

1. Introduction

1.1 Overview

This 2002 periodic ozone emissions inventory was developed to meet requirements set forth in Title I of the Clean Air Act Amendments of 1990 (CAAA). The CAAA requires development of a baseline emission inventory and periodic revisions for areas that fail to meet the National Ambient Air Quality Standards (NAAQS). A portion of Maricopa County is classified as serious nonattainment for the one-hour ozone standard.

This inventory includes emission estimates for three ozone precursors: volatile organic compounds (VOCs), carbon monoxide (CO) and nitrogen oxides (NO_x). VOC is defined by Maricopa County's Rule 100 as "any organic compound, which participates in atmospheric photochemical reactions, except the non-precursor organic compounds". The inventory provides emission estimates from point, area, nonroad mobile, onroad mobile, and biogenic sources. Note that totals shown in tables may not equal the sum of individual values due to independent rounding.

1.2 Agencies responsible for the emissions inventory

Maricopa County Environmental Services Department (MCESD) has primary responsibility for preparing and submitting the 2002 Periodic Ozone Emissions Inventory. MCESD prepared emission estimates for point, area, and certain nonroad mobile sources (locomotives and aircraft). The remaining nonroad mobile emission estimates were developed by ENVIRON Corp. (Environ *et al.*, 2003), with additional work conducted by MCESD to develop estimates for the nonattainment area and a typical season day. The Maricopa Association of Governments (MAG) prepared the onroad mobile and biogenic emissions estimates. Table 1.2–1 lists those responsible for inventory preparation and quality assurance/quality control activities, which are described in the respective chapters.

Table 1.2–1. Chapter authors and QA/QC contacts.

Chapter	Author(s)	QA/QC contact persons
Point Sources	Bob Downing MCESD (602) 506-6790	Matt Poppen, Eric Raisanen and Dena Konopka MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Area Sources	Matt Poppen, Eric Raisanen and Dena Konopka MCESD (602) 506-6790	Bob Downing MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Nonroad Mobile Sources	Matt Poppen and Eric Raisanen MCESD (602) 506-6790	Bob Downing and Dena Konopka MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Onroad Mobile Sources	Roger Roy MAG (602) 254-6300	Ruey-in Chiou MAG (602) 254-6300 Bob Downing and Dena Konopka MCESD (602) 506-6790
Biogenic Sources	Steve Ochs MAG (602) 254-6300	Ruey-in Chiou MAG (602) 254-6300 Bob Downing and Dena Konopka MCESD (602) 506-6790

