United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

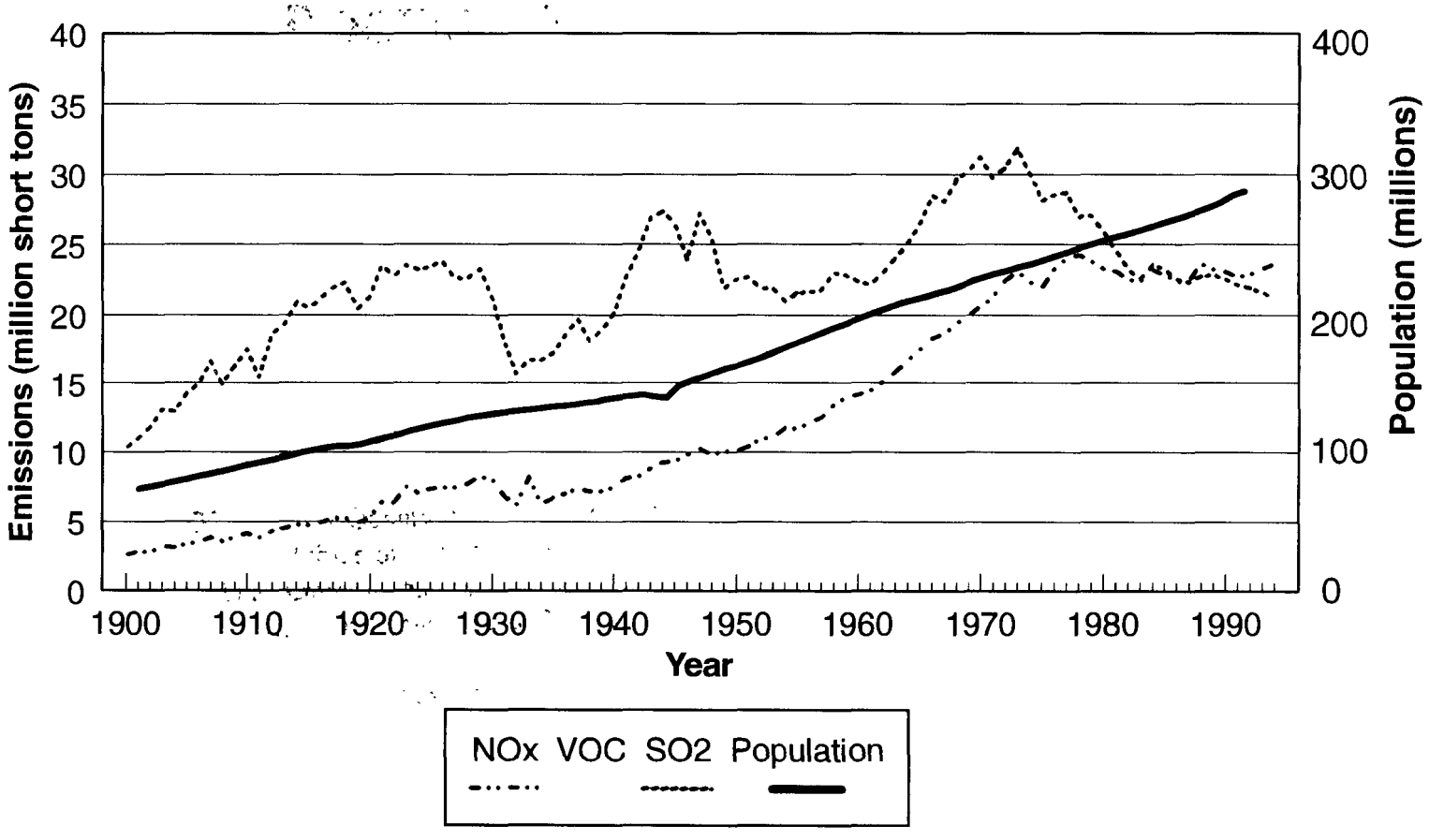
EPA-454/R-95-011
October 1995

Air

PB96 135678

NATIONAL AIR POLLUTANT EMISSION TRENDS, 1900 - 1994

TREND IN NATIONAL EMISSIONS 1900-1994



National Air Pollutant Emission Trends 1900 — 1994

U.S. Environmental Protection Agency
Region 5, Library (PL-12J)
77 West Jackson Boulevard, 12th Floor
Chicago, IL 60604-3590

Disclaimer

This report has been reviewed by the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, and has been approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

Foreword

This document presents the most recent estimates of national emissions of the criteria air pollutants. The emissions of each pollutant are estimated for many different source categories, which collectively account for all anthropogenic emissions. The report presents the total emissions from all 50 States and from each United States Environmental Protection Agency (EPA) region in the country. These estimates are updated annually.

