

3. Area Sources

3.1 Scope and methodology

This chapter considers all stationary sources which are too small or too numerous to be treated as point sources. EPA guidance documents, including “Introduction to Area Source Inventory Development” (US EPA, 2001a) as well as permit and emissions data in the MCAQD’s Environmental Management System (EMS) database, and previous SIP inventories, were evaluated to develop the list of area-source categories for inclusion. Some source categories were deemed “insignificant” because there are no large production facilities and/or very few small sources, and therefore emissions were not quantified. MCAQD prepared the area-source emission estimates for all area sources and provided quality assurance checks on all data. Table 3.1–1 contains a list of all area-source categories, with Source Classification Codes (SCCs), addressed in this chapter.

Table 3.1–1. List of area-source categories included in this PM₁₀ inventory.

SCC Code	Category Description	Section
<i>Fuel combustion:</i>		
2102006000	Industrial natural gas	3.2.1
2102004000	Industrial fuel oil	3.2.2
2103006000	Commercial/institutional natural gas	3.2.3
2103004000	Commercial/institutional fuel oil	3.2.4
2104006000	Residential natural gas	3.2.5
2104008000	Residential wood	3.2.6
2104004000	Residential fuel oil	3.2.7
<i>Industrial processes:</i>		
2301010000	Chemical manufacturing	3.3.1
2302002000	Commercial cooking	3.3.2.1
2302040000	Grain handling/processing	3.3.2.2
2302080000	Ammonia cold storage	3.3.2.3
2304000000	Secondary metal production	3.3.3
2305000000	Non-metallic mineral processes	3.3.4
2325000000	Mining and quarrying	3.3.5
2307000000	Wood product manufacturing	3.3.6
2308000000	Rubber/plastics manufacturing	3.3.7
2309000000	Fabricated metal products manufacturing	3.3.8
2311010000	Residential construction	3.3.9
2311020000	Commercial construction	3.3.9
2311030000	Road construction	3.3.9
n/a	Other construction	3.3.9
2312000000	Electrical equipment manufacturing	3.3.10
n/a	State-permitted portable sources	3.3.11
n/a	Paved/unpaved road travel on industrial sites	3.3.12
2399000000	Industrial processes not elsewhere classified (NEC)	3.3.13
<i>Waste treatment and disposal:</i>		
2601000000	On-site incineration	3.4.1
2610000000	Open burning	3.4.2
2620000000	Landfills	3.4.3
2630000000	Publicly owned treatment works (POTWs)	3.4.4
2650000000	Other industrial waste disposal	3.4.5
<i>Miscellaneous area sources:</i>		
2810001000	Wildfires	3.5.1.1
2810014000	Prescribed fires	3.5.1.2

Table 3.1–1. (continued) List of area-source categories.

SCC Code	Category Description	Section
<i>Miscellaneous area sources: (continued)</i>		
2810030000	Structure fires	3.5.1.3
2810050000	Vehicle fires	3.5.1.4
2810040000	Engine testing	3.5.1.5
2801000003	Tilling	3.5.2.1
2801000005	Harvesting	3.5.2.2
n/a	Travel on unpaved agricultural roads	3.5.2.3
2801000000	Cotton ginning	3.5.2.4
2801700000	Fertilizer application	3.5.2.5
2810060000	Livestock	3.5.3
2810060000	Health services: crematories	3.5.4
2830000000	Accidental releases	3.5.5
2810010000	Humans	3.5.6
n/a	Leaf blower fugitive dust	3.5.7
n/a	Offroad recreational vehicle fugitive dust	3.5.8
n/a	Unpaved parking lots fugitive dust	3.5.9
2730100000	Windblown dust	3.5.10

For nearly all categories, emissions were calculated in one of the following ways:

- Emissions estimates for some categories were developed by conducting surveys on local usage (e.g., natural gas consumption) or derived from state-wide data (e.g., fuel oil use).
- For some widespread or diverse categories (e.g., ammonia cold storage), emissions were calculated using published per-capita or per-employee emission factors.
- For source categories with some information available from annual emissions reports (e.g., wood product manufacturing), these data were combined with employment data to “scale up” reported emissions to reflect the entire source category.
- For those source categories that have detailed emissions data available from most or all of the significant sources in the category, emissions were calculated based on the detailed process-level and operational data provided by these sources.

The specific emissions estimation methodologies used for each source category (including the derivation and application of rule effectiveness) are described in greater detail in the respective sections.

3.2 Fuel combustion

Area-source emissions for the following seven categories of fuel consumption were calculated: Industrial natural gas, industrial fuel oil, commercial/institutional natural gas, commercial/institutional fuel oil, residential natural gas, residential wood, and residential fuel oil. Data for emissions calculations from natural gas combustion came from a survey of the three natural gas suppliers in Maricopa County. Table 3.2–1 summarizes the natural gas sales data received from Maricopa County natural gas suppliers.

Table 3.2–1. Maricopa County natural gas sales data by supply company and end-user category.

Natural gas supplier	Sales by end user category (in MMCF/yr)					
	Electric Utilities	Industrial	Commercial/Institutional	Residential	Transport*	Other*
Southwest Gas	17.07	1,543.27	15,643.15	14,911.67	6,487.35	n/a
City of Mesa	6.52	93.02	1,609.12	1,339.62	n/a	244.97
El Paso	227,608.92	201.90	n/a	n/a	n/a	6.07

* For emissions calculations, sales from transport and other were grouped with industrial sales.

Area-source emissions for wood and fuel oil combustion were calculated from Arizona state-level sales and consumption data as described in the following subsections. Area-source emissions from coal and liquid petroleum gas were not calculated, as emissions from these categories were determined to be insignificant.

3.2.1 Industrial natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2008. Area-source industrial natural gas usage for the county is based on the reported total volume of natural gas sold to industrial sources, minus natural gas used by industrial point sources:

$$\begin{aligned}
 \text{County area-source industrial natural gas usage} &= \text{Total reported industrial natural gas sales} - \text{Industrial point source natural gas usage} \\
 &= 8,576.57 \text{ MMCF} - 516.15 \text{ MMCF} \\
 &= 8,060.42 \text{ MMCF}
 \end{aligned}$$

Natural gas is used for both external combustions (boilers and heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be divided between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all industrial area sources in 2008.

Annual emissions for the county and the PM₁₀ nonattainment area were calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external natural gas combustion:

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from external natural gas combustion} &= \text{External industrial natural gas usage (MMCF)} \times \text{PM}_{10} \text{ emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 7,934.68 \times 7.6 \div 2,000 \\
 &= 30.15 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–2. Natural gas usage, emission factors, and annual emissions from area-source industrial natural gas combustion, by combustion type.

Type of Combustion	% of total	Natural gas use (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	98.44	7,934.68	7.6	7.6	100	0.6	3.2	30.15	30.15	396.73	2.38	12.70
Internal	1.56	125.74	10.0	10.0	2840	0.6	n/a	0.63	0.63	178.55	0.04	n/a
Total:	100.00	8,060.43						30.78	30.78	575.29	2.42	12.70

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days that activity occurs throughout the year:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from industrial natural gas (lbs/day)} &= \text{Annual PM}_{10} \text{ emissions} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 30.78 \text{ tons/yr} \div (6 \times 52) \times 2,000 \\
 &= 197.3 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area were calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{Emissions from area-source industrial natural gas combustion} &= \text{Annual county PM}_{10} \text{ emissions (tons/yr)} \times \text{NAA:County industrial employment ratio in the PM}_{10} \text{ NAA} \\
 &= 30.78 \times 0.9974 \\
 &= 30.70 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2-3. Annual and typical daily emissions from area-source industrial natural gas combustion.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
PM ₁₀ NAA	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2

3.2.2 Industrial fuel oil

Area-source emissions from industrial fuel oil combustion were calculated by a multi-step process which allocates Arizona state-level industrial fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2010a) to Maricopa County.

To derive industrial fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2008 are first subtracted from Arizona state-level total industrial fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local air quality regulations and market conditions.

$$\begin{aligned}
 \text{State industrial fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)} &= \text{Reported state total industrial fuel oil sales} - \text{Reported state high-sulfur diesel sales} \\
 &= 137,044 \text{ Mgal} - 224 \text{ Mgal} \\
 &= 136,820 \text{ Mgal/yr}
 \end{aligned}$$

Arizona state industrial fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of industrial employment in Maricopa County to Arizona State (0.70), as determined by data from the US Census Bureau (2010a) to estimate annual Maricopa County-level industrial fuel oil sales, as follows:

$$\begin{aligned}
 \text{Maricopa County industrial fuel oil sales} &= \text{Arizona state industrial fuel oil sales less high-sulfur diesel} \times \text{Maricopa County:State industrial employment ratio} \\
 &= 136,820 \text{ Mgal} \times 0.7007 \\
 &= 95,869.77 \text{ Mgal/yr}
 \end{aligned}$$

To avoid double-counting, industrial fuel oil use attributable to stationary point sources (addressed in Chapter 2) and nonroad mobile sources (addressed in Chapter 4) are subtracted from County industrial fuel oil sales to estimate county fuel oil usage by area sources:

$$\begin{aligned}
 \text{Maricopa County area} &= \text{Maricopa County} & - & \text{Fuel oil used by industrial} & - & \text{Fuel oil used by industrial} \\
 \text{source fuel oil sales} & \text{industrial fuel oil sales} & & \text{nonroad mobile equipment} & & \text{stationary point sources} \\
 & = 95,869.77 \text{ Mgal} & - & 11,596.87 \text{ Mgal} & - & 136.82 \text{ Mgal} \\
 & = 84,136.09 \text{ Mgal/yr} & & & &
 \end{aligned}$$

Industrial fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source industrial fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all industrial area sources surveyed in 2008 (shown in Table 3.2–4 below).

Annual emissions for the county and the PM₁₀ nonattainment area were calculated by multiplying industrial fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external fuel oil combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions} &= \text{External industrial fuel} & \times & \text{PM}_{10} \text{ emission factor for external} & \div & 2,000 \text{ lbs/ton} \\
 \text{from external industrial} & \text{oil sales (Mgal)} & & \text{fuel oil combustion (lb/Mgal)} & & \\
 \text{fuel oil combustion} & & & & & \\
 & = 65,634.56 & \times & 2 & \div & 2,000 \\
 & = 65.63 \text{ tons PM}_{10}/\text{yr} & & & &
 \end{aligned}$$

Table 3.2–4. Emission factors and annual emissions from area-source industrial fuel oil combustion, by combustion type.

Combustion type	% of total	Annual sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	78.01	65,634.56	2.0	2.0	24	7.39	0.8	65.63	65.63	787.61	242.36	26.25
Internal	21.99	18,501.53	42.5	42.5	604	39.70	–	393.16	393.16	5,587.46	367.26	n/a
Totals:	100.00	84,136.09						458.79	458.79	6,375.08	609.61	26.25

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days during which activity occurs throughout the year, as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions} &= \text{Annual PM}_{10} \text{ emissions} & \div & (\text{days/week} \times \text{wks/yr}) & \times & 2,000 \text{ lbs/ton} \\
 \text{from industrial fuel oil} & \text{(tons/yr)} & & & & \\
 & = 458.79 & \div & (6 \times 52) & \times & 2,000 \\
 & = 2,941.0 \text{ lbs PM}_{10}/\text{day} & & & &
 \end{aligned}$$

Annual and typical daily emissions in the PM₁₀ nonattainment area were calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{PM}_{10} \text{ NAA emissions from area} &= \text{Annual county} & \times & \text{NAA:County industrial employment ratio} \\
 \text{source industrial fuel oil combustion} & \text{PM}_{10} \text{ emissions} & & \\
 & = 458.79 \text{ tons/yr} & \times & 0.9974 \\
 & = 457.60 \text{ tons PM}_{10}/\text{yr} & &
 \end{aligned}$$

Table 3.2-5. Annual and typical daily emissions from area-source industrial fuel oil combustion.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
PM ₁₀ NAA	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9

3.2.3 Commercial/institutional natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2008. Area-source commercial and institutional (C&I) natural gas usage for the county is based on the reported total volume of natural gas sold to C&I sources, minus natural gas used by C&I point sources:

$$\begin{aligned}
 \text{County area-source C\&I natural gas usage} &= \text{Reported C\&I natural gas sales} - \text{C\&I point source natural gas usage} \\
 &= 17,503.31 \text{ MMCF} - 84.08 \text{ MMCF} \\
 &= 17,419.23 \text{ MMCF}
 \end{aligned}$$

Natural gas is used for both external combustion (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all C&I area sources in 2008.

Annual emissions for the county were calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external natural gas combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external natural gas combustion} &= \text{External C\&I natural gas usage (MMCF)} \times \text{PM}_{10} \text{ emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 17,130.07 \times 7.6 \div 2,000 \\
 &= 65.09 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2-6. Emission factors and annual emissions from area-source commercial/institutional natural gas combustion, by combustion type.

Combustion type	% of total	C&I natural gas usage (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	98.34	17,130.07	7.6	7.6	100	0.6	0.49	65.09	65.09	856.50	5.14	4.20
Internal	1.66	289.16	10.0	10.0	2840	0.6	n/a	1.45	1.45	410.61	0.09	n/a
Total:	100.00	17,419.23						66.54	66.54	1,267.11	5.23	4.20

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days that activity occurs throughout the year:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from comm./inst. natural gas} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 66.54 \div (6 \times 52) \times 2,000 \\
 &= 426.54 \text{ lbs/day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area were calculated by applying the combined ratio of retail, office, public and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{PM}_{10} \text{ NAA emissions from area-source} &= \text{Annual county PM}_{10} \text{ emissions} \times \text{NAA:County C\&I employment ratio} \\
 \text{comm./inst. natural gas combustion} & \quad \quad \quad (\text{tons/yr}) \\
 &= 66.54 \quad \quad \quad \times 0.9949 \\
 &= 66.20 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2-7. Annual and typical daily emissions from area-source commercial/institutional natural gas combustion.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
PM ₁₀ NAA	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8

3.2.4 Commercial/institutional fuel oil

Area-source emissions from commercial and institutional (C&I) fuel oil combustion were calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2010b) to Maricopa County.

To derive commercial/institutional fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2008 are first subtracted from Arizona state-level total C&I fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local clean air act requirements and market conditions.

$$\begin{aligned}
 \text{State C\&I fuel oil sales} &= \text{Reported state total} & - & \text{Reported state high-sulfur diesel sales} \\
 \text{other than high-sulfur diesel} & \quad \quad \quad \text{C\&I fuel oil sales} \\
 \text{(in thousand gallons, or Mgal)} & \\
 &= 47,586 \text{ Mgal} & - & 367 \text{ Mgal} \\
 &= 47,219 \text{ Mgal/yr}
 \end{aligned}$$

Arizona state commercial/institutional fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of C&I employment in Maricopa County to Arizona state (0.80), as determined by data from the US Census Bureau (2010a) to estimate annual Maricopa County-level commercial/institutional fuel oil sales, as follows:

$$\begin{aligned}
 \text{Maricopa County} &= \text{Arizona state C\&I fuel oil} & \times & \text{Maricopa County:state commercial/} \\
 \text{C\&I fuel oil sales} & \quad \quad \quad \text{sales (less high-sulfur diesel)} & \quad \quad \quad \text{institutional employment ratio} \\
 &= 47,219 \text{ Mgal} & \times & 0.7973 \\
 &= 37,647.71 \text{ Mgal/yr}
 \end{aligned}$$

To avoid double-counting, C&I fuel oil use attributable to stationary point sources (addressed in Chapter 2) and nonroad mobile sources (addressed in Chapter 4) are subtracted from County C&I fuel oil sales to estimate county fuel oil usage used by area sources:

$$\begin{aligned}
 \text{Annual Maricopa County commercial/institutional area-source fuel oil sales} &= \text{Maricopa County C\&I fuel oil sales} && - \text{Fuel oil used by C\&I nonroad mobile equipment} && - \text{Fuel oil used by C\&I stationary point sources} \\
 &= 37,647.71 \text{ Mgal} && - 7,291.00 \text{ Mgal} && - 3.94 \text{ Mgal} \\
 &= 30,352.77 \text{ Mgal/yr}
 \end{aligned}$$

Fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source C&I fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all commercial and institutional area sources surveyed in 2008 (shown in Table 3.2–8 below).

Annual emissions for the county were calculated by multiplying comm./inst. fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external fuel oil combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external fuel oil combustion} &= \text{External C\&I fuel oil sales (Mgal)} \times \text{PM}_{10} \text{ emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lbs/ton} \\
 &= 20,321.18 \times 1.08 \div 2,000 \\
 &= 10.97 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–8. Emission factors and annual emissions from area-source commercial/institutional fuel oil combustion, by combustion type.

Combustion type	% of total	C&I fuel oil sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	66.95	20,321.18	1.08	1.08	24	7.1	0.8	10.97	10.97	243.85	72.14	8.13
Internal	33.05	10,031.59	42.5	42.5	604	39.7	n/a	213.17	213.17	3,029.54	199.13	n/a
Total:	100.00	30,352.78						224.14	224.14	3,273.40	271.27	8.13

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days activity occurs throughout the year, as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from C\&I fuel oil combustion} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 224.14 \div (6 \times 52) \times 2,000 \\
 &= 1,436.8 \text{ lbs/day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area were calculated by applying the combined ratio of retail, public, office and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{PM}_{10} \text{ NAA emissions from area source C\&I fuel oil combustion} &= \text{Annual county PM}_{10} \text{ emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
 &= 224.14 \times 0.9949 \\
 &= 223.00 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–9. Annual and typical daily emissions from area-source commercial/institutional fuel oil combustion.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
PM ₁₀ NAA	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8

3.2.5 Residential natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas sold, by user category, within the county. Annual emissions from residential natural gas combustion emissions were calculated by multiplying residential natural gas sales by emission factors for residential natural gas combustion summarized in the table below (US EPA, 1998a), as follows:

Table 3.2–10. Residential natural gas combustion emission factors.

Emission Factors (lb/MMCF)			
PM ₁₀	PM _{2.5}	NO _x	SO _x
7.6	7.6	94	0.6

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential natural gas combustion} &= \text{Annual sales of residential natural gas (MMCF)} \times \text{PM}_{10} \text{ emission factor for residential natural gas (lbs/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 16,251.29 \times 7.6 \div 2,000 \\
 &= 61.75 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated by dividing annual emissions by the number of days (366) that activity occurs for residential natural gas combustion, as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from residential natural gas combustion} &= \text{Annual PM}_{10} \text{ emissions} \times 2,000 \text{ lbs/ton} \div \text{days/yr} \\
 &= 61.75 \text{ tons/yr} \times 2,000 \div 366 \\
 &= 337.4 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily residential natural gas emissions in the PM₁₀ nonattainment area were calculated by multiplying county-level emissions by the percentage of total residential population in the PM₁₀ nonattainment area as follows:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential natural gas combustion in the NAA} &= \text{Annual PM}_{10} \text{ emissions in Maricopa County} \times \% \text{ of County residential population in the NAA} \\
 &= 61.75 \times 99.96\% \\
 &= 61.73 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–11. Annual and typical daily emissions from residential natural gas combustion.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	61.75	61.75	763.81	4.88	337.5	337.5	4,173.8	26.6
PM ₁₀ NAA	61.73	61.73	763.51	4.87	337.3	337.3	4,172.2	26.6

3.2.6 Residential wood combustion

Area-source emissions from residential wood combustion were calculated based on the amount of wood burned in fireplaces and woodstoves in Maricopa County, as recommended by EIIP guidance (US EPA, 2001b). Residential wood combustion in the county is estimated by multiplying data on statewide residential wood combustion usage from the US Department of Energy (US DOE, 2010c) by the ratio of county to state households that report use of wood for heating from the US Census Bureau (2010b). The latest available data on residential wood use for household heating from the US Department of Energy is for the calendar year 2007. Since all fireplaces in homes constructed since 1999 are required by Arizona statute to be clean-burning, it is assumed that these new homes have negligible emissions. Thus, year 2007 data is assumed to be representative of 2008 emissions.

$$\begin{aligned}
 \text{Maricopa County residential wood usage (cords/yr)} &= \text{Arizona residential wood usage (cords/yr)} \times \text{Ratio of county:state households using wood for heat} \\
 &= 651,000 \times 1,457 / 44,330 \\
 &= 21,397 \text{ cords/yr}
 \end{aligned}$$

To calculate emissions, the amount of wood used is converted to tons by multiplying cords by the number of cubic feet of wood in a cord and by the density of the wood used (US EPA, 2001b). Wood density is determined by weighted average of types of wood used for residential combustion in Maricopa County, provided by the US Forest Service (USFS, 1993).

$$\begin{aligned}
 \text{County residential wood usage (tons/yr)} &= \text{County wood usage (cords)} \times \text{avg. ft}^3 \text{ wood/cord} \times \text{Wood density (lbs/ ft}^3) \div 2,000 \text{ lbs/ton} \\
 &= 21,397 \times 79 \times 31.57 \div 2,000 \\
 &= 26,682 \text{ tons}
 \end{aligned}$$

Annual emissions from residential wood combustion were calculated by multiplying the tons of wood used by the PM₁₀ emission factor for residential woodstoves and fireplaces from Table 2.4 –1 of US EPA (2001b).

