

5. Onroad Mobile Sources

5.1 Introduction

Onroad mobile source emission estimates have been calculated for particulate matter for the 2005 Periodic Particulate Matter Emissions Inventory. For the purposes of this particulate matter inventory, the following pollutants were included: PM₁₀, PM_{2.5}, nitrogen oxides (NO_x), sulfur oxides (SO_x), and ammonia (NH₃). PM₁₀ refers to all particles less than or equal to 10 micrometers in diameter, about one-seventh the diameter of a human hair. PM_{2.5} refers to particles less than or equal to 2.5 micrometers in diameter.

Onroad mobile source emissions are estimated for the PM₁₀ nonattainment area (approximately 3,000 square miles), as well as for Maricopa County (approximately 9,000 square miles). Emission factors were calculated using MOBILE6.2 and AP-42. MOBILE6.2 is the latest version in a series of models developed by the US Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors. AP-42 is the EPA Compilation of Air Pollutant Emission Factors. AP-42 emission factors were used to calculate fugitive dust emission factors, while the MOBILE6.2 model was used to estimate all other emission factors. The resulting emission factors were multiplied by the estimates of vehicle miles of travel (VMT) to generate emission estimates.

The 2005 motor vehicle exhaust, tire wear, and brake wear emissions were estimated using the MOBILE6.2 model. The modeling accounted for the oxygenated fuel and vehicle inspection/maintenance (I/M) programs in existence in Maricopa County in 2005. Fuel use assumptions for 2005, including oxygen content and Reid Vapor Pressure (RVP), were based on actual July 2005 testing results provided by the Arizona Department of Weight and Measures. MOBILE6.2 calculations reflected a 91.6 percent participation in the I/M program.

The 2005 vehicle miles of travel (VMT) used in developing the onroad mobile source emissions were derived from the latest 2005 traffic assignment produced by the MAG travel demand model (i.e., EMME2). The 2005 VMT was split into 28 vehicle classes. The VMT by vehicle class was derived using the VMT mix produced by MOBILE6.2. The MOBILE6.2 VMT mix is based on July 2003 vehicle registration data for Maricopa County obtained from the Arizona Department of Transportation. The VMT by vehicle class was multiplied by the appropriate MOBILE6.2 emission factors to produce 2005 onroad exhaust, tire wear, and brake wear emissions.

Paved road fugitive dust emissions were estimated using emission factors from AP-42 applied to VMT from the 2005 traffic assignment produced by the MAG EMME2 travel demand model. The 2005 VMT for freeways, high traffic arterials, and low traffic arterials were derived from the traffic assignment. Low traffic arterials are assumed to carry 5,000 or fewer vehicles on an average weekday, while high traffic arterials carry more than 5,000 vehicles per weekday. These VMTs were multiplied by the appropriate paved road particulate emission factors from AP-42. The paved road fugitive dust particulate emission factors were derived from the AP-42 equation for paved roads, assuming silt loadings from the Serious Area PM₁₀ Plan and a mean vehicle weight of three tons. GIS was applied to obtain VMT estimates for the PM₁₀ nonattainment area and Maricopa County.

Unpaved road VMT was developed using the mileage for low and high traffic unpaved roads derived from the unpaved road inventory in the Serious Area PM₁₀ Plan. Low traffic unpaved roads are assumed to carry an average of four vehicles per day, while high traffic unpaved roads carry an average of 120 vehicles per day. The unpaved road mileage used in developing the 2005 particulate emission inventory assumes that all commitments to pave unpaved roads in the Serious Area PM₁₀ Plan have been implemented. Low and high traffic unpaved road VMTs were multiplied by the appropriate AP-42 emission factor to produce unpaved road particulate emissions. The unpaved road particulate emission factors were derived from the AP-42 equation for publicly accessible unpaved roads, assuming a silt content of 11.9%, soil moisture content of 0.5%, a mean vehicle weight of three tons, and an average speed of 25 mph.

The main references for preparing the onroad mobile source portion of the 2005 emissions inventory were:

- Emission Inventory Requirements for Ozone State Implementation Plans, EPA-450/4-91-010, March 1991,
- Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, US EPA, January 2002,
- User's Guide to MOBILE6.1 and MOBILE6.2 (Mobile Source Emission Factor Model), EPA420-R-03-010, August 2003, and
- Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA-450/4-81/026d (Revised), 1992.

5.2 VMT estimation

MAG prepared the 2005 vehicle miles of travel (VMT) estimates for the PM₁₀ nonattainment area and Maricopa County. The source of data for these estimates is the 2005 traffic assignment prepared by MAG using the EMME2 travel demand model. Highway Performance Monitoring System (HPMS) data for 2005 prepared by the Arizona Department of Transportation was not available in time to be used for the 2005 periodic particulate matter emissions inventory.