This report tracks changes in national emissions since passage of the Clean Air Act Amendments of 1990 (CAAA). The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities that cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. These reports will serve as a measure of our nation's progress in reducing air pollution emissions as a result of mandatory and voluntary controls and of continuous changes in national activity.

This report also reflects recent improvements in the way national and regional emissions are calculated. Improvement in estimation methods is an on-going effort, and it is expected that future reports will reflect this effort. Revisions to the methodology used in the previous version of this report, *National Air Pollutant Emission Trends, 1900-1993,* (hereinafter referred to as *"Trends"*) include: a change in the method used to estimate pre-1985 to the present emissions, recalculation of mobile source emissions for the years 1970 to 1994 using a new emissions model, use of certain years' estimates for trends only, modification of the method used to calculate particulate matter emissions, and use of other years' estimates as both trend and absolute indicators. Further details of these methodological changes are described in chapter 6 of this report.

In addition to the extensive coverage of criteria air pollutant emissions from anthropogenic sources in the United States, this year's report continues to provide limited coverage of biogenic, global warming gases, air toxics, and international emissions. Preliminary estimates are presented for the years 1990 through 1994. Final estimates (including refinements to the data used to estimate emissions) will be presented in future reports.

Contents

Page

Foreword iii

Tables ix

Figures xi

Acronyms and Abbreviations xiii

Acknowledgement xvi

Executive Summary ES-1
- ES.1 EMISSIONS SUMMARY ES-1
- ES.2 EMISSIONS SUMMARY BY POLLUTANT ES-2
  - ES.2.1 Carbon Monoxide Emissions ES-2
  - ES.2.2 Nitrogen Oxide Emissions ES-2
  - ES.2.3 Volatile Organic Compound Emissions ES-2
  - ES.2.4 Sulfur Dioxide Emissions ES-3
  - ES.2.5 Particulate Matter (PM-10) Emissions ES-3
  - ES.2.6 Lead Emissions ES-4
- ES.3 CURRENT NONATTAINMENT AREAS ES-4
- ES.4 REFERENCES ES-5

1.0 Introduction 1-1
- 1.1 HEALTH EFFECTS 1-1
- 1.2 REPORT ENHANCEMENTS 1-2
- 1.3 REPORT STRUCTURE 1-2
- 1.4 REFERENCES 1-3

2.0 Summary of 1994 Emissions 2-1
- 2.1 EMISSIONS FOR 1994 BY SOURCE CATEGORY 2-1
  - 2.1.1 Carbon Monoxide Emissions 2-1
  - 2.1.2 Nitrogen Oxide Emissions 2-2
  - 2.1.3 Volatile Organic Compound Emissions 2-2
  - 2.1.4 Sulfur Dioxide Emissions 2-2
  - 2.1.5 Particulate Matter (PM-10) Emissions 2-2
  - 2.1.6 Lead Emissions 2-3
- 2.2 SPATIAL EMISSIONS 2-3
  - 2.2.1 State Level 2-3
  - 2.2.2 County Level 2-3
  - 2.2.3 Nonattainment Areas 2-3
- 2.3 LARGEST POINT SOURCES IN AIRS/AFS 2-3
- 2.4 REFERENCES 2-4