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential wood combustion (tons/yr)} &= \text{Residential wood usage (tons)} \times \text{PM}_{10} \text{ emission factor (lbs/ton)} \div 2,000 \text{ lbs/ton} \\
 &= 26,682 \times 34.6 \div 2,000 \\
 &= 461.59 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–12. Annual wood usage, emission factors, and annual emissions from residential wood combustion.

Residential wood usage (tons/yr)	Emission factors (lbs/ton)				Annual emissions (tons/yr)			
	PM ₁₀	PM _{2.5} *	NO _x	SO _x	PM ₁₀	PM _{2.5} *	NO _x	SO _x
26,681.76	34.6	32.2	2.6	0.4	461.59	429.28	34.69	5.34

*PM_{2.5} is assumed to be 93% of PM₁₀ (Houck and Tiegs, 1998).

Typical daily emissions were calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona Department of Commerce (ADOC, 2010) indicated that there were five months (April, plus June–September, totaling 152 days) in 2008 where no heating degree days were recorded. Assuming that no wood burning activity took place during those months, it is assumed that all residential wood burning occurred during the remaining 213 days

of the year. Thus, typical daily emissions were calculated by dividing annual emissions by the number of days residential wood burning occurred, as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions} &= \text{Annual PM}_{10} \text{ emissions} \times 2,000 \text{ lbs/ton} \div \text{no. days wood burning occurred} \\
 \text{from residential wood combustion} & \quad (\text{tons/yr}) \\
 \text{(lbs/day)} & \\
 &= 461.59 \quad \quad \quad \times 2,000 \quad \quad \quad \div 213 \\
 &= 4,334.2 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area (presented in Table 3.2–13) were calculated by multiplying county totals by the ratio of residential population in the nonattainment area to the residential population in the county. See Section 1.5.1 for a further discussion of the population used.

$$\begin{aligned}
 \text{Annual emissions from residential wood} &= \text{County annual emissions} \times \text{NAA:county residential population ratio} \\
 \text{combustion in the PM}_{10} \text{ NAA (tons/yr)} & \\
 &= 461.59 \quad \quad \quad \times 0.9996 \\
 &= 461.41 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–13. Annual and typical daily emissions from residential wood combustion.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	461.59	429.28	34.69	5.34	4,334.2	4,030.8	325.7	50.1
PM ₁₀ NAA	461.41	429.11	34.67	5.33	4,332.5	4,029.2	325.6	50.1

3.2.7 Residential fuel oil

Emissions from residential fuel oil use were calculated using an approach similar to that used for residential wood combustion described in Section 3.2.6. County-level residential fuel oil use was derived from statewide totals (US EIA, 2010) using the ratio of county to state households that report fuel oil use from the US Census Bureau (2010c):

$$\begin{aligned}
 \text{Maricopa County residential} &= \text{Arizona residential} \times \text{Ratio of county:state households} \\
 \text{fuel oil usage (Mgal/yr)} & \quad \text{fuel oil use (Mgal/yr)} \quad \text{reporting fuel oil use} \\
 &= 91 \quad \quad \quad \times 573 / 1,881 \\
 &= 27.72 \text{ Mgal/yr}
 \end{aligned}$$

Annual and daily emissions were calculated using AP-42 emission factors (shown below in Table 3.2–14) and data on heating degree days and residential housing units described in Section 3.2.6. Annual and daily emissions are shown below in Table 3–2.14.

Table 3.2–14. Annual and typical daily emissions from residential fuel oil combustion.

Geographic area	Emission factors (lb/Mgal)				Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.4	0.4	18	7.1	0.01	0.01	0.25	0.10	0.1	0.1	2.3	0.9
PM ₁₀ NAA	0.4	0.4	18	7.1	0.01	0.01	0.25	0.10	0.1	0.1	2.3	0.9

3.2.8 Summary of all area-source fuel combustion

Tables 3.2–15 and 3.2–16 provide a summary of annual and typical daily emissions from all fuel combustion, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.2–15. Annual and typical daily emissions from area-source fuel combustion in Maricopa County.

Fuel combustion type	Annual emissions (tons/yr)					Typical 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
Industrial natural gas	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
Industrial fuel oil	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
Comm./inst. natural gas	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
Comm./inst. fuel oil	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
Residential natural gas	61.75	61.75	763.81	4.88		337.5	337.5	4,173.8	26.6	
Residential wood	461.59	429.28	34.69	5.34		4,334.2	4,030.8	325.7	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
Total:	1,303.61	1,271.30	12,289.62	898.83	51.27	9,673.4	9,370.0	78,161.3	5,773.3	328.7

Table 3.2–16. Annual and typical daily emissions from all area-source fuel combustion for the PM₁₀ NAA.

Fuel combustion type	Annual emissions (tons/yr)					Typical 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
Industrial natural gas	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2
Industrial fuel oil	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9
Comm./inst. natural gas	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8
Comm./inst. fuel oil	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8
Residential natural gas	61.73	61.73	763.51	4.87		337.3	337.3	4,172.2	26.6	
Residential wood	461.41	429.11	34.67	5.33		4,332.5	4,029.2	325.6	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
Total:	1,300.65	1,268.35	12,248.07	895.83	51.11	9,653.8	9,350.6	77,895.2	5,754.1	327.6

3.3 Industrial processes

3.3.1 Chemical manufacturing

Emissions from area-source chemical manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2007 employment were used. Table 3.3–1 shows the NAICS codes and employment data used to calculate emissions from chemical manufacturing.

Table 3.3–1. NAICS codes and descriptions for chemical manufacturing.

NAICS Code	Description	US Census employment data
325	Chemical Manufacturing	3,930
42469	Other Chemical and Allied Products Merchant Wholesalers	1,093
424910	Farm Supplies Merchant Wholesalers	229
33312	Construction Machinery Manufacturing	212
Total:		5,464

There were no point sources in this category. Area-source employment estimate were used to “scale up” emissions reported from those facilities surveyed in 2008 as follows:

$$\begin{aligned}
 \text{Area-source PM}_{10} \text{ emissions from chemical mfg.} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 &= \frac{35.71 \text{ tons of PM}_{10}/\text{yr}}{1,041 \text{ employees}} \times 5,464 \text{ employees} \\
 &= 187.43 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source chemical mfg. in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions (tons/yr)} \times \text{NAA:county ratio of industrial employment} \\
 &= 187.43 \times 0.9974 \\
 &= 186.94 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–2 summarizes annual and typical daily emissions from chemical manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–2. Annual and typical daily emissions from area-source chemical manufacturing.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH _x	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH _x
Maricopa County	187.43	151.42	0.00	0.34	0.03	1,445.8	1,164.5	0.0	2.6	0.9
PM ₁₀ NAA	186.94	151.03	0.00	0.34	0.03	1,442.0	1,161.5	0.0	2.6	0.9

3.3.2 Food and kindred products

3.3.2.1 Commercial cooking

Emissions from commercial cooking were estimated for five types of commercial cooking equipment using EPA methodology (US EPA, 2006a). The equipment types include: chain-driven charbroilers, under-fired charbroilers, deep-fat fryers, flat griddles, and clamshell griddles. EPA’s methodology estimates commercial cooking activity rates for restaurants with each type of cooking equipment (ethnic, family, fast food, seafood, and steak & barbeque) based on an average number of equipment pieces in each restaurant type, and also the and average quantity of meat cooked on each type of equipment per week (steak, hamburger, poultry, pork, and seafood). The estimates number of restaurants in Maricopa County for the five restaurant types was obtained from a commercial database (www.selectoronline.com) and is shown in Table 3.3–3.

Table 3.3–3. Number of Maricopa County restaurants, by restaurant type.

Restaurant Type	No. of restaurants
Ethnic food	907
Fast food	1,068
Family	253
Seafood	37
Steak and barbecue	75
All restaurants:	2,340

Using EPA’s emissions estimation methodology (US EPA, 2006a), commercial cooking activity data were estimated by first multiplying the county number of restaurants that use commercial cooking equipment in each category (ethnic, fast food, family, seafood, and steak and barbeque) by the percentage of restaurants with each type of cooking equipment (Table 3.3–4).

$$\begin{aligned}
 \text{Number of ethnic food} &= \text{Number of ethnic food} && \times \text{\% ethnic food restaurants} \\
 \text{restaurants with under-} & \text{restaurants in Maricopa County} && \text{with underfired charbroilers} \\
 \text{fired charbroilers} & && \\
 &= 907 && \times 47.5\% \\
 &= 431 &&
 \end{aligned}$$

Table 3.3–4. Percentages of restaurants with each type of cooking equipment.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	3.5%	47.5%	81.9%	62.7%	4.0%
Family	10.1%	60.9%	91.4%	82.9%	1.4%
Fast Food	18.6%	30.8%	96.8%	51.9%	14.7%
Seafood	0.0%	52.6%	100.0%	36.8%	10.5%
Steak and Barbeque	6.9%	55.2%	82.8%	89.7%	0.0%

The resulting product was then multiplied by the average number of equipment pieces by restaurant type (shown in Table 3.3–5) to derive an estimate of the total number of each cooking equipment type in Maricopa County restaurants (Table 3.3–6).

Table 3.3–5. Average number of equipment pieces per restaurant, by type.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	1.62	1.54	1.63	1.88	1.80
Family	1.71	1.29	2.34	2.03	—
Fast Food	1.07	1.58	3.10	1.43	2.09
Seafood	—	1.10	2.47	1.11	1.50
Steak and Barbeque	—	1.63	2.42	1.35	—

$$\begin{aligned}
 \text{Number of underfired charbroilers} &= \text{number of ethnic food restaurants} && \times \text{average number of underfired char-} \\
 \text{at ethnic food restaurants} & \text{with underfired charbroilers} && \text{broilers per ethnic food restaurant} \\
 &= 431 && \times 1.54 \\
 &= 664 &&
 \end{aligned}$$

Table 3.3–6. Total pieces of cooking equipment, by restaurant type.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	51.43	663.47	1,210.82	1,069.14	65.30
Family	43.70	198.76	541.11	425.77	—
Fast Food	212.55	519.73	3204.85	792.64	328.12
Seafood	—	21.41	91.39	15.11	5.83
Steak and Barbeque	—	67.48	150.28	90.82	—
Totals:	307.68	1,470.85	5,198.45	2,393.47	399.25

The total number of each type of cooking equipment is then multiplied by average pounds of meat cooked on each type of equipment per week (Table 3.3–7) to derive the total estimate of the amount of meat cooked in Maricopa County each week (Table 3.3–8).

Table 3.3–7. Meat cooked weekly per restaurant (in pounds), by equipment type.

Type of Meat	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	236	180	181	166	94
Hamburger	798	270	274	362	1314
Poultry, with Skin	147	144	365	88	113
Poultry, Skinless	266	179	208	111	108
Pork	57.6	148	58.6	112	118
Seafood	119	143	159	92.1	632
Other	0	41.5	274	57.5	0

$$\begin{aligned}
 \text{Total steak cooked on all under-fired charbroilers (tons/wk)} &= \text{Steak cooked on each under-fired charbroiler (lbs/wk)} \times \text{Total number of under-fired charbroilers at all restaurants} \div 2,000 \text{ lbs/ton} \\
 &= 180 \text{ lbs/ week} \times 1,470.85 \div 2,000 \\
 &= 132.38 \text{ tons/week}
 \end{aligned}$$

Table 3.3–8. Total meat cooked weekly (in tons), by equipment type.

Type of Meat	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	36.31	132.38	470.46	198.66	18.76
Hamburger	122.76	198.56	712.19	433.22	262.31
Poultry, with Skin	22.61	105.90	948.72	105.31	22.56
Poultry, Skinless	40.92	131.64	540.64	132.84	21.56
Pork	8.86	108.84	152.31	134.03	23.56
Seafood	18.31	105.17	413.28	110.22	126.16
Other	0.00	30.52	712.19	68.81	0.00
Totals:	249.77	813.01	3,949.78	1,183.09	474.91

The total amount of meat cooked in Maricopa County restaurants weekly (Table 3.3–8) was then multiplied by the appropriate emission factor from Table 3.3–9 (US EPA, 2006a). The results were then summed to estimate annual emissions for each type of cooking equipment, shown in Table 3.3–10. Commercial cooking is assumed to occur uniformly throughout both the week (i.e., 7 days/week) and year.

Table 3.3–9. PM₁₀ and PM_{2.5} emission factors for commercial cooking equipment, by device type.

Equipment type	Emission Factor (lb/ton)	
	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	15.996058	15.506208
Underfired charbroilers	32.666124	31.577929
Deep fat fryers	0.00	0.00
Flat griddle fryers	5.922517	4.501113
Clamshell griddles	1.006137	0.852257

Table 3.3–10. Annual and daily emissions from commercial cooking equipment in Maricopa County.

Equipment type	Annual Emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	103.88	100.70	570.8	553.3
Underfired charbroilers	690.51	667.51	3,794.0	3,667.6
Deep fat fryers	0.00	0.00	0.0	0.0
Flat griddles	182.18	138.46	1,001.0	760.7
Clamshell griddles	12.42	10.52	68.3	57.8
Totals:	988.99	917.18	5,434.0	5,039.5

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the county totals by the ratio of total population in the nonattainment area to the total population in the county (100.41%) (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–11 summarizes the annual and typical daily emissions from commercial cooking for the PM₁₀ NAA.

Table 3.3–11. Annual and daily PM emissions from commercial cooking equipment in the PM₁₀ NAA.

Equipment type	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	104.31	101.11	573.1	555.6
Underfired charbroilers	693.34	670.24	3,809.6	3,682.6
Deep fat fryers	0.00	0.00	-	-
Flat griddles	182.93	139.02	1,005.1	763.9
Clamshell griddles	12.47	10.57	68.5	58.1
Totals:	993.04	920.94	5,456.3	5,060.1

3.3.2.2 Grain handling/processing

Annual emissions from area-source grain handling and processing operations were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Annual and typical daily emissions for the PM₁₀ nonattainment area were derived based on the location data of the individual facilities. Annual and typical daily emissions for both the County and the PM₁₀ NAA are shown in Table 3.3–12.

Table 3.3–12. Annual and typical daily emissions from area-source grain handling and processing.

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	20.59	6.71	149.3	49.5
PM ₁₀ NAA	16.73	5.68	125.3	43.0

3.3.2.3 Ammonia cold storage

Area-source emissions from ammonia cold storage are estimates of ammonia emissions from food and kindred products industrial sources that use ammonia for refrigeration of food products. Emission calculations are based on the number of employees in the food and kindred products industry classification (NAICS codes 311, 312) as reported by the 2007 County Business Patterns (US Census Bureau, 2010a). Annual emissions were calculated by multiplying employment numbers by the emission factor for ammonia cold storage as listed in Table 6-5 of “Development and Selection of Ammonia Emission Factors” (Battye et al., 1994) as follows:

$$\begin{aligned}
 \text{Annual NH}_3 \text{ emissions} &= \text{Number of employees} \times \text{NH}_3 \text{ emission} \div 2,000 \text{ lbs/ton} \\
 \text{from ammonia cold} & \quad \text{in relevant industries} \quad \text{factor (lb/employee-yr)} \\
 \text{storage (tons/yr)} & \quad \text{(from CBP)} \\
 &= 8,128 \times 413 \div 2,000 \\
 &= 1,678.43 \text{ tons NH}_3/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated by dividing annual emissions by the number of days per year that activity occurred, as follows:

$$\begin{aligned}
 \text{Typical daily} &= \text{Annual emissions (tons/yr)} \times 2,000 \text{ lbs/ton} \div (\text{weeks/year} \times \text{days/week}) \\
 \text{NH}_3 \text{ emissions} & \\
 \text{(lbs/day)} & \\
 &= 1,678.43 \times 2,000 \div (52 \times 6) \\
 &= 10,759.2 \text{ lbs NH}_3/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area (shown in Table 3.3–13 below) were calculated by multiplying Maricopa County emissions by the ratio of County industrial employment that occurs in the PM₁₀ nonattainment area. (See Section 1.5.1 for a more detailed discussion of the employment data used).

$$\begin{aligned}
 \text{Annual NH}_3 \text{ emissions from} &= \text{Annual county emissions (tons/yr)} \times \text{NAA:County industrial employment ratio} \\
 \text{ammonia cold storage in the} & \\
 \text{PM}_{10} \text{ NAA (tons/yr)} & \\
 &= 1,678.43 \times 0.9974 \\
 &= 1,674.07 \text{ tons NH}_3/\text{yr}
 \end{aligned}$$

Table 3.3–13. Annual and typical daily ammonia emissions from ammonia cold storage.

Geographic area	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Maricopa County	1,678.43	10,759.2
PM ₁₀ NAA	1,674.07	10,731.2

3.3.3 Secondary metal production

Annual emissions from secondary metal production facilities were derived from annual emission reports from permitted sources. As this category consists primarily of foundries, it was assumed that there were no significant unpermitted sources within Maricopa County. Since all facilities considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the PM₁₀ NAA from area-source secondary metal production are equal. Annual and daily emissions are shown in Table 3.3–14.

Table 3.3–14. Annual and typical daily emissions from secondary metal production.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
PM ₁₀ NAA	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0

3.3.4 Non-metallic mineral processes

The primary contributors to this source category include concrete batch plants, ceramic clay and tile manufacturing, brick manufacturing, and gypsum mining. Emissions from this source were derived from annual emission reports from permitted facilities. Since all permitted facilities in this category were surveyed in 2008, it was assumed that there were no significant unpermitted sources within Maricopa County. Some portable concrete batch operations which operate within Maricopa County for only part of the year are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM₁₀ nonattainment area were derived based on the location data of the individual facilities. County-permitted portable sources with no location data were assumed to operate within the PM₁₀ nonattainment area as a conservative estimate.

Table 3.3–15 summarizes annual and typical daily emissions from non-metallic mineral processing activities in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–15. Annual and typical daily emissions from area-source non-metallic mineral products.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	192.82	95.47	1,337.7	659.3
PM ₁₀ NAA	187.73	91.92	1,302.8	635.6

3.3.5 Mining and quarrying

Annual emissions from area-source mining and quarrying (sand and gravel) operations were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County. Some portable mining and quarrying operations which operate within Maricopa County for only part of the year are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Emissions within the PM₁₀ nonattainment area were identified using information on the location of each permitted facility. County-permitted portable sources with no location data were assumed to operate within the PM₁₀ nonattainment area as a conservative estimate. Annual and daily emissions are shown in Table 3.3–16.