The distribution of VMT by vehicle class for the PM₁₀ nonattainment area was derived from the MAG EMME2 traffic assignment and MOBILE6.2 runs for 2005. The output of the traffic assignment was evaluated using GIS to obtain VMT for the PM₁₀ nonattainment area and Maricopa County. Since information provided by the 2005 traffic assignment does not cover the far western and far northeastern areas of Maricopa County, 2005 VMT for Maricopa County was obtained by multiplying the 2005 traffic assignment VMT by the ratio of the 2002 HPMS VMT for Maricopa County to the 2002 traffic assignment VMT for Maricopa County. The traffic assignment VMTs shown below represent annual average daily traffic volumes. The ratio applied to obtain Maricopa County VMT was calculated as follows:

Maricopa County 2002 HPMS VMT = 73,579,000 miles per day
Maricopa County 2002 traffic assignment VMT = 71,988,181 miles per day
Maricopa County 2005 traffic assignment VMT = 80,374,602 miles per day
Ratio = 73,579,000 / 71,988,181 = 1.02
2005 VMT for Maricopa County = 1.02 × 80,374,602 = 82,150,747 miles per day

VMTs for the PM₁₀ nonattainment area and Maricopa County were split by vehicle class using VMT mix data obtained from the MOBILE6.2 run. The VMT estimates by 28 vehicle class categories for the PM₁₀ nonattainment area and Maricopa County are shown in Table 5.2–1.

Table 5.2–1. 2005 daily VMT (vehicle miles of travel) by vehicle class.

Vehicle Type	PM₁₀ NAA	Maricopa County
LDGV	32,364,131	33,951,479
LDGT1	5,937,079	6,228,272
LDGT2	19,761,545	20,730,780
LDGT3	6,579,349	6,902,043
LDGT4	3,023,368	3,171,653
HDGV2B	2,294,940	2,407,498
HDGV3	78,326	82,167
HDGV4	31,330	32,867
HDGV5	93,991	98,601
HDGV6	195,814	205,418
HDGV7	78,326	82,167
HDGV8A	0	0
HDGV8B	0	0
MC	375,963	394,402
LDDV	62,660	65,734
LDDT12	23,498	24,650
LDDT34	140,986	147,901
HDDV2B	720,595	755,938
HDDV3	219,312	230,068
HDDV4	234,977	246,502
HDDV5	109,656	115,034
HDDV6	556,112	583,387
HDDV7	806,754	846,322
HDDV8A	971,237	1,018,873
HDDV8B	3,430,661	3,598,922
HDGB	15,665	16,433
HDDBT	70,493	73,950
HDDBS	133,153	139,684
Total	78,309,918	82,150,747

VMT for estimating fugitive dust emissions from paved roads was also estimated using data from the 2005 EMME2 traffic assignment. Roadway silt loading measurements used in the Serious Area PM₁₀ Plan reflect three silt loading classifications: freeways, high traffic arterials (greater than or equal to 5,000 vehicles per average weekday), and low traffic arterials (less than 5,000 vehicles per average weekday). GIS was applied to extract VMT for the PM₁₀ modeling area from the MAG 2005 traffic assignment. The PM₁₀ modeling area for the Serious Area PM₁₀ Plan is a rectangle that encompasses the portion of the PM₁₀ nonattainment area in Maricopa County. The VMT for freeways and high and low traffic arterials in the PM₁₀ modeling area is shown in Table 5.2–2. These VMTs represent annual average daily traffic volumes. All travel on local streets is included in the low traffic arterial category below.

Table 5.2–2. 2005 VMT by silt loading category on paved roads in the PM₁₀ modeling area.

	VMT			
	Freeways	High Traffic	Low Traffic	Total
		Arterials	Arterials	
PM ₁₀ Modeling Area	27,929,802	40,164,352	9,688,202	77,782,356

The miles of unpaved roads used to estimate VMT for unpaved roads was derived from the Serious Area PM₁₀ Plan (MAG, 2000). The unpaved road mileages shown in Table 5.2–3 have been reduced to account for control measures to Reduce Particulate Emissions from Unpaved Roads and Alleys in the Plan. The Plan classifies the miles of unpaved roads as low traffic and high traffic. Low traffic unpaved roads have an annual average traffic level of 4 vehicles per day; high traffic unpaved roads have an annual average traffic level of 120 vehicles per day. Applying these traffic volumes to the unpaved road mileages, after implementation of committed measures in the Plan, results in the daily VMTs for the PM₁₀ modeling area shown in Table 5.2–3. The PM₁₀ modeling area is a rectangle that includes the portion of the PM₁₀ nonattainment area located in Maricopa County.

Table 5.2–3. 2005 unpaved road mileages and VMT in the PM₁₀ modeling area.

Unpaved Road Type	2005	
	Miles	Daily VMT
High Traffic	224.3	26,916
Low Traffic	1,129.2	4,517
Total	1,353.5	31,433

To estimate paved and unpaved road emissions for Maricopa County and the entire PM₁₀ nonattainment area, including Apache Junction in Pinal County, the emissions for the PM₁₀ modeling area were multiplied by the ratio of the total daily VMT in Maricopa County (or the PM₁₀ nonattainment area) to the total daily VMT in the PM₁₀ modeling area. GIS was applied to extract the total VMTs for Maricopa County and the PM₁₀ nonattainment area from the 2005 MAG traffic assignment. These VMTs represent annual average daily traffic volumes. The resultant VMTs and ratios are shown in Table 5.2–4.

Table 5.2–4. VMTs for the PM₁₀ modeling area, PM₁₀ nonattainment area, and Maricopa County.

