

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, 2001) as well as permit and emissions data in the MCESD’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. MCESD 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.

AMS code	Area source description	Section
Fuel combustion:		
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
Industrial processes:		
2301000000	Chemical manufacturing	3.3.1
2302002000	Commercial cooking	3.3.2
n/a	State-permitted portable sources	3.3.3
2399000000	Industrial processes not elsewhere classified	3.3.4
Waste treatment and disposal:		
2601000000	On-site incineration	3.4.1
2610000000	Open burning	3.4.2
2620000000	Landfills	3.4.3
Miscellaneous area sources:		
2810001000	Wildfires and brush fires	3.5.1.1
2810030000	Structure fires	3.5.1.2
2810050000	Vehicle fires	3.5.1.3
2810040000	Engine testing	3.5.1.4
2601020000	Health services (crematories)	3.5.2
2830000000	Accidental releases	3.5.3

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, pesticide usage) or derived from state-wide data (e.g., fuel oil use).
- for some widespread or diverse categories (e.g., consumer solvent use), 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., bakeries), these data were combined with employment data to “scale up” reported emissions to reflect the entire source category.

- for those source categories with detailed emissions data available from most or all significant sources in the category, emissions were calculated based on detailed process and operational data provided by these sources.

The specific emissions estimation methodologies used for each source category (including any 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 four natural gas suppliers in Maricopa County. The following table summarizes the natural gas sales data received from Maricopa County natural gas suppliers.

Table 3.2–1. Natural gas sales data from Maricopa County natural gas suppliers.

Natural gas supplier	Sales by end user category (in MMCF/yr)					
	Electric Utilities	Industrial	Commercial/Institutional	Residential	Transport*	Other*
Southwest Gas	n/a	3,092.760	13,774.986	14,842.508	3,802.155	1,977.644
City of Mesa	80.169	386.692	1,486.877	1,112.936	59.924	n/a
El Paso	58,334.169	161.429	n/a	n/a	n/a	n/a
Black Mountain	n/a	n/a	142.561	464.084	n/a	n/a

* For emissions calculations, sales from these two categories 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 2002. 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:

$$\begin{aligned}
 \text{Area source industrial} &= \text{Reported industrial} & - & \text{Industrial point source} \\
 \text{natural gas usage} & \text{ natural gas sales} & & \text{natural gas usage} \\
 & = 9,480.60 \text{ MMCF} & - & 7,929.38 \text{ MMCF} \\
 & = 1,551.23 \text{ MMCF}
 \end{aligned}$$

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 industrial area sources in 2002.

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

$$\begin{aligned}
 \text{Annual CO emissions from external natural gas combustion} &= \text{External industrial natural gas usage (MMCF)} \times \text{CO emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lb/ton} \\
 &= 1,527.09 \times 84 \div 2,000 \\
 &= 64.14 \text{ tons CO/yr}
 \end{aligned}$$

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

Combustion type	% of total	Annual natural gas usage (MMCF)	CO emission factor (lbs/MMCF)	Annual emissions (tons/yr)
External	98.44	1,527.09	84	64.14
Internal	1.56	24.14	399	4.82
Totals:	100.00	1,551.23		68.95

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of industrial natural gas sold used during the CO season. (Figures reported by natural gas suppliers for the December–February time period are assumed to be representative for the November–January CO season.) CO season emission totals are then divided by the number of days that activity occurs during the CO season:

$$\begin{aligned}
 \text{Season-day CO emissions from industrial natural gas} &= \text{Annual CO emissions (tons/yr)} \times \text{\% natural gas sold during CO season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 68.95 \times 28.59 \% \div (6 \times 13) \times 2,000 \\
 &= 505.5 \text{ lbs/day}
 \end{aligned}$$

Annual and season-day emissions within the CO nonattainment area are 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).

$$\begin{aligned}
 \text{Emissions from area source industrial natural gas combustion in the CO NAA} &= \text{Annual county CO emissions (tons/yr)} \times \text{Industrial employment ratio} \\
 &= 68.95 \times 0.9809 \\
 &= 67.64 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.2–3. Annual and season-day emissions from area-source industrial natural gas combustion.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	68.95	505.5
CO NAA	67.64	495.9

3.2.2 Industrial fuel oil

Area source emissions from industrial fuel oil combustion are calculated by a multi-step process which allocates Arizona state-level industrial fuel oil sales data from the US Department of Energy, Energy Information Administration (US DOE, 2002b) to Maricopa County.

To derive industrial fuel oil usage in Maricopa County, reported Arizona sales of high-sulfur diesel for 2002 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.

$$\begin{aligned}
 \text{State industrial fuel oil sales} &= \text{Reported state total} & - & \text{Reported state high-sulfur diesel sales} \\
 \text{other than high-sulfur diesel} & \text{ industrial fuel oil sales} & & \\
 \text{(in thousand gallons, or Mgal)} & = 61,748 \text{ Mgal} & - & 34,076 \text{ Mgal} \\
 & = 27,672 \text{ Mgal/yr} & &
 \end{aligned}$$

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 (0.71), as determined from data from the US Census (2003a) to estimate annual Maricopa County industrial fuel oil sales, as follows:

$$\begin{aligned}
 \text{Maricopa County} &= \text{Arizona industrial fuel oil} & \times & \text{Maricopa County:state} \\
 \text{industrial fuel oil sales} & \text{ sales less high-sulfur diesel} & \text{ industrial employment ratio} & \\
 & = 27,672 \text{ Mgal} & \times & 0.71 \\
 & = 19,647.12 \text{ Mgal/yr} & &
 \end{aligned}$$

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, as follows:

$$\begin{aligned}
 \text{Maricopa County industrial} &= \text{Maricopa County} & - & \text{Fuel oil used by industrial} & - & \text{Fuel oil used by industrial} \\
 \text{area source fuel oil sales} & \text{ industrial fuel oil sales} & \text{ nonroad mobile equipment} & \text{ stationary point sources} & & \\
 & = 19,647.12 \text{ Mgal} & - & 7,365.927 \text{ Mgal} & - & 2,021.10 \text{ Mgal} \\
 & = 10,260.097 \text{ Mgal/yr} & & & &
 \end{aligned}$$

Industrial fuel oil is used for both external combustion (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 by MCESD in 2002 (shown in Table 3.2–4 below).

