

APPENDIX L
On-Road Mobile Sources

INTRODUCTION

Inhalable Particulate Matter (PM_{10}) emissions generated by on-road vehicles are directly affected by vehicle miles traveled (VMT). Emissions generated directly from the vehicle operation are calculated by Environmental Protection Agency (EPA's) mobile particulate model as exhaust, tire, and brake wear emissions. Particulate emissions resulting from vehicle travel on road surfaces are addressed in the section on dust reentrainment from paved and unpaved roads.

Emission Estimation Methodology

To estimate on-road mobile PM_{10} emissions, two items are needed: VMT and PM_{10} emission factors. This appendix first outlines development of gridded 1990 VMT estimates for El Paso County, then it explains the development of PM_{10} emission factors from both paved road reentrained dust and unpaved roads.

Gridded Vehicle Miles Traveled by Road Type

The Texas State Department of Highways and Public Transportation (TSDH&PT) used the Texas Travel Demand Package (TTDP) to establish gridded VMT for El Paso County for 1987. The TTDP contains the following three modules:

- Trip generation;
- Trip distribution; and
- Traffic assignments.

To produce gridded VMT for El Paso County, the TSDH&PT modeled the county using IMPACT, a macroscale computer model. This model uses a loaded highway network and MOBILE4 emission factors to compute mobile source emissions and allocate them spatially to a grid cell system designated by the user. A recent modification to IMPACT allowed the TSDH&PT to provide Texas Air Control Board (TACB) with VMT by road type per grid cell.

VMT in 1990 was estimated to be 3.5 percent higher than VMT for 1987. This percent increase was based on countywide population growth from 1985 to 1990. The linear annual average percent increase of population based on this data was 1.17 percent. The percent increase in VMT from 1987 to 1990 is, therefore, 3.5 (1.17 x 3).

The 1987 VMT was adjusted downward to correct for a possible VMT overestimation by the traffic assignments module of the TTDP. A correction factor was derived by comparing the VMT from counted volumes to the VMT from the traffic assignment module volumes, excluding VMT from centroid connectors (an estimation for VMT from city streets for which no actual traffic counts are made).

The ratio of these products of the TTDP should equal 1.0 if the transportation model were 100 percent validated.

Currently the ratio of assigned to counted VMT is 11,491,838/11,055,981, or 1.0394, or about a four percent overestimation by the traffic assignment module.

Actual counts of traffic are considered to be more realistic than VMT estimations from the traffic assignment module, and, therefore, the counted VMT is used as a gauge in validating the traffic assignment module. However, the TACB used the VMT from the traffic assignment module, in estimating mobile emissions because this model included a VMT estimation for city streets.

The total adjustment factor for VMT (including the increase for population growth and the decrease for the traffic assignment module overestimation) is 1.035/1.0394 or 0.9958. The adjustments are shown in Table L-1.

TABLE L-1
El Paso County VMT
(1987 adjusted to 1990)

<u>Year</u>	<u>Miles/day</u>	<u>Adjustment</u>
1987	12,452,530	none
1987	11,980,498	decrease for overestimation
1990	12,399,772	increase for population growth

The TACB condensed this VMT by first dividing the VMT by total miles for each TSDH&PT road type to get an estimated average daily traffic count, then matching these counts to the appropriate roadway categories in Compilation of Air Pollutant Emission Factors (AP-42) table 11.2.5-2 shown in Table L-3.

TABLE L-3

AP-42 Paved Urban Roadway Classification

<u>Roadway Category</u>	<u>Average Daily Traffic Count</u>	<u>Lanes</u>
Freeways	> 50,000	≥ 4
Majors	10,000 - 50,000	≥ 4
Collectors	500 - 10,000	2
Locals	< 500	2

Reclassification of TSDH&PT VMT into AP-42 Roadway Class System

The traffic assignment module VMT is grouped in 13 functional classifications (road types) that do not correspond to the AP-42 road classifications. Therefore, it was necessary for the TACB to combine the VMT into four AP-42 road types as shown in Table L-2.