Table 3.3–16. Annual and typical daily emissions from area-source mining and quarrying operations.

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	181.01	55.20	1,239.2	362.6
PM ₁₀ NAA	156.60	46.81	1,075.7	307.2

3.3.6 Wood product manufacturing

Emissions from wood product manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) to estimate an annual per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent employment estimates (for the year 2007) from the US Census Bureau’s County Business Patterns (CBP) were used. Table 3.3–17 shows the NAICS codes and employment estimates used to calculate emissions from wood product manufacturing.

Table 3.3–17. County-level employment estimates for wood product manufacturing, by NAICS code.

NAICS Code	NAICS Code Description	2007 employment estimate
321---	Wood products manufacturing	6,917
337---	Furniture and related products manufacturing	7,153
Total:		14,070

Since some larger facilities in this category are considered point sources, they have been included in the point source calculations presented earlier in Chapter 2. To avoid double-counting, employment at point sources was subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in wood products} &= \text{Total County employment for the sector} && - \text{Employment reported from facilities reported as point sources} \\
 &= 14,070 && - 930 \\
 &= 13,140 \text{ employees}
 \end{aligned}$$

Annual emissions for the entire wood product manufacturing sector were calculated by “scaling up” detailed area-source emissions reported from those facilities surveyed in 2008 as follows:

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source PM}_{10} \text{ emissions from wood products} &= \frac{102.99 \text{ tons PM}_{10}/\text{yr}}{6,229 \text{ employees}} \times 13,140 \text{ employees} \\
 &= 217.26 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated in the same method, using surveyed daily emissions estimates from the subset of surveyed area sources. From these County totals, emissions estimates for the PM₁₀ nonattainment area were calculated by multiplying the County totals by the percentage of industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
\text{PM}_{10} \text{ emissions from area-source wood product manufacturing in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Total County emissions} \times \text{NAA:county ratio for industrial employment} \\
&= 217.26 \text{ tons/yr} \times 0.9974 \\
&= 216.69 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Table 3.3–18 summarizes annual and typical daily emissions from wood products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–18. Annual and typical daily emissions from area-source wood product manufacturing.

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	217.26	203.25	1,668.6	1,548.3
PM ₁₀ NAA	216.69	202.72	1,664.3	1,544.3

3.3.7 Rubber/plastics manufacturing

Emissions from area-source rubber and plastic manufacturing facilities were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category. The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2007 employment were used. Where CBP employment estimates were presented as a range, the midpoint values were chosen for these calculations. Table 3.3–19 lists the NAICS codes and employment data used to calculate emissions from rubber and plastic manufacturing facilities.

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
\text{Total area-source employment in rubber \& plastic product manufacturing} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
&= 11,380 - 896 \\
&= 10,484 \text{ employees}
\end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2008 as follows:

$$\begin{aligned}
\text{Total area-source PM}_{10} \text{ emissions from rubber/plastic product mfg.} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Area-source employment} \\
&= \frac{30.37 \text{ tons PM}_{10}/\text{yr}}{2,256 \text{ employees}} \times 10,484 \text{ employees} \\
&= 140.94 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Table 3.3–19. County-level employment estimates for rubber and plastic manufacturing, by NAICS code.

NAICS Code	NAICS Code Description	2007 employment estimate
32614	Polystyrene Foam Product Manufacturing	351
32619	Other Plastics Product Manufacturing	4,178
32622	Rubber & Plastics Hoses & Belting Manufacturing	60
33992	Sporting & Athletic Goods Manufacturing	1,750
42461	Plastics Materials & Basic Forms & Shapes Merchant Wholesalers	368
325211	Plastics Material & Resin Manufacturing	10
325520	Adhesive Manufacturing	123
325991	Custom Compounding of Purchased Resins	194
326113	Unlaminated Plastics Film & Sheet (except Packaging) Mfg.	60
326122	Plastics Pipe & Pipe Fitting Manufacturing	144
326140	Polystyrene Foam Product Manufacturing	351
326160	Plastics Bottle Manufacturing	175
326199	All Other Plastics Product Manufacturing	175
326212	Tire Retreading	42
326299	All Other Rubber Product Manufacturing	71
327991	Cut Stone & Stone Product Manufacturing	583
332913	Plumbing Fixture Fitting & Trim Manufacturing	10
336612	Boat Building	53
337920	Blind & Shade Manufacturing	286
339113	Surgical Appliance & Supplies Manufacturing	88
339115	Ophthalmic Goods Manufacturing	60
441320	Tire Dealers	2,248

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source plastic/rubber in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 140.94 \text{ tons PM}_{10}/\text{yr} \times 0.9974 \\
 &= 140.57 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–20 summarizes annual and typical daily emissions from rubber/plastic products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–20. Annual and typical daily emissions from area-source rubber/plastic product manufacturing.

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	140.94	105.96	953.3	698.8
PM ₁₀ NAA	140.57	105.68	950.9	697.0

3.3.8 Fabricated metal products manufacturing

Emissions from fabricated metal products manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from

the US Census Bureau (2010a) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2007 employment were used. CBP employment data for NAICS code 332* (fabricated metal products manufacturing) indicated that there were 16,138 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in fab. metal products} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 16,138 - 4,000 \\
 &= 12,138 \text{ employees}
 \end{aligned}$$

Annual emissions were calculated by “scaling up” area-source emissions reported from those facilities surveyed in 2007 as follows:

$$\text{Total area-source emissions} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$\begin{aligned}
 \text{Area-source PM}_{10} \text{ emissions from fab. metal products} &= \frac{18.07 \text{ tons of PM}_{10}/\text{yr}}{4,261 \text{ employees}} \times 12,138 \text{ employees} \\
 &= 51.48 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source fabricated metal production in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions (tons/yr)} \times \text{NAA:County ratio of industrial employment} \\
 &= 51.48 \text{ tons/yr} \times 0.9974 \\
 &= 51.35 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–21 summarizes annual and typical daily emissions from fabricated metal products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–21. Annual and typical daily emissions from area-source fabricated metal product manufacturing.

Geographic Area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NH _x	PM ₁₀	PM _{2.5}	NH _x
Maricopa County	51.48	42.62	4.50	538.1	460.6	28.9
PM ₁₀ NAA	51.35	42.51	4.49	536.7	459.4	28.8

3.3.9 Construction

Maricopa County's air quality permits database was used to identify all dust control permits issued during 2008. A total of 4,622 permits were issued, comprising a total of 42,130 acres (Table 3.3–22). Data requested on each dust control permit application includes the project type and acreage. It was assumed there is no unpermitted earthmoving activity.

Table 3.3–22. Maricopa County dust control permits issued in 2008, by type.

Total Acreage, by Project Type	Reported Acres
Residential (single- and multi-family)	20,437.0
Commercial	10,850.0
Road construction	4,449.0
Trenching	3,396.1
Demolition	1,970.6
Weed control	687.0
Site prep / land development	218.9
Temp. storage yard	122.4
Totals:	42,130.9

The Western Regional Air Partnership (WRAP) Fugitive Dust Handbook (WRAP, 2006a) provides different emission factors for residential (single-family houses and apartment buildings), nonresidential, road, and general construction. MCAQD used the WRAP-suggested emission factors except for the following activities:

- The WRAP Fugitive Dust Handbook recommended using 0.42 ton PM₁₀/acre-month for road construction to account for the large amount of dirt moved during the construction of roadways. However, both the South Coast Air Quality Management District (SCAQMD) and the Clark County Department of Air Quality and Environmental Management have estimated that a certain percentage of their road construction projects do not involve large-scale earthmoving activities, and thus have developed average emission factors for road construction projects (0.1895 ton PM₁₀/acre-month and 0.265 ton PM₁₀/acre-month, respectively). Since Maricopa County and Clark County have similar population growth rates, climatic conditions, and PM₁₀ sources, MCAQD used the Clark County road construction emission factor of 0.265 tons/acre-month to estimate emissions from road construction projects (Clark County, 2001).
- Specific emission factors were not available in the WRAP Fugitive Dust Handbook for trenching, demolition, weed control, and temporary storage yard activities; thus, the general construction emission factor of 0.11 tons PM₁₀/acre-month was used to estimate emissions from these activities.

Information was not readily available regarding the breakout of residential construction activity between single-family and multi-family residential construction; thus, acreage for residential construction was allocated based on single-family and multi-family household percentages (See Section 1.5.1 for single-family and multi-family household percentages used).

Estimates for the duration of house and apartment construction were obtained from EIIP guidance (US EPA, 2002). Estimates for the duration of nonresidential construction and road construction were obtained from the WRAP Fugitive Dust Handbook (WRAP, 2006a). No estimates for the duration of trenching, demolition, weed control, site prep/land development, and temporary storage yard activities were available; thus, MCAQD assumed the following:

- 1-month duration for trenching, demolition, and weed control.
- 8-month duration for site prep/land development activities (weighted average of residential and commercial duration) because the duration depends on the project type and size.
- 12-month duration for temporary storage yard activities because these activities are frequently associated with road construction.

The average duration of construction activity and emission factors for each project type are shown below in Table 3.3–23.

Table 3.3–23. Average project duration and emission factor, by project type.

Project Type	Average Duration (months)	Emission factor (tons PM₁₀/acre-month)
Residential: single-family	6	0.032
Residential: multi-family	12	0.11
Commercial	11	0.19
Road construction	12	0.265
Trenching	1	0.11
Demolition	1	0.11
Weed control	1	0.11
Site prep / land development	8	0.11
Temp. storage yard	12	0.11

County-wide annual uncontrolled PM₁₀ emissions for each construction category were then calculated as follows:

$$\text{Annual uncontrolled PM}_{10} \text{ emissions} = \text{total acres/yr} \times \text{no. months} \times \text{emission factor}$$

Example:

$$\begin{aligned} \text{Annual uncontrolled PM}_{10} \text{ emissions from single-family residential construction} &= 15,327.8 \text{ acres/yr} \times 6 \text{ months} \times 0.032 \text{ tons PM}_{10}/\text{acre-month} \\ &= 2,942.93 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

As in prior years, a control efficiency of 90% was applied to the uncontrolled emissions calculations. This factor is in line with values applied in a number of earlier SIP documents for Maricopa and Clark Counties, including:

- Revised MAG 1999 Serious Area Particulate Plan for PM₁₀ (Appendices volume two, page V-9, and vol. four), Feb. 2000.
- Revised MAG 1999 Serious Area Particulate Plan for PM₁₀, (Appendix C, Exhibit 3: Evaluation for Compliance with 24-Hour PM₁₀ Standard for West Chandler and Gilbert Microscale Sites, Arizona Department of Environmental Quality, June 1999, pp. 3-5 and 3-9), Feb. 2000.
- “Evaluation of Fugitive Dust Control in the Maricopa Co. PM₁₀ Nonattainment Area”, report by ENSR in: Final Plan for Attainment of the 24-hour PM₁₀ Standard, ADEQ, May 1997, Appendix B.
- Clark Co. PM₁₀ State Implementation Plan, June 2001, pg. L-5. (An 87% emission reduction percentage is assumed for watering at construction activities.)

A recent rule effectiveness study by Maricopa County (contained in Appendix 3) indicated an 89.94% compliance rate with Maricopa County Rule 310 on dust control at construction sites.

Thus, an overall control effectiveness of 80.9% (= 90% × 89.94%) was applied. Controlled PM₁₀ emissions were calculated as follows:

$$\text{Annual controlled PM}_{10} \text{ emissions} = \text{Uncontrolled PM}_{10} \text{ emissions (tons/yr)} \times [1 - (\text{control efficiency} \times \text{rule effectiveness})]$$

Example:

$$\begin{aligned} \text{Annual controlled PM}_{10} \text{ emissions from single-family residential construction} &= 2,942.93 \text{ tons/yr} \times [1 - (90\% \text{ control} \times 89.94\% \text{ rule effectiveness})] \\ &= 560.75 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

PM_{2.5} emissions were estimated to comprise 10% of PM₁₀ emissions (WRAP, 2006a). Table 3.3–24 summarizes the calculations for each dust control permit category.

Table 3.3–24. Annual emissions from construction in Maricopa County, by project type.

Project Type	Total acre-months	Emission factor (tons/acre-month)	Uncontrolled PM ₁₀	Controlled PM ₁₀	Controlled PM _{2.5}
Residential: single-family	91,966.5	0.032	2,942.93	560.75	56.07
Residential: multi-unit	61,311.0	0.11	6,744.21	1,285.04	128.50
Commercial	119,349.7	0.19	22,676.44	4,320.77	432.08
Road construction	53,388.0	0.265	14,147.82	2,695.73	269.57
Trenching	3,396.1	0.11	373.57	71.18	7.12
Demolition	1,970.6	0.11	216.76	41.30	4.13
Weed control	687.0	0.11	75.56	14.40	1.44
Site prep/land development	1,750.9	0.11	192.60	36.70	3.67
Temporary storage yard	1,468.7	0.11	161.55	30.78	3.08
Totals:			47,531.45	9,056.64	905.66

Dust control permit site location data were used to determine construction activity that occurred in the Maricopa County PM₁₀ nonattainment area. The same average duration of construction activity and emission factors used to estimate Maricopa County emissions (see Table 3.3–18) were applied to construction activity in the Maricopa County PM₁₀ nonattainment area. Table 3.3–25 summarizes Maricopa County PM₁₀ nonattainment area construction activity and calculations for each project type.

Table 3.3–25. Annual emissions from construction within the Maricopa County portion of the PM₁₀ nonattainment area, by project type.

Project Type	Total Acres	Total acre-months	EF (tons/acre-month)	Uncontrolled PM ₁₀	Controlled PM ₁₀	Controlled PM _{2.5}
Residential: single-family	13,989.0	83,934.0	0.032	2,685.89	511.77	51.18
Residential: multi-unit	4,663.0	55,956.0	0.11	6,155.16	1,172.80	117.28
Commercial	10,125.2	111,376.9	0.19	21,161.61	4,032.13	403.21
Road construction	3,383.9	40,606.8	0.265	10,760.80	2,050.36	205.04
Trenching	1,938.2	1,938.2	0.11	213.20	40.62	4.06
Demolition	1,949.0	1,949.0	0.11	214.39	40.85	4.08
Weed control	638.5	638.5	0.11	70.23	13.38	1.34
Site prep/land development	218.9	1,750.9	0.11	192.60	36.70	3.67
Temporary storage yard	122.4	1,468.7	0.11	161.55	30.78	3.08
Totals:	37,027.9			41,615.42	7,929.40	792.94

In addition, the Pinal County Air Quality Department (PCAQD) provided construction emission estimates for the Pinal County portion of the PM₁₀ nonattainment. PCAQD estimated that approximately 0.8 percent of the Pinal County construction activity occurred in the Pinal County portion of the PM₁₀ nonattainment area, thus, annual and typical daily emission for the Pinal

County portion of the PM₁₀ nonattainment area was calculated by multiplying the Pinal County emission totals by 0.8 percent. The PCAQD estimates (presented in Table 3.3–26 below) incorporated the same assumptions concerning relevant input variables such as the average duration of construction activity, emission factors, control efficiency, and rule effectiveness as Maricopa County's estimates.

Table 3.3–26. Annual emissions from construction in the Pinal County portion of the PM₁₀ NAA, by project type.

Project Type	PM ₁₀	PM _{2.5}
Residential: single-family	7.65	0.77
Residential: multi-family	0.16	0.02
Commercial	25.16	2.52
Road construction	1.42	0.14
Trenching	0.08	0.00
Totals:	34.47	3.45

To calculate average daily emissions from construction activity, It was assumed that construction activity typically occurs 6 days per week and remains relatively even throughout the year. Thus, typical daily emissions were calculated by dividing annual emissions for each category were divided by 312 (= 6 days/wk × 52 wks/yr) to derive the daily emissions estimates shown in Table 3.3–27.

Table 3.3–27. Annual and typical daily emissions from construction in Maricopa County and the PM₁₀ NAA.

Construction Type	Maricopa County				PM ₁₀ NAA			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Residential	1,845.79	184.58	11,832.0	1,183.2	1,692.38	169.24	10,920.3	1,092.0
Commercial	4,320.77	432.08	27,697.2	2,769.7	4,057.29	405.73	25,897.4	2,589.7
Road construction	2,695.73	269.57	17,280.3	1,728.0	2,051.78	205.18	13,156.8	1,315.7
All other*	194.36	19.44	1,245.9	124.6	162.41	16.24	1,043.9	104.4
Total:	9,056.64	905.66	58,055.4	5,805.5	7,963.87	796.39	51,018.4	5,101.8

*Includes: trenching, demolition, weed control, site prep/land development, and temporary storage yard.

3.3.10 Electrical equipment manufacturing

Annual and typical daily emissions from electric equipment manufacturing were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County and all electrical equipment manufacturing permitted sources are reported here as area-sources.

As all facilities addressed in this source category are located within the PM₁₀ nonattainment area, emission totals for both areas are equal. Annual and typical daily emissions are shown in Table 3.3–28.

Table 3.3–28. Annual and typical daily emissions from area-source electric equipment manufacturing.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
PM ₁₀ NAA	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7

3.3.11 State-permitted portable sources

The Arizona Department of Environmental Quality (ADEQ) retains the authority to permit certain categories of sources within Maricopa County, including portable sources. MCAQD requested information from ADEQ for all ADEQ-permitted sources that reported any activity in Maricopa County during 2008. Annual total emissions for most pollutants were provided, along with information on the facility type, and information on the location of the site(s) during the year. Permits were classified into four major types: asphalt batch, concrete batch, crushing/screening, and other (including soil remediation, generators, etc.). From this information, emissions that occurred within Maricopa County were estimated as in the following example.

Data provided:

Source information: McNeil Brothers - Erie Strayer Portable Plant
 Permit type: Concrete batch plant
 Operating schedule: Operated from 1/1-5/15 in Mesa at SR202 and McKellips (SE Corner);
 operated from 10/16-12/31 in Goodyear at Northside I-10 east of Estrella.

Total annual emissions: (tons/yr)	PM₁₀	PM_{2.5}*	NO_x	SO_x
	0.923	0.461	8.429	2.306

* PM2.5 was assumed to be 50% of reported PM10 for crushing/screening operations.

Using this information, calculations were made to determine:

Total operating days in 2008: 136 = 31 (Jan.) + 29 (Feb.) + ...16 (Oct.) + 30 (Nov.) + 31 (Dec.)
 Total operating days in Maricopa County: 136 = 31 (Jan.) + 29 (Feb.) + ...16 (Oct.) + 30 (Nov.) + 31 (Dec.)

All emissions were assumed to be equally distributed among all reported days of operation. First, emissions attributable to activity within Maricopa County were calculated as follows:

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions in Maricopa County (tons/yr)} &= \text{Total annual emissions (tons/yr)} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2008}} \\ &= 0.923 \times \frac{136}{136} \\ &= 0.923 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Typical daily emissions were then calculated as follows:

$$\begin{aligned} \text{Typical daily emissions (lbs/day)} &= \frac{\text{total emissions attributable to activity in Maricopa County}}{\text{number of operating days in Maricopa County}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{0.923 \text{ tons}}{136 \text{ days}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= 13.6 \text{ lbs PM}_{10}/\text{day} \end{aligned}$$

Table 3.3–29 summarizes the annual and typical daily emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2008. Since precise location data was not available for all permits, all emissions are conservatively assumed to have originated within the PM₁₀ nonattainment area; thus emission estimates for Maricopa County and the PM₁₀ nonattainment area are equal.