County-level annual emissions from this area source category 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 CO emissions from external industrial fuel oil combustion:

$$\begin{aligned}
 \text{Annual CO emissions} &= \text{External industrial fuel} & \times & \text{CO emission factor for external} & \div & 2,000 \text{ lb/ton} \\
 \text{from external industrial} & \text{ oil sales (Mgal)} & \text{ fuel oil combustion (lb/Mgal)} & & & \\
 \text{fuel oil combustion} & & & & & \\
 & = 8,003.949 & \times & 5 & \div & 2,000 \\
 & = 20.01 \text{ tons CO/yr} & & & &
 \end{aligned}$$

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

Combustion type	% of total	Annual fuel oil sales (Mgals)	CO emission factor (lbs/Mgals)	Annual emissions (tons/yr)
External	78.01	8,003.949	5	20.01
Internal	21.99	2,256.147	130	146.65
Totals:	100.00	10,260.097		166.66

Season-day emissions for the county are calculated by first multiplying annual emissions by 25% to estimate CO season emission totals. CO season emission totals are then divided by the number of days that activity occurs during the CO season, as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{CO season-day emissions from industrial fuel oil} &= \text{Annual CO emissions (tons/yr)} \times \% \text{ fuel oil sold during CO season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 166.66 \times 25 \% \div (6 \times 13) \times 2,000 \\
 &= 1,068.3 \text{ lbs/day}
 \end{aligned}$$

Annual and season-day emissions in the CO nonattainment area are 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).

$$\begin{aligned}
 \text{CO NAA emissions from area source industrial fuel oil combustion} &= \text{Annual county CO emissions (tons/yr)} \times \text{NAA:County industrial employment ratio} \\
 &= 166.66 \text{ tons/yr} \times 0.9809 \\
 &= 163.48 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.2–5. Annual and season-day emissions from area-source industrial fuel oil combustion.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	166.66	1,068.3
CO NAA	163.48	1,047.9

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 2002. 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:

$$\begin{aligned}
 \text{County area source C\&I natural gas usage} &= \text{Reported C\&I natural gas sales} - \text{C\&I point source natural gas usage} \\
 &= 15,404.42 \text{ MMCF} - 725.35 \text{ MMCF} \\
 &= 14,679.07 \text{ MMCF}
 \end{aligned}$$

Natural gas is used for both external combustions (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 2002.

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

$$\begin{aligned}
 \text{Annual CO emissions from external natural gas combustion} &= \text{External C\&I natural gas usage (MMCF)} \times \text{CO emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lb/ton} \\
 &= 14,434.79 \times 84 \div 2,000 \\
 &= 606.26 \text{ tons CO/yr}
 \end{aligned}$$

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

Combustion type	% of total	Annual natural gas usage (MMCF)	CO emission factor (lbs/MMCF)	Annual emissions (tons/yr)
External	98.34	14,434.79	84	606.26
Internal	1.66	244.29	399	48.74
Totals:	100.00	14,679.07		655.00

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of C&I natural gas sold used during the CO season. (Figures reported by natural gas suppliers for the December–February time period are assumed to be representative for the November–January CO season.) CO season emission totals are then divided by the number of days that activity occurs during the CO season:

$$\begin{aligned}
 \text{Season-day CO emissions from C\&I natural gas} &= \text{Annual CO emissions (tons/yr)} \times \text{\% natural gas sold during CO season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 655.00 \times 33.31 \% \div (6 \times 13) \times 2000 \\
 &= 5,594.0 \text{ lbs/day}
 \end{aligned}$$

Annual and season-day emissions in the CO nonattainment area are 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).

$$\begin{aligned}
 \text{Emissions from area source C\&I natural gas combustion in the CO NAA} &= \text{Annual county CO emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
 &= 655.00 \times 0.9829 \\
 &= 643.80 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.2–7. Annual and season-day emissions from area-source commercial/institutional natural gas combustion.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	655.00	5,594.0
CO NAA	643.80	5,498.4

3.2.4 Commercial/institutional fuel oil

Area source emissions from commercial and institutional (C&I) fuel oil combustion are calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the US Department of Energy, Energy Information Administration (US DOE, 2002a) to Maricopa County.

To derive commercial/institutional fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2002 are first subtracted from Arizona state-level total commercial/institutional 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.

$$\begin{aligned}
 \text{State C\&I fuel oil sales} &= \text{Reported state total} & - & \text{Reported state high-sulfur diesel sales} \\
 \text{other than high-sulfur diesel} & \text{C\&I fuel oil sales} & & \\
 \text{(in thousand gallons, or Mgal)} & = 30,077 \text{ Mgal} & - & 71 \text{ Mgal} \\
 & = 30,006 \text{ Mgal/yr} & &
 \end{aligned}$$

Arizona state commercial/institutional fuel oil sales less high-sulfur diesel are then multiplied by the ratio of C&I employment in Maricopa County to Arizona state (0.71), as determined by data from the US Census (2003a), to estimate Maricopa County-level C&I fuel oil sales, as follows:

$$\begin{aligned}
 \text{Maricopa County} &= \text{Arizona C\&I fuel oil} & \times & \text{Maricopa County:state} \\
 \text{C\&I fuel oil sales} & \text{sales less high-sulfur diesel} & \text{C\&I employment ratio} & \\
 & = 30,006 \text{ Mgal} & \times & 0.71 \\
 & = 21,304.26 \text{ Mgal/yr} & &
 \end{aligned}$$

To avoid double-counting, commercial/institutional 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 C&I area sources, as follows:

$$\begin{aligned}
 \text{Maricopa County C\&I} &= \text{Maricopa County} & - & \text{Fuel oil used by C\&I} & - & \text{Fuel oil used by C\&I} \\
 \text{area source fuel oil sales} & \text{C\&I fuel oil sales} & \text{nonroad mobile equipment} & \text{stationary point sources} & & \\
 & = 21,304.26 \text{ Mgal} & - & 4,435.974 \text{ Mgal} & - & 190.672 \text{ Mgal} \\
 & = 16,677.614 \text{ Mgal/yr} & & & &
 \end{aligned}$$

Fuel oil is used for both external combustion (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/institutional area sources surveyed by MCESD in 2002 (shown in Table 3.2–8 below).