3.0 Summary of National Emission Trends and Economic, Demographic, and Regulatory Influences on Historic Trends in Emissions . . . 3-1
3.1 INTRODUCTION . . . 3-1
3.2 OVERVIEW OF AIR POLLUTION CONTROL HISTORY . . . 3-2
3.2.1 Pre-1970 Efforts . . . 3-2
3.2.2 1970 Clean Air Act and Post-1970 Activities . . . 3-2
3.3 CARBON MONOXIDE EMISSION TRENDS, 1940 THROUGH 1994 . . . 3-3
3.3.1 Fuel Combustion Carbon Monoxide Emissions: Electric Utility, Industrial, and Other . . . 3-3
3.3.2 Industrial Process Carbon Monoxide Emissions . . . 3-3
3.3.3 Transportation Carbon Monoxide Emissions: On-Road Vehicles and Non-Road Sources . . . 3-4
3.3.4 Remaining Sources . . . 3-4
3.4 NITROGEN OXIDE EMISSION TRENDS AND VOLATILE ORGANIC COMPOUND TRENDS, 1900 THROUGH 1994 . . . 3-4
3.4.1 Regulatory History for Nitrogen Oxide and Volatile Organic Compound Emissions . . . 3-4
3.4.2 Nitrogen Oxide Emissions Trends . . . 3-5
3.4.2.1 Fuel Combustion Nitrogen Oxide Emissions: Electric Utility, Industrial, and Other . . . 3-5
3.4.2.2 Transportation Nitrogen Oxide Emissions: On-Road Vehicles and Non-Road Sources . . . 3-5
3.4.2.3 Remaining Sources . . . 3-5
3.4.3 Volatile Organic Compound Emission Trends . . . 3-5
3.4.3.1 Fuel Combustion Volatile Organic Compound Emissions: Electric Utility, Industrial, and Other . . . 3-6
3.4.3.2 Industrial Process Volatile Organic Compound Emissions . . . 3-6
3.4.3.3 Transportation Volatile Organic Compound Emissions: On-Road Vehicles and Non-Road Sources . . . 3-6
3.4.3.4 Remaining Sources . . . 3-6
3.5 SULFUR DIOXIDE EMISSION TRENDS, 1900 THROUGH 1994 . . . 3-6
3.5.1 Fuel Combustion Sulfur Dioxide Emissions: Electric Utility, Industrial, and Other . . . 3-7
3.5.2 Industrial Process Sulfur Dioxide Emissions . . . 3-7
3.5.3 Remaining Sources . . . 3-7
3.6 PARTICULATE MATTER (PM-10) EMISSION TRENDS, 1940 THROUGH 1994 . . . 3-8
3.6.1 Point and Fugitive Process Sources . . . 3-8
3.6.1.1 Fuel Combustion Particulate Matter (PM-10) Emissions: Electric Utility, Industrial, and Other . . . 3-8
3.6.1.2 Transportation Particulate Matter (PM-10) Emissions: On-Road Vehicles and Non-Road Sources . . . 3-8
3.6.1.3 Remaining Sources . . . 3-8
3.6.2 Fugitive Dust Sources . . . 3-9
3.7 LEAD EMISSION TRENDS, 1970 THROUGH 1994 . . . 3-9
3.7.1 Fuel Combustion Lead Emissions: Electric Utility, Industrial, and Other . . . 3-9
3.7.2 Industrial Process Lead Emissions . . . 3-9
3.7.3 Transportation Lead Emissions: On-Road Vehicles and Non-Road Sources . . . 3-9
3.8 REFERENCES . . . 3-10

4.0 Emission Trends, 1985 through 1994 . . . 4-1
4.1 REFERENCES . . . 4-2

5.0 National Emission Projections, 1996 to 2010 . . . 5-1
5.1 DIFFERENCES BETWEEN PROJECTIONS, 1994 AND 1995 REPORTS . . . 5-1
5.2 FUTURE EXPECTED TRENDS IN CARBON MONOXIDE EMISSIONS . . . 5-1
5.3 FUTURE EXPECTED TRENDS IN NITROGEN OXIDE EMISSIONS . . . 5-2
5.4 FUTURE EXPECTED TRENDS IN VOLATILE ORGANIC COMPOUND EMISSIONS . . . 5-2
5.5 FUTURE EXPECTED TRENDS IN SULFUR DIOXIDE EMISSIONS . . . 5-2
5.6 FUTURE EXPECTED TRENDS IN PARTICULATE MATTER (PM-10) EMISSIONS . . . 5-2
5.7 REFERENCES . . . 5-3