Area	Total Daily VMT
PM ₁₀ Modeling Area (MA)	77,782,356
PM ₁₀ Nonattainment Area (NA)	78,309,918
Maricopa County (MC)	82,150,747
Ratio (NA/MA)	1.007
Ratio (MC/MA)	1.056

5.3 Vehicle speed

Vehicle speeds have no effect on the emission factors for exhaust particulate matter, re-entrained dust from paved roads, brake wear, tire wear, or exhaust ammonia (NH₃) and have only a very slight effect on the pollutants, SO₄ and SO₂. However, speeds can have a significant effect on NO_x exhaust emissions and re-entrained dust from unpaved roads. The MOBILE6.2 default speeds were assumed for the NO_x emission calculations and 25 miles per hour was assumed on all unpaved roads.

5.4 Emission factor estimation procedures

PM₁₀, PM_{2.5}, SO₂, NH₃, and oxides of nitrogen (NO_x) vehicle exhaust emission factors were calculated using MOBILE6.2. The PM₁₀ and PM_{2.5} non-exhaust components of tire wear and brake wear were also estimated using MOBILE6.2. The PM₁₀ and PM_{2.5} estimates include the components lead, elemental carbon from diesel exhaust, organic carbon from diesel exhaust, sulfate portion, and carbon portion of gasoline exhaust. MOBILE6.2 is the latest version in a series of models developed by the U.S. EPA for the purpose of estimating motor vehicle emission factors. The MOBILE6.2 runs were executed by MAG. The contact person for the MOBILE6.2 emission estimates is Taejoo Shin (602-254-6300).

Fugitive dust emission factors were derived from AP-42. The contact person for the fugitive dust emission estimates is Cathy Arthur (602-254-6300).

5.4.1 MOBILE6.2 emission factor model

The emission factors not related to fugitive dust were calculated using MOBILE6.2. Two MOBILE6.2 runs were executed for an annual average day (24-hour period) reflecting vehicles registered locally (subject to the I/M program) and those not registered locally (not participating in the I/M program). Of the pollutants modeled for this study, the presence or lack of an I/M program only affects the modeled emission factors for NO_x. Refer to Appendix 5 for portions of the actual input and output files.

The emission factors estimated with these runs were combined to reflect the actual proportions of vehicles subject to the specified levels of inspection. The term “I/M vehicles” denotes vehicles which are required to undergo an emission test and/or inspection under the Arizona Vehicle Inspection/Maintenance Program. It is important to note that participation in the I/M program is required for all vehicles registered in the nonattainment area, with the exception of certain model year and vehicle types. However, it is assumed that of the vehicles which are of an age and type subject to an I/M program, only 91.6 percent of the vehicles operating within the nonattainment area participate in the I/M program. The remaining 8.4 percent do not participate in the program. These percentages reflect the implementation of the control measures “Tougher Registration Enforcement” and “Expansion of Area A Boundaries”, described in the Revised MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, MAG, March 2001. In the absence of any additional data, this percentage split is assumed to apply directly to VMT as well.

5.4.1.1 MOBILE6.2 inputs

In order to accurately reflect the state of the I/M program in the modeling area, several MOBILE6.2 runs were performed and the emission factors from those runs were weighted together. The specific model run inputs to the MOBILE6.2 model are described in Appendix 5.

5.4.1.2 MOBILE6.2 outputs

MOBILE6.2 was executed to obtain composite emission factors in grams per mile (g/mi) for exhaust PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃. These values were obtained for 28 vehicle classes. The emission factors generated for 2005 are presented in the following section. Representative output runs are contained in Appendix 5. These values were then used in developing emission estimates.

5.4.1.3 Summary of MOBILE6.2 emission factors

MOBILE6.2 was used to generate emission factors by vehicle class in terms of gram per mile. Table 5.4–1 provides the emission factors for each vehicle class for the PM₁₀ nonattainment area and Maricopa County.

Table 5.4–1. Emission factors by vehicle class for the PM₁₀ nonattainment area and Maricopa County.

