MISCELLANEOUS PROCESS METHODOLOGY 7.11
Unpaved Road Dust, Farm Roads

(Revised and Updated, December 2013)

EMISSION INVENTORY SOURCE CATEGORY
Miscellaneous Processes / Road Dust

EMISSION INVENTORY CODE (CES CODE) AND DESCRIPTION
645-646-5400-0000 (47431) Unpaved Road Travel Dust – Farm Roads

METHODS AND SOURCES

This source category provides estimates of the entrained geologic particulate matter (PM) emissions that result from vehicular travel over unpaved roads on agricultural lands due to mechanical disturbance of the roadway and vehicle-generated air turbulence effects. Emissions vary during the year according to the level of agricultural activity in each region. The California Air Resources Board (ARB) estimates PM emissions using an equation that incorporates crop specific vehicle miles traveled (VMT) factors, harvested crop acreage data, and an emission factor derived for unpaved roads.

ESTIMATION METHODOLOGY

ARB estimates unpaved farm road PM10 emissions for each county by multiplying the number of harvested acres for each crop by a crop specific VMT factor and an emission factor for unpaved roads. Fractions for other PM components (PM2.5 and total PM) are calculated using an ARB speciation profile. This update provides substantial enhancements to the emissions estimates by including detailed California-specific activity data.

Activity Data. Agricultural unpaved road activity data is based on county specific harvested crop acreage and on crop specific vehicle miles traveled (VMT/acre/year). Activity, expressed as pounds PM10 per vehicle mile traveled/acre/year (VMT/acre/year), is based on crop specific commodity factors that reflect annual land preparation and harvest activity. These factors are used to compute farm road VMT for each county.

Harvested acreage. For this update, 2005 harvested acreage from the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) was used for all regions except for the San Joaquin Valley Air Basin (SJV Air Basin). NASS data are compiled from county level reports provided by the California County Agricultural Commissioners for more than 200 commodities identified by the California

Department of Food and Agriculture (CDFA). For the SJV Air Basin, 2007 farmland acreage from the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP) was allocated to the various crops based on the 2007 harvested acreage reports compiled by NASS. For all regions, acreage for pasture lands, mushrooms, greenhouse, nursery and flower crops, and forest firewood was excluded. Also excluded was crop specific acreage that was aggregated statewide as "Sum of Others". These data, representing less than 1% of statewide harvested acreage, could not be reported due to disclosure of confidential business information. For counties split among two or more air basins, acreage was apportioned based on land surface areas [ARB, 2009 Almanac], except for Kern County, which was assigned 98% to the SJV Air Basin and 2% to the Mojave Desert Air Basin. Complete listings of California crop acreage by county/air basin/air district (COABDIS) region for this update are available here: https://www.arb.ca.gov/ei/areasrc/arbmiscprocunpaverddst.htm

Vehicle Miles Traveled (VMT). Prior to 2004, estimates of dust emissions from unpaved farm roads were based on an assumption of 4.38 VMT/acre/year for all crops [Gaffney, 1997]. In the early 2000's, ARB staff and a group of agricultural experts in the SJV Air Basin developed 21 representative crop profiles (Crop Calendars) that characterize the monthly distribution of annual land preparation and harvest activities for about 90 percent of California's crop acreage [ARB, April 2003]. Crops that were not specifically addressed were assigned a crop profile from a similar crop. Five commodity VMT factors, presented in Table A, were used to develop the crop specific VMT factors (VMT/acre/year) presented in Table B. Annual VMT are calculated as the product of crop specific harvested acreage and the assigned VMT factor. There is no adjustment for rainfall as crop calendars are assumed to reflect weather-related travel patterns on farm roads.

Table A. VMT Factors for Unpaved Farm Roads

Commodity	VMT/acre/year
Grapes	0.38
Tree & Citrus Fruit	1.23
Nut Crops	0.49
Cotton (large field)	0.40
Cotton (small field)	2.40

Table B

CDFA Commodity and Assigned VMT Factor

CDFA Code	Crop Description	VMT Category	VMT Factor VMT/acre/year
101999	WHEAT ALL	Cotton (large)	0.40
104999	RYE GRAIN	Cotton (large)	0.40
106199	RICE MILLING	Cotton (large)	0.40
106269	FIELD CROP BY-PRODUCTS	Cotton (large)	0.40
111559	CORN WHITE	Cotton (large)	0.40
111991	CORN GRAIN	Cotton (large)	0.40
111992	CORN SILAGE	Cotton (small)	2.40
112999	OATS GRAIN	Cotton (large)	0.40
113995	BARLEY FEED	Cotton (large)	0.40
113999	BARLEY UNSPECIFIED	Cotton (large)	0.40
114991	SORGHUM GRAIN	Cotton (large)	0.40
115991	TRITICALE	Cotton (large)	0.40
121219	COTTON LINT UPLAND	Cotton (large)	0.40
121229	COTTON LINT PIMA	Cotton (large)	0.40
121299	COTTON LINT UNSPECIFIED	Cotton (large)	0.40
132999	SUGAR BEETS	Cotton (small)	2.40
151999	COTTONSEED	Cotton (large)	0.40
158269	SAFFLOWER	Cotton (large)	0.40
158316	SUNFLOWER SEED PLANTING	Cotton (small)	2.40
158499	JOJOBA	Cotton (small)	2.40
161131	BEANS LIMA LG. DRY	Cotton (small)	2.40
161132	BEANS LIMA BABY DRY	Cotton (small)	2.40
161199	BEANS LIMA UNSPECIFIED	Cotton (small)	2.40
161717	BEANS KIDNEY RED	Cotton (small)	2.40
161741	BEANS BLACKEYE (PEAS)	Cotton (small)	2.40
161742	BEANS GARBANZO	Cotton (small)	2.40
169999	BEANS DRY EDIBLE UNSPEC.	Cotton (small)	2.40
171019	WHEAT SEED	Cotton (large)	0.40
171049	RYE SEED	Cotton (large)	0.40
171069	RICE SEED	Cotton (large)	0.40
171129	OATS SEED	Cotton (large)	0.40
171139	BARLEY SEED	Cotton (large)	0.40
171519	COTTON SEED PLANTING	Cotton (large)	0.40
171582	SAFFLOWER SEED PLANTING	Cotton (large)	0.40
171619	BEANS SEED	Cotton (small)	2.40
171949	FIELD CROPS SEED MISC.	Cotton (large)	0.40
171959	SEED VEG & VINECROP	Cotton (small)	2.40
172119	SEED ALFALFA	Cotton (large)	0.40
172289	SEED CLOVER UNSPECIFIED	Cotton (large)	0.40