Annual emissions for the county are calculated by multiplying C&I fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for CO emissions from external C&I fuel oil combustion:

$$\begin{aligned}
 \text{Annual CO emissions from external C\&I fuel oil combustion} &= \text{External C\&I oil sales (Mgal)} \times \text{CO emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lb/ton} \\
 &= 11,165.542 \times 5 \div 2,000 \\
 &= 27.91 \text{ tons CO/yr}
 \end{aligned}$$

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

Combustion type	% of total	Annual fuel oil sales (Mgals)	CO emission factor (lbs/Mgals)	Annual emissions (tons/yr)
External	66.95	11,165.542	5	27.91
Internal	33.05	5,512.072	130	358.28
Totals:	100.00	16,677.614		386.20

Season-day emissions for the county are calculated by first multiplying annual emissions by 35% to estimate CO season emission totals. CO season emission totals are then divided by the number of days that activity occurs during the CO season as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{CO season-day emissions from C\&I fuel oil use} &= \text{Annual CO emissions (tons/yr)} \times \text{\% fuel oil sold during CO season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 386.20 \times 35\% \div (6 \times 13) \times 2,000 \\
 &= 3,465.9 \text{ lbs/day}
 \end{aligned}$$

Annual and season-day emissions within the CO nonattainment area are 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).

$$\begin{aligned}
 \text{CO NAA emissions from area source C\&I fuel oil combustion} &= \text{Annual county CO emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
 &= 386.20 \times 0.9829 \\
 &= 379.59 \text{ tons CO/yr}
 \end{aligned}$$

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

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	386.20	3,465.9
CO NAA	379.59	3,406.6

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 listed in AP-42 Tables 1.4-1 and 1.4-2 (US EPA, 1998), as follows:

$$\begin{aligned}
 \text{Annual emissions from residential natural gas combustion} &= \text{Residential natural gas annual sales (MMCF)} \times \text{Residential natural gas emission factor for CO (lbs/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 16,419.53 \times 40 \div 2,000 \text{ lbs/ton} \\
 &= 328.39 \text{ tons CO/yr}
 \end{aligned}$$

CO season-day emissions are calculated by first multiplying reported natural gas usage during the CO season (5,989.84 MMCF) by the emission factor for CO for residential natural gas combustion to produce CO season emissions (natural gas usage reported for the months of December-February are assumed to represent CO season usage). CO season emissions are then divided by the number of days during the CO season that residential natural gas combustion occurs (US EPA, 2001a).

$$\begin{aligned}
 \text{Season-day emissions from residential natural gas combustion} &= \text{Residential natural gas seasonal sales (MMCF)} \times \text{Residential natural gas emission factor for CO (lbs/MMCF)} \div (\text{days/week} \times \text{weeks/season}) \\
 &= 5,989.84 \times 40 \div (7 \times 13) \\
 &= 2,632.9 \text{ lbs CO/day}
 \end{aligned}$$

Annual and season-day residential natural gas emissions in the CO nonattainment area are calculated by multiplying county-level emissions by the percentage of total occupied households (98.18%) in the CO nonattainment area as follows:

$$\begin{aligned}
 \text{Annual emissions from residential natural gas combustion in the NAA} &= \text{County annual emissions} \times \text{Percentage of occupied households in the NAA} \\
 &= 328.39 \text{ tons/yr} \times 98.18\% \\
 &= 322.41 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.2–10. Annual and season-day emissions from residential natural gas combustion.

Geographic area	Annual emissions (tons/year)	CO season-day emissions (lbs/day)
Maricopa County	328.39	2,632.9
CO NAA	322.41	2,585.0

3.2.6 Residential wood combustion

Area source emissions from residential wood combustion are 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 (2003) by the ratio of county to state households that report use of wood for heating from the US Census Bureau (2003c). The latest available data on residential wood use for household heating from the US Census Bureau is for the calendar year 2000. 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 2000 data is assumed to be representative of 2002 emissions.

$$\begin{aligned}
 \text{Maricopa County residential wood usage (cords/yr)} &= \text{Arizona residential wood usage (cords/yr)} \times \text{Ratio of county:state households using wood for heat} \\
 &= 491,000 \times 1,655 / 39,842 \\
 &= 20,396 \text{ cords/yr}
 \end{aligned}$$

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).

$$\begin{aligned}
 \text{County residential wood usage (tons/yr)} &= \text{County wood usage (cords)} \times \text{avg. ft}^3 \text{ wood/cord} \times \text{Wood density (lbs/ft}^3) \div 2,000 \text{ lbs/ton} \\
 &= 20,396 \times 79 \times 31.57 \div 2,000 \\
 &= 25,433.73 \text{ tons}
 \end{aligned}$$

Annual emissions from residential wood combustion are calculated by multiplying the tons of wood used by the CO emission factor for residential total woodstoves and fireplaces from EIIP Volume III, Chap. 2, Table 2.4-1 (US EPA, 2001b):

$$\begin{aligned}
 \text{Annual CO emissions from residential wood combustion (tons/yr)} &= \text{Residential wood usage (tons)} \times \text{CO emission factor (lbs/ton)} \div 2,000 \text{ lbs/ton} \\
 &= 25,433.73 \times 252.6 \div 2,000 \\
 &= 3,212.28 \text{ tons CO/yr}
 \end{aligned}$$

Following EIIP guidance, season-day CO emissions are 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 State University (2003) indicated that there were a total of 776 heating degree days in Phoenix during 2002, with 586 heating degrees days reported during the CO season. By applying the ratio of CO season heating degree days to annual heating degree days, CO season-day emissions are calculated as follows:

$$\begin{aligned}
 \text{Season-day CO emissions from residential wood combustion (lbs/day)} &= \text{Annual emissions (tons/yr)} \times \text{Heating degree days (ratio)} \times 2,000 \text{ lbs/ton} \div \text{CO season-days/yr} \\
 &= 3,212.28 \times (586 / 776) \times 2,000 \div 91 \\
 &= 53,313.6 \text{ lbs/day}
 \end{aligned}$$

Annual and season-day emissions within the CO nonattainment area (NAA) are calculated by multiplying county totals by the ratio of total occupied housing units inside the nonattainment area (1,337,099) to total residential housing units in the county (1,361,837). See Section 1.5.1 for a further discussion of the housing data used.