Vehicle Type	PM ₁₀ Ext	PM ₁₀ Tire	PM ₁₀ Brake	PM _{2.5} Ext	PM _{2.5} Tire	PM _{2.5} Brake	NO _x	SO _x
LDGV	0.0052	0.0080	0.0125	0.0048	0.0020	0.0053	0.766	0.020
LDGT1	0.0061	0.0080	0.0125	0.0057	0.0020	0.0053	0.788	0.026
LDGT2	0.0061	0.0080	0.0125	0.0057	0.0020	0.0053	1.043	0.026
LDGT3	0.0066	0.0080	0.0125	0.0061	0.0020	0.0053	1.200	0.034
LDGT4	0.0066	0.0080	0.0125	0.0061	0.0020	0.0053	1.590	0.034
HDGV2B	0.0616	0.0080	0.0125	0.0547	0.0020	0.0053	4.024	0.049
HDGV3	0.0671	0.0120	0.0125	0.0583	0.0030	0.0053	4.442	0.053
HDGV4	0.0731	0.0120	0.0125	0.0586	0.0030	0.0053	4.769	0.054
HDGV5	0.0602	0.0120	0.0125	0.0505	0.0030	0.0053	4.844	0.062
HDGV6	0.0593	0.0120	0.0125	0.0500	0.0030	0.0053	4.788	0.061
HDGV7	0.0605	0.0120	0.0125	0.0507	0.0030	0.0053	5.375	0.067
HDGV8A	0.0620	0.0360	0.0125	0.0513	0.0090	0.0053	5.961	0.071
HDGV8B	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.000
MC	0.0208	0.0040	0.0125	0.0145	0.0010	0.0053	1.240	0.010
LDDV	0.1857	0.0080	0.0125	0.1711	0.0020	0.0053	1.563	0.070
LDDT12	0.3148	0.0080	0.0125	0.2899	0.0020	0.0053	2.736	0.069
LDDT34	0.1079	0.0080	0.0125	0.0998	0.0020	0.0053	1.147	0.115
HDDV2B	0.1405	0.0080	0.0125	0.1301	0.0020	0.0053	3.996	0.152
HDDV3	0.1252	0.0120	0.0125	0.1162	0.0030	0.0053	4.443	0.169
HDDV4	0.1286	0.0120	0.0125	0.1194	0.0030	0.0053	5.286	0.192
HDDV5	0.1210	0.0120	0.0125	0.1124	0.0030	0.0053	5.642	0.199
HDDV6	0.2371	0.0120	0.0125	0.2194	0.0030	0.0053	7.711	0.225
HDDV7	0.2427	0.0120	0.0125	0.2247	0.0030	0.0053	9.578	0.260
HDDV8A	0.2961	0.0360	0.0125	0.2741	0.0090	0.0053	12.217	0.298
HDDV8B	0.3127	0.0360	0.0125	0.2895	0.0090	0.0053	14.339	0.313
HDGB	0.1377	0.0120	0.0125	0.0995	0.0030	0.0053	7.831	0.079
HDDBT	0.5888	0.0120	0.0125	0.5442	0.0030	0.0053	17.002	0.455
HDDBS	0.6102	0.0120	0.0125	0.5631	0.0030	0.0053	11.940	0.315

5.4.1.4 MOBILE6.2 emission estimates

The annual average daily VMT shown in Table 5.2–1 was multiplied by the appropriate emission factor shown in Table 5.2–1 for each vehicle class to calculate exhaust emissions. Calculations for brake wear and tire wear involved the multiplication of the VMT by appropriate emission factors from MOBILE6.2 also shown in the table above.

Tables 5.4–2 through 5.4–3 show the resultant PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃ emissions for each vehicle class in the PM₁₀ nonattainment area and Maricopa County, respectively. The emissions are shown in terms of metric tons per day.

Tables 5.4–4 and 5.4–5 show the same emissions on an annual basis in metric tons per year. In Tables 5.4–1 through 5.4–5, the abbreviation “Ext” refers to exhaust particulate emissions, “Tire” refers to tire wear particulate emissions, and “Brake” refers to brake wear particulate emissions. NO_x and SO_x refer to exhaust emissions.

Table 5.4–2. Daily PM₁₀ nonattainment area emissions by vehicle class (metric tons/day).

Vehicle type	PM ₁₀ Ext	PM ₁₀ Tire	PM ₁₀ Brake	PM _{2.5} Ext	PM _{2.5} Tire	PM _{2.5} Brake	PM ₁₀ Total	PM _{2.5} Total	NO _x	SO _x	NH ₃
LDGV	0.168	0.259	0.405	0.155	0.065	0.172	0.832	0.392	24.788	0.660	3.285
LDGT1	0.036	0.047	0.074	0.034	0.012	0.031	0.158	0.077	4.679	0.156	0.594
LDGT2	0.121	0.158	0.247	0.113	0.040	0.105	0.526	0.257	20.611	0.518	1.976
LDGT3	0.043	0.053	0.082	0.040	0.013	0.035	0.178	0.088	7.895	0.225	0.651
LDGT4	0.020	0.024	0.038	0.018	0.006	0.016	0.082	0.041	4.807	0.103	0.299
HDGV2B	0.141	0.018	0.029	0.126	0.005	0.012	0.188	0.142	9.234	0.112	0.104
HDGV3	0.005	0.001	0.001	0.005	0.000	0.000	0.007	0.005	0.348	0.004	0.004
HDGV4	0.002	0.000	0.000	0.002	0.000	0.000	0.003	0.002	0.149	0.002	0.001
HDGV5	0.006	0.001	0.001	0.005	0.000	0.000	0.008	0.006	0.455	0.006	0.004
HDGV6	0.012	0.002	0.002	0.010	0.001	0.001	0.016	0.011	0.938	0.012	0.009
HDGV7	0.005	0.001	0.001	0.004	0.000	0.000	0.007	0.005	0.421	0.005	0.004
HDGV8A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HDGV8B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MC	0.008	0.002	0.005	0.005	0.000	0.002	0.014	0.008	0.466	0.004	0.004
LDDV	0.012	0.001	0.001	0.011	0.000	0.000	0.013	0.011	0.098	0.004	0.000
LDDT12	0.007	0.000	0.000	0.007	0.000	0.000	0.008	0.007	0.064	0.002	0.000
LDDT34	0.015	0.001	0.002	0.014	0.000	0.001	0.018	0.015	0.162	0.016	0.001
HDDV2B	0.101	0.006	0.009	0.094	0.001	0.004	0.116	0.099	2.879	0.110	0.019
HDDV3	0.027	0.003	0.003	0.025	0.001	0.001	0.033	0.027	0.974	0.037	0.006
HDDV4	0.030	0.003	0.003	0.028	0.001	0.001	0.036	0.030	1.242	0.045	0.006
HDDV5	0.013	0.001	0.001	0.012	0.000	0.001	0.016	0.013	0.619	0.022	0.003
HDDV6	0.132	0.007	0.007	0.122	0.002	0.003	0.145	0.127	4.288	0.125	0.015
HDDV7	0.196	0.010	0.010	0.181	0.002	0.004	0.216	0.188	7.727	0.210	0.022
HDDV8A	0.288	0.035	0.012	0.266	0.009	0.005	0.335	0.280	11.866	0.290	0.026
HDDV8B	1.073	0.124	0.043	0.993	0.031	0.018	1.239	1.042	49.192	1.075	0.093
HDGB	0.002	0.000	0.000	0.002	0.000	0.000	0.003	0.002	0.123	0.001	0.001
HDDBT	0.042	0.001	0.001	0.038	0.000	0.000	0.043	0.039	1.199	0.032	0.002
HDDBS	0.081	0.002	0.002	0.075	0.000	0.001	0.085	0.076	1.590	0.042	0.004
Total	2.587	0.759	0.979	2.385	0.190	0.415	4.324	2.990	156.814	3.817	7.133

