis nonattainment area.

Pollutant Process ID
To begin development of the I/M input table, the default data for the I/M input table for St. Louis County was exported from the MOVES county database manager. The default data included four different I/M test types. However, the actual St. Louis area only had two different test types (On-board diagnostics) OBD tests for the exhaust and evaporative systems. In the default I/M input table, these were the only two types of tests that were "turned on" along with the appropriate pollutant process IDs that would be impacted by each test. Therefore, the pollutant process IDs that were included in the default table for the two OBD tests were the same pollutant process IDs used in the I/M input table for the St. Louis nonattainment area. The other two tests included in the default data along with their associated pollutant process IDs were still included in the I/M input table, but they were "turned off".

Source Type ID
The St. Louis I/M program includes passenger cars and also trucks with a gross vehicle weight rating of 8,500 lbs. or less. Therefore, the three source type IDs included in the I/M input table for the St. Louis nonattainment area are passenger cars, passenger trucks, and light commercial trucks (IDs = 21, 31, and 32).

Fuel Type ID
The St. Louis I/M program is applicable to both gasoline and diesel vehicles; however, MOVES only calculates an I/M benefit for gasoline vehicles. Therefore, the fuel type ID for gasoline was the only uel type ID used in the I/M input table for the St. Louis nonattainment area.

Inspection Frequency
The St. Louis I/M program requires that emission be tested every two years, so the inspection frequency ID that represents biennial tests (ID = 2) was used in the I/M input table for the OBD tests applicable to the St. Louis nonattainment area.

Test Standards
The St. Louis I/M program is a centralized program with OBD tests for exhaust and evaporative systems on the vehicles. Therefore, the test standard IDs for exhaust OBD check and the

evaporative system OBD check (IDs = 43 and 51) were used in the I/M input table for the St. Louis nonattainment area.

I/M Program ID
This is an arbitrary number developed by the MOVES user to define a unique test given for vehicles within a range of model years. Therefore, I/M program IDs were arbitrarily assigned to the various unique tests within the St. Louis I/M program.

Beginning and Ending Model Years
The St. Louis I/M program applies to gasoline vehicles with a model year of 1996 or later and it also applies to diesel vehicles with a model year of 1997 or later. Since the emissions inspection is required biennially, the ending model year would always be two years less than the emissions inventory year that is being developed. Therefore, for the tests for gasoline vehicles, the beginning model year is 1996 and the ending model year is two years earlier than the year for which MOVES is being run, and the for diesel vehicles the beginning model year is 1997 and the ending model year is two years earlier than the year for which MOVES is being run.

Compliance Factor
According to page 39 of the MOVES guidance document the compliance factor is calculated with the following equation:

> Compliance Factor = percent compliance rate x (100 – percent waiver rate) x regulatory class coverage adjustment.

Therefore, in order to calculate the compliance factor for each source type included in the I/M program, the compliance rate, waiver rate, and regulatory class coverage adjustment needed to be determined. These three values were determined by the processes described below and then the compliance factors for each source type were calculated with the equation written above.

Compliance Rate
The compliance rate was calculated with the following equation:

> Compliance Rate = Number of vehicles that were tested over a two year period (2008 – 2009) / Population of vehicles that is theoretically subject to I/M during the same period.

In order to determine the compliance rate, as it compares to the source type population by model year, the population of vehicles that is theoretically subject to I/M first needed to be determined.

In May 2009, the Missouri Department of Revenue (DOR) Vehicle Registration database was queried and a VIN decoder was used to separate the vehicle counts into Mobile 6.2 vehicle classes by model year. In the St. Louis nonattainment area, the Mobile 6.2 vehicle classes that are subject to I/M include 1996 and newer light duty gasoline vehicles, light duty gasoline trucks Class 1, light duty gasoline trucks Class 2, light duty gasoline trucks Class 3, light duty gasoline trucks Class 4, as well as 1997 and newer light duty diesel vehicles, light duty diesel trucks Class 1, light duty diesel trucks Class 2, light duty diesel trucks Class 3, and light duty diesel trucks Class 4. Table 1 below shows the total combined population of these 10 vehicle classes within

the appropriate model years by county in the St. Louis nonattainment area according the May 2009 DOR data.