Table B

CDFA Commodity and Assigned VMT Factor

CDFA Code	Crop Description	VMT Category	VMT Factor VMT/acre/year
173079	SEED BERMUDA GRASS	Cotton (large)	0.40
173669	SEED SUDAN GRASS	Cotton (large)	0.40
173999	SEED GRASS UNSPECIFIED	Cotton (large)	0.40
178999	SEED OTHER (NO FLOWERS)	Cotton (large)	0.40
181999	HAY ALFALFA	Cotton (large)	0.40
188499	HAY GRAIN	Cotton (large)	0.40
188799	HAY WILD	Cotton (large)	0.40
188899	HAY SUDAN	Cotton (large)	0.40
188999	HAY OTHER UNSPECIFIED	Cotton (large)	0.40
195199	SILAGE	Cotton (large)	0.40
195299	HAY GREEN CHOP	Cotton (large)	0.40
195399	STRAW	Cotton (large)	0.40
198199	RICE WILD	Cotton (large)	0.40
198999	FIELD CROPS UNSPECIFIED	Cotton (large)	0.40
201119	ORANGES NAVEL	Tree & Citrus Fruit	1.23
201519	ORANGES VALENCIA	Tree & Citrus Fruit	1.23
201999	ORANGES UNSPECIFIED	Tree & Citrus Fruit	1.23
202999	GRAPEFRUIT ALL	Tree & Citrus Fruit	1.23
203999	TANGERINES & MANDARINS	Tree & Citrus Fruit	1.23
204999	LEMONS ALL	Tree & Citrus Fruit	1.23
205999	LIMES ALL	Tree & Citrus Fruit	1.23
206999	TANGELOS	Tree & Citrus Fruit	1.23
207999	KUMQUATS	Tree & Citrus Fruit	1.23
208059	CITRUS BY-PRODUCTS MISC.	Tree & Citrus Fruit	1.23
209999	CITRUS UNSPECIFIED	Tree & Citrus Fruit	1.23
211999	APPLES ALL	Tree & Citrus Fruit	1.23
212199	PEACHES FREESTONE	Tree & Citrus Fruit	1.23
212399	PEACHES CLINGSTONE	Tree & Citrus Fruit	1.23
212999	PEACHES UNSPECIFIED	Tree & Citrus Fruit	1.23
213199	CHERRIES SWEET	Tree & Citrus Fruit	1.23
214199	PEARS BARTLETT	Tree & Citrus Fruit	1.23
214899	PEARS ASIAN	Tree & Citrus Fruit	1.23
214999	PEARS UNSPECIFIED	Tree & Citrus Fruit	1.23
215199	PLUMS	Tree & Citrus Fruit	1.23
215399	PLUMCOTS	Tree & Citrus Fruit	1.23
215999	PLUMS DRIED	Tree & Citrus Fruit	1.23
216199	GRAPES TABLE	Cotton (small)	2.40
216299	GRAPES WINE	Grapes (all)	0.38
216399	GRAPES RAISIN	Grapes (all)	0.38