Table 5.4-3. Daily Maricopa County emissions by vehicle class (metric tons/day).

Vehicle type	PM₁₀ Ext	PM₁₀ Tire	PM₁₀ Brake	PM_{2.5} Ext	PM_{2.5} Tire	PM_{2.5} Brake	PM₁₀ Total	PM_{2.5} Total	NO_x	SO_x	NH₃
LDGV	0.177	0.272	0.424	0.163	0.068	0.180	0.873	0.411	26.004	0.693	3.446
LDGT1	0.038	0.050	0.078	0.036	0.012	0.033	0.166	0.081	4.909	0.163	0.623
LDGT2	0.126	0.166	0.259	0.118	0.041	0.110	0.551	0.270	21.622	0.543	2.073
LDGT3	0.046	0.055	0.086	0.042	0.014	0.037	0.187	0.092	8.282	0.236	0.683
LDGT4	0.021	0.025	0.040	0.019	0.006	0.017	0.086	0.043	5.043	0.108	0.314
HDGV2B	0.148	0.019	0.030	0.132	0.005	0.013	0.198	0.149	9.687	0.117	0.109
HDGV3	0.006	0.001	0.001	0.005	0.000	0.000	0.008	0.005	0.365	0.004	0.004
HDGV4	0.002	0.000	0.000	0.002	0.000	0.000	0.003	0.002	0.157	0.002	0.001
HDGV5	0.006	0.001	0.001	0.005	0.000	0.001	0.008	0.006	0.478	0.006	0.004
HDGV6	0.012	0.002	0.003	0.010	0.001	0.001	0.017	0.012	0.984	0.013	0.009
HDGV7	0.005	0.001	0.001	0.004	0.000	0.000	0.007	0.005	0.442	0.005	0.004
HDGV8A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HDGV8B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MC	0.008	0.002	0.005	0.006	0.000	0.002	0.015	0.008	0.489	0.004	0.004
LDDV	0.012	0.001	0.001	0.011	0.000	0.000	0.014	0.012	0.103	0.005	0.000
LDDT12	0.008	0.000	0.000	0.007	0.000	0.000	0.008	0.007	0.067	0.002	0.000
LDDT34	0.016	0.001	0.002	0.015	0.000	0.001	0.019	0.016	0.170	0.017	0.001
HDDV2B	0.106	0.006	0.009	0.098	0.002	0.004	0.122	0.104	3.021	0.115	0.020
HDDV3	0.029	0.003	0.003	0.027	0.001	0.001	0.034	0.029	1.022	0.039	0.006
HDDV4	0.032	0.003	0.003	0.029	0.001	0.001	0.038	0.031	1.303	0.047	0.007
HDDV5	0.014	0.001	0.001	0.013	0.000	0.001	0.017	0.014	0.649	0.023	0.003
HDDV6	0.138	0.007	0.007	0.128	0.002	0.003	0.153	0.133	4.498	0.131	0.016
HDDV7	0.205	0.010	0.011	0.190	0.003	0.004	0.226	0.197	8.106	0.220	0.023
HDDV8A	0.302	0.037	0.013	0.279	0.009	0.005	0.351	0.294	12.448	0.304	0.028
HDDV8B	1.125	0.130	0.045	1.042	0.032	0.019	1.300	1.093	51.605	1.128	0.097
HDGB	0.002	0.000	0.000	0.002	0.000	0.000	0.003	0.002	0.129	0.001	0.001
HDDBT	0.044	0.001	0.001	0.040	0.000	0.000	0.045	0.041	1.257	0.034	0.002
HDDBS	0.085	0.002	0.002	0.079	0.000	0.001	0.089	0.080	1.668	0.044	0.004
Total	2.713	0.796	1.027	2.502	0.199	0.435	4.536	3.136	164.506	4.004	7.483

Table 5.4-4. Annual PM₁₀ nonattainment area emissions by vehicle class (metric tons/year).