Table 1. Vehicles Theoretically Subject to the I/M Program in the St. Louis Nonattainment Area		
	1996 and later	1997 and later
County	**Light Duty Gas (1996 and newer)**	**Light Duty Diesel (1997 and newer)**
Franklin	73,300	328
Jefferson	150,998	484
St Charles	238,672	589
St Louis City	144,871	345
St Louis County	756,978	1,653
Total	**1,364,819**	**3,399**
Total Count	**1,368,218**	

The Air Program also queried the I/M report generator to determine the total number of vehicles, which had their emissions tested at least once from January 1, 2008 through December 31, 2009. The query also included the total number of vehicles that received waivers during the same time period. Table 2 below, was generated with data from this query.

Table 2. Initially Tested Vehicles that Received a Waiver in the St. Louis I/M Program from January 1, 2008 through December 31, 2009

Model Year	Passenger Car			Truck			Total Initially Tested		
	Test Count	Waivers	% Waivers	Test Count	Waivers	% Waivers	Test Count	Waivers	% Waivers
1996	48858	547	1.12 %	5605	61	1.09 %	54463	608	1.12 %
1997	56769	406	0.72 %	8834	50	0.57 %	65603	456	0.70 %
1998	73704	473	0.64 %	8391	63	0.75 %	82095	536	0.65 %
1999	83090	412	0.50 %	12182	46	0.38 %	95272	458	0.48 %
2000	102025	474	0.46 %	10267	44	0.43 %	112292	518	0.46 %
2001	99275	533	0.54 %	13552	57	0.42 %	112827	590	0.52 %
2002	118172	407	0.34 %	11417	18	0.16 %	129589	425	0.33 %
2003	105898	294	0.28 %	14664	24	0.16 %	120562	318	0.26 %
2004	116039	226	0.19 %	11951	16	0.13 %	127990	242	0.19 %
2005	122101	165	0.14 %	13992	20	0.14 %	136093	185	0.14 %
2006	117968	178	0.15 %	10795	21	0.19 %	128763	199	0.15 %
2007	119535	147	0.12 %	11898	18	0.15 %	131433	165	0.13 %
2008	36470	49	0.13 %	2396	3	0.13 %	38866	52	0.13 %
2009	8373	9	0.11 %	396	0	0.00 %	8769	9	0.10 %
2010	129	0	0.00 %	1	0	0.00 %	130	0	0.00 %
Total	1208406	4320	0.36 %	136341	441	0.32 %	1344747	4761	0.35 %

Using the data from Tables 1 and 2 above the compliance rate is calculated for the St. Louis I/M Program with the following equation:

Compliance Rate: (1,344,747 / 1,368,218) x 100% = 98.28%

Waiver Rate

The waiver rate is the percentage of vehicles that fail an initial I/M test and do not pass a retest, but do receive a certificate of compliance. The waiver rate was determined by dividing the number of vehicles that received waivers from January 1, 2008 through December 31, 2009 by the total number of vehicles that were tested at least once during the same time period. Therefore, the waiver rate was calculated for the St. Louis I/M Program with the following equation:

Waiver Rate: (4,761 / 1,344,747) X 100% = 0.35%

Regulatory Class Coverage Adjustment

The regulatory class coverage adjustment is an adjustment that accounts for the fraction of vehicles within a source type that are covered by the I/M program. Since the I/M program in St. Louis exempts vehicles with a gross vehicle weight rating above 8,500 lbs., the compliance factor needs to reflect the percentage of vehicles in the source types subject to I/M that are exempt because of their GVWR. Table A.3 in the Appendix of the MOVES Technical Guidance Document was used to develop adjustments to the compliance factor to account for this discrepancy. The adjustments are percentages of vehicle miles traveled by the various regulatory weight classes within a source type. The corresponding adjustment factors used for the three source categories are as follow:

Passenger cars: 100%
Passenger Trucks: 94%
Light Commercial Trucks: 88%

Calculating the Compliance Factor

Based on the calculations listed above the compliance factor for each source category impacted by the I/M program in St. Louis is listed below.