Table B

CDFA Commodity and Assigned VMT Factor

CDFA Code	Crop Description	VMT Category	VMT Factor VMT/acre/year
216999	GRAPES UNSPECIFIED	Grapes (all)	0.38
217999	APRICOTS ALL	Tree & Citrus Fruit	1.23
218199	NECTARINES	Tree & Citrus Fruit	1.23
218299	PERSIMMONS	Tree & Citrus Fruit	1.23
218399	POMEGRANATES	Tree & Citrus Fruit	1.23
218499	QUINCE	Tree & Citrus Fruit	1.23
218889	BIOMASS ORCHARD	Nut Crops	0.49
218899	FRUITS & NUTS UNSPECIFIED	Tree & Citrus Fruit	1.23
221999	AVOCADOS ALL	Tree & Citrus Fruit	1.23
224999	DATES	Tree & Citrus Fruit	1.23
225999	FIGS DRIED	Tree & Citrus Fruit	1.23
226999	OLIVES	Tree & Citrus Fruit	1.23
229999	KIWIFRUIT	Grapes (all)	0.38
234799	BERRIES LOGANBERRIES	Grapes (all)	0.38
236199	BERRIES RASPBERRIES	Grapes (all)	0.38
237199	BERRIES STRAWBERRIES F MKT	Cotton (small)	2.40
237299	BERRIES STRAWBERRIES PROC.	Cotton (small)	2.40
237999	BERRIES STRAWBERRIES UNSPEC	Cotton (small)	2.40
238199	BERRIES BLUEBERRIES	Grapes (all)	0.38
239999	BERRIES BUSHBERRIES UNSPEC.	Cotton (small)	2.40
261999	ALMONDS ALL	Nut Crops	0.49
263999	WALNUTS ENGLISH	Nut Crops	0.49
264999	PECANS	Nut Crops	0.49
265999	WALNUTS BLACK	Nut Crops	0.49
267999	MACADAMIA NUTS	Nut Crops	0.49
268079	PISTACHIOS	Nut Crops	0.49
268099	ALMOND HULLS	Nut Crops	0.49
301999	ARTICHOKES	Cotton (small)	2.40
302999	ASPARAGUS UNSPECIFIED	Cotton (small)	2.40
303999	BEANS LIMA GREEN	Cotton (small)	2.40
304199	BEANS SNAP FRESH MARKET	Cotton (small)	2.40
304399	BEANS FRESH UNSPECIFIED	Cotton (small)	2.40
304999	BEANS SNAP UNSPECIFIED	Cotton (small)	2.40
305999	BEETS GARDEN	Cotton (small)	2.40
306999	RAPPINI	Cotton (small)	2.40
307189	BROCCOLI FOOD SERVICE	Cotton (small)	2.40
307199	BROCCOLI FRESH MARKET	Cotton (small)	2.40
307299	BROCCOLI PROCESSING	Cotton (small)	2.40
307919	BROCCOLI UNSPECIFIED	Cotton (small)	2.40

Table B

CDFA Commodity and Assigned VMT Factor

CDFA Code	Crop Description	VMT Category	VMT Factor VMT/acre/year
308999	BRUSSELS SPROUTS	Cotton (small)	2.40
309999	CABBAGE CH. & SPECIALTY	Cotton (small)	2.40
310999	CABBAGE HEAD	Cotton (small)	2.40
313189	CARROTS FOOD SERVICE	Cotton (small)	2.40
313199	CARROTS FRESH MARKET	Cotton (small)	2.40
313299	CARROTS PROCESSING	Cotton (small)	2.40
313999	CARROTS UNSPECIFIED	Cotton (small)	2.40
314189	CAULIFLOWER FOOD SERVICE	Cotton (small)	2.40
314199	CAULIFLOWER FRESH MARKET	Cotton (small)	2.40
314999	CAULIFLOWER UNSPECIFIED	Cotton (small)	2.40
316189	CELERY FOOD SERVICE	Cotton (small)	2.40
316199	CELERY FRESH MARKET	Cotton (small)	2.40
316999	CELERY UNSPECIFIED	Cotton (small)	2.40
318999	RADICCHIO	Cotton (small)	2.40
323999	CORN SWEET ALL	Cotton (small)	2.40
325999	CUCUMBERS	Cotton (small)	2.40
330999	EGGPLANT ALL	Cotton (small)	2.40
331999	ENDIVE ALL	Cotton (small)	2.40
332999	ESCAROLE ALL	Cotton (small)	2.40
333999	ANISE (FENNEL)	Cotton (small)	2.40
335999	GARLIC ALL	Cotton (small)	2.40
337999	KALE	Cotton (small)	2.40
339196	LETTUCE BULK SALAD PRODS.	Cotton (small)	2.40
339999	LETTUCE UNSPECIFIED	Cotton (small)	2.40
340999	LETTUCE HEAD	Cotton (small)	2.40
341999	LETTUCE ROMAINE	Cotton (small)	2.40
342999	LETTUCE LEAF	Cotton (small)	2.40
343999	MELONS CANTALOUPE	Cotton (small)	2.40
348999	MELONS HONEYDEW	Cotton (small)	2.40
354299	MELONS UNSPECIFIED	Cotton (small)	2.40
354999	MELONS WATERMELON	Cotton (small)	2.40
358999	ONIONS	Cotton (small)	2.40
359999	PARSLEY	Cotton (small)	2.40
361999	PEAS GREEN UNSPECIFIED	Cotton (small)	2.40
363999	PEPPERS BELL	Cotton (small)	2.40
364999	PEPPERS CHILI HOT	Cotton (small)	2.40
366999	PUMPKINS	Cotton (small)	2.40
367999	RADISHES	Cotton (small)	2.40
372999	ONIONS GREEN & SHALLOT	Cotton (small)	2.40

