



# Maricopa County

## Air Quality Department

### 2011 Periodic Emissions Inventory for Ozone Precursors

for the  
Maricopa County, Arizona, Eight-Hour Ozone Nonattainment Area

February 2014

## **Foreword**

Maricopa County Air Quality Department released a draft version of this document, its 2011 emission inventory of ozone precursors, for a 30-day public review period on January 22, 2014. (The department's news release to announce the availability of the draft report, which outlines the schedule for public review and comment, is contained in Appendix D, along with a copy of the department's calendar item providing details on the workshop). The department held a public workshop on February 14, 2014 to discuss the draft inventory. No formal comments were received during the 30-day public review period.

Maricopa County Air Quality Department  
Emissions Inventory Unit  
1001 N. Central Avenue, Suite 595  
Phoenix, AZ 85004  
e-mail: [EmisInv@mail.maricopa.gov](mailto:EmisInv@mail.maricopa.gov)

# 2011 Periodic Emissions Inventory for Ozone Precursors for the Maricopa County, Arizona Eight-Hour Ozone Nonattainment Area

February 2014

## Table of Contents

<b>1. Introduction</b> .....	<b>1</b>
1.1 Overview.....	1
1.2 Agencies responsible for the emissions inventory.....	1
1.3 Temporal scope.....	2
1.4 Geographic scope.....	2
1.5 Overview of local demographic and land use data.....	3
1.5.1 Demographic profile.....	3
1.5.2 Land use data.....	3
1.6 Emissions overview by source category.....	4
1.6.1 Point sources.....	4
1.6.2 Area sources.....	4
1.6.3 Nonroad mobile sources.....	5
1.6.4 Onroad mobile sources.....	6
1.6.5 Biogenic sources.....	6
1.6.6 Summary of all source categories.....	7
<b>2. Point Sources</b> .....	<b>11</b>
2.1 Introduction and scope.....	11
2.2 Identification of point sources.....	11
2.3 Procedures for estimating emissions from point sources.....	12
2.3.1 Application of rule effectiveness.....	13
2.4 Detailed overview of point source emissions.....	13
2.5 Emission reduction credits.....	13
2.6 Summary of point source emissions.....	14
2.7 Quality assurance/quality control procedures.....	14
2.7.1 Emission survey preparation and data collection.....	14
2.7.2 Submission processing.....	15
2.7.3 Analysis of annual point source emissions data for this inventory.....	16
2.8 References.....	16
<b>3. Area Sources</b> .....	<b>17</b>
3.1 Scope and methodology.....	17
3.2 Fuel combustion.....	19
3.2.1 Industrial distillate oil.....	19
3.2.2 Industrial natural gas.....	20
3.2.3 Commercial/institutional distillate oil.....	21
3.2.4 Commercial/institutional natural gas.....	21