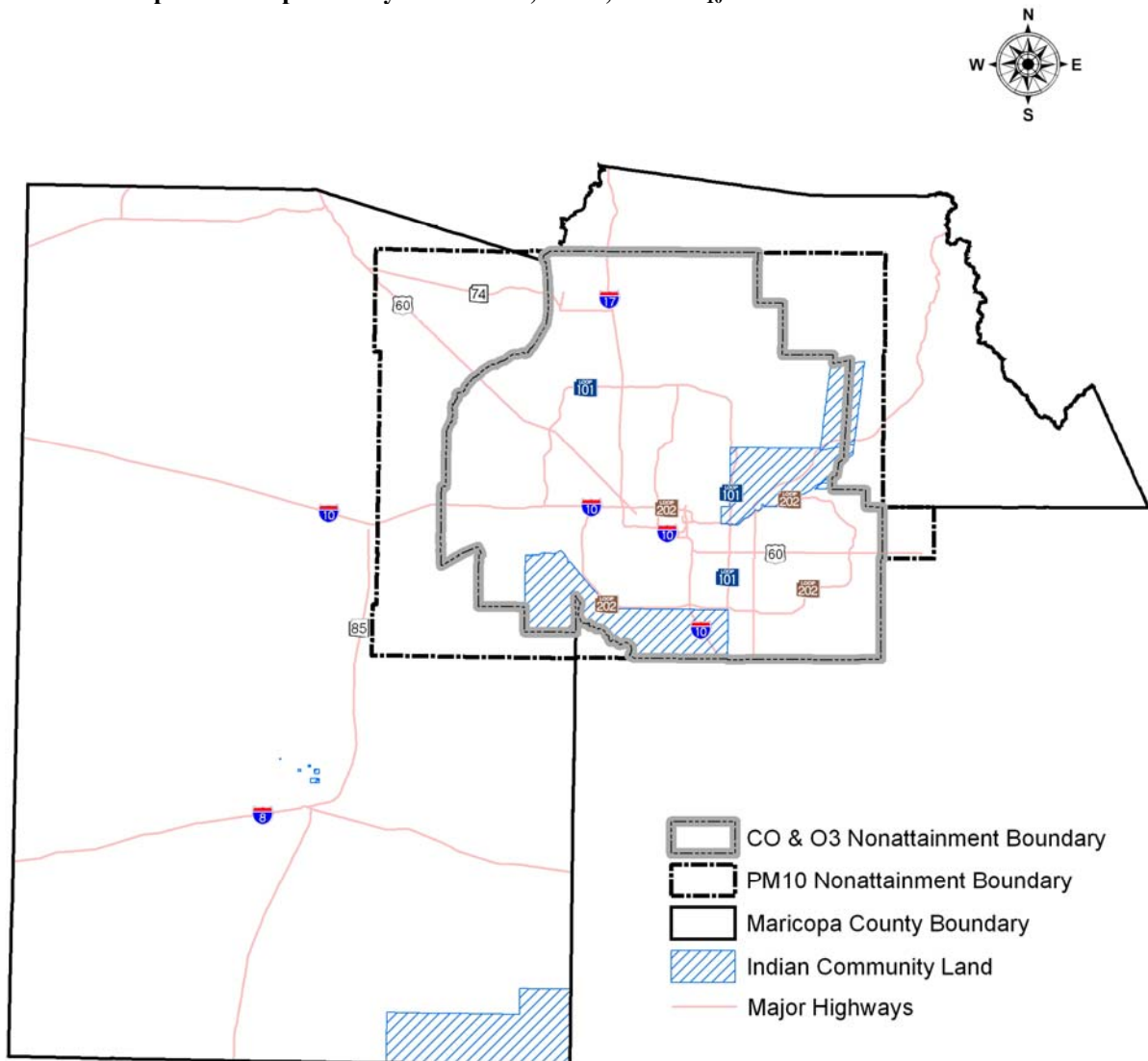
1.3 Temporal scope

Annual and ozone season-day emissions were estimated for the year 2002, for Maricopa County and the Maricopa County ozone nonattainment area (NAA). The three-month peak ozone season for the Maricopa County nonattainment area has been defined as July 1 through September 30 based on ozone exceedances that occurred from 1981 through 1991.

1.4 Geographic scope

This inventory includes emission estimates for Maricopa County and for the Maricopa County ozone nonattainment area. Maricopa County encompasses approximately 9,223 square miles of land area, while the Maricopa County ozone nonattainment area is approximately 1,946 square miles, or approximately 21 percent of the Maricopa County land area. A map of Maricopa County and the ozone nonattainment area is provided in Figure 1.4–1.

Figure 1.4–1. Map of Maricopa County and the CO, ozone, and PM₁₀ nonattainment areas.



1.5 Overview of local demographic and land-use data

Many of the emissions estimates generated in this report were calculated using demographic and land-use data provided by the Maricopa Association of Governments (MAG). These data were used to apportion and/or scale Maricopa County emissions estimates to the nonattainment area and vice versa. (For example, county-level emissions from residential natural gas usage in Maricopa County was apportioned to the nonattainment area using the ratio of occupied households in each area). Detailed explanations of how emission estimates were apportioned or scaled are presented in each of the following chapters, along with the data sources used.

1.5.1 Demographic data

The demographic data provided by MAG included population, housing and employment data for calendar year 2002, for Maricopa County and the nonattainment area. Table 1.5-1 provides an overview of the demographic data used in this report.

Table 1.5–1. Demographic profile of Maricopa County and the ozone nonattainment area.

Demographic variable	Maricopa County	Within the ozone NAA	Percent within the ozone NAA
Total resident population	3,296,250	3,232,387	98.06%
Total non-resident population	253,443	249,420	98.41%
Total population:	3,549,693	3,481,807	98.09%
Occupied resident housing units	1,215,173	1,192,680	98.15%
Total non-resident households	146,664	144,419	98.47%
Total occupied households:	1,361,837	1,337,099	98.18%
Retail employment	438,674	431,973	98.47%
Office employment	392,383	390,375	99.49%
Industrial employment	383,938	376,610	98.09%
Public employment	221,676	213,061	96.11%
Other employment	232,614	227,953	98.00%
Total employment:	1,669,285	1,639,972	98.24%

1.5.2 Land-use data

The most recent land-use data available from MAG was for the year 2000. The 2000 land-use data was assumed to be representative of 2002. Table 1.5–2 presents a summary of the land-use categories and acreage used to develop emission estimates for this inventory. Note that the land-use data used to model emissions from biogenic sources is different from the land-use data discussed here. See Chapter 6 for a discussion of the biogenic land-use data.

Table 1.5–2. Land-use categories used to apportion emissions.

Description	Acreage in Maricopa County	Acreage within the ozone NAA	Percent within the ozone NAA
Active open space (e.g., parks)	127,792	90,038	70.46%
Passive open space (e.g., mountain preserves)	2,057,048	40,846	1.99%
General open space (not elsewhere classified)	849	782	92.16%
Golf courses	22,922	22,231	96.98%
Water	110,940	38,057	34.30%
Agriculture	415,473	185,029	44.53%
Vacant (e.g., developable land)	2,653,351	414,465	15.62%

1.6 Emissions overview by source category

1.6.1 Point sources

The point source category includes those stationary sources that emit a significant amount of pollution into the air such as power plants, petroleum product storage and transfer facilities, and large industrial facilities. As Maricopa County has an established annual reporting program for sources with air quality permits, the thresholds for defining a point source are lower than the minimums required by the US EPA. For the purposes of this inventory, a point source is a stationary operation within Maricopa County or within 25 miles of the ozone nonattainment area, which in 2002 emitted:

- 25 English (short) tons or more of carbon monoxide (CO); or
- 10 tons or more of volatile organic compounds (VOC), oxides of nitrogen (NO_x), or sulfur oxides (SO_x); or
- 5 tons or more of particulate matter less than 10 microns (PM₁₀) or ammonia compounds (NH_x).