$$\begin{aligned}
 \text{NAA annual emissions from residential wood combustion (tons/yr)} &= \text{County annual emissions (tons/yr)} \times \text{NAA:county residential housing ratio} \\
 &= 3,212.28 \times 0.9818 \\
 &= 3,153.82 \text{ tons/yr}
 \end{aligned}$$

Table 3.2–11. Annual and season-day emissions from residential wood combustion.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	3,212.28	53,313.6
CO NAA	3,153.82	52,343.3

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 using the ratio of county to state households that report fuel oil use from the US Census Bureau (2003b):

$$\begin{aligned}
 \text{Maricopa County residential fuel oil usage (Mgal/yr)} &= \text{Arizona residential fuel oil use (Mgal/yr)} \times \text{Ratio of county:state households reporting fuel oil use} \\
 &= 340 \times 490 / 1,813 \\
 &= 91.89 \text{ Mgal/yr}
 \end{aligned}$$

An AP-42 emission factor of 5 lbs CO/Mgal, and data on heating degree days and residential housing units described in Section 3.2.6, were used to calculate annual and daily CO emissions shown in Table 3.2–12.

Table 3.2–12. Annual and season-day emissions from residential fuel oil combustion.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	0.23	3.8
CO NAA	0.23	3.7

3.2.8 Summary of all area-source fuel combustion

Table 3.2–13. Summary of annual and season-day area source fuel combustion.

Source category	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Industrial natural gas	68.95	505.5	67.64	495.9
Industrial fuel oil	166.66	1,068.3	163.48	1,047.9
Commercial/institutional natural gas	655.00	5,594.0	643.80	5,498.4
Commercial/institutional fuel oil	386.20	3,465.9	379.59	3,406.6
Residential natural gas	328.39	2,632.9	322.41	2,585.0
Residential wood	3,212.28	53,313.6	3,153.82	52,343.3
Residential fuel oil	0.23	3.8	0.23	3.7
Totals:	4,817.71	66,584.1	4,730.96	65,380.8

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 (2003b) 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’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. 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	Value used
32551	Paint & coating manufacturing	100–249	175
32591	Printing ink manufacturing	20–99	60
422910	Farm supplies, wholesale	298	298
325991	Custom compounding of purchased resin	100–249	175
325998	All other misc. chemical product & prep. manufacturing	316	316
325188	All other basic inorganic chemical manufacturing	100–249	175
325412	Pharmaceutical manufacturing	500–999	750
Total:			1,949

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:

$$\begin{aligned}
 \text{Total area-source employment in chemical mfg.} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 1,949 - 191 \\
 &= 1,758 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source CO emissions from chemical mfg.} &= \frac{0.03 \text{ tons/yr}}{744 \text{ employees}} \times 1,758 \text{ employees} \\
 &= 0.07 \text{ tons CO/yr}
 \end{aligned}$$

CO season-day emissions are calculated based on the operating schedule data reported by chemical manufacturing facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day CO emissions from chemical mfg.} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{0.07 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 0.5 \text{ lbs CO/day}
 \end{aligned}$$

Annual and season-day emissions for the CO 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.)

$$\begin{aligned}
 \text{CO emissions from area-source chemical mfg. in the CO NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 0.07 \text{ tons/yr} \times 98.09\% \\
 &= 0.07 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.3–2 summarizes annual and season-day emissions from chemical manufacturing in both Maricopa County and the CO nonattainment area.

Table 3.3–2. Annual and season-day emissions from area-source chemical manufacturing.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	0.07	0.5
CO NAA	0.07	0.5

3.3.2 Commercial cooking

Emissions from commercial cooking were estimated for five source categories based on equipment type. These equipment types include: chain-driven (conveyorized) charbroilers (SCC 2302002100), under-fired charbroilers (2302002200), flat griddles (2302003100), clamshell griddles (2302003200), and deep-fat fryers (2302003000). Emission inventory methods outlined in EPA guidance (US EPA, 2004) for these source categories include emissions from all meat types (hamburger, steak, fish, pork, and chicken) and five restaurant types (ethnic, fast food, family, seafood, and steak & barbeque).

Data obtained from MCESD’s eating and drinking establishments permit database indicated that 9,038 restaurants operated in Maricopa County in 2002. The percent of restaurants in Maricopa County for the five restaurant types was obtained from a commercial business database (Harris InfoSource, 2003). The percent of restaurants for each restaurant type was multiplied by the total number of restaurants operated in Maricopa County in 2002 to derive the number of restaurants for each restaurant type as shown in Table 3.3–3.

Using the number of restaurants for each restaurant type, along with the default emission factors and equations from US EPA (2004), emissions for each combination of equipment type, restaurant type, and meat type were calculated, and the results were summed to estimate annual emissions for each type of cooking equipment, as shown in Table 3.3–4.

Table 3.3–3. Maricopa County restaurants, by type.

Restaurant category	Percentage	# of restaurants
Ethnic food	14.47	1,308
Fast food	15.35	329
Family	3.64	1,387
Seafood	0.61	55
Steak & barbecue	1.15	104
Unrelated restaurant types (e.g., lunchrooms, bars)	64.79	5,856
All restaurants:	100.00	9,038

Table 3.3–4. Annual emissions from commercial cooking, by equipment type.

Equipment type	Annual CO emissions (tons/yr)
Chain-driven charbroilers	60.75
Underfired charbroilers	196.43
Deep fat fryers	0.00
Flat griddles	16.32
Clamshell griddles	0.00
Total:	273.50

Commercial cooking is assumed to occur uniformly throughout the year, therefore, it was assumed that 25% of annual activity occurs during the CO season, and activity occurs 7 days/week.

Table 3.3–5. Season-day emissions from commercial cooking, by equipment type.

Equipment type	CO season-day emissions (lbs/day)
Chain-driven charbroilers	333.8
Underfired charbroilers	1,079.3
Deep fat fryers	0.0
Flat griddles	89.7
Clamshell griddles	0.0
Total:	1,502.8

Annual and season-day emissions for the CO nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage population within the nonattainment area (98.09%). (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–6 summarizes the annual and season-day emissions from commercial cooking for Maricopa County and the CO NAA.

Table 3.3–6. Annual and season-day emissions from commercial cooking.