3.2.5	Residential distillate oil.....	22
3.2.6	Residential natural gas .....	23
3.2.7	Residential liquefied petroleum gas (LPG).....	23
3.2.8	Residential kerosene .....	24
3.2.9	Residential wood combustion .....	24
3.3	Industrial processes.....	25
3.3.1	Chemical manufacturing.....	25
3.3.2	Food and kindred products.....	26
3.3.2.1	Commercial cooking.....	26
3.3.2.2	Bakeries .....	27
3.3.3	Secondary metal production .....	28
3.3.4	Rubber/plastics product manufacturing .....	28
3.3.5	Electrical equipment manufacturing.....	29
3.3.6	Industrial processes not elsewhere classified (NEC) .....	30
3.4	Solvent use.....	30
3.4.1	Surface coating.....	30
3.4.1.1	Architectural coatings.....	30
3.4.1.2	Auto refinishing .....	31
3.4.1.3	Traffic markings .....	31
3.4.1.4	Factory-finished wood.....	32
3.4.1.5	Wood furniture .....	33
3.4.1.6	Aircraft surface coating .....	34
3.4.1.7	Miscellaneous surface coating.....	34
3.4.2	Degreasing .....	35
3.4.3	Dry cleaning.....	36
3.4.4	Graphic arts.....	36
3.4.5	Miscellaneous industrial solvent use.....	37
3.4.6	Consumer and commercial products.....	38
3.4.7	Asphalt application .....	38
3.4.8	Agricultural pesticides .....	40
3.5	Storage and transport .....	40
3.5.1	Portable fuel containers.....	40
3.5.2	Bulk plants .....	41
3.5.3	Gasoline stations (Stage I) .....	42
3.5.4	Gasoline stations (Stage II).....	42
3.5.5	Gasoline stations underground tanks, breathing/emptying.....	43
3.5.6	Airports: Aviation gasoline.....	43
3.5.7	Gasoline tank trucks in transit.....	44
3.5.8	Pipeline gasoline .....	44
3.5.9	Volatile organic liquid (VOL) storage and transport .....	45
3.6	Waste treatment and disposal .....	45
3.6.1	On-site incineration.....	45
3.6.2	Open burning: Land clearing debris .....	46
3.6.3	Landfills .....	47
3.6.4	Publicly owned treatment works.....	47
3.6.5	Leaking underground storage tanks .....	48
3.6.6	Other waste .....	48
3.7	Miscellaneous area sources.....	49
3.7.1	Agricultural field burning .....	49

3.7.2	Structure fires .....	50
3.7.3	Aircraft engine testing.....	51
3.7.4	Vehicle fires .....	51
3.7.5	Crematories .....	52
3.7.6	Accidental releases.....	52
3.7.7	Hospitals .....	53
3.7.8	Wildfires .....	53
3.7.9	Prescribed fires.....	55
3.8	Summary of all area sources .....	57
3.9	Quality assurance / quality control procedures.....	60
3.10	References.....	62
<b>4.</b>	<b>Nonroad Mobile Sources .....</b>	<b>65</b>
4.1	Introduction.....	65
4.2	Agricultural equipment .....	66
4.3	Airport ground support equipment .....	67
4.4	Commercial equipment.....	68
4.5	Construction and mining equipment.....	68
4.6	Industrial equipment .....	69
4.7	Lawn and garden equipment.....	69
4.8	Pleasure craft.....	70
4.9	Railway maintenance equipment .....	70
4.10	Recreational equipment .....	71
4.11	Aircraft.....	71
4.12	Locomotives.....	77
4.13	Summary of all nonroad mobile source emissions .....	78
4.14	Quality assurance procedures .....	79
4.15	References.....	79
<b>5.</b>	<b>Onroad Mobile Sources .....</b>	<b>81</b>
5.1	Introduction.....	81
5.2	Onroad emissions.....	81
5.2.1	MOVES2010b model.....	82
5.2.2	MOVES2010b local input data .....	82
5.2.2.1	Fuel data .....	82
5.2.2.2	I/M programs .....	82
5.2.2.3	Meteorological data .....	83
5.2.2.4	Vehicle population.....	83
5.2.2.5	Source type age distribution .....	83
5.2.2.6	Annual VMT.....	83
5.2.2.7	Road type distribution .....	84
5.2.2.8	VMT fraction.....	84
5.2.2.9	Average speed distribution .....	85
5.2.2.10	Ramp fraction .....	85
5.2.2.11	AVFT strategy .....	85
5.2.2.12	Stage II refueling control programs.....	85
5.2.3	MOVES2010b outputs.....	86
5.2.4	MOVES2010b emission estimates .....	86

5.3	Summary of ozone precursor emissions from onroad mobile sources .....	95
5.4	Quality assurance process .....	97
5.4.1	VMT estimates .....	97
5.4.2	Emission estimates .....	97
5.4.3	Draft emissions inventory for ozone precursors .....	97
5.5	References.....	97
<b>6.</b>	<b>Biogenic Sources.....</b>	<b>99</b>
6.1	Introduction.....	99
6.2	Modeling domain.....	99
6.3	Input data .....	99
6.3.1	Land cover data.....	100
6.3.2	Weather data .....	100
6.4	Emission estimation.....	101
6.5	Summary of biogenic source emissions.....	105
6.6	References.....	106