Table 1.6–1 summarizes annual and season-day emissions of the chief point source categories. A detailed breakdown of emissions calculations for all point sources is contained in Chapter 2.

Table 1.6–1. Summary of annual and season-day emissions from point sources in Maricopa County.

Source category	Annual emissions (tons/yr)			Ozone season-day emissions (lbs/day)		
	VOC	NO_x	CO	VOC	NO_x	CO
Electricity generation	69.07	2,783.19	1,058.25	495.6	20,778.6	7,231.3
Commercial/institutional fuel combustion	6.99	103.90	45.63	62.0	877.3	273.9
Industrial fuel combustion	43.99	481.08	426.44	335.3	3,322.8	2,773.6
Food/agriculture	98.76			674.7		
Industrial processes	35.21	60.74	82.07	211.3	342.0	565.5
Manufacturing processes	1,013.62	65.13	146.12	7,225.9	464.8	928.3
Petroleum product storage	19.74			126.4		
Petroleum product transportation/marketing	550.34			2,948.7		
Waste disposal	40.79	27.51	64.40	236.4	152.8	357.8
Health services	17.94			98.6		
Solvent use	367.47			2,541.0		
Surface coating	1,831.86			15,771.8		
All point sources:	4,095.77	3,521.55	1,822.90	30,727.8	25,938.4	12,130.3

Table 1.6–2. Summary of annual and season-day emissions from point sources in the ozone NAA.

Source category	Annual emissions (tons/yr)			Ozone season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Electricity generation	53.50	2,560.30	894.61	412.9	19,595.3	6,379.1
Commercial/institutional fuel combustion	6.99	103.90	45.63	62.0	877.3	273.9
Industrial fuel combustion	39.05	387.15	401.93	304.7	2,770.6	2,630.9
Food/agriculture	98.76			674.7		
Industrial processes	22.82	60.74	82.07	146.7	342.0	565.5
Manufacturing processes	925.90	52.24	135.99	6,551.1	365.6	850.4
Petroleum product storage	13.21			86.5		
Petroleum product transportation/marketing	550.34			2,948.7		
Waste disposal	27.64	26.24	56.41	164.1	145.8	313.9
Health services	17.94			98.6		
Solvent use	361.14			2,504.9		
Surface coating	1,752.52			15,171.1		
All point sources:	3,869.81	3,190.56	1,616.64	29,126.1	24,096.6	11,013.6

1.6.2 Area sources

Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively they can release significant amounts of a pollutant. Stationary sources with annual emissions lower than the point source thresholds described in Section 1.6.1 were included in the area source inventory. Examples of area source categories include residential wood burning, commercial cooking, waste incineration and wildfires.

Tables 1.6–3 and 1.6–4 summarize annual and season-day emissions of the chief area source categories, for Maricopa County and the ozone nonattainment area, respectively. A detailed breakdown of emissions calculations for each area source category is contained in Chapter 3.

Table 1.6–3. Summary of annual and season-day emissions from area sources in Maricopa County.

Source category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Fuel combustion	3,211.00	4,560.90	4,817.71	1,351.4	20,625.8	7,445.5
Industrial processes	930.91	589.86	412.98	6,501.7	3,919.7	2,436.7
Solvent use	31,817.28			210,530.0		
Storage/transport	2,187.56			12,577.5		
Waste treatment/disposal	655.70	67.36	616.30	4,966.7	430.0	3,293.9
Miscellaneous area sources	209.46	95.36	2,976.99	80,048.8	36,594.5	1,693,053.6
All area sources:	39,011.90	5,313.47	8,823.98	315,976.1	61,570.0	1,706,229.7

Table 1.6-4. Summary of annual and season-day emissions from area sources in the ozone NAA.

Source category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Fuel combustion	3,152.71	4,480.24	4,730.96	1,327.4	20,259.1	7,314.1
Industrial processes	915.75	589.52	407.76	6,393.8	3,917.8	2,408.0
Solvent use	30,873.65			202,023.5		
Storage/transport	2,110.96			12,139.6		
Waste treatment/disposal	596.19	45.87	159.71	4,616.9	314.2	834.6
Miscellaneous area sources	68.76	30.82	243.43	372.0	274.9	1,341.4
All area sources:	37,718.02	5,146.47	5,541.86	226,873.2	24,766.1	11,898.0

1.6.3 Nonroad mobile sources

Nonroad mobile sources include off-highway vehicles and engines that move or are moved within a 12-month period. Tables 1.6-5 and 1.6-6 summarize annual and season-day emissions from nonroad mobile sources, for Maricopa County and the ozone NAA, respectively. A detailed breakdown of emissions calculations for each source category is contained in Chapter 4.