Table 3.3–29. Annual and typical daily emissions from ADEQ-permitted portable sources.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Total:	59.00	29.50	282.18	88.93	492.9	246.5	2,275.7	721.7

3.3.12 Paved/unpaved road travel on industrial sites

This section addresses emissions from travel on paved and unpaved roads within the boundaries of a permitted facility. Emissions from motor vehicle travel on public and private roads is addressed in Chapter 5, Mobile Sources, and road travel emissions from facilities considered point sources are addressed in Chapter 2, Point Sources. PM₁₀ emissions from this source category were derived from annual emission reports from permitted sources, using AP-42 equations based on vehicle size and average speed (US EPA, 1997; 1998b). It is assumed that there are no unpermitted sources with significant emissions from on-site road travel.

PM_{2.5} emissions were calculated from PM₁₀ using a ratio derived from California Air Resources Board's (CARB) PM_{2.5} Fraction Table (CARB, 2006).

Typical daily emissions were calculated using operating schedule information for each reported process (normally a 5 or 6-day week), which were then summed to provide total daily emissions for the county. Emissions totals for the PM₁₀ nonattainment area were determined from the site locations of each facility. Results for each geographic area are shown in Table 3.3–30.

Table 3.3–30. Annual and typical daily emissions from paved and unpaved road travel at industrial facilities.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	566.30	271.29	3,880.4	1,847.2
PM ₁₀ NAA	472.36	217.08	3,273.9	1,500.1

3.3.13 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes NEC were derived from annual emissions reports from permitted facilities. Other industrial processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from other industrial processes, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions were calculated based on operating schedule information provided by individual facilities through MCAQD's annual emissions reporting program. Emissions estimates for the PM₁₀ nonattainment area were derived using data on the location of the facilities that report other industrial processes. Emissions totals are presented in Table 3.3–31.

Table 3.3–31. Annual and typical daily emissions from other industrial processes not elsewhere classified.

Geographic area	Annual emissions (tons/yr)					Typical 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
Maricopa County	144.60	107.24	10.22	21.49	16.79	953.3	726.4	69.6	137.7	94.6
PM ₁₀ NAA	136.00	99.12	8.12	21.47	14.10	906.0	681.7	55.4	137.6	79.8

3.3.14 Summary of all area-source industrial processes

Tables 3.3–32 and 3.3–33 provide a summary of annual and typical daily emissions from all industrial sources, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.3–32. Annual and daily emissions from all area-source industrial processes in Maricopa County.

Source category	Annual emissions (tons/yr)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	187.43	151.42	0.00	0.34	0.03
Commercial cooking	988.99	917.18			
Grain handling/processing	20.59	6.71			
Ammonia cold storage					1,678.43
Secondary metal production	60.56	52.16	49.73	18.65	.004
Non-metallic mineral processes	195.81	97.28			
Mining and quarrying	210.39	59.56			
Wood product manufacturing.	217.26	203.25			
Rubber/plastic product manufacturing	140.94	105.96			
Fabricated metal product manufacturing	51.48	42.62			
Residential construction	2,451.72	245.17			
Commercial construction	5,739.18	573.92			
Road construction	3,580.67	358.07			
Other construction	258.18	25.82			
Electrical equipment manufacturing	13.94	9.64	20.45	0.18	31.55
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93	
Road travel at industrial sites	566.30	271.29			
Industrial processes NEC	144.60	107.24	10.22	21.49	16.79
All industrial processes:	11,881.57	2,953.30	362.58	129.60	1,731.34

Source category	Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	1,445.8	1,164.5	0.0	2.6	0.6
Commercial cooking	5,434.0	5,039.5			
Grain handling/processing	149.3	49.5			
Ammonia cold storage					10,759.2
Secondary metal production	442.7	386.2	358.8	142.7	0.0
Non-metallic mineral processes	1,357.4	671.7			
Mining and quarrying	1,442.1	390.8			
Wood product manufacturing.	1,668.6	1,548.3			
Rubber/plastic product manufacturing	953.3	698.8			
Fabricated metal product manufacturing	538.1	460.6			28.9
Residential construction	15,716.1	1,571.6			
Commercial construction	36,789.6	3,679.0			
Road construction	22,953.0	2,295.3			
Other construction	1,654.9	165.5			
Electrical equipment manufacturing	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	3,880.4	1,847.2			
Industrial processes NEC	953.3	726.4	69.6	137.7	94.6
All industrial processes:	76,667.6	19,048.2	2,816.5	1,005.8	11,077.2

Table 3.3–33. Annual and typical daily emissions from all area-source industrial processes in the PM₁₀ NAA.

Source category	Annual emissions (tons/yr)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	186.94	151.03	0.00	0.34	0.03
Commercial cooking	993.04	920.94			
Grain handling/processing	16.73	5.68			
Ammonia cold storage					1,674.1
Secondary metal production	60.56	52.16	49.73	18.65	0.04
Non-metallic mineral processes	187.73	91.92			
Mining and quarrying	156.60	46.81			
Wood product manufacturing.	216.69	202.72			
Rubber/plastic product manufacturing	140.57	105.68			
Fabricated metal product manufacturing	51.35	42.51			4.49
Residential construction	1,692.38	169.24			
Commercial construction	4,057.29	405.73			
Road construction	2,051.78	205.18			
Other construction	162.41	16.24			
Electrical equipment manufacturing	13.94	9.64	20.45	0.18	31.55
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93	
Road travel at industrial sites	472.36	217.08			
Industrial processes NEC	136.00	99.12	8.12	21.47	14.10
All industrial processes:	10,655.39	2,771.19	360.48	129.58	1,724.27

Source category	Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	1,442.0	1,161.5	0.0	2.6	0.9
Commercial cooking	5,456.3	5,060.1			
Grain handling/processing	125.3	43.0			
Ammonia cold storage					10,731.2
Secondary metal production	442.7	386.2	358.8	142.7	0.0
Non-metallic mineral processes	1,302.8	635.6			
Mining and quarrying	1,075.7	307.2			
Wood product manufacturing.	1,664.3	1,544.3			
Rubber/plastic product manufacturing	950.9	697.0			
Fabricated metal product manufacturing	536.7	459.4			28.8
Residential construction	10,920.3	1,092.0			
Commercial construction	25,897.4	2,589.7			
Road construction	13,156.8	1,315.7			
Other construction	1,043.9	104.4			
Electrical equipment manufacturing	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	3,273.9	1,500.1			
Industrial processes NEC	906.0	681.7	55.4	137.6	79.8
All industrial processes:	68,764.6	17,877.6	2,802.3	1,005.7	11,034.4

3.4 Waste treatment and disposal

3.4.1 On-site incineration

This section includes emissions from on-site industrial incinerators, primarily burn-off ovens used to reclaim electric wire or other materials. Emissions from human and animal crematories are addressed in Section 3.5.4. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2008.

Emissions from on-site incineration were determined from annual emission inventory reports. It is assumed that all incinerator emissions are accounted for, since all permitted incinerators received surveys in 2008. All surveyed facilities are located within the PM₁₀ nonattainment area, thus total emissions for the county and NAA are equal.

Table 3.4–1. Annual and typical daily emissions from on-site incineration.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.06	0.04	5.01	0.01	0.7	0.4	38.9	0.1
PM ₁₀ NAA	0.06	0.04	5.01	0.01	0.7	0.4	38.9	0.1

3.4.2 Open burning

Emissions from controlled open burning are regulated by Maricopa County Air Pollution Control Regulations Rule 314 (Open Outdoor Fires), which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, air curtain destructor burning of trees, and fire fighting training. Maricopa County’s burn permit data base was used to identify all burn permits issued during 2008. A total of 55 permits were issued during the year; however, not all permit applications contained the requested information that is needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained the necessary information, as follows:

$$\text{Total activity} = \sum \text{activity reported} \times \frac{\text{total number of permits issued}}{\text{number of permits with activity data}}$$

Example:

$$\text{Total ditch - bank/fencerows} = 541,336 \text{ linear ft (reported)} \times \frac{32 \text{ burn permits issued}}{22 \text{ permits with data}} = 787,398 \text{ linear ft}$$

Reported and estimated activity data for each open burning category are summarized in Table 3.4–2. Permits issued for firefighting training are addressed Section 3.5.1.2.

Table 3.4–2. Summary of 2008 Maricopa County burn permit activity.

Category	Unit of measure	Total reported activity	Number of permits with activity data	Total permits issued	Estimated total annual activity level
Ditchbank/fencerow	Linear ft	541,336	22	32	787,398
Land clearance	Acres	564	5	12	1,354
Air curtain	Tons of Material Burned	70*	0	7	70
Tumbleweeds	Piles	14	2	4	28

* Assumed that air curtain destructors burn 10 tons/day of brush/trees/vegetation.

The above activity data were converted to tons material burned using fuel loading factors from AP-42, Table 2.5–5 (US EPA, 1992). The emission and loading factors used are shown in Table 3.4–3. As a conservative estimate, all particulate matter is presumed to be PM₁₀ (and PM_{2.5}).

Table 3.4–3. Emission and fuel loading factors for open burning.

Category	Emission factors (lbs/ton burned)					Fuel loading factor (tons/acre)
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	
Weeds, unspecified	15	15	4	N/A	N/A	3.2
Russian Thistle (tumbleweeds)	22	22	4	N/A	N/A	0.1
Orchard crops: Citrus	6	6	4	N/A	N/A	1.0

The following assumptions were made based on previous Maricopa County emission inventory and information from MCAQD's open burn program staff:

- Ditch banks and fence rows in Maricopa County average 7 feet in width and are burned twice per year (MCESD, 1999).
- A pile of tumbleweeds 15 feet in diameter and 5 feet high weighs 200 lbs (MCESD, 1993). This is equivalent to the AP-42 fuel loading factor for tumbleweeds (0.1 tons/acre).
- Air curtain destructors burn between 7–10 tons of material per day (MCAQD, 2006).

To calculate the annual amount of material burned on ditch banks and fence rows in Maricopa County, MCAQD estimated the area burned and then applied AP-42 fuel loading factor. The tons of material burned in ditch banks and fence rows in Maricopa County were estimated as follows:

$$\begin{aligned} \text{Material burned from ditchbanks and fence rows} &= \frac{787,398 \text{ ft length}}{43,560 \text{ ft}^2/\text{acre}} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/yr} \\ &= 809.81 \text{ tons/yr} \end{aligned}$$

Activity data for the other categories were similarly converted to derive the total mass of material burned using AP-42 fuel loading factors.

Annual emissions were then calculated by multiplying the amount of material burned by AP-42 emission factors (listed in Table 3.4–3) for each open burning category. To account for unpermitted illegal outdoor burning, all calculated emissions estimates were multiplied by a factor of 2.87, based on complaints received in 2008 reporting suspected open or illegal outside burning in the County (158 complaints were received in 2008; thus 158 complaints/55 open burn permits = 2.87).

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions from ditchbank and fence row burning} &= \text{Total material burned} \times \text{emission factor} \times \text{unit conversion factor} \\ &= 809.81 \text{ tons} \times 15 \text{ lbs/ton} \times 1 \text{ ton} / 2,000 \text{ lbs} \\ &= 6.07 \text{ tons/yr} \end{aligned}$$

$$\begin{aligned} \text{Total annual PM}_{10} \text{ emissions including unpermitted burning} &= \text{Calculated emissions from permit data} \times \text{unpermitted burning adjustment factor} \\ &= 6.07 \text{ tons/yr} \times 2.87 \\ &= 17.43 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Table 3.4–4 summarizes the 2008 emissions in Maricopa County from each category of open burning activity.

Table 3.4–4. Annual and typical daily emissions from open burning in Maricopa County.

Category	Ton-equivalents	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
		PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Ditchbank/fencerow	809.8	17.45	17.45	4.65	179.0	179.0	47.7
Land clearance	4,331.5	93.32	93.32	24.89	717.9	717.9	191.4
Air curtain	70.0	0.60	0.60	0.40	4.6	4.6	3.1
Tumbleweeds	2.8	0.09	0.09	0.02	0.7	0.7	0.1
Totals:		111.46	111.46	29.96	902.2	902.2	242.4

It was assumed that open burning occurs 5 days per week (most burn permits are issued for weekdays but permits may be issued on weekends depending on circumstances). Open burning occurs year-round with the exception of ditch bank and fence row burning, which is not allowed during the CO season (November through January).

PM₁₀ typical daily emissions for Maricopa County were derived as follows:

$$\text{Typical daily PM}_{10} \text{ emissions} = \frac{\text{annual PM}_{10} \text{ emissions (tons/yr)} \times 2000 \text{ lbs/ton}}{(\text{burn days/week}) \times (\text{burn weeks/year})}$$

$$\text{Typical daily PM}_{10} \text{ emissions from ditchbank/ fence row burning} = \frac{17.45 \text{ tons/yr} \times 2000 \text{ lbs/ton}}{5 \text{ days/wk} \times 39 \text{ wks/yr}}$$

$$= 179.0 \text{ lbs PM}_{10}/\text{day}$$

Table 3.4–4 above summarizes the typical daily emissions for Maricopa County from each open burning category.

Annual and daily emissions for the nonattainment area were calculated by multiplying the percentage of agricultural and/or vacant land use within the PM₁₀ nonattainment area by the County wide emissions estimates, results are shown in Table 3.4–5. (See Section 1.5.1 for a discussion of the land use data used.) Table 3.4–6 summarizes the annual emissions for the PM₁₀ non-attainment area.

Table 3.4–5. Surrogate land use classes and NAA:County activity ratios for burn permit categories.

Category	Surrogate land use categories	2008 NAA:county land use ratio
Ditchbank/fencerow	Agriculture	44.14 %
Land clearance	Vacant	21.22 %
Air curtain	Agriculture and vacant	23.91 %
Tumbleweeds	Agriculture and vacant	23.91 %

Table 3.4–6. Annual and typical daily emissions from open burning in the PM₁₀ NAA.

Category	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Ditchbank/fencerow	7.70	7.70	2.05	79.0	79.0	21.1
Land clearance	19.81	19.81	5.28	152.4	152.4	40.6
Air curtain	0.14	0.14	0.10	1.1	1.1	0.7
Tumbleweeds	0.02	0.02	0.00	0.2	0.2	0.0
Totals:	27.67	27.67	7.44	232.6	232.6	62.5

3.4.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as from cover operations and combustion from control measures, such as a flare. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county; results are shown in Table 3.4–7 below. No landfills were considered point sources; thus all MSW landfills are reported here as an area-source activity.

Table 3.4–7. Annual and typical daily emissions from landfills.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	86.21	75.92	24.11	7.57	486.1	425.4	132.9	41.7
PM ₁₀ NAA	60.25	50.78	19.47	6.22	342.4	286.6	107.4	34.3

3.4.4 Publicly owned treatment works (POTWs)

Emissions from publicly owned treatment works (POTWs) were calculated by multiplying per-capita emission factors (Battye et al., 1994) by population estimates and per-capita wastewater usage estimates of 100 gallons per day per person (Tchobanoglous, 1979), as shown in Table 3.4–8. Typical daily emissions were calculated by dividing annual emissions by 366 days, as activity is assumed to occur uniformly throughout the year.

Table 3.4–8. NH₃ emissions from publicly-owned treatment works (POTWs).

Geographic area	2008 Population	NH ₃ emission factor (lbs/10 ⁶ gals treated)	Annual NH ₃ emissions (tons/yr)	Typical daily NH ₃ emissions (lbs/day)
Maricopa County	4,279,760	19.0	1,488.07	8,131.5
PM ₁₀ NAA	4,297,140	19.0	1,494.12	8,164.6

3.4.5 Other industrial waste disposal

Annual area-source emissions from other industrial waste disposal were derived from annual emissions reports from permitted facilities. Other industrial waste disposal processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from this category, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions were calculated based on operating schedule information provided by the facilities in their annual emissions report. Emission estimates are shown in Table 3.4–9 below.

All facilities that reported area-source emissions from other industrial waste disposal are located inside the PM₁₀ nonattainment area, therefore emissions for Maricopa County and the PM₁₀ NAA are equal.

Table 3.4–9. Annual and typical daily emissions from other industrial waste disposal.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	32.78	16.93	18.39	50.62	224.1	110.9	101.0	278.1
PM ₁₀ NAA	32.78	16.93	18.39	50.62	224.1	110.9	101.0	278.1

3.4.6 Summary of all area-source waste disposal

Tables 3.4–10 and 3.4–11 provide a summary of annual and typical daily emissions from all waste disposal activity, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.4–10. Annual and typical daily emissions from all area-source waste disposal for Maricopa County.

Category	Annual emissions (tons/yr)					Typical 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
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	111.46	111.46	29.96			902.2	902.2	242.4		
Landfills	86.21	75.92	24.11	7.57		486.1	425.4	132.9	41.7	
POTWs					1,488.07					8,131.5
Other	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
Total:	230.52	204.35	77.47	58.20	1,488.07	1,613.0	1,438.8	515.3	320.0	8,131.5

Table 3.4–11. Annual and typical daily emissions from all area-source waste disposal for the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical 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
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	27.67	27.67	7.44			232.62	232.62	62.46		
Landfills	60.25	50.78	19.47	6.22		342.4	286.6	107.4	34.3	
POTWs					1,494.12					8,164.6
Other	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
Total:	120.77	95.42	50.30	56.85	1,494.12	799.8	630.5	309.9	312.6	8,164.6

3.5 Miscellaneous area sources

3.5.1 Other combustion

3.5.1.1 Wildfires

Data on wildfires in 2008 within Maricopa County were obtained from the Arizona State Land Department (ASLD) Forestry Division (ASLD, 2009); the Arizona Department of Fire, Building, and Life Safety (DFBLS, 2009); and the Federal Fire Occurrence website (FFOW, 2009).

The ASLD Forestry Division provides for the prevention and suppression of wildfires on state and private lands located outside of incorporated municipalities. The wildfire data provided by ASLD includes wildfires that occur outside of local fire districts and municipalities on State, private, and U.S. Bureau of Land Management (BLM) land in 2008. The ASLD reported 25 wildfires in 2008 in Maricopa County, encompassing a total of nearly 750 acres. Wildfire data provided by ASLD were compared to that data reported in the Geospatial Multi-Agency Coordination Group (GeoMAC) Wildland Fire Support database¹ and 2008 Incident Status Summary reports (ICS-209) to identify wildfires that may have occurred outside of ASLD jurisdiction. GeoMAC and ICS-209 reports only include large wildfires, generally fires greater than 100 acres. Three Maricopa County wildfires were reported in GeoMAC and on ICS-209 reports in 2008 (USDA, 2008a; USGS, 2008). Two of these fires were included in the ASLD data, one

¹ The GeoMAC, is an internet-based mapping application designed for fire managers to access online maps of current fire locations and perimeters in the conterminous 48 States and Alaska. Historical fire data is also housed in the GeoMac database <http://www.geomac.gov/>.

fire, the Ethan fire, was not captured in the ASLD data because it occurred on tribal lands. The Ethan fire encompassed 6,660 acres.

The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire departments. NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included ten “forest, woods or wildland fires”. The ten “forest, woods or wildland fires” were analyzed for inclusion in the wildfire emission estimates. First, the DFBLS fires were culled for duplicates by comparing the incident dates and locations with wildfires reported by ASLD. One DFBLS fire was excluded from combined dataset because it may have been a duplicate already captured in the ASLD data. Because only four of the ten DFBLS fires included acreage, an average number of acres burned per fire (= 1.05 acres) were determined from the fires with reported acreage. This average number of acres burned was then applied to the fires with no reported acreage.