### List of Tables

Table 1.2–1.	Chapter authors and QA/QC contacts for this report. ....	1
Table 1.5–1.	Demographic profile of Maricopa County and the eight-hour ozone NAA.....	3
Table 1.5–2.	Land use categories used to apportion emissions.....	4
Table 1.6–1.	Annual and season-day emissions from point sources.....	4
Table 1.6–2.	Annual and season-day emissions from area sources in Maricopa County. ....	5
Table 1.6–3.	Annual and season-day emissions from area sources in the eight-hour ozone NAA.....	5
Table 1.6–4.	Annual and season-day emissions from nonroad mobile sources in Maricopa County. ....	5
Table 1.6–5.	Annual and season-day emissions from nonroad mobile sources in the eight-hour ozone NAA.....	6
Table 1.6–6.	Annual and season-day emissions from onroad mobile sources in Maricopa County and the eight-hour ozone NAA.....	6
Table 1.6–7.	Annual and season-day emissions from biogenic sources in Maricopa County and the eight-hour ozone NAA. ....	6
Table 1.6–8.	Annual and season-day emissions from all sources in Maricopa County.....	7
Table 1.6–9.	Annual and season-day emissions from all sources in the eight-hour ozone nonattainment area. ....	9
Table 2.2–1.	Name and location of all point sources in Maricopa County.....	12
Table 2.4–1.	Annual and season-day point source emissions, by facility.....	13
Table 2.5–1.	Emission reduction credits as of December 31, 2011. ....	14
Table 2.6–1.	Annual and season-day point source emissions (including emission reduction credits).....	14
Table 3.1–1.	List of area source categories included in this ozone precursor inventory.....	17
Table 3.2–1.	Maricopa County natural gas sales by end-user category and supplier. ....	19
Table 3.2–2.	Annual and season-day emissions from area-source industrial distillate oil combustion for boilers.....	20
Table 3.2–3.	Annual and season-day emissions from area-source industrial distillate oil combustion for engines. ....	20

Table 3.2–4.	Natural gas usage, emission factors, and annual emissions from area-source industrial natural gas consumption, by combustion type. ....	20
Table 3.2–5.	Annual and season-day emissions from area-source industrial natural gas combustion. ....	21
Table 3.2–6.	Annual and season-day emissions from area-source commercial/institutional distillate oil combustion for boilers. ....	21
Table 3.2–7.	Annual and season-day emissions from area-source commercial/institutional distillate oil combustion for engines. ....	21
Table 3.2–8.	Emission factors and annual emissions from area-source commercial/institutional natural gas combustion, by combustion type. ....	22
Table 3.2–9.	Annual and season-day emissions from area-source commercial/institutional natural gas combustion. ....	22
Table 3.2–10.	Annual and season-day emissions from residential distillate oil combustion. ....	23
Table 3.2–11.	Residential natural gas combustion emission factors. ....	23
Table 3.2–12.	Annual and season-day emissions from residential natural gas combustion. ....	23
Table 3.2–13.	Annual and season-day emissions from residential liquefied petroleum gas (LPG) combustion. ....	24
Table 3.2–14.	Annual and season-day emissions from residential kerosene combustion. ....	24
Table 3.2–15.	Annual emissions by appliance type for Maricopa County from EPA’s residential wood combustion estimation tool. ....	25
Table 3.2–16.	Annual and season-day emissions from residential wood combustion. ....	25
Table 3.3–1.	County-level employment estimates for chemical manufacturing, by NAICS code. ..	26
Table 3.3–2.	Annual and season-day emissions from area-source chemical manufacturing. ....	26
Table 3.3–3.	Emission factors for commercial cooking equipment, by device type. ....	26
Table 3.3–4.	Annual and daily emissions from commercial cooking equipment in Maricopa County. ....	27
Table 3.3–5.	Annual and daily emissions from commercial cooking equipment in the eight-hour ozone NAA. ....	27
Table 3.3–6.	Annual and season-day emissions from area-source bakeries. ....	28
Table 3.3–7.	Annual and season-day emissions from area-source secondary metal production. ....	28
Table 3.3–8.	County-level employment estimates for rubber and plastic product manufacturing, by NAICS code. ....	29
Table 3.3–9.	Annual and season-day emissions from area-source rubber/plastic product manufacturing. ....	29
Table 3.3–10.	Annual and season-day emissions from area-source electric equipment manufacturing. ....	30
Table 3.3–11.	Annual and season-day emissions from industrial processes not elsewhere classified. ....	30
Table 3.4–1.	Annual and season-day emissions from architectural coating. ....	31
Table 3.4–2.	County-level employment estimates for auto refinishing, by NAICS code. ....	31
Table 3.4–3.	Annual and season-day emissions from auto refinishing. ....	31
Table 3.4–4.	Annual and season-day emissions from traffic markings. ....	32
Table 3.4–5.	County-level employment estimates for factory-finished wood coating, by NAICS code. ....	32
Table 3.4–6.	Annual and season-day emissions from area-source factory-finished wood surface coating. ....	33
Table 3.4–7.	County-level employment estimates for wood furniture surface coating, by NAICS code. ....	33