Table 1.6-5. Summary of annual and season-day emissions from nonroad mobile sources in Maricopa County.

Source category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Agricultural	70.60	477.46	632.96	621.8	4,147.2	5,839.5
Airport ground support	139.57	147.09	3,471.09	766.9	808.1	19,071.9
Commercial	1,758.91	1,319.44	45,797.55	12,446.4	7,799.2	340,043.7
Construction & mining	1,786.47	9,834.69	15,584.58	15,336.6	83,115.7	143,428.8
Industrial	361.99	3,174.80	15,135.47	2,457.9	20,062.1	104,078.3
Lawn & garden	4,523.18	695.48	77,273.13	46,424.7	5,607.4	851,032.3
Logging	20.94	38.74	136.54	136.4	247.0	991.6
Pleasure craft	600.20	43.01	1,423.91	15,428.5	1,001.7	39,125.6
Railway maintenance	5.10	20.35	61.28	36.5	140.2	473.6
Recreational	885.25	63.35	9,788.20	11,451.8	656.1	137,421.0
Aircraft	1,924.48	4,187.59	10,097.03	10,574.1	23,008.7	55,478.2
Locomotives	136.88	3,444.32	344.35	750.0	18,873.0	1,886.8
All nonroad mobile sources:	12,213.57	23,446.32	179,746.09	116,431.6	165,466.4	1,698,871.3

Table 1.6-6. Summary of annual and season-day emissions from nonroad mobile sources in the ozone NAA.

Source category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Agricultural	31.43	212.61	281.86	276.9	1,846.8	2,600.3
Airport ground support	136.08	143.42	3,384.31	747.7	787.9	18,595.1
Commercial	1,725.31	1,294.24	44,922.82	12,208.7	7,650.3	333,548.9
Construction & mining	1,752.35	9,646.84	15,286.91	15,043.6	81,528.2	140,689.3
Industrial	355.07	3,114.16	14,846.36	2,411.0	19,678.9	102,090.4
Lawn & garden	4,440.86	682.82	75,866.76	45,579.7	5,505.3	835,543.5
Logging	20.53	38.01	133.94	133.8	242.3	972.7
Pleasure craft	205.88	14.75	488.40	5,292.0	343.7	13,420.1
Railway maintenance	5.01	19.96	60.11	35.8	137.6	464.5
Recreational	89.32	6.40	987.63	1,155.4	66.1	13,865.9
Aircraft	1,920.37	4,186.89	9,888.43	10,551.5	23,004.9	54,332.0
Locomotives	68.43	1,593.04	160.78	374.9	8,729.0	881.0
All nonroad mobile sources:	10,750.64	20,953.14	166,308.31	93,811.0	149,521.0	1,517,003.7

1.6.4 Onroad mobile sources

Emission from onroad mobile sources were calculated for the ozone nonattainment area located primarily within Maricopa County, as well as for Maricopa County as a whole. A detailed breakdown of emissions calculations by vehicle class and roadway type is contained in Chapter 5.

Table 1.6–7 summarizes annual and season-day emissions from onroad mobile sources in both Maricopa County and the ozone nonattainment area.

Table 1.6–7. Annual and season-day emissions from onroad mobile sources in the ozone NAA.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	31,960	79,572	352,821	180,380	437,741	2,023,444
Ozone NAA	29,402	72,691	322,867	165,922	399,742	1,850,382

1.6.5 Biogenic sources

The biogenic source category includes emissions from all vegetation (e.g., crops, indigenous vegetation, landscaping, etc.) in Maricopa County and the ozone nonattainment area. Emissions were estimated through MAG-BEIS2, a local computer model developed by the Maricopa Association of Governments (MAG) that is based on the US EPA model UAM-BEIS2, but which uses county-specific land-use and temperature data. Annual and season-day VOC and NO_x emissions from biogenic sources are shown in Table 1.6–8 for Maricopa County and the ozone nonattainment area.

Table 1.6–8. Annual and season-day emissions from biogenic sources in the ozone NAA.

Geographic area	Annual emissions (tons/yr)		Season-day emissions (lbs/day)	
	VOC	NO _x	VOC	NO _x
County	24,152	8,327	309,511	71,648
Ozone NAA	7,223	1,604	92,015	13,870

1.6.6 Summary of emissions by source category

Figures 1.6–1 through 1.6–6 provide a graphical overview of the relative contributions of the major source categories (point, area, nonroad, onroad and biogenic) to emissions in the ozone nonattainment area, on an annual and season-day basis, respectively.

Figure 1.6–1. Annual VOC emissions in the ozone nonattainment area, by source category (tons/yr).