Passenger cars: 98.28% x (100% - 0.35%) x 100% = **97.94%**
Passenger Trucks: 98.28% x (100% - 0.35%) x 94% = **92.06%**
Light Commercial Trucks: 98.28% x (100% - 0.35%) x 88% = **86.18%**

2008/2011/2015/2017/2022 Off-Road Mobile Source Emissions

The Air Program Staff followed the 2008 and 2022 off-road modeling protocol submitted by EPA Region 7 to the Department for the development of the 2008, 2011, 2015, 2017and 2022 off-road mobile emissions with two exceptions. The Staff used 3.5% oxygen weight instead of 0.35% and 100% ethanol blend market instead if 10%. The modeling protocol can be found in Attachment 1 of Appendix H of this document. The data generated by the Air Program Staff for the 2008, 2011, 2015, 2017and 2022 off-road mobile sources emissions for the Missouri counties in the St. Louis ozone nonattainment area are summarized in Table 1. The values in Table 1 do not include emissions from the commercial marine vessel and railroad locomotive source categories.

Table 1
2008 Off-Road Mobile Source VOC Emissions by County in the
St. Louis Ozone Nonattainment Area (Excludes Marine and Rail Emissions)
(Tons/Ozone Season Day)
(Missouri Counties Only)

County Name	2008	2011	2015	2017	2022
Franklin County	3.53	3.15	2.49	2.18	1.76
Jefferson County	3.54	3.09	2.43	2.21	1.99
St. Charles County	7.32	6.15	4.65	4.27	3.83
St. Louis County	25.84	22.39	17.67	16.97	16.98
St. Louis City	3.86	3.19	2.29	2.13	2.10
Totals	44.09	37.97	29.53	27.76	26.66

Attachment 1 of Appendix H

EPA Region 7 Off-Road Emissions Modeling Protocol for 2008 and 2022 for the St. Louis, Missouri Five-County Nonattainment Area

Ozone and PM2.5 Maintenance Plan Work Share St. Louis, Missouri Five-County Area Nonroad Modeling for Inventory Development

For this modeling exercise, the EPA Region 7 utilized the NONROAD2008a model to calculate an ozone and PM2.5 nonroad inventory in five counties in the St. Louis nonattainment area for the 1997 PM2.5 annual and 1997 Ozone NAAQS. The NONROAD2008a model provides the emissions for all nonroad source categories except aircraft, commercial marine vessel, and railroad locomotive.

In running the NONROAD model, the user must specify a modeling scenario by the inventory year, geographic area (nation, state, county), period (annual, seasonal, monthly, daily), and the equipment categories. For all other required variables, the NONROAD model provides default input values. For the following modeling exercises, fuel parameters (Reid Vapor Pressure (RVP), oxygen weight, sulfur content, ethanol volume and market percentage) and temperatures for each geographical area were provided by MDNR in lieu of the modeling default settings for more accurate results (see attachment).

<u>Ozone Precursor Emissions</u>

Ozone Methodology/Input Data:
Nonroad mobile source emissions for the years of 2008 and 2022 are calculated using the EPA approved model, NONROAD2008a, and included Franklin County, Jefferson County, St. Charles County, St. Louis County and St. Louis City in St. Louis, Missouri.
For modeling ozone precursor pollutants, temperatures and fuel characteristics representative of each county during an ozone summer weekday, were entered into NONROAD2a and modeled to calculate an ozone season weekday emissions for nonroad sources. Minimum, maximum, and average temperatures for a typical summer season were provided by MDNR (see attachment). Modeling input parameters are as follows:

Table B-27
NONROAD Model Temperature & Fuel Characteristic Input Values by County

County	Oxygen Weight %	RVP psi	Gasoline Sulfur %	Diesel Sulfur	Marine Diesel Sulfur %	CNG / LPG Sulfur %	Temperatures		
							Min.	Max.	Avg.
Franklin	0.35	7	0.0049	0.0355	0.0402	0.003	61.8	90	75.96

Jefferson	0.35	7	0.0049	0.0355	0.0402	0.003	61	88.6	75.16
St. Charles	0.35	7	0.0049	0.0355	0.0402	0.003	62.2	89.2	76.15
St. Louis	0.35	7	0.0049	0.0355	0.0402	0.003	64.1	89.5	77.1
St. Louis City	0.35	7	0.0049	0.0355	0.0402	0.003	65.1	89.8	77.72