Table 3.4–8. Annual and season-day emissions from area-source wood furniture surface coating. ....	34
Table 3.4–9. Annual and season-day VOC emissions from area-source aircraft surface coating. ....	34
Table 3.4–10. Annual and season-day emissions from miscellaneous surface coating. ....	35
Table 3.4–11. Annual and season-day VOC emissions from area-source degreasing. ....	35
Table 3.4–12. Annual and season-day emissions from dry cleaning. ....	36
Table 3.4–13. County-level employment estimates for graphic arts, by NAICS code. ....	36
Table 3.4–14. Annual and season-day VOC emissions from area-source graphic arts sources. ....	37
Table 3.4–15. Annual and season-day emissions from area-source miscellaneous industrial solvent use. ....	38
Table 3.4–16. Annual and season-day emissions from consumer and commercial products. ....	38
Table 3.4–17. 2008 and 2011 population and VMT, by geographic area. ....	39
Table 3.4–18. Emissions from asphalt use, by type, in Maricopa County. ....	39
Table 3.4–19. Emissions from asphalt use, by type, in the eight-hour ozone NAA. ....	39
Table 3.4–20. Annual and season-day emissions from agricultural pesticide application. ....	40
Table 3.5–1. Annual and season-day emissions from portable fuel containers (PFCs). ....	41
Table 3.5–2. Annual and season-day emissions from bulk plants. ....	42
Table 3.5–3. Emission factors for gasoline service stations (Stage I). ....	42
Table 3.5–4. Annual and season-day emissions from gasoline service stations (Stage I). ....	42
Table 3.5–5. Annual and season-day emissions from gasoline service stations underground tank, breathing and emptying. ....	43
Table 3.5–6. Annual emissions from aviation gasoline for Maricopa County. ....	43
Table 3.5–7. Annual and season-day emissions from aviation gasoline. ....	44
Table 3.5–8. Annual and season-day emissions from gasoline trucks in transit. ....	44
Table 3.5–9. Annual and season-day emissions from pipeline gasoline. ....	45
Table 3.5–10. Annual and season-day emissions from area-source volatile organic liquid storage/transport. ....	45
Table 3.6–1. Annual and season-day emissions from on-site incineration. ....	46
Table 3.6–2. Maricopa County burn permit activity. ....	46
Table 3.6–3. Emission and fuel loading factors for open burning. ....	46
Table 3.6–4. Annual and season-day emissions from land clearance and fire hazard open burning. ....	47
Table 3.6–5. Annual and season-day emissions from landfills. ....	47
Table 3.6–6. VOC emissions from publicly owned treatment works. ....	48
Table 3.6–7. Annual and season-day emissions from remediation of leaking underground storage tanks. ....	48
Table 3.6–8. Annual and season-day emissions from other waste. ....	49
Table 3.7–1. Emission factors for open burning. ....	49
Table 3.7–2. Annual and season-day emissions from ditchbank and fence row burning. ....	50
Table 3.7–3. Maricopa County population growth, 2008 to 2011. ....	50
Table 3.7–4. 2008 and 2011 annual emissions from structure fires in Maricopa County. ....	50
Table 3.7–5. Annual and season-day emissions from structure fires. ....	51
Table 3.7–6. Annual and season-day emissions from aircraft engine testing. ....	51
Table 3.7–7. 2008 and 2011 annual emissions from vehicle fires in Maricopa County. ....	51
Table 3.7–8. Annual and season-day emissions from vehicle fires. ....	51
Table 3.7–9. County-level employment estimates for crematories, by NAICS code. ....	52
Table 3.7–10. Annual and season-day emissions from crematories. ....	52
Table 3.7–11. Annual and season-day emissions from accidental releases. ....	53
Table 3.7–12. Annual and season-day emissions from hospitals. ....	53