6.0 National Criteria Pollutant Estimation Methodology 6-1
6.1 INTRODUCTION 6-1
6.2 NATIONAL EMISSIONS, 1900 THROUGH 1939 6-1
6.3 NATIONAL EMISSIONS, 1940 THROUGH 1984 6-2
6.4 NATIONAL EMISSIONS, 1985 THROUGH 1994 6-2
6.4.1 Fuel Combustion 6-2
6.4.1.1 Electric Utility Units 6-2
6.4.1.2 Industrial and Other Combustion 6-3
6.4.2 Transportation 6-4
6.4.2.1 On-Road Vehicles 6-4
6.4.2.2 Non-Road Sources 6-5
6.4.3 Industrial Processes 6-5
6.4.4 Remaining Categories 6-5
6.4.4.1 Natural Sources, Geogenic, Wind Erosion 6-5
6.4.4.2 Miscellaneous, Agriculture and Forestry 6-5
6.4.4.3 Miscellaneous, Other Combustion 6-6
6.4.4.4 Miscellaneous, Fugitive Dust 6-6
6.5 EMISSION REVISIONS 6-7
6.5.1 Methodological Changes 6-7
6.5.2 Other Changes 6-7
6.6 COUNTY AND SEASONAL EMISSIONS, 1994 6-7
6.7 LARGEST POINT SOURCES IN AIRS/AFS 6-7
6.8 NATIONAL EMISSIONS, 1996 to 2010 6-8
6.8.1 On-Road Vehicles 6-8
6.8.2 Utilities 6-8
6.8.3 Nonutility Point Sources 6-8
6.8.3.1 Carbon Monoxide Controls 6-9
6.8.3.2 Nitrogen Oxide and Volatile Organic Compound Controls 6-9
6.8.3.3 Sulfur Dioxide Controls 6-9
6.8.3.4 Particulate Matter (PM-10) Controls 6-9
6.8.4 Area/Non-Road Projections 6-9
6.8.4.1 Carbon Monoxide Area/Non-Road Controls 6-9
6.8.4.2 Nitrogen Oxide Area/Non-Road Controls 6-9
6.8.4.3 Volatile Organic Compound Area/Non-Road Controls 6-9
6.8.4.4 Sulfur Dioxide Area/Non-Road Controls 6-9
6.8.4.5 Particulate Matter (PM-10) Area/Non-Road Controls 6-10
6.9 REFERENCES 6-10

7.0 International Criteria Pollutant Emissions 7-1
7.1 CANADA 7-1
7.2 EUROPE 7-1
7.2.1 CORINAIR: The Atmospheric Emission Inventory for Europe 7-1
7.2.2 CORINAIR85 7-1
7.2.3 CORINAIR90 7-2
7.3 REFERENCES 7-3

8.0 Air Toxic Emissions 8-1
8.1 INTRODUCTION 8-1
8.2 TOXICS RELEASE INVENTORY SUMMARIES 8-1
8.3 NATIONAL INVENTORIES FOR SPECIFIC POLLUTANTS 8-2
8.3.1 Section 112(k) Inventories (Urban Area Source Program) 8-2
8.3.2 Section 112(c)(6) Inventories 8-3
8.4 STATE-LEVEL INVENTORIES FOR SPECIFIC POLLUTANTS 8-3
8.5 REFERENCES 8-4

9.0 Biogenic Emissions 9-1
9.1 REFERENCES 9-1

10.0 National and International Greenhouse Gas Emissions 10-1
10.1 NATIONAL 10-1
10.1.1 Methodology and Data 10-1
10.1.2 Trends 10-1
10.2 INTERNATIONAL 10-2
10.2.1 Carbon Dioxide Emissions 10-2
10.2.2 Global Trends 10-2
10.2.3 United States 10-2
10.2.4 Canada 10-2
10.2.5 Mexico 10-2
10.3 REFERENCES 10-3

Appendix A National Emissions (1970 to 1994) by Subcategory A-1

Appendix B Regional Emissions (1985 to 1994) B-1

Appendix C National Total Particulate Emissions (1940 to 1992) by Subcategory C-1