The Federal Fire Occurrence Website is an official government website that provides users with the ability to query, research and download wildland fire occurrence data. The data available through this website contains over 548,000 fire records collected by Federal land management agencies for fires that occurred from 1980 through 2008 in the United States. The 2008 data for Maricopa County included eighty-one fires. The federal wildland fire occurrence data were culled for duplicates by comparing the incident names, dates and locations with wildfires reported by ASLD and DFBLS. Thirteen fires were excluded from the combined dataset as they appeared to be duplicates already captured in either the ASLD or DFBLS data and seven fires contained no acreage data. The final 2008 dataset listed 96 fires encompassing over 7,400 acres. Table 3.5–1 summarizes fire data obtained from each data source.

Table 3.5–1. Sources and input data used to estimate emissions from fires in Maricopa County.

Data Source	Number of Fires in 2008	Total Acreage
Arizona State Land Department (ASLD)	25	747.25
Arizona Department of Fire, Building, and Life Safety (DFBLS)	9	9.45
Federal Fire Occurrence website (FFOW)	61	16.79
ICS-209	1	6,660.00
Total:	96	7,433.49

Estimates for fuel loading rates were assigned using fuel model codes from the National Fire Danger Rating System (NFDRS) and a table of fuel loading values for NFDRS fuel model categories (WGA/WRAP, 2005). The department used the NFDRS Fuel Model map in ArcGIS to identify NFDRS fuel types for fires with latitude and longitude data.

Table 3.5–2. NFDRS fuel model categories and fuel loading factors for 2008 Maricopa County wildfires.

NFDRS Model Category	2008 Fires	Total Acreage	Fuel Loading Factor (tons/acre)
Agriculture*	33	744.05	4.5
California chaparral	1	0.01	19.5
Barren*	2	0.40	0.5
Pine-grass savanna	1	0.01	4.7
Intermediate brush	17	2.87	15.0
Sagebrush grass	42	6,686.15	4.5
Total	96	7,433.49	—

* “Agriculture” and “barren” NFDRS model descriptions were not included in WGA/WRAP 2002 fuel loading values for NFDRS fuel model categories. Therefore, it was assumed that “Agriculture” is similar to “sagebrush grass” and “Barren” is similar to “western grasses (annual)” and fuel loadings were assigned accordingly.

Estimates of the material burned were derived by multiplying the number of acres burned for each category by the applicable fuel loading factor. Table 3.5–3 shows the number of wildfires and acres burned within both Maricopa County and the PM₁₀ nonattainment area during 2008, as well as estimates of total material burned.

Table 3.5–3. Summary of data on fire occurrence, total acres burned, and total material burned in 2008.

Geographic Area	No. of Fires	Total Acres Burned	Material Burned (tons)
Maricopa County	96	7,433	33,479
PM ₁₀ NAA	55	6,699	30,147

The prescribed-fire emission factors listed in Table 3.5–4 were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005).

Table 3.5–4. Summary of emission factors for prescribed fire.

	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
WRAP Emission Factors for Wildfires and Prescribed Broadcast Burning (lbs/ton)	28.1	24.1	6.2	1.7	1.3

Source: WGA/WRAP, 2005

Annual emissions from wildfires for each geographic area were calculated as follows:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from wildfires in Maricopa County} &= \frac{\text{material burned} \times \text{emission factor (lbs/ton)}}{2,000 \text{ lbs/ton}} \\
 &= \frac{33,479 \text{ tons of material burned} \times 28.1 \text{ lbs PM}_{10}/\text{ton}}{2,000 \text{ lbs/ton}} \\
 &= 470.38 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

The majority of fire data included fire locations in latitude and longitude. For those fires without longitude and latitude, the fire location address was used to determine latitude and longitude. This latitude and longitude data was used to determine the number of acres burned inside of the nonattainment areas. Fifty-five wildfires occurred within the PM₁₀ nonattainment area, resulting in nearly 6,700 acres burned. The largest fire within the PM₁₀ nonattainment area was the Ethan fire which occurred in July 2008 and resulted in more than 6,600 acres burned.

Annual emissions from wildfires within the nonattainment area were calculated in the same method as Maricopa County annual emissions.

Table 3.5–5. Annual emissions from wildfires in Maricopa County and the PM₁₀ NAA.

Geographic Area	Annual emissions (tons/yr)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	470.39	403.43	103.79	28.46	21.76
PM ₁₀ NAA	423.56	363.27	93.46	25.62	19.60

Average daily emissions were estimated by dividing annual emissions by the number of burn days in 2008. There were 150 burn days in Maricopa County and 90 burn days in the PM₁₀ nonattainment area in 2008; thus:

$$\begin{aligned} \text{Average daily PM}_{10} \text{ emissions from wildfires in Maricopa County} &= \frac{470.39 \text{ tons PM}_{10}/\text{yr} \times 2,000 \text{ lbs/ton}}{150 \text{ days/yr}} \\ &= 6,271.8 \text{ lbs PM}_{10}/\text{day} \end{aligned}$$

Table 3.5–6. Average daily emissions from wildfires in Maricopa County and the PM₁₀ NAA.

Geographic Area	Number of Burn Days	Average daily emissions (lbs/day)				
		PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	150	6,271.8	5,379.0	1,383.8	379.4	290.2
PM ₁₀ NAA	90	9,412.5	8,072.7	2,076.8	569.4	435.5

3.5.1.2 Prescribed fires

Prescribed fires data were obtained from the U. S. Forest Service (USFS, 2009). The USFS reported that six prescribed fires occurred in Maricopa County in 2008. Twenty-nine acres of piled fuels were burned. Four of six prescribed fires occurred inside the PM₁₀ nonattainment area. Because all 2008 prescribed fires were piled fuels, material burned was derived by multiplying the number of acres burned by tons of piles per acre for each fire. The data provided by the USFS, the resulting material burned for each fire, and whether the fire occurred within the nonattainment area are shown below in Table 3.5–7.

Table 3.5–7. Summary of data used to estimate emissions from prescribed fires.

Burn Date	Burn Number	Burn Location	Acres Treated	Tons of Piles/ Acre	Material Burned (tons)	Within NAA?
01/13/2008	TNF0106	T6N,R7E,S28	3	1	3	Yes
03/13/2008	TNF0106P	T6N,R7E,S28	3	3	9	Yes
04/04/2008	TNF0302	T3N,R7E,S34	2	5	10	Yes
04/09/2008	TNF0302	T3N,R8E,S28	5	5	25	No
09/25/2008	TNF0302	T3N,R8E,S31	10	5	50	No
11/06/2008	TNF0302	T2N,R7E,S18	6	5	30	Yes
			29	24	127	

Prescribed fire emission factors for “piled fuels” were obtained from the Western Regional Air Partnership’s (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). The emission factors are listed below in Table 3.5–8.

Table 3.5–8. Emission factors for prescribed fires.

Type of fire	Emission factors (lbs/ton burned)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Prescribed fire (piled fuels)	8.0	8.0	6.2	1.7	0.5

Annual emissions from prescribed fires in Maricopa County were calculated as follows.

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from prescribed fires in Maricopa County} &= \frac{\text{material burned (tons/acre)} \times \text{emission factor (lbs/ton)}}{2,000 \text{ lbs/ton}} \\
 &= \frac{127 \text{ tons/acre} \times 8.0 \text{ lbs/ton}}{2,000 \text{ lbs/ton}} \\
 &= 0.508 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

It was assumed that each prescribed fire lasted one day. Thus, daily emissions from prescribed fires were determined by dividing the annual emissions (converted to lbs/yr) by the number of burn days. Because six prescribed fires occurred in Maricopa County in 2008, it was assumed that there were 6 burn days in 2008.

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions} &= \frac{\text{annual PM}_{10} \text{ emissions (lbs) from prescribed fires}}{\text{Number of burn days}} \\
 &= \frac{1,016 \text{ lbs PM}_{10}}{6 \text{ burn days}} \\
 &= 169.3 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Since the prescribed fire data provided by USFS (2009) included burn location, GIS was used to determine the fires that burned inside the nonattainment area. Fifty-two of the one-hundred twenty-seven acres burned were within the nonattainment area. Thus, annual emissions from prescribed fires for the nonattainment area were determined using the formula shown above with the material burned within the nonattainment area. Results are shown in Table 3.5–9 below.

Table 3.5–9. Annual and typical daily emission from prescribed fire in Maricopa County and the PM₁₀ NAA.

Geographic Area	Annual emissions (tons/yr)					Typical daily emission (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
PM ₁₀ NAA	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5

3.5.1.3 Structure fires

2008 structure fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS; DFBLS, 2009). The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire departments. The NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included nearly 2,150 reported structure fires. Because the DFBLS data only included data reported by twenty-one of thirty-six fire departments in Maricopa County, the number of structure fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of structure fires (ADC, 2008). Seven open burn permits were issued in 2008 for fire training; these were included in the total number of estimated structure fires for 2008. It was estimated that 2,422 structure fires occurred in Maricopa County in 2008.

Estimates of the material burned in a structure fire were determined by multiplying the number of structure fires by a fuel loading factor of 1.15 tons of material per fire, which factors in the estimated percentage of structural loss and content loss (US EPA, 2001c). The amount (tons) of material burned was estimated as follows:

$$\begin{aligned} \text{Material burned in structure fires (tons/yr)} &= 2,422 \text{ fires/yr} \times 1.15 \text{ tons/fire} \\ &= 2,785 \text{ tons material burned/yr} \end{aligned}$$

Table 3.5–10. Material burned, emission and fuel loading factors for structure fires.

Estimated number of structure fires	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM ₁₀	PM _{2.5} *	NO _x	SO _x	NH ₃
2,422	1.15	2,785	10.8	10.8	1.4	n/a	n/a

* All PM₁₀ is assumed to be PM_{2.5}.

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.5–10 (from US EPA, 2001c), as follows:

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions from structure fires in Maricopa County} &= \text{Quantity of material burned} \times \text{emission factor} \times \text{unit conversion factor} \\ &= 2,785 \text{ tons} \times 10.8 \text{ lbs/ton} \times (1 \text{ ton}/2,000 \text{ lbs}) \\ &= 15.04 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Annual emissions for the PM₁₀ nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM₁₀ nonattainment area (100.41%), as shown in the example below. See Section 1.5.2 for a discussion of the population data used.

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions within the PM}_{10} \text{ NAA} &= \text{Annual PM}_{10} \text{ emissions for Maricopa County} \times \text{Percentage residential population within the NAA} \\ &= 15.04 \text{ tons/yr} \times 100.41\% \\ &= 15.10 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Typical daily emissions for both Maricopa County and the PM₁₀ nonattainment area were calculated by dividing annual emissions by 366, as activity is assumed to take place 7 days a week. Typical daily emissions for Maricopa County were derived using the following formula:

$$\begin{aligned} \text{Typical daily PM}_{10} \text{ emissions from structure fires} &= \frac{\text{annual PM}_{10} \text{ emissions (lbs)}}{366 \text{ days/yr}} \\ &= \frac{30,080 \text{ lbs}}{366} \\ &= 82.2 \text{ lbs/day} \end{aligned}$$

Table 3.5–11. Annual and typical daily emissions from structure fires in Maricopa County and the NAA.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Maricopa County	15.04	15.04	1.95	82.2	82.2	10.7
PM ₁₀ NAA	15.10	15.10	1.96	82.5	82.5	10.7

3.5.1.4 Vehicle fires

2008 vehicle fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS) (DFBLS, 2009). The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire department. NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included over 2,100 reported vehicle fires. Because the DFBLS data only included data reported by twenty-one of thirty-six fire departments in Maricopa County, the number of vehicle fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of vehicle fires (ADC, 2008). It was estimated that 2,403 vehicle fires occurred in Maricopa County in 2008.

Annual emissions from vehicle fires were calculated by first multiplying the number of vehicle fires by a fuel loading factor of per vehicle fire to estimate the annual amount of material burned in vehicle fires (US EPA, 2000). The amount of annual material burned in vehicle fires is then multiplied by emission factors for open burning of automobile components from AP-42 as listed in table 3.5–12 (US EPA, 1992).

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from vehicle fires} &= \text{annual number of vehicle fires} \times \text{fuel loading factor} \times \text{emission factor} \times \text{unit conversion factor} \\
 &= 2,403 \times 0.25 \text{ tons/vehicle} \times 100 \text{ lbs/ton} \times (1 \text{ ton} / 2,000 \text{ lbs}) \\
 &= 30.04 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.5–12. Estimated material burned, fuel loading factors, and emission factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM ₁₀	PM _{2.5} *	NO _x	SO _x	NH ₃
2,403	0.25	600.75	100	100	4	n/a	n/a

* All PM₁₀ is assumed to be PM_{2.5}.

Annual emissions for the PM₁₀ nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM₁₀ nonattainment area (100.41%). See Section 1.5.1 for a discussion of the population data used.

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from vehicle fires in the PM}_{10} \text{ NAA} &= \text{annual PM}_{10} \text{ emissions for Maricopa County} \times \text{percentage of total residential population within the PM}_{10} \text{ NAA} \\
 &= 30.04 \text{ tons/yr} \times 100.41\% \\
 &= 30.16 \text{ tons/yr}
 \end{aligned}$$

It is assumed that vehicle fires occur evenly throughout the year. Thus, typical daily emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 366 days/year. The results are shown in Table 3.5–13 below.

Table 3.5–13. Annual and typical daily emissions from vehicle fires.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Maricopa County	30.04	30.04	1.20	164.1	164.1	6.6
PM ₁₀ NAA	30.16	30.16	1.21	164.8	164.8	6.6

3.5.1.5 Engine testing

Annual emissions from engine testing facilities were derived from annual emission reports from permitted sources that were not considered point sources in this inventory. It was assumed that there were no significant unpermitted sources within Maricopa County. Typical daily emissions were calculated based on operating schedule information provided in the facilities' annual emission reports.

Since all facilities considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the PM₁₀ NAA are equal. Results are shown in Table 3.5–14.

Table 3.5–14. Annual and typical daily emissions from engine testing.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.18	0.17	6.74	2.49	1.3	1.2	50.5	19.0
PM ₁₀ NAA	0.18	0.17	6.74	2.49	1.3	1.2	50.5	19.0

3.5.2 Agricultural activities

3.5.2.1 Tilling

Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The majority of planted acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Planted acres for potatoes and sorghum for grain were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus acreage were obtained from the 2007 Census of Agriculture (USDA, 2007a). Crop-specific annual land preparation operations data were obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001). The agricultural tillage emission factor was calculated as follows:

$$EF = k (4.8) s^{0.6}$$

where:

EF = Agricultural emission tillage factor (lbs PM₁₀/acre-pass)

k = Particle size multiplier (value of 0.15 for PM₁₀)

s = Silt content of soil (%) = 35.2% (URS and ERG, 2001)

$$\begin{aligned} \text{Thus: } EF &= 0.15 \times 4.8 \times (35.2)^{0.6} \\ &= 6.10 \text{ lbs PM}_{10}\text{/acre-pass} \end{aligned}$$

Annual PM₁₀ emissions from agricultural tillage were calculated for each crop category using the following equation (URS and ERG, 2001; Pollack et al., 2003):

$$Tillage_{Crop} = EF \times AP_{Crop} \times A_{Crop}$$

where:

- $Tillage_{Crop}$ = Annual PM₁₀ emissions from tilling each crop type (lbs)
- EF = Tillage emission factor (lbs PM₁₀/acre-pass)
- AP_{Crop} = Number of tillage passes per crop (passes)
- A_{Crop} = Total number of tilled acres for each crop type (acres)

For example, annual PM₁₀ emissions from cotton tilling were calculated using:

- EF = 6.10 lbs PM₁₀/acre-pass
- AP_{cotton} = 8.8 tillage passes for a cotton crop
- A_{cotton} = 19,300 acres cotton

Thus:

$$\begin{aligned} Tillage_{cotton} &= 6.10 \times 8.8 \times 19,300 \\ &= 1,036,024 \text{ lbs/yr} \\ &= 518.01 \text{ tons/yr} \end{aligned}$$

Table 3.5–15 lists crop types and acreage; typical number of land preparation operations and acre-passes; and annual uncontrolled PM₁₀ emissions from agricultural tillage for Maricopa County.

Table 3.5–15. 2008 crop acreage, activity, and annual uncontrolled PM₁₀ emissions in Maricopa County.

Crop	Acres Planted	No. of land preparation operations/yr	Acre-passes	Annual uncontrolled PM₁₀ emissions (tons/yr)
Cotton	19,300	8.8	169,978	518.43
Corn	11,500	7.3	84,180	256.75
Wheat	30,500	3.1	93,488	285.14
Barley	10,100	2.1	20,856	63.61
Alfalfa (stand establishment) ¹	21,875	5.1	110,469	336.93
Potatoes	1,400	10.6	14,805	45.16
Sorghum for grain	16,500	3.1	50,575	154.25
Vegetables ²	16,072	14.0	224,888	685.91
Citrus ³	425	5.0	2,124	6.48
Totals:	127,672			2,352.66

1. Alfalfa is a multi-year crop and alfalfa stand establishment is assumed to occur once every 4 years to approximately 25% of the total alfalfa acreage (URS and ERG, 2001).
2. Including melons, not including potatoes.
3. 15 to 20% of citrus orchard acreage is non-bearing in a given year (URS and ERG, 2001); therefore, tillage is assumed to occur in 20% of the reported harvested acreage.

In November 2007, the agricultural PM₁₀ general permit (Arizona Administrative Code R18-2-610 and R18-2-611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. Previously this rule only applied to the Maricopa County PM₁₀ NAA. The agricultural PM₁₀ general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM₁₀ emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by

URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*. URS and ERG quantified three BMPs for tillage: 1) combining tractor operations, 2) limited activity during high-wind events, and 3) multi-year crops. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3). To estimate controlled tillage emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP were applied to 63.09% (the percent of agricultural land in the Maricopa County portion of Area A) of the uncontrolled annual emissions (MAG, 2009) as follows:

$$\begin{aligned} \text{Controlled annual tillage}_{\text{Crop}} \text{ emissions} &= \text{Annual uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}_{\text{crop}}) \times \% \text{ agricultural land in the Area A} \\ \text{Controlled annual tillage}_{\text{Cotton}} \text{ emissions} &= 518.01 \text{ tons PM}_{10}/\text{yr} \times (100\% - 22.8\%) \times 63.09\% \\ &= 252.30 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The uncontrolled portion of tillage emissions from agricultural operations taking place outside Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM₁₀ emissions by the percentage of agricultural land located within Maricopa County but outside of Area A (100% – 63.09%) as follows:

$$\begin{aligned} \text{Uncontrolled annual tillage}_{\text{Crop}} \text{ emissions} &= \text{Uncontrolled annual PM}_{10} \text{ emissions} \times 36.91\% \\ &= 518.01 \text{ tons PM}_{10}/\text{yr} \times 36.91\% \\ &= 191.20 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Controlled and uncontrolled emissions were then summed to estimate total annual PM₁₀ emissions from agricultural tillage in Maricopa County. Annual PM_{2.5} emissions from agricultural tillage were calculated by multiplying the annual PM₁₀ emissions by a conversion factor of 0.15 (WRAP, 2006b). Annual PM₁₀ and PM_{2.5} emissions from agricultural tillage in Maricopa County and Area A are shown in Table 3.5–16.

Table 3.5–16. Annual emissions from agricultural tillage in Maricopa County and Area A (tons/yr).