Table 3.7–13. 2011 wildfire activity in Maricopa County. ....	54
Table 3.7–14. Data used to estimate 2011 wildfire emissions. ....	54
Table 3.7–15. Summary of 2011 wildfires, acres burned, and estimate of material burned. ....	54
Table 3.7–16. Emission factors for wildfires and prescribed broadcast burning. ....	55
Table 3.7–17. Annual emissions from wildfires. ....	55
Table 3.7–18. Season-day emissions from wildfires. ....	55
Table 3.7–19. 2011 prescribed fire activity in Maricopa County. ....	56
Table 3.7–20. Emission factors for prescribed fire (piled fuels). ....	56
Table 3.7–21. Annual and season-day emissions from prescribed fires. ....	56
Table 3.8–1. Annual and season-day emissions from all area sources in Maricopa County. ....	57
Table 3.8–2. Annual and season-day emissions from all area sources in the eight-hour ozone NAA. ....	59
Table 4.1–1. NONROAD2008 model county temperature and fuel-related inputs. ....	65
Table 4.1–2. Default weekday and weekend day activity allocation fractions. ....	66
Table 4.2–1. Annual and season-day emissions from agricultural equipment. ....	67
Table 4.3–1. Annual emissions (tons/yr) from airport ground support equipment (GSE) and auxiliary power units (APUs). ....	68
Table 4.3–2. Season-day emissions (lbs/day) from airport GSE and APU. ....	68
Table 4.4–1. Annual and season-day emissions from commercial equipment. ....	68
Table 4.5–1. Annual and season-day emissions from construction and mining equipment. ....	69
Table 4.6–1. Annual and season-day emissions from industrial equipment. ....	69
Table 4.7–1. Annual and season-day emissions from lawn and garden equipment. ....	70
Table 4.8–1. Annual and season-day emissions from pleasure craft equipment. ....	70
Table 4.9–1. Annual and season-day emissions from railway maintenance equipment. ....	70
Table 4.10–1. Annual and season-day emissions from recreational equipment. ....	71
Table 4.11–1. Annual airport operations (by aircraft category) and related data sources. ....	73
Table 4.11–2. Growing aircraft-specific activity for EDMS modeling input. ....	75
Table 4.11–3. Annual and season-day emissions, by aircraft type, for airports in the eight-hour ozone NAA. ....	76
Table 4.11–4. Annual and season-day emissions, by aircraft type, for airports outside the eight- hour ozone NAA. ....	77
Table 4.12–1. Emission factors for locomotives. ....	77
Table 4.12–2. Fuel use and annual emissions from locomotives in Maricopa County. ....	77
Table 4.12–3. Annual emissions from locomotives in the eight-hour ozone NAA. ....	77
Table 4.12–4. Season-day emissions from locomotives in Maricopa County and the eight-hour ozone NAA. ....	78
Table 4.13–1. Annual and season-day emissions from nonroad mobile sources in Maricopa County. ....	78
Table 4.13–2. Annual and season-day emissions from nonroad mobile sources in the eight-hour ozone NAA. ....	78
Table 5.2–1. 2011 daily VMT by facility type (annual average daily traffic). ....	84
Table 5.2–2. Annual and ozone season-day onroad mobile source emissions by facility type and vehicle class in the eight-hour ozone NAA. ....	87
Table 5.2–3. Annual and ozone season-day onroad mobile source emissions by facility type and vehicle class in Maricopa County. ....	91
Table 5.3–1. Annual and ozone season-day onroad mobile source emissions by facility type in the eight-hour ozone NAA. ....	95
Table 5.3–2. Annual and ozone season-day onroad mobile source emissions by facility type in Maricopa County. ....	95