Vehicle type	PM ₁₀ Ext	PM ₁₀ Tire	PM ₁₀ Brake	PM _{2.5} Ext	PM _{2.5} Tire	PM _{2.5} Brake	PM ₁₀ Total	PM _{2.5} Total	NO _x	SO _x	NH ₃
LDGV	61.4	94.5	147.7	56.7	23.6	62.6	303.6	142.9	9,047.6	241.0	1,199.0
LDGT1	13.2	17.3	27.1	12.4	4.3	11.5	57.6	28.2	1,708.0	56.8	216.7
LDGT2	44.0	57.7	90.2	41.1	14.4	38.2	191.9	93.8	7,523.0	189.0	721.3
LDGT3	15.8	19.2	30.0	14.6	4.8	12.7	65.1	32.2	2,881.7	82.1	237.7
LDGT4	7.3	8.8	13.8	6.7	2.2	5.8	29.9	14.8	1,754.6	37.7	109.2
HDGV2B	51.6	6.7	10.5	45.8	1.7	4.4	68.8	51.9	3,370.4	40.7	37.8
HDGV3	1.9	0.3	0.4	1.7	0.1	0.2	2.6	1.9	127.0	1.5	1.3
HDGV4	0.8	0.1	0.1	0.7	0.0	0.1	1.1	0.8	54.5	0.6	0.5
HDGV5	2.1	0.4	0.4	1.7	0.1	0.2	2.9	2.0	166.2	2.1	1.5
HDGV6	4.2	0.9	0.9	3.6	0.2	0.4	6.0	4.2	342.2	4.4	3.2
HDGV7	1.7	0.3	0.4	1.4	0.1	0.2	2.4	1.7	153.7	1.9	1.3
HDGV8A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HDGV8B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MC	2.9	0.5	1.7	2.0	0.1	0.7	5.1	2.9	170.2	1.3	1.6
LDDV	4.2	0.2	0.3	3.9	0.0	0.1	4.7	4.1	35.7	1.6	0.2
LDDT12	2.7	0.1	0.1	2.5	0.0	0.0	2.9	2.5	23.5	0.6	0.1
LDDT34	5.6	0.4	0.6	5.1	0.1	0.3	6.6	5.5	59.0	5.9	0.3
HDDV2B	37.0	2.1	3.3	34.2	0.5	1.4	42.3	36.1	1,051.0	40.0	7.1
HDDV3	10.0	1.0	1.0	9.3	0.2	0.4	12.0	10.0	355.7	13.5	2.2
HDDV4	11.0	1.0	1.1	10.2	0.3	0.5	13.1	11.0	453.4	16.5	2.3
HDDV5	4.8	0.5	0.5	4.5	0.1	0.2	5.8	4.8	225.8	7.9	1.1
HDDV6	48.1	2.4	2.5	44.5	0.6	1.1	53.1	46.2	1,565.2	45.7	5.5
HDDV7	71.5	3.5	3.7	66.2	0.9	1.6	78.7	68.6	2,820.4	76.5	8.0
HDDV8A	105.0	12.8	4.4	97.2	3.2	1.9	122.2	102.2	4,330.9	105.7	9.6
HDDV8B	391.6	45.1	15.7	362.5	11.3	6.6	452.3	380.4	17,955.2	392.4	33.8
HDGB	0.8	0.1	0.1	0.6	0.0	0.0	0.9	0.6	44.8	0.5	0.3
HDDBT	15.1	0.3	0.3	14.0	0.1	0.1	15.8	14.2	437.5	11.7	0.7
HDDBS	29.7	0.6	0.6	27.4	0.1	0.3	30.8	27.8	580.3	15.3	1.3
Total	944	277	357	871	69	151	1,578	1,091	57,237	1,393	2,603

Table 5.4-5. Annual Maricopa County emissions by vehicle class (metric tons/year).