Equipment type	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Chain-driven charbroilers	60.75	333.8	59.59	327.4
Underfired charbroilers	196.43	1,079.3	192.68	1,058.7
Deep fat fryers	0.00	0.0	0.00	0.0
Flat griddles	16.32	89.7	16.01	88.0
Clamshell griddles	0.00	0.0	0.00	0.0
Totals:	273.50	1,502.8	268.28	1,474.1

3.3.3 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. MCESD requested information from ADEQ for all ADEQ-permitted sources that reported any activity in Maricopa County during 2002. Annual total emissions for each pollutant were provided, along with information on the facility type, and information on the location of the site 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: Fisher Sand & Gravel - Arizona Crusher #1, ID 13464
 Permit type: Portable crushing/screening plant
 Operating schedule: Operated in Maricopa County 1/3/02 to 4/20/02, Gila County from 4/30/02 to 6/15/02 and 6/20/02 to 11/02/02, and in Greenlee County from 11/08/02 to 12/31/02
 Total annual emissions: 1.7592 tons CO/year

Using this information, calculations were made to determine:

Total operating days in 2002: 345 = 29 (Jan.) + 28 (Feb.) + ... + 31 (Dec.)
 Total operating days in Maricopa County: 108 = 29 (Jan.) + 28 (Feb.) + 31 (Mar.) + 20 (April)
 Any operating days in Maricopa County during CO season? (December–February): yes

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

$$\begin{aligned} \text{Annual CO emissions in Maricopa County (tons/yr)} &= \text{Total annual emissions} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2002}} \\ &= 1.7592 \times \frac{108}{345} \\ &= 0.55 \text{ tons CO/yr} \end{aligned}$$

If the facility had any operations in Maricopa County during the December–February CO season, season-day emissions (lbs/day) were calculated as follows:

$$\begin{aligned} \text{Season-day emissions (lbs/day)} &= \frac{\text{total emissions attributable to activity in Maricopa County}}{\text{number of operating days in Maricopa County}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{0.55 \text{ tons}}{108 \text{ days}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= 10.2 \text{ lbs CO/day} \end{aligned}$$

Table 3.3–7 summarizes the annual and season-day emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2002. Since no precise location data was available, all emissions are conservatively assumed to have originated within the CO nonattainment area, therefore emissions in Maricopa County and the CO nonattainment area are equal.

Table 3.3–7. Emissions from ADEQ-permitted portable sources, by permit type.

Permit type	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Asphalt batch	25.34	173.8
Concrete batch	7.25	15.8
Crushing/screening	105.56	696.5
Other	0.28	1.5
Totals:	138.43	887.6

3.3.4 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes not elsewhere classified (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. CO season-day emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report. All facilities that reported area-source emissions from other industrial processes are located inside the CO nonattainment area, therefore emissions for Maricopa County and the CO NAA are equal.

Table 3.3–8. Annual and season-day emissions from other industrial processes.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	0.98	7.5
CO NAA	0.98	7.5

3.3.5 Summary of all area-source industrial processes

Table 3.3–9 provides a summary of annual and season-day emissions from all industrial processes.

Table 3.3–9. Summary of annual and season-day area source industrial processes.

Source category	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Chemical manufacturing	0.07	0.5	0.07	0.5
Commercial cooking	273.50	1,502.8	268.28	1,474.1
State-permitted portable sources	138.43	887.6	138.43	887.6
Industrial processes NEC	0.98	7.5	0.96	7.5
Totals:	412.98	2,398.4	407.74	2,369.6

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 3.5.2. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2002.

Emissions from on-site incineration were determined from annual emission inventory reports. Of the four incinerators under permit in 2002, two were surveyed and reported annual emissions. As all four facilities are roughly similar in terms of capacity, these survey results were doubled to estimate total annual and season-day emissions from all four incinerators in Maricopa County. All four facilities are located within the CO nonattainment area, thus total emissions for the county and NAA are equal.

Table 3.4-1. Annual and season-day emissions from on-site incineration.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	0.59	4.5
CO NAA	0.59	4.5

3.4.2 Open burning

Emissions from controlled open burning are regulated by MCESD Rule 314, which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fencerow 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 2002. A total of 140 permits were issued during the year; however, not all permit applications contained the information needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained 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:

$$\begin{aligned} \text{Total ditch -} & \\ \text{bank/fencerows} & = 973,885 \text{ linear ft} \times \frac{85 \text{ ditchbank/fencerow burn permits issued}}{29 \text{ permits with quantitative data}} = 2,854,491 \text{ linear ft} \end{aligned}$$

Reported and estimated activity data for each open burning category are summarized in Table 3.4-2. Permits issued for fire fighting training are addressed in Section 3.5.1.2, Structure fires.

Table 3.4–2. 2002 Maricopa County burn permit activity data.

Category	Unit of measure	Total reported activity	Number of permits with activity data	Total permits issued	Activity grown to total number of permits issued
Ditchbank/fencerow	Linear ft	973,885	29	85	2,854,491
Land clearance	Acres	1,345	17	34	2,690
Land clearance	Piles	69	8	34	293
Air curtain	Trees	200	1	2	400
Tumbleweeds	Piles	9	3	8	24

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.

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

Category	CO emission factor (lb/ton burned)	Fuel loading factors
Weeds, unspecified	85	3.2 tons/acre
Russian Thistle (tumbleweeds)	309	0.1 tons/acre
Orchard Crops: Citrus	81	1.0 tons/acre

The following assumptions were made based on previous MCESD emission inventory work:

- 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.
- The estimated weight of a mature, partially dried citrus tree, including trunk, limbs and bulk of root is 500 lbs per tree (MCESD, 1993).