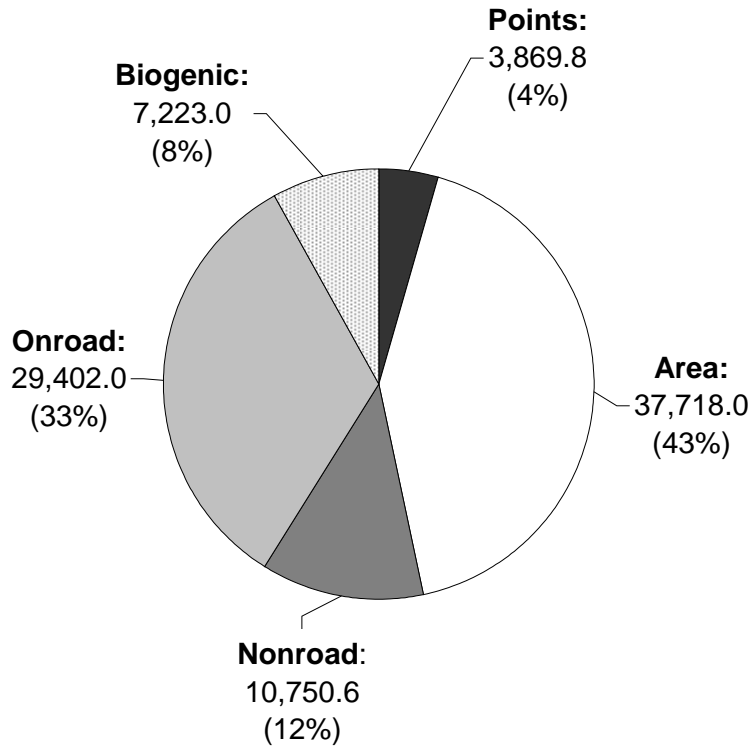


Figure 1.6–2. Annual NO_x emissions in the ozone nonattainment area, by source category (tons/yr).

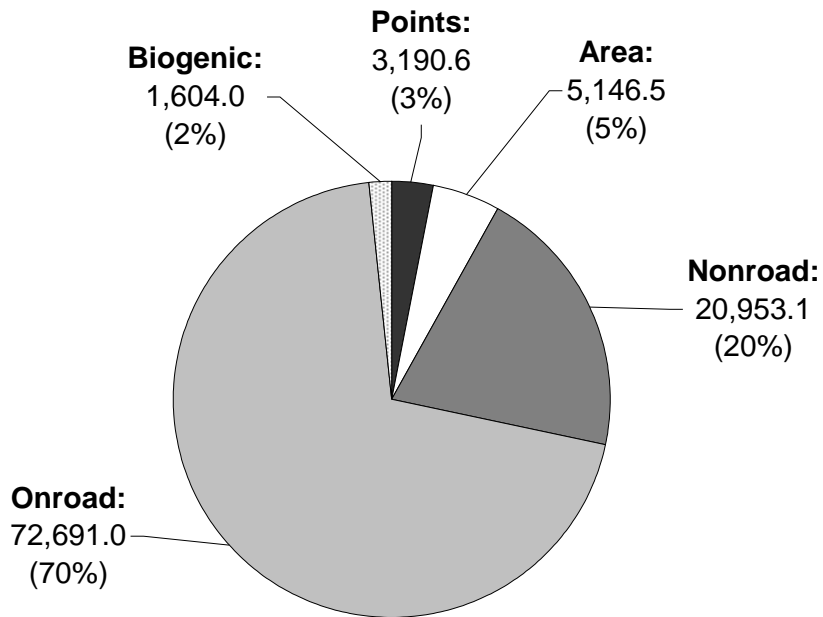


Figure 1.6–3. Annual CO emissions in the ozone nonattainment area, by source category (tons/yr).

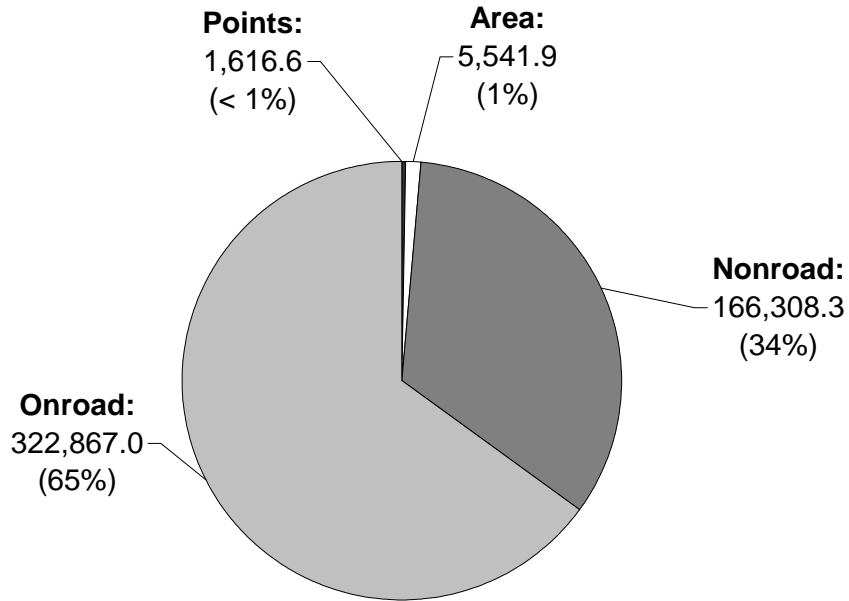


Figure 1.6–4. Season-day VOC emissions in the ozone nonattainment area, by source category (lbs/day).