Table B

CDFA Commodity and Assigned VMT Factor

CDFA Code	Crop Description	VMT Category	VMT Factor VMT/acre/year
374189	SPINACH FOOD SERVICE	Cotton (small)	2.40
374199	SPINACH FRESH MARKET	Cotton (small)	2.40
374999	SPINACH UNSPECIFIED	Cotton (small)	2.40
375999	SQUASH	Cotton (small)	2.40
376999	SWISS CHARD	Cotton (small)	2.40
378199	TOMATOES FRESH MARKET	Cotton (small)	2.40
378299	TOMATOES PROCESSING	Cotton (large)	0.40
378999	TOMATOES UNSPECIFIED	Cotton (small)	2.40
380999	TURNIPS ALL	Cotton (small)	2.40
381999	GREENS TURNIP & MUSTARD	Cotton (small)	2.40
387999	LEEKS	Cotton (small)	2.40
391999	POTATOES IRISH ALL	Cotton (large)	0.40
392999	POTATOES SWEET	Cotton (large)	0.40
393999	HORSERADISH	Cotton (small)	2.40
394199	SALAD GREENS NEC.	Cotton (small)	2.40
394999	PEAS EDIBLE POD (SNOW)	Cotton (small)	2.40
395999	VEGETABLES ORIENTAL ALL	Cotton (small)	2.40
398499	TOMATILLO	Cotton (small)	2.40
398559	CILANTRO	Cotton (small)	2.40
398599	SPICES AND HERBS	Cotton (small)	2.40
398999	VEGETABLES UNSPECIFIED	Cotton (small)	2.40

PM_{10} Emission Factor. The statewide emission factor for geologic dust emissions from vehicular travel on all unpaved roads is 2.0 lbs PM10 per VMT [ARB, May 2003]. This is based on tests performed in the San Joaquin Valley by the University of California, Davis (UCD) [Flocchini, 2001] and the Desert Research Institute (DRI) [Gilles, 1996] and replaces the former emission factor of 2.27 lbs PM10 per VMT, which was based on preliminary data from the same studies.

PM10 Emissions. PM10 emissions on unpaved farm roads are calculated for each crop as the product of VMT and the PM10 emission factor (EF_{PM10}) for unpaved roads. Emissions are summed by county, then distributed to each COABDIS region:
PM10 (tons/year) = VMT x EF_{PM10}/(2000 lbs/ton)
EF_{PM10} = 2.0 lbs PM10/VMT (statewide unpaved road default)

PM2.5 and Total PM Emissions. PM2.5 and total PM are derived from calculated PM_{10} emissions using ARB's size speciation profile #470 [Houck, 1989; Cowherd, 2005]. Particle size fractions are based on an average of dust measurements from 8 fields in the San Joaquin Valley and on 2006 updates to ARB PM2.5 speciation profiles [Gaffney, 2006] that apportioned more of the fine PM (<2.5 microns) into the coarse PM (>2.5 microns) category. Compared to the previous methodology, the revised particle size profile reduces the PM2.5/PM10 fraction from 21.2% to 10% and reduces the PM2.5/total PM fraction from 12.6% to 5.9%.

Total PM and PM2.5 emissions on unpaved farm roads are calculated as follows:
Total PM emissions (tons/year) = PM10 (tons/year)/0.5943
PM2.5 emissions (tons/year) = (PM10 (tons/year)/0.5943) x 0.0594
= PM10 x 0.10
Table 1 presents tons per year PM10, PM2.5 and total PM emissions from unpaved farm roads for 2005 (non-SJV Air Basin regions) by COABDIS region, along with harvested acreage and VMT. Table 2 presents the same information for 2007 (SJV Air Basin).

TEMPORAL ACTIVITY

Monthly temporal profiles allocate emissions to reflect the percentage of annual activity occurring each month. The activity profiles are used to distribute emissions to the summer months (May - October) and winter months (November - April). Farm road activity is assumed to be the same each day of the week and to occur primarily during daylight hours. The profiles reflect the crop mix and the associated harvested acreage unique to each county. Monthly emissions are calculated by multiplying annual emissions by the monthly fraction. No adjustments are made for rainfall as the crop calendars are assumed to reflect seasonal activity patterns. Table 3 presents the monthly temporal emissions profiles by COABDIS region; a single county profile is used for counties split into two or more air districts.

GROWTH FORECASTING

In the prior update, this category was grown by the projected county acreage for irrigated and non-irrigated agricultural lands, excluding native grazing land, as reported by the FMMP. Growth projections were revised for this update [Griffin, 2011]. For all regions of the state except the SJV Air Basin, growth reflects linear regressions of the 2000-2009 NASS harvested crop acreage for regions showing a definite trend (-3% to +3% annually) and no growth when the regression analysis showed either no observable trend or an unsustainable trend. For the SJV Air Basin, growth reflects

linear regressions of 2000-2009 FMMP farmland acreage by COABDIS, applied to NASS harvested crop acreage for base year 2007. For all regions, growth is projected through 2020.

ASSUMPTIONS AND LIMITATIONS

1. The methodology assumes that unpaved farm road dust emissions are primarily related to the VMT on the unpaved roads.
2. It is assumed that five crop-specific base factors (VMT/acre/year) are adequate to develop VMT estimates for all unpaved farm roads statewide.
3. The methodology assumes that all unpaved roads in California emit the same levels of PM10 per VMT for all vehicles.
4. The methodology assumes that crop calendars for the San Joaquin Valley adequately describe crop specific cultural activities throughout the state.
5. It is assumed that the effects of rainfall are adequately incorporated into the VMT estimate because the crop calendars reflect seasonal activity.
6. It is assumed that there is more travel on unpaved farm roads during the times of year when land preparation and harvest activities are at their highest.
7. This methodology assumes that unpaved road travel associated with pasture lands is negligible.
8. This methodology assumes that no emission controls, such as watering, are used on the roads included in this inventory.
9. It is assumed that the particle size speciation profiles derived for the San Joaquin Valley are applicable to the rest of the state.
10. It is assumed that county-specific trends for harvested acreage over the past 10 years provides adequate growth parameters to estimate future unpaved farm road dust.