Vehicle type	PM ₁₀ Ext	PM ₁₀ Tire	PM ₁₀ Brake	PM _{2.5} Ext	PM _{2.5} Tire	PM _{2.5} Brake	PM ₁₀ Total	PM _{2.5} Total	NO _x	SO _x	NH ₃
LDGV	64.4	99.1	154.9	59.5	24.8	65.7	318.5	149.9	9,491.3	252.8	1,257.8
LDGT1	13.9	18.2	28.4	13.0	4.5	12.0	60.5	29.6	1,791.7	59.6	227.3
LDGT2	46.2	60.5	94.6	43.1	15.1	40.1	201.3	98.4	7,892.0	198.2	756.7
LDGT3	16.6	20.2	31.5	15.4	5.0	13.4	68.3	33.8	3,023.1	86.2	249.4
LDGT4	7.6	9.3	14.5	7.1	2.3	6.1	31.4	15.5	1,840.7	39.6	114.6
HDGV2B	54.1	7.0	11.0	48.1	1.8	4.7	72.1	54.5	3,535.7	42.7	39.6
HDGV3	2.0	0.4	0.4	1.7	0.1	0.2	2.7	2.0	133.2	1.6	1.4
HDGV4	0.9	0.1	0.1	0.7	0.0	0.1	1.2	0.8	57.2	0.7	0.5
HDGV5	2.2	0.4	0.4	1.8	0.1	0.2	3.0	2.1	174.3	2.2	1.6
HDGV6	4.4	0.9	0.9	3.7	0.2	0.4	6.3	4.4	359.0	4.6	3.4
HDGV7	1.8	0.4	0.4	1.5	0.1	0.2	2.5	1.8	161.2	2.0	1.4
HDGV8A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HDGV8B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MC	3.0	0.6	1.8	2.1	0.1	0.8	5.4	3.0	178.5	1.4	1.6
LDDV	4.5	0.2	0.3	4.1	0.0	0.1	4.9	4.3	37.5	1.7	0.2
LDDT12	2.8	0.1	0.1	2.6	0.0	0.0	3.0	2.7	24.6	0.6	0.1
LDDT34	5.8	0.4	0.7	5.4	0.1	0.3	6.9	5.8	61.9	6.2	0.4
HDDV2B	38.8	2.2	3.4	35.9	0.6	1.5	44.4	37.9	1,102.6	42.0	7.4
HDDV3	10.5	1.0	1.0	9.8	0.3	0.4	12.6	10.5	373.1	14.2	2.3
HDDV4	11.6	1.1	1.1	10.7	0.3	0.5	13.8	11.5	475.6	17.3	2.4
HDDV5	5.1	0.5	0.5	4.7	0.1	0.2	6.1	5.1	236.9	8.3	1.1
HDDV6	50.5	2.6	2.7	46.7	0.6	1.1	55.7	48.5	1,642.0	48.0	5.7
HDDV7	75.0	3.7	3.9	69.4	0.9	1.6	82.5	72.0	2,958.7	80.2	8.3
HDDV8A	110.1	13.4	4.6	101.9	3.3	2.0	128.2	107.3	4,543.4	110.9	10.0
HDDV8B	410.8	47.3	16.4	380.3	11.8	7.0	474.5	399.1	18,835.8	411.7	35.5
HDGB	0.8	0.1	0.1	0.6	0.0	0.0	1.0	0.6	47.0	0.5	0.3
HDDBT	15.9	0.3	0.3	14.7	0.1	0.1	16.6	14.9	458.9	12.3	0.7
HDDBS	31.1	0.6	0.6	28.7	0.2	0.3	32.4	29.1	608.8	16.1	1.4
Total	990	291	375	913	73	159	1,656	1,145	60,045	1,461	2,731

5.4.2 AP-42 emission factors for paved and unpaved roads

While the exhaust, tire wear, and brake wear emissions were calculated using the EPA MOBILE6.2 model, fugitive dust from paved and unpaved roads were calculated using equations found in AP-42, Fifth Edition, November 2006. AP-42 is the common name for the EPA Compilation of Air Pollutant Emission Factors. Specifically, sections 13.2.1 and 13.2.2 of AP-42 describe calculations for fugitive dust from paved and unpaved roads, respectively.

The calculations for paved road fugitive dust emissions are related to silt loading values on road surfaces. As described previously, paved roads were split into three silt loading levels; freeways with a silt loading of 0.02 grams per square meter, high traffic arterials, 0.067 grams per square meter, and low traffic arterials, 0.23 grams per square meter. All local roadways were assumed to fall into the low traffic arterial category. These silt loading estimates are consistent with the Serious Area PM₁₀ Plan. When input to the AP-42 equation, these silt loadings result in the following PM₁₀ emission factors: for freeways 0.15 grams per VMT, for high ADT non-freeways, 0.58 grams per VMT, and for low ADT non-freeways, 1.54 grams per VMT.

Applying the same AP-42 equation produces PM_{2.5} emission rates of 0.00 grams per VMT for freeways and high ADT non-freeways and 0.06 grams per VMT for low ADT non-freeways.

The VMT in each silt loading category may be found in Table 5.2–2. Multiplying the paved road fugitive dust emission factors by the VMT estimates in Table 5.2–2 results in the emission totals for the PM₁₀ modeling area shown in Table 5.4–6.

Table 5.4–6. 2005 paved road fugitive dust emissions in the PM₁₀ modeling area.

Silt Loading Category	Emissions (kg/day)	
	PM ₁₀	PM _{2.5}
Freeway	4,189	0
High Traffic Arterial	23,295	0
Low Traffic Arterial	14,920	581
Total	42,404	581

Applying the VMT ratios in Table 5.2–4 to the modeling area emissions in Table 5.4–6 produces the total 2005 paved road fugitive dust emissions in the PM₁₀ nonattainment area and Maricopa County without reductions due to control measures in the Serious Area PM₁₀ Plan. These results are shown in Table 5.4–7.

Table 5.4–7. 2005 paved road fugitive dust emissions without Serious Area PM₁₀ Plan control measures.

Total emissions (kg/day)	PM ₁₀	PM _{2.5}
Nonattainment area	42,701	585
Maricopa County	44,779	614

The Serious Area PM₁₀ Plan contained a number of measures to reduce paved road fugitive dust emissions (MAG, 2000). The estimated emission reductions attributable to these measures in 2005 are summarized below in Table 5.4–8:

Table 5.4–8. Estimated emission reductions attributed to measures to reduce paved road fugitive dust.

Paved Road Control Measures	2005 PM ₁₀ Emission Reductions (kg/day)
1. PM ₁₀ Efficient Street Sweepers	6,441
2. Curbing, Paving or Stabilizing Shoulders on Paved Roads	1,412
3. Paving, Vegetating or Chemically Stabilizing Unpaved Access Points onto Paved Roads	590
Total 2005 PM₁₀ Emission Reductions	8,443

Applying these control measures to the PM₁₀ emissions in Table 5.4–7, results in the PM₁₀ emissions shown in Table 5.4–9. The PM_{2.5} emissions in Table 5.4–9 were obtained by applying the percentage reductions in PM₁₀ (i.e., 19.8% for the NAA and 18.9% for Maricopa County) to the PM_{2.5} emissions in Table 5.4–7.