To calculate the annual amount of material burned on ditch banks and fence rows in Maricopa County, MCESD 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:

$$\begin{aligned}
 &\text{Material burned} \\
 &\text{for ditch bank and} \\
 &\text{fence row burning} \\
 &= \frac{2,854,491 \text{ ft length} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/year}}{43,560 \text{ ft}^2 / \text{acre}} \\
 &= 2,936 \text{ tons material burned/yr}
 \end{aligned}$$

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

Annual emissions were then calculated by multiplying the amount of material burned by emission factors listed in AP-42 (Table 3.4–3). To account for unpermitted illegal outdoor burning, the county's Air Quality Complaint data base was examined, which indicated 65 illegal outdoor open burning complaints (mostly residential) and 6 issued Notices of Violation. All calculated emissions estimates were thus increased by 10 percent, as a conservative estimate.

$$\begin{aligned}
 \text{Annual CO emissions from ditchbank and fence row burning} &= \text{Total material burned} \times \text{emission factor} \times \text{unit conversion factor} \\
 &= 2,936 \text{ tons} \times 85 \text{ lbs/ton} \times 1 \text{ ton} / 2,000 \text{ lbs} \\
 &= 124.78 \text{ tons CO/yr}
 \end{aligned}$$

$$\begin{aligned}
 \text{Total annual CO emissions including unpermitted burning} &= \text{Calculated emissions from permit data} + \text{unpermitted burning adjustment factor} \\
 &= 124.78 \text{ tons/yr} + (10\% \times 124.78) \\
 &= 137.25 \text{ tons CO/yr}
 \end{aligned}$$

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

Table 3.4–4. Annual emissions from open burning (tons/yr).

Category	CO emissions	
	Ton-equivalents	(tons/yr)
Ditchbank/fencerow	2,935.7	137.25
Land clearance	9,545.5	446.25
Air curtain	100.0	4.46
Tumbleweeds	2.4	0.41
Total:		588.36

Annual emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the CO nonattainment area by the Maricopa County emission totals. (See Section 1.5.2 for a discussion of the land-use data used.) Table 3.4–5 summarizes the annual emissions for the CO nonattainment area.

Table 3.4–5. Surrogate land-use classes, ratios and annual emissions from open burning in the CO NAA.

Category	Surrogate land-use category	2000 NAA:county	
		land-use ratio	Emissions (tons/yr)
Ditchbank/fencerow	Agriculture	44.53 %	61.12
Land clearance	Vacant	15.62 %	69.70
Air curtain	agriculture and vacant	19.53 %	0.87
Tumbleweeds	agriculture and vacant	19.53 %	0.08
Total:			131.77

Ditch bank/fence row burning is not allowed from November to February, therefore daily emissions during the CO season are zero. For the other burning categories, 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) and open burning occurs evenly during the CO season months (November – December). A seasonal adjustment factor was derived as follows:

$$\text{Seasonal adjustment factor} = \frac{\text{\# of permits issued Nov. – Dec. for the category}}{\text{total \# of permits issued in 2002 for the category}}$$

Example:

$$\begin{aligned}
 \text{Seasonal adjustment factor for tumbleweed burning} &= \frac{3 \text{ permits issued during Nov. – Dec. for tumbleweed burning}}{8 \text{ total permits issued in 2002 for tumbleweed burning}} \\
 &= 37.50 \%
 \end{aligned}$$

CO season-day emissions for Maricopa County are derived using the following formula:

$$\begin{aligned}
 \text{CO season-day emissions from tumbleweed burning} &= \frac{(\text{annual CO emissions lbs}) \times (\text{seasonal adjustment factor})}{(\text{\# of burn days/week}) \times (\text{\# of season weeks/year})} \\
 &= \frac{820 \text{ lbs} \times 0.3750}{5 \text{ days/wk} \times 13 \text{ wks/yr}} \\
 &= 4.73 \text{ lbs CO/day}
 \end{aligned}$$

CO season-day emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the nonattainment area (listed in Table 3.4–5) by the total County season-day emissions. Table 3.4–6 summarizes the CO season-day emissions from open burning for both Maricopa County and the CO nonattainment area.

Table 3.4–6. Season-day emissions (lbs/day) from open burning.

Category	Maricopa County (lbs/day)	CO nonattainment area (lbs/day)
Ditchbank/fencerow	0.0	0.0
Land clearance	3,634.6	567.7
Air curtain	0.0	0.0
Tumbleweeds	4.7	0.9
Totals:	3,639.3	568.6

3.4.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as combustion from control measures, such as flares. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county. Two MSW landfills (Butterfield Station and Allied Waste Industries Southwest Regional Facility) are considered point sources and are reported in Chapter 2. All other MSW landfills are reported here as area source landfills.

Since there are no area-source landfills located outside the CO nonattainment area, total emission values for the county and the CO nonattainment area are equal. Season-day emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on a 7 day week. Emissions within the CO nonattainment area were identified using information on the location of each permitted facility. Annual and daily emissions are shown in Table 3.4–7.

Table 3.4–7. Annual and season-day emissions from landfills.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	27.35	150.3
CO NAA	27.35	150.3

3.4.4 Summary of all area-source waste treatment and disposal

Table 3.4–8. Summary of annual and season-day emissions from waste treatment and disposal.

Source category	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
On-site incineration	0.59	4.5	0.59	4.5
Open burning	588.36	3,639.3	131.77	568.6
Landfills	27.35	150.3	27.35	150.3
Totals:	616.30	3,794.2	159.71	723.5

3.5 Miscellaneous area sources

3.5.1 Other combustion

3.5.1.1 Wildfires and brush fires

The Arizona Department of Environmental Quality, in cooperation with the United States Forest Service, reported that one wildfire burned 1000 acres in the Tonto National Forest in July 2002. The wildfire occurred within Maricopa County but outside of the nonattainment area. ADEQ also reported that negligible prescribed fires occurred in Maricopa County in 2002.

In addition, 2002 survey results from Maricopa County fire departments, the Bureau of Land Management, and the Arizona State Land Department were used to calculate emissions from brush fires. In some cases, the survey results included limited information on the average size of fires. Thus, when acreage data was incomplete or unclear, each reported brush fire was assumed to be equal to 0.1 acres. Survey results are included in Appendix 3.1. It was estimated that 7,054 brush fires occurred in Maricopa County in 2002 and burned approximately 1,656.5 acres.

Wildfire emission factors and fuel loading factors were obtained from the Western Regional Air Partnership’s (WRAP) 1996 Fire Emission Inventory (WGA/WRAP, 2002), while brush fire emission factor and fuel loading factors were obtained from AP-42 (US EPA, 1992). Both are listed in Table 3.5–1. Estimates of the material burned in are derived by multiplying the number of acres burned by the appropriate fuel loading factor. For wildfires, a “combustive efficiency” factor of 90% is included in the calculation to reflect the fact that not all available material (fuel) is consumed in a wildfire (WGA/WRAP, 2002).