CHANGES IN THE METHODOLOGY

This update incorporates significant changes to the emission estimation methodology that reflect the most current research data and California specific VMT input. The changes to the unpaved farm road dust methodology are listed below:

- Use of a revised unpaved road dust emission factor, 2.0 lbs PM10/VMT, based on California test data.
- Use of a new method to substantially improve VMT estimates that replaces the use of a single VMT value for all crops (4.38 VMT/acre/year) with an approach based on crop specific VMT factors (0.38 - 2.40 VMT/acre/year).
- For non-SJV regions, harvested crop acreage was updated using NASS data for 2005. For the SJV Air Basin, 2007 farmland acreage from FMMP was allocated based on 2007 NASS harvested acreage data.

- Use of an updated particle size profile for unpaved roads (ARB profile #470), which reduces the PM2.5/PM10 particle size ratio from 21.2% to 10%. Estimated emissions for PM2.5 and total PM are reported for the first time.
- County specific temporal profiles were updated to reflect seasonal variations in emissions.
- New growth surrogates were adopted for non-SJV Air Basin regions based on linear regressions of harvested acreage for 2000-2009. For the SJV Air Basin, linear regressions of 2000-2009 FMMP farmland acreage were applied to NASS harvested crop acreage for base year 2007.

COMMENTS AND RECOMMENDATIONS

Emissions Estimates. Estimates of unpaved farm road activity could be improved for this category. Although expensive to develop, VMT factors, emission factors and speciation profiles that incorporate greater regional and seasonal specificity would improve the accuracy of the unpaved farm road dust PM inventory.

Ongoing Unpaved Road Research. In 1999, ARB contracted with UCD to conduct a study of vehicle activity and roadway mileage for unpaved roads in California, including unpaved farm roads [Morey, 2002]. While the methodology represents an advancement in characterizing unpaved road VMT, based on geographic information systems (GIS) coverages, traffic counts and visual surveys, ARB did not use the UCD study for this update because it lacks full documentation of the calculation methodology for unpaved road miles.

Growth. The assumptions concerning growth for agricultural fugitive dust categories should be periodically reviewed to ensure that the growth surrogate accurately reflects the current status of California's agricultural lands.

SAMPLE CALCULATIONS

Provided below are example calculations for PM10, PM2.5 and total PM emissions from unpaved farm road dust for Yolo County for the year 2005.

Estimating annual unpaved farm road dust PM10 emissions in Yolo County:

Step 1: VMT: From Table 1, input the annual VMT

VMT = 172,857.60

Step 2: PM10 Emission Factor (EF_{PM10}). Input the unpaved road PM10 emission factor.

The default ARB EF_{PM10} for all unpaved roads is 2.0 lbs PM10/VMT.

EF_{PM10} = 2.0 lbs PM10/VMT

Step3: Compute Emissions (tons per year). Multiply the VMT in Step 1 by the PM10 emission factor in Step 2. Divide by 2000 to compute annual tons.

Tons per year PM10 = (VMT x EF_{PM10})/2000

= (172,857.60 VMT x 2.0 lbs PM10/VMT)/2,000 lbs/ton

= 172.86 tons PM10/year

Estimating annual unpaved farm road dust PM2.5 emissions in Yolo County:

From ARB's particle size speciation profile #470, the fraction <PM10 = 0.5943

and the fraction <PM2.5 = 0.0594

Tons PM2.5/year = (Tons PM10/year/0.5943) x 0.0594

= (172.86 tons PM10/year/0.5943) x 0.0594

= 17.28 tons PM2.5/year

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Table 1
2005 Emissions from Unpaved Farm Roads

Year	Air Basin	County	Air District	Harvested Acres	VMT	Emissions, tons/year		
						PM10	PM2.5	Total PM
2005	GBV	Alpine	GBU	7.00	2.80	0.00	0.00	0.00
2005	GBV	Inyo	GBU	4,830.00	1,956.98	1.96	0.20	3.29
2005	GBV	Mono	GBU	11,956.00	5,094.40	5.09	0.51	8.57
2005	LC	Lake	LAK	16,426.00	8,813.75	8.81	0.88	14.83
2005	LT	El Dorado	ED	322.47	214.14	0.21	0.02	0.36
2005	LT	Placer	PLA	1,073.05	550.32	0.55	0.06	0.93
2005	MC	Amador	AMA	6,038.00	2,373.98	2.37	0.24	3.99
2005	MC	Calaveras	CAL	1,750.00	922.97	0.92	0.09	1.55
2005	MC	El Dorado	ED	3,260.53	2,165.23	2.17	0.22	3.64
2005	MC	Mariposa	MPA	981.00	505.08	0.51	0.05	0.85
2005	MC	Nevada	NSI	350.00	131.25	0.13	0.01	0.22
2005	MC	Placer	PLA	13,949.65	7,154.09	7.15	0.72	12.04
2005	MC	Plumas	NSI	10,000.00	4,000.00	4.00	0.40	6.73
2005	MC	Sierra	NSI	3,500.00	1,400.00	1.40	0.14	2.36
2005	MC	Tuolumne	TUO	600.00	240.00	0.24	0.02	0.40
2005	MD	Kern	KER	17,406.02	12,078.97	12.08	1.21	20.32
2005	MD	Los Angeles	AV	9,535.36	12,730.02	12.73	1.27	21.42
2005	MD	Riverside	MOJ	31,823.83	32,180.48	32.18	3.22	54.15
2005	MD	Riverside	SC	46,799.75	47,324.23	47.32	4.73	79.63
2005	MD	San Bernardino	MOJ	27,628.48	23,924.27	23.92	2.39	40.26
2005	NC	Del Norte	NCU	1,950.00	780.00	0.78	0.08	1.31
2005	NC	Humboldt	NCU	3,000.00	1,200.00	1.20	0.12	2.02
2005	NC	Mendocino	MEN	18,743.00	9,308.72	9.31	0.93	15.66
2005	NC	Sonoma	NS	48,291.56	20,958.81	20.96	2.10	35.27
2005	NC	Trinity	NCU	564.00	222.75	0.22	0.02	0.37
2005	NCC	Monterey	MBU	331,025.00	668,563.11	668.56	66.86	1,124.96
2005	NCC	San Benito	MBU	56,414.00	83,265.45	83.27	8.32	140.11
2005	NCC	Santa Cruz	MBU	20,146.00	38,971.92	38.97	3.90	65.58
2005	NEP	Lassen	LAS	67,605.00	27,442.00	27.44	2.74	46.18
2005	NEP	Modoc	MOD	89,248.00	48,031.20	48.03	4.80	80.82
2005	NEP	Siskiyou	SIS	97,444.00	42,469.60	42.47	4.24	71.46
2005	SC	Los Angeles	SC	10,752.64	14,355.13	14.36	1.43	24.15
2005	SC	Orange	SC	6,817.00	13,610.17	13.61	1.36	22.90
2005	SC	Riverside	SC	52,415.72	53,003.14	53.00	5.30	89.19
2005	SC	San Bernardino	SC	1,763.52	1,527.08	1.53	0.15	2.57