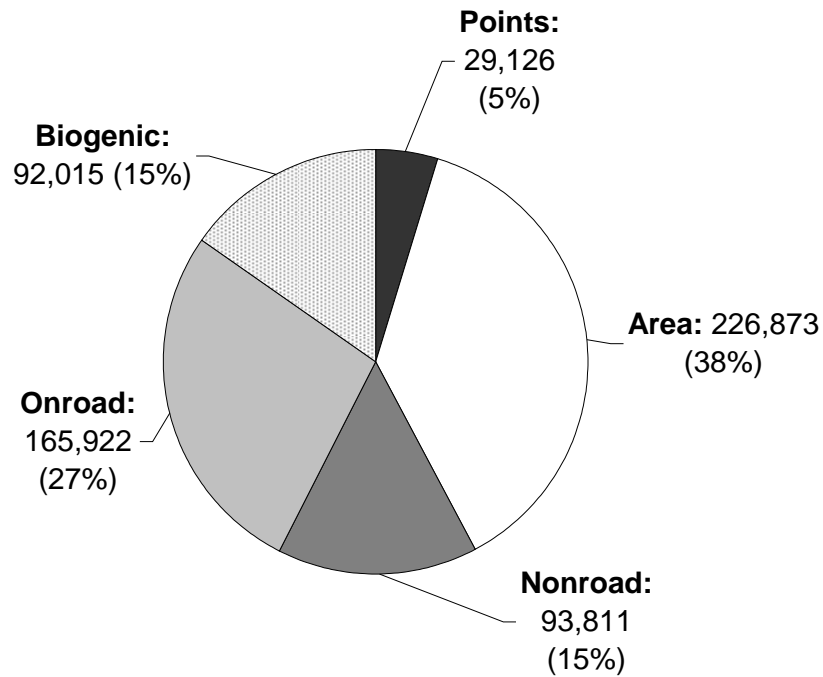


Figure 1.6–5. Season-day NO_x emissions in the ozone nonattainment area, by source category (lbs/day).

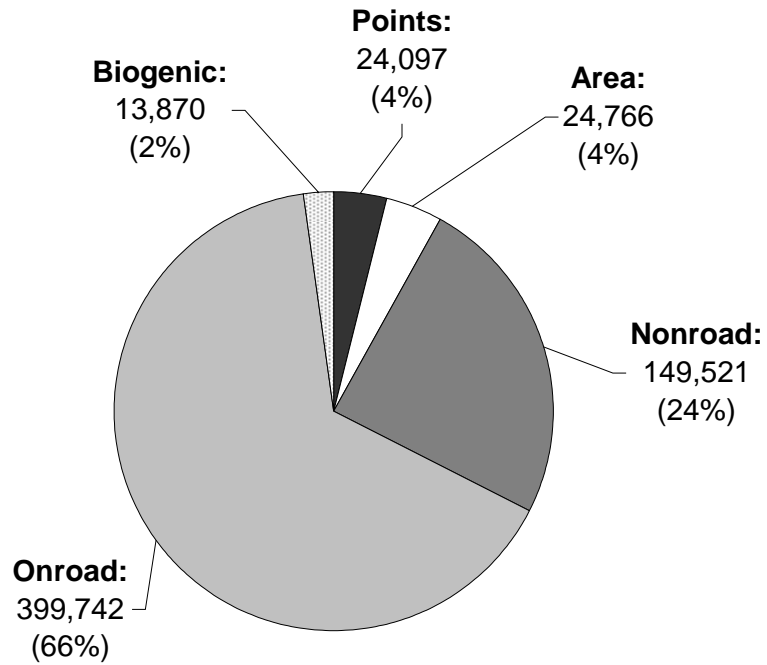
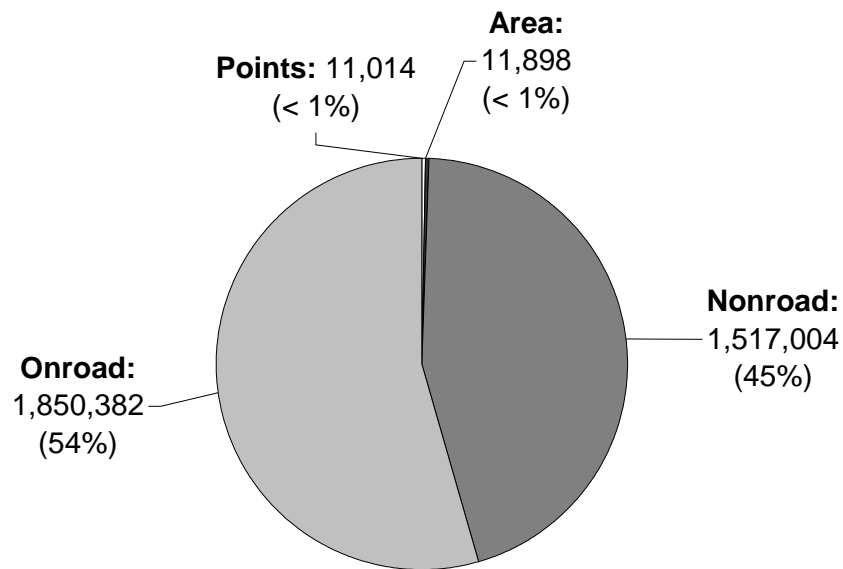