Appendix D Chapter 2 Color Maps Converted to Black and White D-1

Tables

		Page
ES-1.	Summary of National Emissions	ES-8
ES-2.	Percentage Change in National Emissions	ES-9
ES-3.	Current Nonattainment Areas	ES-10
1-1.	Major Source Categories	1-4
2-1.	1994 National Point and Area Emissions by Source Category and Pollutant	2-5
2-2.	1994 State-level Carbon Monoxide Emissions and Rank by Major Category in Alphabetical Order of State Name	2-6
2-3.	1994 State-level Nitrogen Oxide Emissions and Rank by Major Category in Alphabetical Order of State Name	2-7
2-4.	1994 State-level Volatile Organic Compound Emissions and Rank by Major Category in Alphabetical Order of State Name	2-8
2-5.	1994 State-level Sulfur Dioxide Emissions and Rank by Major Category in Alphabetical Order of State Name	2-9
2-6.	1994 State-level Particulate Matter (PM-10) Emissions and Rank by Major Category in Alphabetical Order of State Name	2-10
2-7.	Ozone Nonattainment Areas with Approved 1990 Base Year Emissions or Areas Designated to Attainment	2-11
2-8.	Predominant Industries Listed Among the Top 50 Plants from AIRS/AFS	2-12
2-9.	Top 50 AIRS/AFS Plants Emitting Carbon Monoxide - 1994	2-13
2-10.	Top 50 AIRS/AFS Plants Emitting Nitrogen Oxides - 1994	2-14
2-11.	Top 50 AIRS/AFS Plants Emitting Volatile Organic Compounds - 1994	2-15
2-12.	Top 50 AIRS/AFS Plants Emitting Sulfur Dioxide - 1994	2-16
2-13.	Top 50 AIRS/AFS Plants Emitting Sulfur Dioxide from Industrial Sources - 1994	2-17
2-14.	Top 50 AIRS/AFS Plants Emitting Particulate Matter (PM-10) - 1994	2-18
2-15.	Top 50 AIRS/AFS Plants Emitting Lead - 1994	2-19
3-1.	Total National Emissions of Carbon Monoxide, 1940 through 1994	3-11
3-2.	Total National Emissions of Nitrogen Oxides, 1940 through 1994	3-12
3-3.	Total National Emissions of Volatile Organic Compound Emissions, 1940 through 1994	3-13
3-4.	Total National Emissions of Sulfur Dioxide, 1940 through 1994	3-14
3-5.	Total National Emissions of Particulate Matter (PM-10), 1940 through 1994	3-15
3-6.	Total National Emissions of Lead, 1970 through 1994	3-16
3-7.	Carbon Monoxide Emission Standards, 1970 to Present	3-17
3-8.	Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Vehicles	3-17
3-9.	Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Trucks	3-18
4-1.	10 U.S. Environmental Protection Agency Administrative Regions	4-2
4-2.	Seasonal Emissions for Carbon Monoxide, 1985 through 1994	4-3
4-3.	Seasonal Emissions for Nitrogen Oxides, 1985 through 1994	4-4
4-4.	Seasonal Emissions for Volatile Organic Compounds, 1985 through 1994	4-5
5-1.	National Carbon Monoxide Emissions by Source Category Projected from 1990 to 2010	5-4
5-2.	National Nitrogen Oxide Emissions by Source Category Projected from 1990 to 2010	5-5
5-3.	National Volatile Organic Compound Emissions by Source Category Projected from 1990 to 2010	5-6
5-4.	National Sulfur Dioxide Emissions by Source Category Projected from 1990 to 2010	5-7
5-5.	National Particulate Matter (PM-10) Emissions by Source Category Projected from 1990 to 2010	5-8
7-1.	1985 Canada Nitrogen Oxide Emissions by Province	7-4
7-2.	1985 Canada Volatile Organic Compound Emissions by Province	7-5
7-3.	1985 Canada Sulfur Dioxide Emissions by Province	7-6
7-4.	1990 Emissions of Common Pollutants for Canada	7-7
7-5.	CORINAIR 1985: Nitrogen Oxide Emissions	7-9
7-6.	CORINAIR 1985: Volatile Organic Compound Emissions	7-9
7-7.	CORINAIR 1985: Sulfur Dioxide Emissions	7-10
7-8.	CORINAIR90 Emissions for Austria and Bulgaria	7-11