Table 1
2005 Emissions from Unpaved Farm Roads, cont.

Year	Air Basin	County	Air District	Harvested Acres	VMT	Emissions, tons/year		
						PM10	PM2.5	Total PM
2005	SCC	San Luis Obispo	SLO	111,623.00	122,767.62	122.77	12.27	206.58
2005	SCC	Santa Barbara	SB	123,654.00	227,201.59	227.20	22.71	382.30
2005	SCC	Ventura	VEN	90,861.00	158,939.02	158.94	15.89	267.44
2005	SD	San Diego	SD	53,458.00	70,727.84	70.73	7.07	119.01
2005	SF	Alameda	BA	7,742.00	3,042.58	3.04	0.30	5.12
2005	SF	Contra Costa	BA	25,940.00	23,435.48	23.44	2.34	39.43
2005	SF	Marin	BA	5,827.00	2,736.10	2.74	0.27	4.60
2005	SF	Napa	BA	42,385.00	16,076.16	16.08	1.61	27.05
2005	SF	San Francisco	BA	0.00	0.00	0.00	0.00	0.00
2005	SF	San Mateo	BA	3,447.00	6,392.88	6.39	0.64	10.76
2005	SF	Santa Clara	BA	21,522.00	37,599.43	37.60	3.76	63.27
2005	SF	Solano	BA	53,404.82	32,781.15	32.78	3.28	55.16
2005	SF	Sonoma	BA	22,725.44	9,862.97	9.86	0.99	16.60
2005	SS	Imperial	IMP	524,679.00	464,842.50	464.84	46.46	782.17
2005	SS	Riverside	SC	56,159.70	56,789.08	56.79	5.68	95.56
2005	SV	Butte	BUT	194,893.00	101,253.83	101.25	10.12	170.37
2005	SV	Colusa	COL	256,544.00	150,029.82	150.03	15.00	252.45
2005	SV	Glenn	GLE	212,733.00	124,985.41	124.99	12.49	210.31
2005	SV	Placer	PLA	6,438.30	3,301.89	3.30	0.33	5.56
2005	SV	Sacramento	SAC	131,189.00	86,732.93	86.73	8.67	145.94
2005	SV	Shasta	SHA	29,305.00	12,212.80	12.21	1.22	20.55
2005	SV	Solano	YS	87,134.18	53,485.04	53.49	5.35	90.00
2005	SV	Sutter	FR	224,428.00	150,834.11	150.83	15.08	253.80
2005	SV	Tehama	TEH	52,936.00	35,042.27	35.04	3.50	58.96
2005	SV	Yolo	YS	301,242.00	172,857.60	172.86	17.28	290.86
2005	SV	Yuba	FR	72,694.00	49,063.72	49.06	4.90	82.56
Totals				3,727,381	3,360,466	3,360	336	5,655

Table 2
2007 Emissions from Unpaved Farm Roads

Year	Air Basin	County	Air District	Harvested Acres	VMT	Emissions, tons/year		
						PM10	PM2.5	Total PM
2007	SJV	Fresno	SJU	1,380,839.17	1,197,804.44	1,197.80	119.72	2,015.48
2007	SJV	Kern	SJU	950,705.13	573,462.85	573.46	57.32	964.93
2007	SJV	Kings	SJU	579,771.60	393,436.77	393.44	39.32	662.02
2007	SJV	Madera	SJU	364,080.25	247,722.97	247.72	24.76	416.83
2007	SJV	Merced	SJU	591,529.49	500,642.63	500.64	50.04	842.40
2007	SJV	San Joaquin	SJU	617,864.25	409,077.08	409.08	40.89	688.34
2007	SJV	Stanislaus	SJU	397,908.34	367,660.16	367.66	36.75	618.64
2007	SJV	Tulare	SJU	866,209.89	949,610.78	949.61	94.91	1,597.86
Totals				5,748,908	4,639,418	4,639	464	7,807