Table 3.5–1. Emission and fuel loading factors for wildfires and brush fires.

Type of fire	Fires reported	Number of acres burned	Fuel loading factor (tons/acre)	CO emission factor (lbs/ton burned)
Wildfire (Calif. chaparral)	1	1,000	19.5	289
Brush fire (weeds)	7,054	1656.5	3.2	85

Annual emissions from wildfires in Maricopa County were calculated as follows:

$$\begin{aligned}
 \text{Annual CO emissions from wildfires in Maricopa County} &= \frac{\text{acres burned} \times \text{fuel loading factor} \times \text{combustive efficiency} \times \text{emission factor (lbs/ton)}}{2,000 \text{ lbs/ton}} \\
 &= \frac{1,000 \text{ acres burned} \times 19.5 \text{ tons/acre} \times 90\% \times 289 \text{ lbs/ton}}{2,000 \text{ lbs/ton}} \\
 &= 2,535.98 \text{ tons CO/yr}
 \end{aligned}$$

Because the 1,000-acre wildfire occurred in the Tonto National Forest, which is located outside of the nonattainment area, emissions from wildfires within the nonattainment area were determined to be zero. However, annual emissions from brush fires for the nonattainment area were calculated by multiplying the Maricopa County annual emissions by the percentage of vacant land located in the CO nonattainment area (15.62%), as shown in Table 3.5–2. (See Section 1.5.2 for a discussion of the land-use data used.)

$$\begin{aligned}
 \text{Annual CO emissions from brush fires within the CO NAA} &= \text{Annual CO emissions from brush fires, County total} \times \text{Percentage of vacant land within the NAA} \\
 &= 225.28 \text{ tons/yr} \times 15.62\% \\
 &= 35.19 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.5–2. Annual emissions from wildfires and brush fires (tons/yr).

Type of fire	Maricopa County	CO nonattainment area
Wildfire	2,535.98	0.00
Brush fire	225.28	35.19
Totals:	2,761.25	35.19

Because the 1,000-acre wildfire occurred in July 2002 and the CO season is November through January, it was presumed that no wildfires occurred during the CO season; therefore season-day emissions from wildfires were zero. It was assumed that brush fires occur evenly throughout the year. Thus, CO season-day emissions from brush fires were derived by dividing the annual emissions from brush fires for Maricopa County and the nonattainment area by a 365 days/yr, as follows:

$$\begin{aligned}
 \text{Season-day CO emissions from brush fires in Maricopa County} &= \frac{225.28 \text{ tons/yr}}{365 \text{ days/yr}} \times 2,000 \text{ lbs/ton} \\
 &= 1,234.41 \text{ lbs/day}
 \end{aligned}$$

Table 3.5–3. Season-day emissions from wildfires and brush fires (lbs/day).

Type of fire	Maricopa County	CO nonattainment area
Wildfire	0.0	0.0
Brush fire	1,234.4	192.8
Totals:	1,234.4	192.8

3.5.1.2 Structure fires

2002 structure fire data were obtained by surveying fire departments in Maricopa County and by querying Maricopa County's burn permit data base. The fire departments surveyed reported 3,597 structure fires in Maricopa County in 2002. The list of fire departments surveyed and survey results are contained in Appendix 3.1. Eleven open burn permits were issued in 2002 for fire training; these were included in the total number of estimated structure fires for 2002. It was estimated that 3,608 structure fires occurred in Maricopa County in 2002.

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 percent structural loss and content loss (US EPA, 2001c). Tons of material burned were estimated as the follows:

$$\begin{aligned} \text{Material burned in} &= 3,608 \text{ fires} \quad \times \quad 1.15 \text{ tons/fire} \\ \text{structure fires (tons/yr)} &= 4,149.2 \text{ tons material burned/year} \end{aligned}$$

Table 3.5–4. Estimated material burned, emission and fuel loading factors for structure fires.

Structure fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	CO emission factor (lbs/ton)
3,608	1.15	4,149.20	60

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.5–4 (US EPA, 2001c), as follows:

$$\begin{aligned} \text{Annual CO emissions} &= \text{Quantity of material burned} \times \text{emission factor} \times \text{unit conversion factor} \\ \text{from structure fires} & \\ \text{Maricopa County} &= 4,149.20 \text{ tons} \quad \times \quad 60 \text{ lbs/ton} \quad \times \quad (1 \text{ ton}/2,000 \text{ lbs.}) \\ &= 124.48 \text{ tons CO/yr} \end{aligned}$$

Annual emissions for the CO nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the CO nonattainment area (98.06%), as shown in the example below. See Section 1.5.1 for a discussion of the population data used.

$$\begin{aligned} \text{Annual CO emissions} &= \text{annual CO emissions} \quad \times \quad \text{percentage residential} \\ \text{within the CO NAA} & \quad \text{for Maricopa County} \quad \quad \quad \text{population within the NAA} \\ &= 124.48 \text{ tons/year} \quad \times \quad 98.06 \% \\ &= 122.06 \text{ tons CO/yr} \end{aligned}$$

It was assumed that structure fires occur 7 days a week; however, structure fires vary seasonally and may increase during cold weather. Because local season-specific data were not available from the fire department surveys, seasonal occurrences of residential and non-residential structure fires reported by the Federal Emergency Management Agency (FEMA) were used to derive a seasonal adjustment factor for the CO season (US EPA, 2001c). FEMA reported that 29.6% of residential structure fires and 24.5% of non-residential structural fires occurred during

November, December, and January 1994. Thus, an average occurrence of 27.05% [(29.6% + 24.5%) ÷ 2] was used as a seasonal adjustment factor to estimate CO season-day emissions.

CO season-day emission for Maricopa County were derived using the following formula:

$$\begin{aligned} \text{CO season-day emissions} &= \frac{\text{annual CO emissions (lbs)} \times \text{seasonal adjustment factor (\%)}}{7 \text{ days/wk} \times 13 \text{ weeks/yr}} \\ \text{from structure fires in} & \\ \text{Maricopa County} &= \frac{248,960 \text{ lbs} \times 27.05\%}{91} \\ &= 740.04 \text{ lbs CO/day} \end{aligned}$$

CO season-day emissions for the nonattainment area are calculated by multiplying the Maricopa County season-day emissions by the percentage of total residential population within the CO nonattainment area (98.06%). Results are shown in Table 3.5–5.