Table 5.3–3.	Annual and ozone season-day onroad mobile source emissions by vehicle class in the eight-hour ozone NAA. ....	96
Table 5.3–4.	Annual and ozone season-day onroad mobile source emissions by vehicle class in Maricopa County. ....	96
Table 5.3–5.	Annual and ozone season-day emissions from all onroad mobile sources in the eight-hour ozone NAA and Maricopa County. ....	96
Table 6.2–1.	Two modeling domains defined in the LCP coordinate system. ....	99
Table 6.4–1.	Daily mean biogenic emissions for each month in the eight-hour ozone NAA. ....	102
Table 6.4–2.	Daily mean biogenic emissions for each month in Maricopa County. ....	103
Table 6.4–3.	Monthly biogenic emissions in the eight-hour ozone NAA. ....	105
Table 6.4–4.	Monthly biogenic emissions in Maricopa County. ....	105
Table 6.5–1.	Season-day biogenic emissions. ....	106
Table 6.5–2.	Annual biogenic emissions. ....	106

### List of Figures

Figure 1.4–1.	Map of Maricopa County and the eight-hour ozone nonattainment area. ....	2
Figure 2.7–1.	Data flow for annual point source emissions inventory reporting. ....	15
Figure 6.3–1.	The masked grid cells in the 4-km modeling domain. ....	100
Figure 6.3–2.	Monthly averaged temperature (left panel) and annual mean diurnal cycle of temperature (right panel) in 2011. ....	101
Figure 6.3–3.	Monthly averaged radiation (left panel) and annual mean diurnal cycle of radiation (right panel) in 2011. ....	101
Figure 6.4–1.	Estimated emission rates of ISOP (left panel) and NO <sub>x</sub> (right panel) at 17:00 MST, August 2011 by MEGAN model. ....	102
Figure 6.4–2.	Monthly emissions of VOC (top), NO <sub>x</sub> (middle) and CO (bottom) in Maricopa County (pink solid line, abbreviated as “County”) and the eight-hour ozone NAA (blue solid line, abbreviated as “O3 NAA”). ....	104

## **Appendices**

### **Appendix A Instructions for Reporting 2011 Annual Air Pollution Emissions**

### **Appendix B Rule Effectiveness Studies**

B.1 Introduction

B.2 Calculating Rule Effectiveness Rates for Title V Facilities and Non-Title V Facilities

B.3 References

### **Appendix C MOVES2010b Local Input Data and RunSpecs**

MOVES2010b RunSpec Summary (Maricopa County, December 2011)

MOVES2010b RunSpec (Maricopa County, December 2011)

MOVES2010b Local Input Data (Maricopa County, December 2011)

### **Appendix D Public Comment Period Documentation**