Table 3
Unpaved Farm Roads PM_{10} Emissions Temporal Profile by COABDIS
(Annual sum of monthly values may not equal 100 due to rounding)

Year	Air Basin	County	Air District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	GBV	Alpine	GBU	0.071	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	GBV	Inyo	GBU	0.071	0.001	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	GBV	Mono	GBU	0.066	0.000	0.066	0.066	0.066	0.072	0.072	0.083	0.083	0.149	0.143	0.132
2005	LC	Lake	LAK	0.043	0.024	0.061	0.058	0.075	0.075	0.058	0.058	0.114	0.155	0.156	0.123
2005	LT	El Dorado	ED	0.044	0.040	0.044	0.075	0.091	0.091	0.075	0.075	0.088	0.147	0.131	0.099
2005	LT	Placer	PLA	0.032	0.023	0.104	0.160	0.160	0.031	0.031	0.028	0.077	0.126	0.137	0.092
2005	MC	Amador	AMA	0.022	0.001	0.024	0.085	0.117	0.117	0.085	0.085	0.107	0.160	0.130	0.065
2005	MC	Calaveras	CAL	0.032	0.019	0.037	0.049	0.060	0.060	0.049	0.049	0.141	0.179	0.173	0.152
2005	MC	El Dorado	ED	0.044	0.040	0.044	0.075	0.091	0.091	0.075	0.075	0.088	0.147	0.131	0.099
2005	MC	Mariposa	MPA	0.089	0.022	0.155	0.029	0.033	0.033	0.029	0.029	0.096	0.122	0.185	0.178
2005	MC	Nevada	NSI	0.000	0.000	0.000	0.105	0.158	0.158	0.105	0.105	0.105	0.158	0.105	0.000
2005	MC	Placer	PLA	0.032	0.023	0.104	0.160	0.160	0.031	0.031	0.028	0.077	0.126	0.137	0.092
2005	MC	Plumas	NSI	0.071	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	MC	Sierra	NSI	0.071	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	MC	Tuolumne	TUO	0.071	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	MD	Kern	KER	0.035	0.041	0.051	0.066	0.052	0.074	0.061	0.045	0.074	0.129	0.217	0.155
2005	MD	Los Angeles	AV	0.054	0.045	0.059	0.053	0.053	0.071	0.076	0.100	0.103	0.141	0.123	0.121
2005	MD	Riverside	MOJ	0.046	0.052	0.071	0.070	0.051	0.064	0.088	0.048	0.053	0.140	0.188	0.130
2005	MD	Riverside	SC	0.046	0.052	0.071	0.070	0.051	0.064	0.088	0.048	0.053	0.140	0.188	0.130
2005	MD	San Bernardino	MOJ	0.055	0.027	0.089	0.056	0.040	0.044	0.129	0.041	0.059	0.194	0.151	0.116
2005	NC	Del Norte	NCU	0.071	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.143	0.143	0.143
2005	NC	Humboldt	NCU	0.046	0.000	0.046	0.046	0.046	0.105	0.105	0.046	0.046	0.093	0.210	0.210
2005	NC	Mendocino	MEN	0.023	0.023	0.023	0.092	0.126	0.126	0.092	0.092	0.092	0.149	0.115	0.047
2005	NC	Sonoma	NS	0.018	0.010	0.021	0.088	0.124	0.134	0.098	0.088	0.092	0.142	0.130	0.056
2005	NC	Trinity	NCU	0.058	0.000	0.058	0.078	0.088	0.088	0.078	0.078	0.078	0.146	0.136	0.115
2005	NCC	Monterey	MBU	0.026	0.042	0.073	0.058	0.029	0.035	0.218	0.035	0.035	0.263	0.127	0.059
2005	NCC	San Benito	MBU	0.027	0.024	0.057	0.054	0.023	0.029	0.226	0.038	0.042	0.286	0.130	0.064
2005	NCC	Santa Cruz	MBU	0.021	0.067	0.089	0.057	0.029	0.044	0.167	0.037	0.037	0.194	0.162	0.097
2005	NEP	Lassen	LAS	0.068	0.001	0.068	0.068	0.068	0.076	0.076	0.068	0.068	0.136	0.151	0.151
2005	NEP	Modoc	MOD	0.058	0.018	0.058	0.058	0.058	0.082	0.082	0.079	0.079	0.126	0.151	0.151
2005	NEP	Siskiyou	SIS	0.046	0.001	0.046	0.046	0.046	0.096	0.097	0.066	0.066	0.111	0.189	0.189
2005	SC	Los Angeles	SC	0.054	0.045	0.059	0.053	0.053	0.071	0.076	0.100	0.103	0.141	0.123	0.121
2005	SC	Orange	SC	0.025	0.164	0.159	0.020	0.020	0.035	0.043	0.040	0.040	0.143	0.202	0.109
2005	SC	Riverside	SC	0.046	0.052	0.071	0.070	0.051	0.064	0.088	0.048	0.053	0.140	0.188	0.130
2005	SC	San Bernardino	SC	0.055	0.027	0.089	0.056	0.040	0.044	0.129	0.041	0.059	0.194	0.151	0.116
2005	SCC	San Luis Obispo	SLO	0.044	0.046	0.063	0.064	0.057	0.067	0.140	0.054	0.057	0.180	0.134	0.094
2005	SCC	Santa Barbara	SB	0.044	0.070	0.084	0.061	0.048	0.052	0.136	0.051	0.051	0.188	0.132	0.084
2005	SCC	Ventura	VEN	0.035	0.072	0.086	0.047	0.030	0.040	0.144	0.046	0.047	0.194	0.151	0.108
2005	SD	San Diego	SD	0.062	0.073	0.069	0.056	0.054	0.059	0.075	0.064	0.065	0.137	0.146	0.137