TABLE L-2
Regrouping of VMT

TSDH&PT Codes	Functional Classification Names	<u>AP-42</u> Road Types
0	Centroid connectors	locals
1	Freeway, circumferential	freeways
2	Freeway, radial	freeways
3	UNUSED	UNUSED
4	Primary arterial, divided	majors
5	Primary arterial, undivided	majors
6	Arterial, divided	majors
7	Arterial, undivided	majors
8	Collector, divided	collectors
9	Collector, undivided	collectors
A	Local	collectors
B	Frontage roads	collectors
C	Ramps	freeways
D	Transmountain roads	majors

The TSDH&PT functional classifications 4, 5, 6, and 7 (arterials) were grouped as one classification to determine the average daily traffic count.

The TSDH&PT functional classification 0 (centroid connectors) does not have miles associated with it in the transportation model; therefore, a traffic count could not be determined for

this class. Centroid connector VMT estimations are based on zonal traffic volume volume in/out estimations, which are based on trip attractions. Centroid connector VMT is considered by the TACB and TSDH&PT to be the best available estimate for the AP-42 "Locals" roadway category.

EXHAUST, TIRE, AND BRAKE WEAR EMISSIONS

Exhaust, tire, and brake wear emissions were estimated using emission factors calculated with EPA's mobile particulate model: A Program to Calculate Size Specific Particulate Emissions for Mobile Sources - User's Guide, EPA 460/3-85-007, August 1985. These emission factors are multiplied by VMT and the units converted to tons per year.

One model run with a countywide average speed of 30 miles per hour (MPH) was used. Inputs to the model were national default values except for VMT mix, which was specific for El Paso. Inspection and maintenance was in effect. The model output is shown in Table L-4.

TABLE L-4

Mobile Sources

Particulate Model Output for El Paso County

Calculations For Year: 1990

Speed: 30.0 mph; urban

Particle Cutoff: 10.00 Microns

Flag Settings:

Tampering rates = normal driving conditions = transient

I/M Program = yes

Mileage & Regist. = normal misfueling rates = normal

vmt Mixture = normal Special conditions = normal

Particulate Emissions (Grams/Mile) by Vehicle Class (Urban Travel)

Veh. Class	Lead	Organic	Sulfate	Diesel	Total	VMT Frac.	VMT Wt.
							Total
LDV	.0039	.0179	.0093	.0174	.0484	.6720	.0325
LDT1	.0083	.0192	.0095	.0434	.0804	.1510	.0121
LDT2	.0167	.0188	.0110	.0434	.0899	.1010	.0091
HDGV	.0622	.0979	.0107	.0000	.1708	.0340	.0058
HDDT	.0000	.0000	.0000	.8063	.8063	.0360	.0290
IC	.0294	.0000	.0000	.0000	.0294	.0060	.0002

Total brake particulates = .0125

Total tire particulates = .0020

Total VMT weighted particulate emissions = .1033

Particulate Fraction by Vehicle Class

<u>Veh. Class</u>	<u>Lead</u>	<u>Organic</u>	<u>Sulfate</u>	<u>Diesel</u>
LDV	.0800	.3701	.1911	.3587
LDT1	.1032	.2386	.1180	.5402
LDT2	.1856	.2093	.1220	.4831
HDGV	.3641	.5731	.0628	.0000
HDDT	.0000	.0000	.0000	1.0000
MC	1.0000	.0000	.0000	.0000

EXHAUST, TIRE, AND BRAKE WEAR EMISSIONS ESTIMATION METHODOLOGY

$$\begin{aligned}
 PM_{10} &= \frac{12,399,772 \text{ VMT} \times 0.1033 \text{ gm} \times \text{lb.} \times \text{ton} \times 365 \text{ days}}{\text{days} \times \text{VMT} \times 453.6 \text{ gm} \times 2,000 \text{ lbs.} \times \text{yr}} \\
 &= 527 \text{ T/Y}
 \end{aligned}$$

DUST REENTRAINMENT FROM ROADS

Paved Roads

Input data and sources used in estimating PM_{10} emissions from paved roads in El Paso County for this inventory were obtained from a number of different sources.

Reentrained Dust Emission Factors

Reentrained dust emission factors were calculated using the equation on page 11.2.5-1 of AP-42. The principal input to this equation is silt loading (sL), which is the silt fraction times the overall dust load on a measured portion of a road. Two EPA source documents of silt loading factors were used in this inventory: AP-42, and Control of Open Fugitive Dust Sources (EPA 450/3-88-008). The factors were southwest specific values determined by sampling various roadways in Arizona for sL. Table L-5 shows a comparison of emission factors published in these two documents.