Figure 1.6–6. Season-day CO emissions in the ozone nonattainment area, by source category (lbs/day).



Figures 1.6–7 and 1.6–8 show the relative contributions of each source category for each pollutant on an annual and season-day basis, respectively.

Figure 1.6–7. Annual emissions in the ozone nonattainment area, by source category (tons/yr).

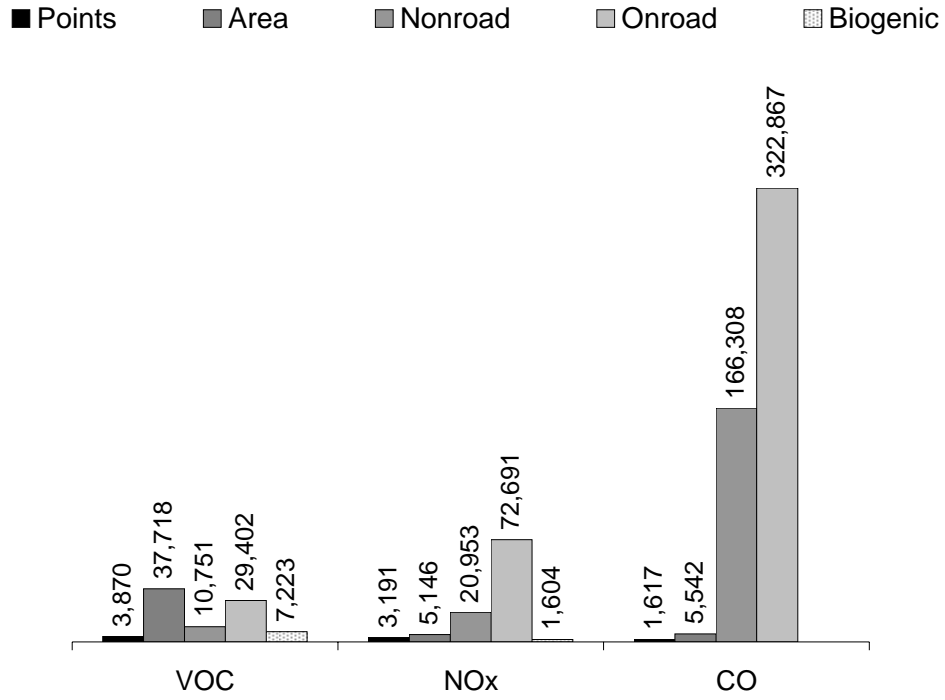
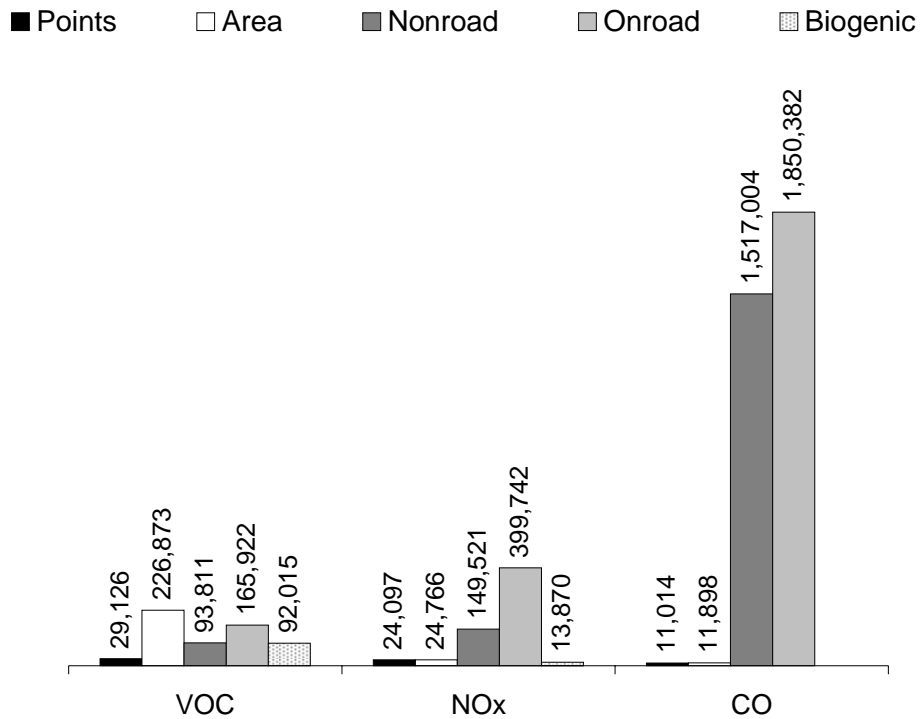