7-9. CORINAIR90 Emissions for Belgium 7-12
7-10. CORINAIR90 Emissions for Croatia and Czech Republic 7-13
7-11. CORINAIR90 Emissions for Denmark and Estonia 7-14
7-12. CORINAIR90 Emissions for Finland and France 7-15
7-13. CORINAIR90 Emissions for Former East Germany and Former West Germany 7-16
7-14. CORINAIR90 Emissions for Greece and Hungary 7-17
7-15. CORINAIR90 Emissions for Ireland and Italy 7-18
7-16. CORINAIR90 Emissions for Latvia and Lithuania 7-19
7-17. CORINAIR90 Emissions for Luxembourg and Malta 7-20
7-18. CORINAIR90 Emissions for Netherlands and Norway 7-21
7-19. CORINAIR90 Emissions for Poland and Portugal 7-22
7-20. CORINAIR90 Emissions for Romania and Slovakia 7-23
7-21. CORINAIR90 Emissions for Slovenia and Spain 7-24
7-22. CORINAIR90 Emissions for Sweden and United Kingdom 7-25
8-1. State Total Air Emissions from TRI, 1988 to 1993 8-5
8-2. 1990 Total Benzene Emissions by Source Category 8-6
8-3. 1990 Total 1,3-Butadiene Emissions by Source Category 8-7
8-4. 1990 Total Formaldehyde Emissions by Source Category 8-8
8-5. 1990 Total Carbon Tetrachloride Emissions by Source Category 8-9
8-6. 1990 Total Perchloroethylene Emissions by Source Category 8-10
8-7. 1990 Total Methylene Chloride Emissions by Source Category 8-11
8-8. 1990 Total Trichloroethylene Emissions by Source Category 8-12
8-9. 1990 National Extractable Organic Matter Emissions 8-13
8-10. 1990 National Tetraethyl Lead and Tetramethyl Lead Emissions 8-14
8-11. 1990 National Polychlorinated Biphenyl Emissions 8-14
8-12. 1990 National Cadmium Emissions 8-15
8-13. National Anthropogenic Mercury Emissions 8-16
8-14. Selected Toxic Emission Estimates by State 8-17
10-1. Summary of U.S. Carbon Dioxide Emissions and Sinks by Source Category, 1990 to 1994 10-4
10-2. Summary of U.S. Methane Emissions by Source Category, 1990 to 1994 10-5
10-3. Summary of U.S. Nitrous Oxide Emissions by Source Category, 1990 to 1994 10-6
10-4. Emissions of Hydrofluorocarbons and Perfluorinated Carbon, 1990 to 1994 10-6
10-5. Global Carbon Dioxide Emissions 10-7
10-6. Regional Carbon Dioxide Emissions 10-9
10-7. Carbon Dioxide Emissions for the United States 10-11
10-8. Carbon Dioxide Emissions for Canada 10-12
10-9. Carbon Dioxide Emissions for Mexico 10-13
A-1. Carbon Monoxide Emissions A-2
A-2. Nitrogen Oxide Emissions A-6
A-3. Volatile Organic Compound Emissions A-10
A-4. Sulfur Dioxide Emissions A-17
A-5. Particulate Matter (PM-10) Emissions A-21
A-6. Lead Emissions A-26
A-7. United States 1990 Ammonia Emissions by Environmental Protection Agency Region A-28
B-1. Regional Emissions of Carbon Monoxide, 1985 to 1994 ..... B-2
B-2. Regional Emissions of Nitrogen Oxides, 1985 to 1994 ..... B-2
B-3. Regional Emissions of Volatile Organic Compounds, 1985 to 1994 ..... B-2
B-4. Regional Emissions of Sulfur Dioxide, 1985 to 1994 ..... B-3
B-5a. Regional Emissions of Particulate Matter (PM-10) from Point and Fugitive Process Sources, 1985 to 1994 ..... B-3
B-5b. Regional Emissions of Particulate Matter (PM-10) from Fugitive Dust Sources, 1985 to 1994 ..... B-3
B-5c. Regional Emissions of Particulate Matter (PM-10) from All Sources, 1985 to 1994 ..... B-4
B-6. Regional Emissions of Lead, 1985 to 1994 ..... B-4
C-1. Total Particulate (TSP) Emissions C-2