Gridded 1987 weighted assigned volumes of VMT were developed by the TSDH&PT. The City of El Paso supplied the 1985 El Paso County population estimate of 556,768. The 1990 Census was the source of the 1990 El Paso population of 591,610. The reentrained dust emission factor equation came from AP-42. The total road surface dust loading value and surface silt content used in

this equation came from EPA 450/3-88-008. Tailpipe, tire, and brake wear factors came from the EPA mobile particulate model.

Values for sL for MAJOR/ART and COLLECTOR for Pima and Maricopa Counties, Arizona, were taken from EPA document 450/3-88-008, Control of Open Fugitive Dust Sources, page 2-6. The values for the two counties were averaged for each of the two provided road types, giving average sL values for MAJOR/ART and COLLECTOR as shown in Table L-5.

TABLE L-5

Southwest Reentrained Dust (RD) Factors

Road Type	sL(g/m ²)	sL(g/m ²)	PM ₁₀ RD Emissions Factors	
	<u>AP-42</u>	<u>SW Average</u>	<u>1b/VMT (AP-42 Avg.)</u>	<u>1b/VMT (SW Avg.)</u>
Freeway	0.022	0.003278	0.00068	0.00015
Major/ART	0.36	0.062	0.00635	0.00155
Collector	0.92	0.115	0.01345	0.00255
Local	1.41	0.21009	0.01892	0.00413

These two average sL values were each divided into the corresponding AP-42 values for MAJOR/ART and COLLECTOR. The southwest MAJOR/ART value was found to be 17.22 percent of the corresponding AP-42 value, and the southwest COLLECTOR value was 12.5 percent of the AP-42 value. These two percentages were averaged, and the resulting average percentage (14.9 percent) was used to estimate southwest sL values for the remaining two road types,

FREEWAY and LOCAL, by multiplying it by the AP-42 values for these two road types.

Table L-6 shows one freeway VMT will produce about ten times less PM₁₀ emissions than one major VMT, about 19 times less than one collector VMT, and about 27 times less than one local VMT--there is more dust emitted from "Locals" than from "Freeways."

TABLE L-6
El Paso County 1990 RD Emissions

<u>Road type</u>	PM ₁₀ Emission Factor		<u>Lb/day</u>	<u>Tons/yr</u>
	<u>(Lbs./VMT)</u>	<u>Daily VMT</u>		
Local	0.00413	956,622	3,951	721
Collector	0.00255	922,323	2,352	429
Major	0.00155	5,773,942	8,950	1,633
Freeway	0.00015	4,746,885	<u>712</u>	<u>130</u>
TOTAL *			15,965	2,913

* (Parts may not sum to totals due to round off error).

Unpaved Roads

Information from El Paso County confirms there are 800 miles of unpaved roads within the county (includes 12 miles within the City of El Paso) plus 200 miles of unpaved roads within the colonias. AP-42, Section 11.2.1.2 was used to determine PM₁₀ emission factors to estimate PM₁₀ emissions from unpaved roads in El Paso County.

$$E = k(5.9) \frac{(s) (S) (W)^{0.7} (w)^{0.5} (365-p)}{(12)(30)(3) (4) (365)}$$

Where:

k = particle size multiplier	= 0.36
s = % silt content of road surface material	= 10
S = mean vehicle speed	= 40 mph
W = mean vehicle weight	= 3 tons
w = mean number of wheels	= 6
p = no. of days with 0.01 inches precip./yr	= 60

$$E = 0.36(5.9) \frac{(10) (40) (3)^{0.7} (6)^{0.5} (365-60)}{(12)(30)(3) (4) (365)}$$

= 2.44 lbs./VMT

Assume one vehicle per day travels the unpaved rural roads in El Paso County:

$$E_R = \frac{(2.44 \text{ lbs.})(\text{Tons})(800 \text{ miles trav.})(1 \text{ veh.})(365 \text{ days})}{(\text{VMT}) (2,000 \text{ lbs.}) (\text{day}) (\text{year})}$$

= 356 T/Y

Assume ten vehicles per day traveled the unpaved colonia roads in El Paso County:

$$E_C = \frac{(2.44 \text{ lbs.})(\text{Tons})(200 \text{ miles trav.})(10 \text{ veh.})(365 \text{ days})}{(\text{VMT}) (2,000 \text{ lbs.}) (\text{day}) (\text{year})}$$

= 890 T/Y

TOTAL = 356 + 890
= 1,246 T/Y