Figure 1.6–8. Season-day emissions in the ozone nonattainment area, by source category (lbs/day).



Tables 1.6–9 through 1.6–14 provide comparisons (by individual pollutant) between this emissions inventory and earlier inventories covering the ozone nonattainment area. Note that figures may not be directly comparable as calculation methods, emission factors, and source category definitions (e.g., point vs. area sources) may have changed over time.

Table 1.6–9. Summary of annual VOC emissions by source category, 1990–2002 (tons/yr).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	7,930	7,699	5,866	5,949	3,870
Area	35,728	36,447	39,550	31,813	37,718
Nonroad mobile	17,923	17,377	38,945	28,605	10,751
Onroad mobile*	n/c	n/c	n/c	n/c	29,402
Biogenic*	n/c	n/c	n/c	n/c	7,223
Totals:	61,581	61,523	84,361	66,367	52,339**

* Prior-year inventories did not include annual totals of onroad mobile or biogenic emissions.

** Not including onroad mobile and biogenic sources, to allow more direct comparison to prior inventories.

Table 1.6–10. Summary of annual NO_x emissions by source category, 1990–2002 (tons/yr).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	5,954	4,721	3,319	5,474	3,191
Area	3,708	3,779	4,589	7,725	5,146
Nonroad mobile	29,082	28,619	13,908	33,942	20,953
Onroad mobile*	n/c	n/c	n/c	n/c	72,691
Biogenic*	n/c	n/c	n/c	n/c	1,604
Totals:	38,744	37,119	21,816	47,141	29,289**

* Prior-year inventories did not include annual totals of onroad mobile or biogenic emissions.

** Not including onroad mobile and biogenic sources, to allow more direct comparison to prior inventories.

Table 1.6–11. Summary of annual CO emissions by source category, 1990–2002 (tons/yr).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	1,493	1,140	736	1,789	1,617
Area	2,237	2,335	1,678	5,867	5,542
Nonroad mobile	167,303	162,021	181,912	195,042	166,308
Onroad mobile*	n/c	n/c	n/c	n/c	322,867
Biogenic*	n/c	n/c	n/c	n/c	n/c
Totals:	171,033	165,496	184,326	202,698	173,467 **

* Prior-year inventories did not include annual totals of onroad mobile or biogenic emissions.

** Not including onroad mobile and biogenic sources, to allow more direct comparison to prior inventories.

Table 1.6–12. Summary of VOC season-day emissions by source category, 1990–2002 (lbs/day).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	56,320	51,260	47,140	43,920	29,126
Area	246,000	220,000	217,800	182,020	226,873
Nonroad mobile	127,400	124,200	132,600	169,720	93,811
Onroad mobile	300,218	239,186	190,283	180,890	165,922
Biogenic	82,000	104,000	104,200	97,340	92,015
Totals:	811,940	737,460	691,940	673,880	607,747

Table 1.6–13. Summary of NO_x season-day emissions by source category, 1990–2002 (lbs/day).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	156,080	155,560	88,880	42,120	24,097
Area	16,000	19,600	23,000	45,260	24,766
Nonroad mobile	187,400	185,200	64,000	183,700	149,521
Onroad mobile	286,243	288,992	285,692	294,299	399,742
Biogenic	n/c	n/c	23,200	20,040	13,870
Totals:	645,720	648,360	484,680	585,400	611,996

Table 1.6–14. Summary of CO season-day emissions by source category, 1990–2002 (lbs/day).

Source category	Inventory year				
	1990	1993	1996	1999	2002
Points	30,420	28,380	17,760	13,100	11,014
Area	8,560	9,000	9,200	92,840	11,898
Nonroad mobile	1,146,400	1,316,000	1,243,200	1,135,520	1,517,004
Onroad mobile	2,005,220	1,708,688	1,243,095	1,268,227	1,850,382
Biogenic	n/c	n/c	n/c	n/c	n/c
Totals:	3,190,600	3,059,380	2,513,160	2,509,680	3,390,98

1.7 References

ENVIRON *et al.*, 2003. Maricopa County 2002 Comprehensive Emission Inventory for the Cap and Trade Oversight Committee, Final Rep. prepared for Arizona Dept. of Environmental Quality, October 9, 2003.