Table 5.4–9. 2005 fugitive dust emissions from paved roads.

Area	PM ₁₀ Emissions			PM _{2.5} Emissions		
	kg/day	lbs/day	tons/yr	kg/day	lbs/day	tons/yr
PM ₁₀ NAA	34,258	75,525	13,783	469	1,034	189
Maricopa County	36,336	80,106	14,619	498	1,098	200

For unpaved roads, emission factors from AP-42 were applied to the VMT estimates from the Serious Area PM₁₀ Plan shown in Table 5.2–3. The unpaved road particulate emission factors were derived from the AP-42 equation for publicly accessible unpaved roads, assuming a silt content of 11.9%, soil moisture content of 0.5%, a mean vehicle weight of three tons, and an

average speed of 25 mph. The resultant emission factor for PM₁₀ is 666.62 grams per vehicle mile of travel. The comparable PM_{2.5} emission factor based on AP-42 is 10 percent of the PM₁₀ factor or 66.66 grams per vehicle mile. The unpaved road mileage estimates in Table 5.2–3 assume that all commitments to pave unpaved roads in the Serious Area PM₁₀ Plan have been implemented by 2005. Multiplying the unpaved road emission factors by the VMT estimates in Table 5.2–3 results in the emissions for the PM₁₀ modeling area shown in Table 5.4–10.

Table 5.4–10. Unpaved road fugitive dust emissions for the PM₁₀ modeling area.

Unpaved road type	Emissions (kg/day)	
	PM ₁₀	PM _{2.5}
High traffic	17,943	1,794
Low traffic	3,011	301
Total	20,954	2,095

Applying the VMT ratios in Table 5.2–4 to the PM₁₀ modeling area emissions in Table 5.4–10 produces the total 2005 unpaved road fugitive dust emissions in the PM₁₀ nonattainment area and Maricopa County. These results are shown in Table 5.4–11.

Table 5.4–11. 2005 fugitive dust emissions from unpaved roads.

Area	PM ₁₀ Emissions			PM _{2.5} Emissions		
	kg/day	lbs/day	tons/yr	kg/day	lbs/day	tons/yr
PM ₁₀ NAA	21,101	46,519	8,490	2,110	4,652	849
Maricopa County	22,127	48,781	8,903	2,213	4,879	890

5.5 Summary of particulate emissions from onroad mobile sources

Table 5.5–1 summarizes the annual emissions (in English tons per year) and the average daily emissions (in pounds per day) for the pollutants PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃ from all onroad mobile sources in the PM₁₀ nonattainment area in 2005. Similar data for all of Maricopa County is presented in Table 5.5–2.

Table 5.5–1. Annual and average daily 2005 emissions from all onroad mobile sources for the PM₁₀ nonattainment area.

	Annual emissions (tons/yr)					Average daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Exhaust	1,041	960	63,093	1,536	2,870	5,702	5,258	345,713	8,415	15,725
Paved road fugitive dust	13,783	189				75,523	1,034			
Unpaved road fugitive dust	8,490	849				46,519	4,652			
Tire wear	305	76				1,673	418			
Brake wear	394	167				2,158	915			
Total:	24,013	2,241	63,093	1,536	2,870	131,575	12,277	345,713	8,415	15,725

Table 5.5–2. Annual and average daily 2005 emissions from all onroad mobile sources for Maricopa County.

	Annual emissions (tons/yr)					Average daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Exhaust	1,092	1,007	66,187	1,611	3011	5,982	5,516	362,669	8,827	16,496
Paved road fugitive dust	14,619	200				80,104	1,098			
Unpaved road fugitive dust	8,903	890				48,781	4,879			
Tire wear	320	80				1,755	439			
Brake wear	413	175				2,264	960			
Total:	25,347	2,352	66,187	1,611	3,011	138,886	12,892	362,669	8,827	16,496

5.6 Quality assurance process

5.6.1 VMT estimates

Normal quality assurance procedures, including automated and manual consistency checks, were conducted by MAG in developing the 2005 EMME2 traffic assignment used to generate the VMT data. The MAG travel demand model VMT estimates have been validated against more than 3,000 traffic counts collected in 2002–2003, as well as Highway Performance Monitoring System data submitted annually by ADOT to the Federal Highway Administration.

5.6.2 Emission factor estimates

The quality assurance process performed on the MOBILE6.2 analyses included accuracy, completeness, and reasonableness checks. For accuracy and completeness, a system was used that included an independent reviewer. All calculations were checked independently for accuracy and completeness by the reviewer. Any errors found were corrected and the changes were then rechecked by the reviewer.

5.6.3 Draft particulate matter emissions inventory

The draft onroad mobile source portion of the 2005 periodic particulate matter emissions inventory was reviewed using published EPA quality review guidelines for base year emission inventories (EPA Document 450/4-91-022, September 1991). The procedural review (Levels I, II, and III) included checks for completeness, consistency, and the correct use of appropriate procedures.

5.7 References

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