Crop	Net control efficiency (%)	Area A (controlled)		Outside Area A (uncontrolled)	Maricopa Co. (Area A + outside Area A)	
		PM ₁₀	PM _{2.5}	PM ₁₀	PM ₁₀	PM _{2.5}
Cotton	22.8%	252.36	37.85	191.35	443.72	66.56
Corn	22.8%	124.98	18.75	94.77	219.75	32.96
Wheat	22.8%	138.80	20.82	105.24	244.04	36.61
Barley	22.8%	30.96	4.64	23.48	54.44	8.17
Alfalfa (stand establishment)	13.8%	183.23	27.49	124.36	307.60	46.14
Potatoes	16.8%	21.98	3.30	16.67	38.65	5.80
Sorghum for grain	22.8%	75.09	11.26	56.94	132.02	19.80
Vegetables	16.8%	359.82	53.97	253.17	612.99	91.95
Citrus	16.8%	3.40	0.51	2.39	5.79	0.87
Totals:		1,190.63	178.59	868.37	2,059.00	308.85

*Includes melons, excludes potatoes.

Annual PM₁₀ emissions from agricultural tillage in the PM₁₀ NAA were calculated in the same manner as the annual PM₁₀ emissions for the Maricopa County portion of Area A; the only difference being the percent of agricultural land located within the Maricopa County PM₁₀ NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–17.

Table 3.5–17. Annual emissions from agricultural tillage in the PM₁₀ NAA (tons/yr).

Crop	Net Control Efficiency (%)	Fraction of Ag Land in PM ₁₀ NAA	PM ₁₀ NAA annual emissions	
			PM ₁₀	PM _{2.5}
Cotton	22.8%	44.14%	176.56	26.48
Corn	22.8%	44.14%	87.44	13.12
Wheat	22.8%	44.14%	97.11	14.57
Barley	22.8%	44.14%	21.66	3.25
Alfalfa (stand establishment)	13.8%	44.14%	128.20	19.23
Potatoes	16.8%	44.14%	16.57	2.49
Sorghum for grain	22.8%	44.14%	52.53	7.88
Vegetables	16.8%	44.14%	251.75	37.76
Citrus	16.8%	44.14%	2.38	0.36
Totals:			834.20	125.13

Typical daily emissions for Maricopa County, Area A, and the PM₁₀ NAA were calculated by dividing the annual emissions by estimated days per year of tillage operation by crop. The number of days of tillage operations was estimated using the calendar of tillage operations by crop in the Technical Support Document for Quantification of Agricultural BMPs (URS and ERG, 2001) and assuming tillage activities occur 7 days per week during the months of tillage operations. Results are shown in Table 3.5–18. The calendar of tillage operations did not include months of tillage operations for citrus, thus, a conservative estimate of three (3) months per year was assumed.

Table 3.5–18. Controlled typical daily emissions from tillage (in lbs/day).

Crop	Tillage operations ¹ (months/yr)	Tillage operations (days/yr)	Maricopa County		Area A		PM ₁₀ NAA	
			PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Cotton	12	364	2,438.0	365.7	1,386.6	208.0	970.1	145.5
Corn	5	152	2,897.8	434.7	1,648.1	247.2	1,153.1	173.0
Wheat	8	243	2,011.3	301.7	1,143.9	171.6	800.3	120.1
Barley	8	243	448.7	67.3	255.2	38.3	178.6	26.8
Alfalfa (stand establishment)	3	91	6,760.3	1,014.1	4,027.1	604.1	2,817.5	422.6
Potatoes	6	182	424.7	63.7	241.6	36.2	182.1	27.3
Sorghum for grain	8	243	1,088.1	163.2	618.9	92.8	433.0	64.9
Vegetables	6	182	6,736.2	1,010.4	3,954.1	593.1	2,766.4	415.0
Citrus	3	91	127.2	19.1	37.3	5.6	26.1	3.9
Totals:			22,932.4	3,439.9	13,312.8	1,996.9	9,327.3	1,399.1

¹ Source: URS and ERG (2001), Table 3-2, p. 3-5.

3.5.2.2 Harvesting

Harvest emissions were estimated using crop-specific emission factors (CARB, 2003). The majority of harvest acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Harvest acres for potatoes were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus were obtained from the 2007 Census of Agriculture (USDA, 2007a). Table 3.5–19 lists the crop types, acres harvested and associated PM₁₀ emission factors used to calculate emissions from agricultural harvesting.

Table 3.5–19. Maricopa County harvested acres and emission factors.

Crop	PM ₁₀ emission factor (lb/acre-yr)	2008 Acreage
Cotton	3.4	18,800
Wheat	5.8	30,100
Barley	5.8	9,900
Alfalfa Hay	0.0	83,000
Other Hay	1.68	4,500
Corn	1.68	700
Sorghum for Grain**	5.8	2,200
Potatoes	2.7	1,400
Vegetables*	0.08	16,072
Citrus	0.08	2,124
Total		168,796

*Includes melons, exclude potatoes.

** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

Annual PM₁₀ emissions from agricultural harvesting were calculated using the following equation:

$$\text{Uncontrolled annual harvest}_{\text{Crop}} \text{ emissions} = EF_{\text{crop}} \times A_{\text{Crop}} \times \text{ton} / 2,000 \text{ lb}$$

where:

$harvest_{\text{Crop}}$ = harvest emissions for each crop type (tons PM₁₀/yr)

EF_{Crop} = harvest emission factor (lbs PM₁₀/acre)

A_{Crop} = number of harvested acres for each crop type per year

Example:

EF_{Cotton} = 3.4 lbs PM₁₀/acre for cotton

A_{Cotton} = 18,800 acres of cotton

Uncontrolled annual Harvest_{Cotton} Emissions = 3.4 lbs PM₁₀/acre × 18,800 acres × 1 ton/2,000 lbs
 = 31.96 tons PM₁₀/yr

In November 2007, the agricultural PM₁₀ general permit program (Arizona Administrative Code R18-2-610 and 611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. (Previously this requirement had only applied to the Maricopa County PM₁₀ NAA.) The agricultural PM₁₀ general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM₁₀ emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*. URS and ERG quantified two BMPs for harvesting: 1) combining tractor operations, and 2) reduced harvest activity. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3). To estimate controlled harvest emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP were applied to 63.09% of the uncontrolled annual emissions (the percent of agricultural land in the Maricopa County portion of Area A) (MAG, 2009) as follows:

Controlled annual harvest _{Crop} emissions	=	annual uncontrolled PM ₁₀ emissions	×	(100% – mid-point net control efficiency _{crop})	×	% agricultural land in the Maricopa Co. portion of Area A
Controlled annual harvest _{Cotton} emissions from within the Maricopa Co. portion of Area A	=	31.96 tons PM ₁₀ /yr	×	(100% – 25.6%)	×	63.09%
	=	15.01 tons PM ₁₀ /yr				

The uncontrolled portion of harvest emissions from agricultural operations outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM₁₀ emissions by the percent of agricultural land located within Maricopa County but outside of the Area A (100% – 63.09%) as follows:

Uncontrolled annual Harvest _{Cotton} emission from outside the Maricopa Co. portion of Area A	=	Uncontrolled PM ₁₀ emissions	×	36.91%
	=	31.96 tons PM ₁₀ /yr	×	36.91%
	=	11.80 tons PM ₁₀ /yr		

The total controlled and uncontrolled annual emissions were then summed to estimate total annual PM₁₀ emissions from agricultural harvesting in Maricopa County as follows:

$$\begin{aligned}
\text{Total annual harvest}_{\text{Cotton}} \text{ emissions for Maricopa County} &= \text{Uncontrolled annual harvest}_{\text{Cotton}} \text{ emissions from outside Area A} + \text{Controlled annual harvest}_{\text{Cotton}} \text{ emissions from within the Maricopa Co. portion of Area A} \\
&= 11.80 + 15.01 \\
&= 26.81 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Annual PM_{2.5} emissions from agricultural harvesting were calculated by multiplying the annual PM₁₀ emissions by a conversion factor of 0.15 (WRAP, 2006c). Annual PM₁₀ and PM_{2.5} emissions from harvesting in Maricopa Co. and Area A are shown in Table 3.5–20.

Table 3.5–20. Annual emissions from harvesting in Maricopa County and Area A (in tons/yr).

Crop	Net control efficiency (%)	Maricopa Co.	Area A		Outside Area A	Maricopa Co. (Area A + outside Area A)	
		Uncontrolled	(controlled)		(uncontrolled)		
		PM ₁₀	PM ₁₀	PM _{2.5}	PM ₁₀	PM ₁₀	PM _{2.5}
Cotton	25.5%	31.96	15.02	2.25	11.80	26.81	4.02
Wheat	23.5%	87.29	42.15	6.32	32.22	74.37	11.16
Barley	23.5%	28.71	13.86	2.08	10.60	24.46	3.67
Alfalfa Hay	27.6%	0.00	0.00	0.00	0.00	0.00	0.00
Other Hay	27.6%	3.78	1.73	0.26	1.40	3.12	0.47
Corn	23.5%	0.59	0.28	0.04	0.22	0.50	0.08
Sorghum for Grain**	23.5%	6.38	3.08	0.46	2.35	5.44	0.82
Potatoes	23.5%	1.89	0.91	0.14	0.70	1.61	0.24
Vegetables*	23.5%	0.64	0.31	0.05	0.24	0.55	0.08
Citrus	23.5%	0.08	0.04	0.01	0.03	0.07	0.01
Total		161.33	77.39	11.61	59.54	136.93	20.54

*Includes melons, excludes potatoes.

** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

Annual PM₁₀ emissions from agricultural harvesting in the PM₁₀ NAA were calculated in the same manner as the annual PM₁₀ emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM₁₀ NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–21.

Table 3.5–21. Annual emissions from harvesting in the PM₁₀ NAA (tons/yr).

Crop	Net control efficiency (%)	Fraction of Ag land in PM ₁₀ NAA	PM ₁₀ NAA (controlled)	
			PM ₁₀	PM _{2.5}
Cotton	25.5%	44.1%	10.51	1.58
Wheat	23.5%	44.1%	29.49	4.42
Barley	23.5%	44.1%	9.70	1.45
Alfalfa Hay	27.6%	44.1%	0.00	0.00
Other Hay	27.6%	44.1%	1.21	0.18
Corn	23.5%	44.1%	0.20	0.03
Sorghum for Grain**	23.5%	44.1%	2.16	0.32
Potatoes	23.5%	44.1%	0.64	0.10
Vegetables*	23.5%	44.1%	0.22	0.03
Citrus	23.5%	44.1%	0.03	0.00
Total			54.14	8.12

*Includes melons, excludes potatoes.

** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

Typical daily emissions for Maricopa County, Area A, and the PM₁₀ NAA were calculated by dividing the annual emissions by the number of harvest days per year and multiplying the result by 2000 lbs/ton (URS and ERG, 2001). Because acres harvested were not reported for individual vegetables and citrus fruit, an average number of harvest days per year were used for vegetables and citrus (116 and 188 harvest days per year, respectively). Results are shown in Table 3.5–22.

Table 3.5–22. Typical daily emissions from harvesting, by crop (in lbs/day).

Crop	Harvest days/yr	Maricopa County		Area A		PM ₁₀ NAA	
		PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Cotton	143	375.0	56.2	210.0	31.5	146.9	22.0
Wheat	60	2,479.0	371.8	1,405.1	210.8	983.0	147.5
Barley	60	815.3	122.3	462.2	69.3	323.3	48.5
Alfalfa Hay	294	0.0	0.0	0.0	0.0	0.0	0.0
Other Hay	294	21.2	3.2	11.7	1.8	8.2	1.2
Corn	91	11.0	1.7	6.2	0.9	4.4	0.7
Sorghum for Grain**	60	181.2	27.2	102.7	15.4	71.8	10.8
Potatoes	70	46.0	6.9	26.1	3.9	18.2	2.7
Vegetables*	116	9.4	1.4	5.3	0.8	3.7	0.6
Citrus	188	0.8	0.1	0.4	0.1	0.3	0.0
Total		3,938.9	590.8	2,229.9	334.5	1,560.0	234.0

*Includes melons, excludes potatoes.

** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

3.5.2.3 Travel on unpaved agricultural roads

Resuspended PM₁₀ emissions from travel on unpaved agricultural roads were estimated using an unpaved road emission factor derived from AP-42 13.2.2 (US EPA, 2006b). The unpaved road emission factor equation is shown below:

$$\text{Unpaved road emission factor (EF) (lb/VMT)} = k (s/12)^a (W/3)^b$$

where:

- s = surface material silt content = 11.90% (MAG, 2000)
- W = mean vehicle weight (tons) = 2.80 (URS and ERG, 2001)
- k = 1.5 (PM₁₀ constant; US EPA, 2006b)
- a = 0.9 (PM₁₀ constant; US EPA, 2006b)
- b = 0.45 (PM₁₀ constant; US EPA, 2006b)

$$\begin{aligned} \text{Unpaved road emission factor (lb/VMT)} &= 1.5 (11.9/12)^{0.9} (2.8/3)^{0.45} \\ &= 1.444 \text{ lb/VMT} \end{aligned}$$

Emissions were estimated using farm vehicle activity data obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001). URS and ERG (2001) estimated average daily vehicle miles traveled per 1,000 acres to be 49.5 VMT.

Daily emissions from travel on unpaved agricultural roads were then estimated as follows:

$$\text{Daily uncontrolled PM}_{10} = \text{unpaved road EF} \times \text{VMT}/1000 \text{ acres} \times 2008 \text{ harvested acres}$$

$$\begin{aligned} \text{emissions from ag roads} &= 1.444 \text{ lbs/VMT} \times 49.5 \text{ VMT/1000 acres} \times 168,796 \text{ acres} \\ &= 12,065 \text{ lbs/day} \end{aligned}$$

In November 2007, the agricultural PM₁₀ general permit (Arizona Administrative Codes R18-2-610 and 611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. Previously this rule only applied to the Maricopa County PM₁₀ NAA. The agricultural PM₁₀ general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM₁₀ emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the Technical Support Document for quantification of Agricultural BMPs.

Two BMPs were quantified for unpaved road travel: 1) access restriction and 2) reduced vehicle speed. A 2001 study (URS and ERG, 2001) estimated net control efficiencies by multiplying a midpoint BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3).

To estimate controlled daily emissions from travel on unpaved agricultural roads within Area A, the mid-point net control efficiency for each BMP (0.4% and 11.6 %, respectively) were applied to 63.09 % (the percent of agricultural land in Area A) of the uncontrolled daily PM₁₀ emissions as follows:

$$\begin{aligned} \text{Controlled daily unpaved ag road emissions within Area A} &= \text{Daily uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}) \times \% \text{ agricultural land in Area A} \\ &= 12,065 \text{ lbs/day} \times (100\% - 12.0\%) \times 63.09\% \\ &= 6,698.4 \text{ lbs/day} \end{aligned}$$

The uncontrolled portion of unpaved agricultural road daily emissions outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying uncontrolled daily PM₁₀ emissions by the percent of agricultural land located within Maricopa County but outside of Area A (100% – 63.09%) as follows:

$$\begin{aligned} \text{Uncontrolled daily unpaved ag road emissions from outside of Area A} &= \text{Uncontrolled PM}_{10} \text{ emissions} \times (100\% - 63.09\%) \\ &= 12,065 \text{ lbs/day} \times 36.91\% \\ &= 4,453 \text{ lbs/day} \end{aligned}$$

Total controlled and uncontrolled daily emissions were then summed to estimate total daily PM₁₀ emissions from travel on unpaved agricultural roads in Maricopa County as follows:

$$\begin{aligned} \text{Total daily unpaved ag road emissions for Maricopa County from outside Area A} &= \text{Uncontrolled daily unpaved ag road emissions} + \text{Controlled daily unpaved ag road emissions from within Area A} \\ &= 4,453 + 6,698 \end{aligned}$$

= 11,151 lbs PM₁₀/day

Daily PM₁₀ emissions from unpaved agricultural roads in the PM₁₀ NAA were calculated in the same manner as the daily PM₁₀ emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM₁₀ NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–21.

Annual emissions for Maricopa County, Area A and the PM₁₀ NAA were calculated by multiplying daily emission estimates by 312 (=6 days per week × 52 weeks per year).

Annual and daily PM_{2.5} emission from travel on unpaved agricultural roads were calculated by multiplying the annual and daily PM₁₀ emissions by a conversion factor of 0.10 (WRAP, 2006c).

Annual and daily PM₁₀ and PM_{2.5} emissions from unpaved agricultural roads are shown in Table 3.5–23.

Table 3.5–23. Annual and typical daily emissions from travel on unpaved agricultural roads.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County (Area A + outside Area A)	1,739.52	173.95	11,150.8	1,115.1
Area A (controlled)	1,044.92	104.49	6,698.2	669.8
PM ₁₀ NAA (controlled)	731.03	73.10	4,686.1	468.6

3.5.2.4 Cotton ginning

Annual emissions from cotton ginning were derived from annual emission reports from all permitted cotton gins in the county. Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM₁₀ nonattainment area were derived based on the location data of the individual facilities.

Table 3.5–24 summarizes annual and typical daily emissions from cotton gins in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.5–24. Annual and typical daily emissions from area-source cotton ginning.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	17.90	5.11	103.8	29.7
PM ₁₀ NAA	4.86	1.39	26.7	7.6

3.5.2.5 Fertilizer application

Annual NH₃ emissions from synthetic nitrogen fertilizers for 2008 were obtained from the US EPA 2008 National Emissions Inventory (US EPA, 2010).

In 2005, MCAQD used the CMU Ammonia Model v.3.6 to calculate NH₃ emissions from synthetic nitrogen fertilizers (MCAQD, 2007). The CMU Ammonia Model used semiannual sales data for 2002 from the Association of American Plant Food Control Officials and crop calendar information from National Agricultural Statistics Service (NASS) to estimate monthly

fertilizer application rates for each county. The activity data in the CMU Ammonia Model v.3.6 has not been updated and therefore, MCAQD was unable to use the model to calculate 2008 NH₃ emissions. EPA, however, obtained county-level fertilizer consumption data for 2002 and 2007 from the Fertilizer Institute's Commercial Fertilizer 2002 and 2007 reports and calculated the percent change in county-level fertilizer quantities applied between 2002 and 2007. EPA used the percent change in applied fertilizer quantity to grow the fertilizer activity files provided with the CMU Ammonia Model v.3.6. EPA then ran the CMU Ammonia Model with the updated county-level fertilizer quantities to calculate NH₃ emissions. Typical daily NH₃ emissions were derived by dividing annual emissions by 366 days/year. Annual and typical daily emissions for the PM₁₀ nonattainment area were derived by multiplying the county annual and typical daily emissions by the percentage of agricultural land located in the PM₁₀ NAA (44.1%). See Section 1.5.2 for a discussion of the land use data used. Annual and typical daily NH₃ emissions from fertilizer application are shown in Table 3.5–25.

Table 3.5–25. Annual and typical daily NH₃ emissions from fertilizer application.

Fertilizer Category	Maricopa County		PM ₁₀ NAA	
	Annual Emissions (tons/year)	Daily NH ₃ Emissions (lbs/day)	Annual NH ₃ Emissions (tons/year)	Daily NH ₃ Emissions (lbs/day)
Anhydrous ammonia	70.64	386.0	31.18	170.4
Aqueous ammonia	3.75	20.5	1.65	9.0
Ammonium nitrate	0.00	0.0	0.00	0.0
Ammonium sulfate	74.40	406.5	32.84	179.5
Ammonium thiosulfate	0.00	0.0	0.00	0.0
N-P-K (multi-grade nutrient fertilizers)	0.00	0.0	0.00	0.0
Calcium ammonium nitrate	0.00	0.0	0.00	0.0
Nitrogen solutions	1,397.66	7637.5	616.93	3371.2
Urea	496.42	2712.7	219.12	1197.4
Diammonium phosphate	2.66	14.6	1.18	6.4
Monoammonium phosphate	71.77	392.2	31.68	173.1
Liquid ammonium polyphosphate	38.94	212.8	17.19	93.9
Potassium nitrate	0.95	5.2	0.42	2.3
Miscellaneous	119.24	651.6	52.63	287.6
Total	2,276.43	12,439.5	1,004.82	5,490.8

3.5.3 Livestock

PM₁₀ and PM_{2.5} emissions estimates were derived using Maricopa County cattle inventory estimates for 2008 from Arizona Agricultural Statistics Bulletin (AASS, 2009) and emission factor for PM₁₀ for dairy cattle, and feedlot cattle from the California Air Resources Board (CARB, 2004). PM_{2.5} was presumed to be 11% of PM₁₀ per WRAP Fugitive Dust Handbook (WRAP, 2006d).