Table 3
Unpaved Farm Roads PM_{10} Emissions Temporal Profile by COABDIS
(Annual sum of monthly values may not equal 100 due to rounding)

Year	Air Basin	County	Air District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	SF	Alameda	BA	0.052	0.000	0.052	0.080	0.095	0.095	0.080	0.080	0.080	0.147	0.133	0.105
2005	SF	Contra Costa	BA	0.084	0.028	0.148	0.026	0.028	0.033	0.035	0.031	0.093	0.121	0.191	0.180
2005	SF	Marin	BA	0.050	0.013	0.050	0.052	0.052	0.101	0.100	0.052	0.052	0.096	0.192	0.191
2005	SF	Napa	BA	0.001	0.001	0.001	0.104	0.156	0.156	0.104	0.104	0.105	0.158	0.106	0.003
2005	SF	San Francisco	BA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	SF	San Mateo	BA	0.027	0.129	0.132	0.030	0.029	0.057	0.055	0.060	0.060	0.095	0.185	0.140
2005	SF	Santa Clara	BA	0.045	0.057	0.076	0.043	0.026	0.030	0.150	0.049	0.057	0.226	0.148	0.093
2005	SF	Solano	BA	0.058	0.039	0.103	0.028	0.029	0.051	0.060	0.037	0.076	0.129	0.208	0.181
2005	SF	Sonoma	BA	0.018	0.010	0.021	0.088	0.124	0.134	0.098	0.088	0.092	0.142	0.130	0.056
2007	SJV	Fresno	SJU	0.046	0.039	0.082	0.037	0.033	0.050	0.069	0.060	0.097	0.154	0.185	0.147
2007	SJV	Kern	SJU	0.039	0.037	0.047	0.067	0.054	0.075	0.063	0.047	0.083	0.132	0.203	0.152
2007	SJV	Kings	SJU	0.066	0.019	0.120	0.019	0.018	0.044	0.048	0.025	0.082	0.109	0.231	0.218
2007	SJV	Madera	SJU	0.050	0.007	0.088	0.037	0.040	0.048	0.036	0.030	0.125	0.151	0.210	0.178
2007	SJV	Merced	SJU	0.074	0.020	0.134	0.014	0.014	0.028	0.033	0.021	0.105	0.126	0.219	0.212
2007	SJV	San Joaquin	SJU	0.060	0.033	0.115	0.022	0.025	0.044	0.047	0.032	0.097	0.123	0.209	0.192
2007	SJV	Stanislaus	SJU	0.065	0.030	0.131	0.015	0.015	0.024	0.029	0.017	0.114	0.149	0.215	0.197
2007	SJV	Tulare	SJU	0.072	0.019	0.127	0.043	0.033	0.047	0.036	0.022	0.083	0.117	0.218	0.183
2005	SS	Imperial	IMP	0.050	0.037	0.079	0.056	0.044	0.056	0.127	0.060	0.066	0.169	0.141	0.116
2005	SS	Riverside	SC	0.046	0.052	0.071	0.070	0.051	0.064	0.088	0.048	0.053	0.140	0.188	0.130
2005	SV	Butte	BUT	0.016	0.025	0.081	0.112	0.112	0.014	0.014	0.013	0.131	0.173	0.178	0.132
2005	SV	Colusa	COL	0.028	0.050	0.101	0.115	0.115	0.025	0.032	0.026	0.087	0.146	0.168	0.109
2005	SV	Glenn	GLE	0.040	0.028	0.121	0.087	0.087	0.020	0.020	0.014	0.105	0.147	0.187	0.145
2005	SV	Placer	PLA	0.032	0.023	0.104	0.160	0.160	0.031	0.031	0.028	0.077	0.126	0.137	0.092
2005	SV	Sacramento	SAC	0.062	0.028	0.119	0.044	0.050	0.053	0.052	0.043	0.086	0.105	0.186	0.170
2005	SV	Shasta	SHA	0.058	0.003	0.077	0.095	0.095	0.058	0.058	0.058	0.080	0.144	0.144	0.131
2005	SV	Solano	YS	0.058	0.039	0.103	0.028	0.029	0.051	0.060	0.037	0.076	0.129	0.208	0.181
2005	SV	Sutter	FR	0.031	0.061	0.116	0.091	0.091	0.029	0.034	0.028	0.078	0.138	0.181	0.123
2005	SV	Tehama	TEH	0.044	0.033	0.048	0.044	0.044	0.046	0.046	0.041	0.127	0.168	0.180	0.179
2005	SV	Yolo	YS	0.066	0.024	0.109	0.042	0.043	0.038	0.049	0.036	0.093	0.117	0.196	0.188
2005	SV	Yuba	FR	0.044	0.034	0.089	0.106	0.107	0.035	0.035	0.035	0.095	0.142	0.151	0.127