Table 3.5–5. Annual and season-day emissions from structure fires.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	124.48	740.0
CO NAA	122.06	725.7

3.5.1.3 Vehicle fires

2002 vehicle fire data were obtained by surveying fire departments in Maricopa County. The fire departments surveyed reported 5,316 vehicle fires (4 boat fires were included in vehicle fires) in Maricopa County in 2002. The list of fire departments surveyed and survey results are presented in Appendix 3.1.

Annual emissions from vehicle fires are 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. 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 3.5–6 (from US EPA, 1992).

$$\begin{aligned} \text{Annual CO emissions} &= \text{annual number} \times \text{fuel loading factor} \times \text{emission factor} \times \text{unit conversion factor} \\ \text{from vehicle fires} & \quad \text{of vehicle fires} \\ &= 5,316 \quad \times 0.25 \text{ tons/vehicle} \quad \times 125 \text{ lbs/ton} \quad \times (1 \text{ ton} / 2,000 \text{ lbs}) \\ &= 83.06 \text{ tons CO/yr} \end{aligned}$$

Table 3.5–6. Estimated material burned, emission and fuel loading factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	CO emission factor (lbs/ton)
5,316	0.25	1,329	125

Annual emissions for the CO nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the CO nonattainment area (98.06%). See Section 1.5.1 for a discussion of the population data used.

It was assumed that vehicle fires occur evenly throughout the year. Thus, CO season-day emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 365 days/year. The results are shown in Table 3.5–7 below.

Table 3.5–7. Annual and season-day emissions from vehicle fires.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	83.06	455.1
CO NAA	81.45	446.3

3.5.1.4 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. Season-day 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 CO non-attainment area, total emission values for the county and the CO NAA are equal. Results are shown in Table 3.5–8.

Table 3.5–8. Annual and season-day emissions from engine testing.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	3.67	99.9
CO NAA	3.67	99.9

3.5.2 Health services: crematories

Emissions from human and animal crematories 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 (2003a) 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 Census’ County Business Patterns (CBP), for 2001 employment, were used. CBP employment data for NAICS code 81222 (cemeteries and crematories) indicated 683 employees in this industry in Maricopa County. This employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Total area-source CO emissions from crematories} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 &= \frac{0.17 \text{ tons/yr}}{110} \times 683 \text{ employees} \\
 &= 1.06 \text{ tons CO/yr}
 \end{aligned}$$

Season-day emissions are calculated based on the operating schedule data reported by surveyed facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned} \text{Season-day CO emissions from crematories} &= \frac{\text{Annual emissions (tons/yr)} \times \text{seasonal \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{1.06 \times 25\%}{5 \times 13} \times 2,000 \\ &= 8.2 \text{ lbs CO/day} \end{aligned}$$

As all facilities addressed in this source category are located within the CO nonattainment area, emission totals for both areas are equal. Annual and daily emissions are shown in Table 3.5–9.

Table 3.5–9. Annual and season-day emissions from crematories.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	1.06	8.2
CO NAA	1.06	8.2

3.5.3 Accidental releases

As part of its air quality permit compliance program, MCESD 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 3.47 tons of CO for the year 2002. Season-day emissions of CO are assumed to be zero, as no recorded releases occurred during the CO season. Emissions in the CO nonattainment area are calculated based on locations of facilities that reported releases. In 2002, all recorded releases occurred outside the CO NAA.

Table 3.5–10. Annual and season-day emissions from accidental releases.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	3.47	0.0
CO NAA	0.00	0.0

3.5.4 Summary of all miscellaneous area sources

Table 3.5–11. Summary of annual and season-day emissions from all miscellaneous area sources.

Source category	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Wildfires and brushfires	2,761.25	1,234.4	35.19	192.8
Structure fires	124.48	740.0	122.06	725.7
Vehicle fires	83.06	455.1	81.45	446.3
Engine testing	3.67	99.9	3.67	99.9
Crematories	1.06	8.2	1.06	8.2
Accidental releases	3.47	0.0	0.00	0.0
Totals:	2,976.99	2,537.6	243.43	1,472.79

3.6 Summary of area source emissions

Table 3.6–1 summarizes the total annual and CO season-day emissions from all area sources addressed in this chapter for both Maricopa County and the CO nonattainment area.

Table 3.6–1. Summary of annual and season-day area source emissions, by source category.

Source category	Maricopa County		CO nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Fuel combustion:				
Industrial natural gas	68.95	505.5	67.64	495.9
Industrial fuel oil	166.66	1,068.3	163.48	1,047.9
Commercial/institutional natural gas	655.00	5,594.0	643.80	5,498.4
Commercial/institutional fuel oil	386.20	3,465.9	379.59	3,406.6
Residential natural gas	328.39	2,632.9	322.41	2,585.0
Residential wood	3,212.28	53,313.6	3,153.82	52,343.3
Residential fuel oil	0.23	3.8	0.23	3.7
Total, all fuel combustion:	4,817.71	66,584.1	4,730.96	65,380.8
Industrial processes:				
Chemical manufacturing	0.07	0.5	0.07	0.5
Commercial cooking	273.50	1,502.8	268.28	1,474.1
State-permitted portable sources	138.43	887.6	138.43	887.6
Industrial process NEC	0.98	7.5	0.96	7.4
Total, all industrial processes:	412.98	2,398.4	407.74	2,369.6
Waste treatment/disposal:				
On-site incineration	0.59	4.5	0.59	4.5
Open burning	588.36	3,639.3	131.77	568.6
Landfills	27.35	150.3	27.95	150.3
Total, all waste treatment/disposal:	616.30	3,794.2	159.71	723.5
Miscellaneous area sources:				
Wildfires and brush fires	2,761.25	1,234.4	35.19	192.8
Structure fires	124.48	740.0	122.06	725.7
Vehicle fires	83.06	455.1	81.45	446.3
Engine testing	3.67	99.9	3.67	99.9
Health Services: crematories	1.06	8.2	1.06	8.2
Accidental releases	3.47	0.0	0.00	0.0
Total, all misc. area sources:	2,976.99	2,537.6	243.43	1,472.8
Total, all area sources:	8,823.98	75,314.2	5,541.86	69,946.8

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 2002 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 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 2002 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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