The number of “cattle on feed” was not available from the Arizona Agricultural Statistics Bulletin (AASS, 2009) for 2005 through 2008; therefore, 2004 numbers were used. Beef cows were excluded from the inventory as information provided by Arizona Agricultural Statistics staff (Koong, 2004) indicated that the majority of beef cows that are not on feed are grazed on range and pastures. Cattle on feed, milk cows, and other cattle (heifers, steers, bulls, and calves on dairies and ranches) were included in the PM₁₀ and PM_{2.5} emission estimates for livestock.

The 2008 Maricopa County cattle inventory and applicable PM emission factors are contained in Table 3.5–26.

Table 3.5–26. Maricopa County cattle populations and PM emission factors.

Animal type	No. of Head	PM₁₀ Emission Factor (lb/1000 head/day)	PM_{2.5}:PM₁₀ Ratio
Cattle on feed	5,000	28.9	0.11
Milk cows	100,000	6.7	0.11
Other cattle	58,000	28.9	0.11
Total:	170,000		

Typical daily PM₁₀ emissions from livestock in Maricopa County were calculated using the following formula:

$$\begin{aligned} \text{Typical daily emissions (lbs/day) from dairy cattle} &= \text{milk cow inventory (1,000 head)} \times \text{emission factor (lbs PM}_{10}\text{/1,000 head/day)} \\ &= 100 \times 6.7 \\ &= 670.0 \text{ lbs PM}_{10}\text{/day} \end{aligned}$$

It was assumed that livestock emissions occur evenly throughout the year. Annual PM₁₀ and PM_{2.5} emissions were derived by multiplying typical daily emissions by 366 days/year.

NH₃ emissions from livestock in Maricopa County were estimated by growing the 2005 NH₃ emissions by the percentage change in Maricopa County cattle and calve numbers from 2002 to 2008 (AASS, 2003; AASS, 2009)². The cattle and calf populations declined 8.11% from 2002 to 2008; as shown in Table 3.5–27 below. The estimated 2005 and 2008 NH₃ emissions from livestock emissions are shown in Table 3.5–28.

Table 3.5–27. Maricopa County cattle inventory for 2002 and 2008.

	Maricopa Co.		Percentage
	2002	2008	Change
All cattle & calves	185,000	170,000	-8.1%

Table 3.5–28. Annual and typical daily NH₃ emissions from livestock in Maricopa County.

	Annual emissions (tons/year)	Typical daily emissions (lbs/day)
2005 Emissions	10,429.53	57,148.1
% Change in cattle and calves, 2002 to 2008	-8.11%	-8.11%
2008 Emissions	9,583.89	52,514.5

MCAQD determined through GIS analysis of confined animal feeding operation (CAFO) locations and animal numbers in Maricopa County that 57.3% of CAFO animals are located within the nonattainment area. Therefore, annual and typical daily emissions for the nonattainment area were calculated by multiplying the Maricopa County emission totals by 57.3%.

Table 3.5–29 summarizes the annual and typical daily emissions from livestock for Maricopa County and the PM₁₀ nonattainment area.

² The 2005 NH₃ emissions were calculated using the CMU Ammonia Model (CMU, 2004). The activity levels in the CMU model are based on the 2002 Census of Agriculture; therefore, emissions were grown using the percentage change in cattle and calve numbers from 2002 to 2008.

Table 3.5–29. Annual and typical daily emissions from livestock.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NH ₃	PM ₁₀	PM _{2.5}	NH ₃
Maricopa County	455.80	50.14	9,583.89	2,490.7	274.0	52,514.5
PM ₁₀ NAA	260.95	28.70	5,486.90	1,426.0	156.9	30,065.2

3.5.4 Health services: crematories

Emissions from human and animal crematories were calculated from annual emissions inventory reports from all crematories located within the county. Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM₁₀ nonattainment area were derived based on the location data of the individual facilities.

Table 3.5–30 summarizes annual and typical daily emissions from crematories in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.5–30. Annual and typical daily emissions from crematories.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.93	0.62	12.39	1.58	7.0	4.7	93.1	11.9
PM ₁₀ NAA	0.93	0.62	12.36	1.58	7.0	4.6	92.6	11.8

3.5.5 Accidental releases

As part of its air quality permit compliance program, MCAQD keeps an “upset log”, for each calendar year that records excess emissions and accidental releases at permitted facilities. Annual emissions inventory reports also provide for recording of accidental releases. Data from these two sources documented the release of 0.01 tons of PM₁₀ and 0.06 tons of NO_x for the year 2008. To be conservative, PM_{2.5} amounts are assumed to be equal to PM₁₀ amounts. (No accidental releases of SO_x or NH₃ were reported).

Typical daily emissions were calculated by summing reported releases and dividing the total by 366 days. Emissions in the PM₁₀ nonattainment area were calculated based on locations of facilities that reported releases. The resulting estimates are shown in Table 3.5–31 below.

Table 3.5–31. Annual and typical daily emissions from accidental releases.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5} *	NO _x	PM ₁₀	PM _{2.5} *	NO _x
Maricopa County	0.01	0.01	0.06	0.1	0.1	0.3
PM ₁₀ NAA	0.01	0.01	0.06	0.1	0.1	0.3

* As a conservative estimate, all PM₁₀ emissions are assumed to be PM_{2.5}.

3.5.6 Humans

A literature review by Battye et al. (1994) recommended using a per-capita emission factor developed for the National Acid Precipitation Assessment Program (NAPAP) inventory in 1985. This factor was applied to MAG population estimates for the county and PM₁₀ nonattainment

areas (see section 1.5 for population information). Daily emissions were calculated by dividing annual values by 366. The resulting estimates are shown in Table 3-5–32.

Table 3.5–32. Annual and typical daily NH₃ emissions from human activity.

Geographic Area	Population	Emission factor (lbs/ person-yr)	Annual NH ₃ emissions (tons/yr)	Typical daily NH ₃ emissions (lbs/day)
Maricopa County	4,279,760	0.55	1,176.93	6,431.3
PM ₁₀ NAA	4,297,140	0.55	1,181.71	6,457.5

3.5.7 Leaf blower fugitive dust

Fugitive dust emissions from leaf blowers are the result of blowing loose material from the area being cleared by the leaf blowers. Exhaust emissions from gasoline-powered leaf blowers are covered under the Nonroad Mobile Sources section of this report (Chapter 4). Fugitive dust emission estimates are developed with the use of three sources: EPA’s NONROAD model, California Air Resources Board report to legislature on leaf blowers (CARB, 2000), and a recent research effort done by the University of Riverside (Fitz et al., 2005).

EPA’s 2008NONROAD model was used to estimate the number of gasoline-powered leaf blowers in Maricopa County ($n = 109,787$), along with the average activity figures for those leaf blowers. Total leaf blower population estimates were derived from CARB (2000), which estimated that 60% of all leaf blowers sold are electric. Thus assuming the remaining 40% are gasoline-powered, the total population was estimated as:

$$\begin{aligned}
 \text{Total leaf blower population} &= \text{Gas-powered leaf blower population} \div 40\% \\
 &= 109,787 \div 0.4 \\
 &= 274,468 \text{ units}
 \end{aligned}$$

The remaining 164,681 units [= 274,468 – 109,787] are thus assumed to be electric-powered. Fitz et al. (2005) developed emission factors for PM₁₀ and PM_{2.5} fugitive dust emissions from leaf blowers. For this report, the most conservative (highest) emission factors were chosen to estimate emissions. Given these two data sources, Table 3.5–33 lists the equipment population numbers, activity estimates and emission factors for leaf blowers in Maricopa County.

Table 3.5–33. Leaf blower equipment populations, activity levels and emission factors for Maricopa County.

Leaf blower description	Population	Annual activity (hrs/yr)	PM ₁₀ emission factors (mg/m ²)	PM _{2.5} Emission factors (mg/m ²)
Commercial 2-stroke gasoline	3,345	626	70	30
Commercial 4-stroke gasoline	1,639	626	70	30
Residential 2-stroke gasoline	99,624	10	70	30
Residential 4-stroke gasoline	5,179	10	70	30
Electric	164,681	10	130	40
Total:	274,468	n/a	n/a	n/a

CARB (2000) estimates that approximately 1600m² of surface can be cleared in one hour of leaf blower operation. Therefore, annual emission estimates were calculated by using the following formula, as in this example for electric leaf blowers:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from electric leaf blowers} &= \text{population} \times \text{activity (hrs/yr)} \times \text{emission factor (mg/m}^2\text{)} \times \text{area covered (m}^2\text{/hr)} \\
 &= 164,681 \times 10 \text{ hrs/yr} \times 130 \text{ mg/m}^2 \times 1600 \text{ m}^2\text{/hr} \\
 &= 342,536,480,000 \text{ mg/yr} \\
 &= 377.24 \text{ tons PM}_{10}\text{/yr}
 \end{aligned}$$

The activity hours associated with leaf blowers can occur at any time during the year in Maricopa County due to the temperate climate, with no substantial seasonal variation. Therefore, typical daily emissions were estimated by dividing annual totals by 366 days per year. Emissions for the PM₁₀ nonattainment area are allocated based on the ratio of population in the County to the nonattainment area (see Section 1.5 for information on population). Table 3.5–34 lists annual and daily fugitive emissions from leaf blowers for Maricopa County and the PM₁₀ nonattainment area.

Table 3.5–34. Annual and typical daily emissions from leaf blower fugitive dust.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	891.36	336.41	4,870.8	1,838.3
PM ₁₀ NAA	894.98	337.78	4,890.6	1,845.8

3.5.8 Offroad recreation vehicles fugitive dust

The EPA NONROAD2008 model estimates exhaust emissions for offroad recreational vehicles. These emissions are included in the nonroad emissions category of the 2008 particulate emissions inventory. Particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces. For the 2008 periodic inventory, these emissions were estimated by MAG using mileage and activity data for offroad recreational vehicles in Maricopa County from the NONROAD2008 model. The methodology and assumptions for calculating fugitive dust emissions from offroad recreational vehicles traveling are described in this section.

The EPA NONROAD2008 model provides annual mileage and number of vehicles by county for all-terrain vehicles (ATVs), offroad motorcycles (ORMs), and specialty vehicles/carts (SVCs). The NONROAD2008 default values for annual mileage and number of vehicles by type for Maricopa County in 2008 are shown in Table 3.5–35.

To be consistent with the 2005 Periodic Emissions Inventory for PM₁₀ (MCAQD, 2007), it was assumed that 75 percent of the annual travel by offroad recreational vehicles occurs on unpaved surfaces inside Maricopa County, with the remaining 25 percent occurring on paved surfaces within Maricopa County and paved and unpaved surfaces outside of Maricopa County. The product of the mileage, number of vehicles, and 75 percent produces the annual vehicle miles traveled (VMT) on unpaved surfaces, shown in Table 3.5–35. Dividing annual VMT totals by 366 produces a daily estimated offroad recreational vehicle travel on unpaved surfaces in Maricopa County in 2008.

Table 3.5–35. 2008 offroad recreational vehicle travel on unpaved surfaces in Maricopa County.

Vehicle Type	Annual Mileage	Number of Vehicles	2008 Annual VMT	2008 Daily VMT
ATV	1,608	30,424	36,691,344	100,250
ORM	1,600	7,359	8,830,800	24,128
SVC (Non-Diesel)	65	1,718	83,753	229
SVC (Diesel)	435	150	48,938	134

The VMTs above were multiplied by emission factors for unpaved industrial roads from AP-42 (US EPA, 2006b), assuming a silt content of 11.9 percent and an average vehicle weight of one-half of a ton. The resultant PM₁₀ emission factor for ATVs and SVCs is 0.594 pounds per vehicle mile traveled. This emission factor was reduced by 50 percent for ORMs (i.e., 0.297 pounds per mile) to account for two wheels generating dust instead of four. Applying the AP-42 equation results in a PM_{2.5} emission factor for ATVs and SVCs of 0.059 pounds per mile, while the comparable PM_{2.5} emission factor for ORMs is 0.0295 pounds per mile.

The AP-42 emission rates were multiplied by the annual and daily VMTs in Table 3.5–36 to obtain uncontrolled fugitive dust emissions in pounds per day and tons per year. The results for Maricopa County are shown in Table 3.5–37.

The emissions for the PM₁₀ nonattainment area were derived by applying geographic information systems (GIS) to MAG 2009 land use data¹ to obtain the acreage of passive open space in the PM₁₀ nonattainment area and Maricopa County. Passive open space includes open desert, mountains and washes. The detailed calculations for deriving the PM₁₀ nonattainment area emissions are shown below:

Passive Open Space in the PM₁₀ nonattainment area (NAA) = 262,662 acres

Passive Open Space in Maricopa County = 1,476,922 acres

Ratio of Passive Open Space in PM₁₀ NAA vs. Maricopa County = 17.8%

PM₁₀ NAA Emissions = 0.178 × Maricopa County Emissions

Application of the ratio above to Maricopa County emissions produces the uncontrolled annual and typical daily PM₁₀ NAA emissions shown in Table 3.5–36. The PM₁₀ and PM_{2.5} emissions for all offroad recreational vehicle types (i.e., ATVs, ORMs and SVCs) are summed in this table. These uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measures in the MAG 2007 Five Percent Plan.

Table 3.5–36. 2008 uncontrolled emissions from offroad recreational vehicles.

Geographic Area	Annual emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	12,248.11	1,216.56	66,929.6	6,647.9
PM ₁₀ NAA	2,180.16	216.55	11,913.5	1,183.3

Two committed measures that reduce emissions from offroad recreational vehicles were quantified in the MAG 2007 Five Percent Plan for PM₁₀ (MAG, 2007). The benefit taken in 2008 for these measures in the Five Percent Plan is shown in Table 3.5–37.

1. Draft, as of March 24, 2010.

Table 3.5–37. Benefits of measures that reduce offroad recreational vehicle emissions.

Committed Measures in Five Percent Plan	2008 PM ₁₀ Emission Reductions	
	tons/yr	lbs/day
1. Reduce offroad vehicle use in areas with high offroad vehicle activity (Measure 19)	140.3	766.5
2. Ban ATV use on high pollution days (Measure 23)	25.7	140.6
Total 2008 PM₁₀ emission reductions for offroad recreational vehicles	166.0	907.0

The emission benefits in Table 3.5–37 were subtracted from the uncontrolled PM₁₀ emissions in Table 3.5–36. The 2008 PM₁₀ emission reduction of 166.0 tons per year represents 7.6% of the uncontrolled emissions in the PM₁₀ NAA of 2,180.16 tons per year. This percent reduction was applied to the uncontrolled PM_{2.5} emissions in the PM₁₀ NAA; then the absolute reduction in PM_{2.5} emissions due to the control measures was applied to the uncontrolled PM_{2.5} emissions in Maricopa County. The annual and daily controlled emission estimates are shown in Table 3.5–38 below.

Table 3.5–38. 2008 controlled emissions from offroad recreational vehicles.

Geographic Area	Annual Emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	12,082.12	1,200.11	66,022.5	6,558.0
PM ₁₀ NAA	2,014.17	200.09	11,006.4	1,093.4

3.5.9 Unpaved parking lots fugitive dust

Fugitive dust emissions from vehicles traveling on unpaved parking lots were developed by MAG based on land area devoted to unpaved parking lots, vehicle activity on unpaved parking lots, and emission rates from AP-42 (US EPA, 2006b). The methodology, assumptions and calculations involved in estimating fugitive dust from vehicles traveling on unpaved parking lots are described in this section.

The vehicle miles traveled on unpaved parking lots in the PM₁₀ nonattainment area (NAA) were derived using assumptions from the Phase I windblown dust modeling for the Western Regional Air Partnership (ENVIRON, 2004). This study estimated that eight percent of the vacant land in core urban areas is disturbed and thirty percent of the land under development is disturbed. For the 2008 periodic emissions inventory, the core urban area is defined as the carbon monoxide maintenance area. In addition, the thirty percent of disturbed land under development has been reduced by two-thirds (i.e., from thirty percent to ten percent) to mirror a 67 percent decline in total permitted construction acreage in the PM₁₀ NAA between 2005 and 2008. GIS was applied to 2009 MAG land use data² to estimate that there are 171,785 acres of vacant land in the core urbanized area and 64,519 acres of land under development in the PM₁₀ NAA. Multiplying the vacant disturbed percentages by these land areas produces:

$$171,785 \text{ acres} \times 0.08 = 13,743 \text{ acres of vacant disturbed land in the urbanized core}$$

$$64,519 \text{ acres} \times 0.10 = 6,452 \text{ acres of vacant disturbed land under development}$$

Summing the vacant disturbed acres in the urbanized core and areas under development produces a total of 20,195 acres of vacant disturbed land in the PM₁₀ NAA. In estimating fugitive dust emissions from unpaved parking lots, the MAG Serious Area PM₁₀ Plan assumed that 24 percent

2. *Ibid.*

of the disturbed vacant non-agricultural land is devoted to unpaved parking areas (MAG, 2000). Applying this percentage to the acres of vacant disturbed land results in 4,847 acres of unpaved parking lots in the PM₁₀ NAA.

The MAG Serious Area PM₁₀ Plan also assumed that the average size of an unpaved parking lot is 625 square meters (i.e., 0.154 acres), an average of ten vehicles travel on each lot per day, and each vehicle travels an average distance of 0.031 miles on a lot. Multiplying 10 vehicles per day times 0.031 miles per vehicle and dividing by 0.154 acres produces 2.0 vehicle miles of travel (VMT) per acre per day. Multiplying 2.0 by 4,847 acres yields 9,694 VMT per day on unpaved parking lots in the PM₁₀ NAA.

The emission factors for unpaved parking lots were derived from the AP-42 equation for unpaved industrial roads (US EPA, 2006b), assuming a silt content of 11.9 percent and an average vehicle weight of 3.18 tons. The resultant AP-42 emission factors are 1.365 pounds per mile for PM₁₀ and 0.137 pounds per mile for PM_{2.5}.

These AP-42 emission factors were applied to the unpaved parking lot VMT of 9,694 to obtain uncontrolled emissions in pounds per day. The pounds per day were converted to tons per year, assuming 366 days in 2008. The results for the PM₁₀ NAA are shown in Table 3.5–40.

To estimate emissions for Maricopa County, GIS was applied to 2009 MAG land use data³ to obtain 2,227,981 acres of vacant land in Maricopa County. Removing the vacant land in the Maricopa County portion of the PM₁₀ NAA (i.e., 466,553 acres) results in 1,761,428 vacant acres located inside Maricopa County, but outside the PM₁₀ NAA.

Assuming one percent of the vacant land outside the PM₁₀ NAA is disturbed (Clark County, 2006) and 24 percent of the disturbed vacant land is unpaved parking areas (MAG, 2000), results in 4,227 acres of unpaved parking areas inside Maricopa County, but outside the PM₁₀ NAA. Multiplying by 2.0 VMT per acre per day results in 8,454 VMT per day. Applying the AP-42 emission rates produces the unpaved parking lot emissions inside Maricopa County, but outside the PM₁₀ NAA of 11,539.7 pounds per day of PM₁₀ and 1,158.2 pounds per day of PM_{2.5}.