Direct PM$_{2.5}$ / PM$_{2.5}$ Precursor Emissions

Methodology/Input Data:
Nonroad mobile source emissions for the years of 2008 and 2022 were calculated using the EPA approved model, NONROAD2008a, and included Franklin County, Jefferson County, St. Charles County, St. Louis County and St. Louis City in St. Louis, Missouri.
For modeling PM$_{2.5}$ and PM$_{2.5}$ precursor pollutants, temperatures and fuel characteristics representative of each county for each of the four seasons (winter, spring, summer, and fall) were entered into the NONROAD2008a model as input parameters. The highest temperature and lowest temperature from each three month period (December-February, March-May, June-August, and September-November) were averaged to create a seasonal average temperature. Those seasonal average temperatures, seasonal minimum and seasonal maximum temperatures were then utilized in the model, including the fuel parameters, to calculate the total emissions for each county and season. Summing the emissions of all four seasons for each county gave the total annual emissions. The temperatures and fuel characteristics representative of each county were provided by MDNR. Modeling input parameters are as follows:

Table B-28
NONROAD Model Temperature & Fuel Characteristic Input Values by County & Season

County	Season	Oxygen Weight %	RVP psi	Gasoline Sulfur %	Diesel Sulfur	Marine Diesel Sulfur %	CNG / LPG Sulfur %	Temperatures		
								Min.	Max.	Avg.
Franklin	Winter	0.35	11.5	0.0043	0.0355	0.0402	0.003	19.7	47	33.4
Franklin	Spring	0.35	9	0.0046	0.0355	0.0402	0.003	33.5	76.9	55.2
Franklin	Summer	0.35	7	0.0049	0.0355	0.0402	0.003	61.8	90	75.9
Franklin	Autumn	0.35	9	0.0046	0.0355	0.0402	0.003	34.3	80.9	57.6
Jefferson	Winter	0.35	11.5	0.0043	0.0355	0.0402	0.003	18.6	45.6	32.1
Jefferson	Spring	0.35	9	0.0046	0.0355	0.0402	0.003	32.4	75.8	54.1
Jefferson	Summer	0.35	7	0.0049	0.0355	0.0402	0.003	61	88.6	74.8
Jefferson	Autumn	0.35	9	0.0046	0.0355	0.0402	0.003	33.6	79.8	56.7
St. Charles	Winter	0.35	11.5	0.0043	0.0355	0.0402	0.003	18.7	43.9	31.3
St. Charles	Spring	0.35	9	0.0046	0.0355	0.0402	0.003	32.3	75.8	54.1
St. Charles	Summer	0.35	7	0.0049	0.0355	0.0402	0.003	62.2	89.2	75.7
St. Charles	Autumn	0.35	9	0.0046	0.0355	0.0402	0.003	34.8	80.3	57.6
St. Louis	Winter	0.35	11.5	0.0043	0.0355	0.0402	0.003	19.8	44.2	32
St. Louis	Spring	0.35	9	0.0046	0.0355	0.0402	0.003	34.5	76.1	55.3
St. Louis	Summer	0.35	7	0.0049	0.0355	0.0402	0.003	64.1	89.5	76.8
St. Louis	Autumn	0.35	9	0.0046	0.0355	0.0402	0.003	35.5	80.2	57.9
St. Louis City	Winter	0.35	11.5	0.0043	0.0355	0.0402	0.003	20.7	45.5	32.6

St. Louis City	Spring	0.35	9	0.0046	0.0355	0.0402	0.003	35.7	76.4	56
St. Louis City	Summer	0.35	7	0.0049	0.0355	0.0402	0.003	65.1	89.8	77.5
St. Louis City	Autumn	0.35	9	0.0046	0.0355	0.0402	0.003	36.6	80.4	58.5

QA/QC:

Quality control and quality assurance were conducted throughout this nonroad modeling process. Data collected from various data sources were verified and correctly entered or transcribed into the model. In some instances, input values, i.e., temperatures and fuel values were double and/or triple checked for accuracy to insure they corresponded to the data supplied by MDNR. In addition, a spot-checking of the modeling results, including rerunning the model for those results in question, was performed to insure reliability