The final step in estimating Maricopa County emissions requires removing the Pinal County portion of the PM₁₀ NAA. The unpaved parking lot emissions in the Pinal County portion of the PM₁₀ NAA are assumed to be proportional to the acres of vacant land. These were derived using GIS and 2009 MAG land use data⁴, with the results shown below:

Vacant land in the Pinal County portion of the PM₁₀ NAA = 6,278 acres

Vacant land in the PM₁₀ NAA = 472,831 acres

Ratio = 6,278/472,831 = 1.3%; Pinal County portion = 1.3% × PM₁₀ NAA emissions

Pinal County portion of PM₁₀ emissions = 1.3% × 13,232.3 = 172.0 pounds per day

Pinal County portion of PM_{2.5} emissions = 1.3% × 1,158.2 = 17.3 pounds/day

Adding the emissions inside and outside the PM₁₀ NAA and subtracting the Pinal County portion produces total Maricopa County emissions attributable to vehicles traveling on unpaved parking

3. *Ibid.*

4. *Ibid.*

lots in pounds per day. Pounds per day were multiplied by 366 [= no. days in 2008] to derive annual totals. The resultant 2008 uncontrolled emissions for Maricopa County are shown in Table 3.5–39. Uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measure in the MAG 2007 Five Percent Plan.

Table 3.5–39. 2008 uncontrolled emissions from vehicles traveling on unpaved parking lots.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	4,501.80	451.83	24,600.0	2,469.0
PM ₁₀ NAA	2,421.51	243.04	13,232.3	1,328.1

One committed measure that reduces emissions from unpaved parking lots was quantified in the MAG 2007 Five Percent Plan for PM₁₀ (MAG, 2007). The benefit taken in 2008 for this measure in the Five Percent Plan is shown in Table 3.5–40.

Table 3.5–40. Benefits of measure that reduces unpaved parking lot emissions.

Committed Measure in Five Percent Plan	2008 PM ₁₀ emission reduction	
	tons/yr	lbs/day
1. Pave or stabilize existing unpaved parking lots (Measure 25)	56.4	308.4

The emission benefit in Table 3.5–40 was subtracted from the uncontrolled PM₁₀ emissions in Table 3.5–39. The 2008 PM₁₀ emission reduction of 56.4 tons per year represents 2.3% of the uncontrolled emissions in the PM₁₀ NAA of 2,421.51 tons per year. This percent reduction was applied to the uncontrolled PM_{2.5} emissions in the PM₁₀ NAA; then the absolute reduction in PM_{2.5} emissions due to the control measure was applied to the uncontrolled PM_{2.5} emissions in Maricopa County. The annual and daily controlled emission estimates are shown in Table 3.5–41 below.

Table 3.5–41. Annual and typical daily controlled emissions from unpaved parking lots.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	4,445.36	446.24	24,291.6	2,438.5
PM ₁₀ NAA	2,365.07	237.45	12,923.9	1,297.5

3.5.10 Windblown dust

Windblown dust emissions were calculated using a combination of local meteorology conditions, land use and vertical flux emission rates. A full description of the methodology can be found in Appendix 4. Tables 3.5–42 and 3.5–43 summarize annual and typical daily emissions from windblown dust by major land use category for Maricopa County and the PM₁₀ nonattainment area.

Table 3.5–42. Annual and typical daily emissions from fugitive windblown dust for Maricopa County.

Land Use Category	Annual Emissions (tons/yr)		Avg. Daily Emissions (lb/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Active open space	215.94	32.39	1,180.0	177.0
Agriculture – active	61.69	9.25	337.1	50.6
Agriculture – inactive	345.86	51.88	1,890.1	283.5
Auto test tracks	49.23	7.38	269.0	40.4
Developing	394.98	59.25	2,158.4	323.8
Landfill	6.33	0.95	34.6	5.2
Mining	25.37	3.81	138.7	20.8
Passive open space / wash	2,755.11	413.27	15,058.1	2,258.7
Sand & gravel	108.47	16.27	592.7	88.9
Vacant	2,846.15	426.92	15,555.8	2,333.4
Total	6,809.13	1,021.37	37,214.6	5,582.2

Table 3.5–43. Annual and typical daily emissions from fugitive windblown dust for the PM₁₀ NAA.

Land Use Category	Annual Emissions (tons/yr)		Avg. Daily Emissions (lb/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Active open space	213.93	32.09	1,169.0	175.4
Agriculture – active	57.82	8.67	315.9	47.4
Agriculture – inactive	296.42	44.46	1,619.8	243.0
Auto test tracks	42.93	6.44	234.6	35.2
Developing	391.00	58.65	2,136.6	320.5
Landfill	6.33	0.95	34.6	5.2
Mining	23.75	3.56	129.8	19.5
Passive open space / wash	1,822.61	273.39	9,959.6	1,493.9
Sand & gravel	107.82	16.17	589.2	88.4
Vacant	1,852.19	277.83	10,121.2	1,518.2
Total	4,814.80	722.22	26,310.4	3,946.6

3.5.11 Summary of all miscellaneous area sources

Tables 3.5–44 and 3.5–45 provide a summary of annual and typical daily emissions from all miscellaneous area sources, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.5–44. Annual and typical daily emissions from all miscellaneous area sources for Maricopa County.

Source Category	Annual emissions (tons/yr)					Typical 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
Wildfires	470.39	403.43	103.79	28.46	21.76	6,271.8	5,379.0	1,383.8	379.4	290.2
Prescribed fires	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
Structure fires	15.04	15.04	1.95			82.2	82.2	10.7		
Vehicle fires	30.04	30.04	1.20			164.1	164.1	6.6		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	2,059.00	308.85				22,932.4	3,439.9			
Harvesting	136.93	20.54				3,938.9	590.8			
Unpaved ag roads	1,739.52	173.95				11,150.8	1,115.1			
Cotton ginning	17.90	5.11				103.8	29.7			
Fertilizer					2,276.43					12,439.5
Livestock	455.80	50.14			9,583.89	2,490.7	274.0			52,514.5
Crematories	0.93	0.62	12.39	1.58		7.0	4.7	93.1	11.9	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,176.93					6,431.3
Leaf blowers dust	891.36	336.41				4,870.8	1,838.3			
Offroad rec. veh. dust	12,082.12	1,200.11				66,022.5	6,558.0			
Unpaved parking lots	4,445.36	446.24				24,291.6	2,438.5			
Windblown dust	6,809.13	1,021.37				37,214.6	5,582.2			
Total:	29,154.21	4,012.53	126.52	32.64	13,059.05	179,712.0	27,667.0	1,676.1	446.4	71,686.1

Table 3.5–45. Annual and typical daily emissions from all miscellaneous area sources for the PM₁₀ NAA.

Source Category	Annual emissions (tons/yr)					Typical 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
Wildfires	423.56	363.27	93.46	25.62	19.60	9,412.5	8,072.7	2,076.8	569.4	435.5
Prescribed fires	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5
Structure fires	15.10	15.10	1.96			82.5	82.5	10.7		
Vehicle fires	30.16	30.16	1.21			164.81	164.81	6.59		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	834.20	125.13				9,327.3	1,399.1			
Harvesting	54.14	8.12				1,560.0	234.0			
Unpaved ag roads	731.03	73.10				4,686.1	468.6			
Cotton ginning	4.86	1.39				26.7	7.6			
Fertilizer					1,004.82					5,490.8
Livestock	260.95	28.70			5,486.90	1,426.0	156.9			30,065.2
Crematories	0.93	0.62	12.36	1.58		7.0	4.6	92.6	11.8	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,181.71					6,457.5
Leaf blowers dust	894.98	337.78				4,890.6	1,845.8			
Offroad rec. veh. dust	2,014.17	200.09				11,006.4	1,093.4			
Unpaved parking lots	2,365.07	237.45				12,923.9	1,297.5			
Windblown dust	4,814.80	722.22				26,310.4	3,946.6			
Total:	12,444.36	2,143.52	115.94	29.74	7,693.04	81,929.6	18,879.4	2,318.0	622.4	61,982.0

3.6 Summary of all area sources

Tables 3.6–1 and 3.6–2 summarize the total annual and typical daily emissions from all area sources addressed in this chapter, for both Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.6–1. Summary of annual and typical daily emissions from all area sources in Maricopa County.

Source Category	Annual emissions (tons/yr)					Typical 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
<i>Fuel Combustion</i>										
Industrial natural gas	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
Industrial fuel oil	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
Comm./inst. natural gas	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
Comm./inst. fuel oil	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
Residential natural gas	61.75	61.75	763.81	4.88		337.5	337.5	4,173.8	26.6	
Residential wood	461.59	429.28	34.69	5.34		4,334.2	4,030.8	325.7	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All fuel combustion	1,303.61	1,271.30	12,289.62	898.83	51.27	9,673.4	9,370.0	78,161.3	5,773.3	328.7
<i>Industrial Processes</i>										
Chemical manufacturing	187.43	151.42	0.00	0.34	0.03	1,445.8	1,164.5	0.0	2.6	0.6
Commercial cooking	988.99	917.18				5,434.0	5,039.5			
Grain processing	20.59	6.71				149.3	49.5			
Cold storage					1,678.43					10,759.2
Secondary metal prod.	60.56	52.16	49.73	18.65	.004	442.7	386.2	358.8	142.7	0.0
Mineral processes	192.82	95.47				1,337.7	659.3			
Mining & quarrying	181.01	55.20				1,239.2	362.6			
Wood product mfg.	217.26	203.25				1,668.6	1,548.3			
Rubber/plastic mfg.	140.94	105.96				953.3	698.8			
Fabricated metal mfg.	51.48	42.62			4.50	538.1	460.6			28.9
Residential construction	1,845.79	184.58				11,832.0	1,183.2			
Commercial construction	4,320.77	432.08				27,697.2	2,769.7			
Road construction	2,695.73	269.57				17,280.3	1,728.0			
Other construction	194.36	19.44				1,245.9	124.6			
Electrical equip mfg.	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93		492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	566.30	271.29				3,880.4	1,847.2			
Industrial processes NEC	144.60	107.24	10.22	21.49	16.79	953.3	726.4	69.6	137.7	94.6
All Industrial Processes	11,881.57	2,953.30	362.58	129.60	1,731.34	76,667.6	19,048.2	2,816.5	1,005.8	11,077.2
<i>Waste Treatment/disposal</i>										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	111.46	111.46	29.96			902.2	902.2	242.4		
Landfills	86.21	75.92	24.11	7.57		486.1	425.4	132.9	41.7	
POTWs					1,484.01					8,131.5
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treatment/Disposal	230.52	204.35	77.47	58.20	1,484.01	1,613.0	1,438.8	515.3	320.0	8,131.5

Table 3.6–1. Summary of annual and typical daily emissions from all area sources in Maricopa County.

Category	Annual emissions (tons/yr)					Typical 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
<i>Misc. Area Sources</i>										
Wildfires fires	470.39	403.43	103.79	28.46	21.76	6,271.8	5,379.0	1,383.8	379.4	290.2
Prescribed fires	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
Structure fires	15.04	15.04	1.95			82.2	82.2	10.7		
Vehicle fires	30.04	30.04	1.20			164.1	164.1	6.6		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	2,059.00	308.85				22,932.4	3,439.9			
Harvesting	136.93	20.54				3,938.9	590.8			
Unpaved ag roads	1,739.52	173.95				11,150.8	1,115.1			
Cotton ginning	17.90	5.11				103.8	29.7			
Fertilizer application					2,276.43					12,439.5
Livestock	455.80	50.14			9,583.89	2,490.7	274.0			52,514.5
Crematories	0.93	0.62	12.39	1.58		7.0	4.7	93.1	11.9	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,176.93					6,431.3
Leaf blowers dust	891.36	336.41				4,870.8	1,838.3			
Offroad rec. veh. dust	12,082.12	1,200.11				66,022.5	6,558.0			
Unpaved parking lots	4,445.36	446.24				24,291.6	2,438.5			
Windblown dust	6,809.13	1,021.37				37,214.6	5,582.2			
All Misc. Sources	29,154.21	4,012.53	126.52	32.64	13,059.05	179,712.0	27,667.0	1,676.1	446.4	71,686.1
TOTAL, ALL AREA SOURCES	42,569.90	8,441.49	12,856.18	1,119.27	16,329.74	267,665.9	57,524.0	83,169.2	7,545.5	91,223.5

Table 3.6–2. Summary of annual and typical daily emissions from all area sources in the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical 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
<i>Fuel Combustion</i>										
Industrial natural gas	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2
Industrial fuel oil	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9
Comm./inst. natural gas	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8
Comm./inst. fuel oil	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8
Residential natural gas	61.73	61.73	763.51	4.87		337.3	337.3	4,172.2	26.6	
Residential wood	461.41	429.11	34.67	5.33		4,332.5	4,029.2	325.6	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All fuel combustion	1,300.65	1,268.35	12,248.07	895.83	51.11	9,653.8	9,350.6	77,895.2	5,754.1	327.6
<i>Industrial Processes</i>										
Chemical manufacturing	186.94	151.03	0.00	0.34	0.03	1,442.0	1161.5	0.0	2.6	0.9
Commercial cooking	993.04	920.94				5,456.3	5,060.1			
Grain processing	16.73	5.68				125.3	43.0			
Cold storage					1,674.1					10,731.2
Secondary metal prod.	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
Mineral processes	187.73	91.92				1,302.8	635.6			
Mining & quarrying	156.60	46.81				1,075.7	307.2			
Wood product mfg.	216.69	202.72				1,664.3	1,544.3			
Rubber/plastic mfg.	140.57	105.68				950.9	697.0			
Fabricated metal mfg.	51.35	42.51			4.49	536.7	459.4			28.8
Residential construction	1,692.38	169.24				10,920.3	1,092.0			
Commercial construction	4,057.29	405.73				25,897.4	2,589.7			
Road construction	2,051.78	205.18				13,156.8	1,315.7			
Other construction	162.41	16.24				1,043.9	104.4			
Electrical equip mfg	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93		492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	472.36	217.08				3,273.9	1,500.1			
Industrial processes NEC	136.00	99.12	8.12	21.47	14.10	906.0	681.7	55.4	137.6	79.8
All Industrial Processes	10,655.39	2,771.19	360.48	129.58	1,724.27	68,764.6	17,877.6	2,802.3	1,005.7	11,034.4

Table 3.6–2 (cont'd). Summary of annual and typical daily emissions from all area sources in the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical 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
<i>Fuel Combustion</i>										
<i>Waste Treatment/disposal</i>										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	27.67	27.67	7.44			232.6	232.6	62.5		
Landfills	60.25	50.78	19.47	6.22		342.4	286.6	107.4	34.3	
POTWs					1,494.12					8,164.6
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treatment/ Disposal	120.77	95.42	50.30	56.85	1,494.12	799.8	630.5	309.9	312.6	8,164.6
<i>Misc. Area Sources</i>										
Wildfires	423.56	363.27	93.46	25.62	19.60	9,412.5	8,072.7	2,076.8	569.4	435.5
Prescribed fires	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5
Structure fires	15.10	15.10	1.96			82.5	82.5	10.7		
Vehicle fires	30.16	30.16	1.21			164.81	164.81	6.59		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	834.20	125.13				9,327.3	1,399.1			
Harvesting	54.14	8.12				1,560.0	234.0			
Unpaved ag roads	731.03	73.10				4,686.1	468.6			
Cotton ginning	4.86	1.39				26.7	7.6			
Fertilizer application					1,004.82					5,490.8
Livestock	260.95	28.70			5,486.90	1,426.0	156.9			30,065.2
Crematories	0.93	0.62	12.36	1.58		7.0	4.6	92.6	11.8	
Accidental releases Humans	0.01	0.01	0.06		1,181.71	0.1	0.1	0.3		6,457.5
Leaf blowers dust	894.98	337.78				4,890.6	1,845.8			
Offroad rec. veh. dust	2,014.17	200.09				11,006.4	1,093.4			
Unpaved parking lots	2,365.07	237.45				12,923.9	1,297.5			
Windblown dust	4,814.80	722.22				26,310.4	3,946.6			
All Misc. Sources	12,444.36	2,143.52	115.94	29.74	7,693.04	81,929.6	18,879.4	2,318.0	622.4	42,455.4
TOTAL, ALL AREA SOURCES:	24,521.17	6,278.48	12,774.79	1,112.00	10,962.54	161,147.8	46,738.0	83,325.3	7,694.7	61,982.0

3.7 Quality assurance/quality control procedures

Quality assurance and quality control (QA/QC) activities for the area source emissions inventory were driven by the goal of creating a comprehensive, accurate, representative and comparable inventory of area source emissions for Maricopa County and the nonattainment area. During each step of creating, building and reviewing the area source emissions inventory, quality checks and assurances were performed to establish confidence in the inventory structure and data.

Area source categories were selected for inclusion in the inventory based on the latest Emission Inventory Improvement Program (EIIP) guidance available. EPA's guidance for area source categories included in the draft 2002 National Emission Inventory (NEI) was also evaluated, as area source emissions from this inventory will be submitted to EPA for the 2008 NEI. The list of area source categories developed based on these guidance documents was modified to fit the characteristics of Maricopa County, with some area source categories determined to be insignificant (such as industrial coal combustion and oil and gas production). The 1999 Maricopa County Periodic Ozone and Carbon Monoxide Emission Inventories and other regional emission inventories were also consulted to confirm the completeness of the area source categories chosen for inclusion.

Data for area source emission calculations were gathered from a wide universe of resources. Whenever applicable, local surveyed data (such as annual emissions report) was used as this data best reflects activity in the county and the nonattainment area. When local data was not

available, state data from Arizona State agencies (such as the Arizona Department of Transportation) and regional bodies (such as the Western Regional Air Partnership, WRAP) were used. National-level data (such as those from the US Census Bureau) was used when no local, state or regional data was available. In addition, the most recent EIIP guidance for area sources was consulted for direction in determining the most relevant data source for use in emissions calculations.

Emissions calculations for area sources were performed by three air quality planners and one unit manager. All area source emission estimates were calculated in spreadsheets to ensure the calculations could be verified and reproduced. Whenever possible or available, the “preferred method” described in the most recent EIIP guidance documents for area sources was used to calculate emissions. Emissions were estimated using emission factors from EIIP guidance, AP-42, and local source testing. Local seasonal and activity data were used when available, with EPA and EIIP guidance used when no local seasonal or activity data existed. All calculations were evaluated to ensure that emissions from point sources were not being double-counted and to determine if rule effectiveness applied.

Once area source emission estimates had been produced, several quality control checks were performed to substantiate the calculations. Most area source calculations were peer-reviewed by two other planners, with all area sources being reviewed by at least one other planner. Peer review ensured that all emission calculations were reasonable and could be reproduced. Sensitivity analyses and computational method checks were performed on area sources when emissions seemed to be outside the expected ranges. When errors were found, the appropriate changes were made by the author of the calculations to ensure consistency of the emissions calculations. The peer-reviewed emissions estimates were combined into a draft area source chapter. This draft chapter was read through in its entirety by the unit manager and the three air quality planners for final review, with any identified errors corrected by the author of the section.

The draft version of the area source chapter was sent to the Arizona Department of Environmental Quality, the Arizona Department of Transportation, and the Maricopa Association of Governments for a quality assurance review. These agencies provided comments which were addressed and incorporated into the final area source chapter. Further quality analysis was performed by inputting the emission estimates into EPA’s “QA/QC basic format and content checker”, prior to submitting the data to the 2008 NEI.

The QA/QC activities described here have produced high levels of confidence in the area source emissions estimates detailed in this chapter, and represent the best efforts of the inventory preparers.

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