Figures

Page

ES-1. Trend in National Emissions, NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, SULFUR DIOXIDE (1900 to 1994), and PARTICULATE MATTER (PM-10 [nonfugitive dust sources]; 1940 to 1994) ES-6
ES-2. Trend in National Emissions, CARBON MONOXIDE (1940 to 1994), FUGITIVE DUST (1985 to 1994), and LEAD (1970 to 1994) ES-7
ES-3. Trend in National Per Capita Emissions of NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, and SULFUR DIOXIDE, 1900 to 1994 ..... ES-9
2-1. 1994 National CARBON MONOXIDE and NITROGEN OXIDE Emissions by Source Categories. 2-20
2-2. 1994 National VOLATILE ORGANIC COMPOUND Emissions by Source Categories. 2-21
2-3. Breakdown of Major 1994 National VOLATILE ORGANIC COMPOUND Emission Sources. 2-22
2-4. 1994 National SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions by Principal Source Categories. 2-23
2-5. 1994 National LEAD Emissions by Principal Source Categories. 2-24
2-6. 1994 Emission Estimates by State and Pollutant for the Top 10 States Emitting Each Pollutant 2-25
2-7. Density Maps of 1994 CARBON MONOXIDE Emissions 2-26
2-8. Density Maps of 1994 NITROGEN OXIDE and VOLATILE ORGANIC COMPOUND Emissions 2-27
2-9. Density Maps of 1994 SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions 2-28
2-10. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Classification and Major Sources 2-29
2-11. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Major Sources and Locations 2-30
2-12. Top 50 Plant Emissions as Reported to AIRS/AFS by Pollutant 2-31
3-1. Trend in CARBON MONOXIDE Emissions by 7 Principal Source Categories, 1940 to 1994 3-19
3-2. Trend in NITROGEN OXIDE Emissions by 7 Principal Source Categories, 1900 to 1994 3-19
3-3. Trend in VOLATILE ORGANIC COMPOUND Emissions by 7 Principal Source Categories, 1900 to 1994 3-20
3-4. Trend in SULFUR DIOXIDE Emissions by 6 Principal Source Categories, 1900 to 1994 3-20
3-5. Trend in PARTICULATE MATTER (PM-10) by Point and Fugitive Process Sources (1940 to 1994), and by Fugitive Dust Sources (1985 to 1994) 3-21
3-6. Trend in LEAD Emissions by 5 Principal Source Categories, 1970 to 1994 3-21
3-7. Trend in CARBON MONOXIDE Emissions for the Period 1940 to 1994 3-22
3-8. Trend in NITROGEN OXIDE Emissions for the Period 1940 to 1994 3-22
3-9. Trend in VOLATILE ORGANIC COMPOUND Emissions for the Period 1940 to 1994 3-23
3-10. Trend in SULFUR DIOXIDE Emissions for the Period 1940 to 1994 3-23
3-11. Trend in PARTICULATE MATTER (PM-10) Emissions from Point and Fugitive Processes for the Period 1940 to 1994 3-24
3-12. Trend in LEAD Emissions for the Period 1970 to 1994 3-24
3-13. Trend in On-Road CARBON MONOXIDE Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price 3-25
3-14. Trend in On-Road NITROGEN OXIDE Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price 3-25
3-15. Trend in On-Road VOLATILE ORGANIC COMPOUND Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price 3-26
3-16. Trend in On-Road LEAD Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price 3-26
3-17. Trend in NITROGEN OXIDE Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold 3-27
3-18. Trend in SULFUR DIOXIDE Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold 3-27
3-19. Trend in PARTICULATE MATTER (PM-10) Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold 3-27

3-20. Trend in Copper Production and SULFUR DIOXIDE Emissions from Copper Production 3-28
3-21. Trend in Cement Production and PARTICULATE MATTER (PM-10) Emissions from Cement Production 3-28
3-22. History of U.S. Municipal, County, and State Air Pollution Control Legislation 3-29
3-23. Criteria Air Pollutant Emissions and Pollution Abatement Expenditures 3-29
5-1. National CARBON MONOXIDE Emissions by Source Category (Projected from 1990 to 2010) 5-4
5-2. National NITROGEN OXIDE Emissions by Source Category (Projected from 1990 to 2010) 5-5
5-3. National VOLATILE ORGANIC COMPOUND Emissions by Source Category (Projected from 1990 to 2010) 5-6
5-4. National SULFUR DIOXIDE Emissions by Source Category (Projected from 1990 to 2010) 5-7
5-5. National PARTICULATE MATTER (PM-10) Emissions by Source Category (Projected from 1990 to 2010) 5-8
8-1. Toxic Release Inventory, Air Emissions Inventory 8-18
8-2. Top 10 Hazardous Air Pollutants - 1988 Basis 8-19
8-3. Toxic Release Inventory, Releases by Industry, 1988 - 1993 8-20
9-1. Seasonal Breakdown of Total 1990 Biogenic VOLATILE ORGANIC COMPOUND and NITRIC OXIDE Emissions 9-2
9-2. Density Maps of VOLATILE ORGANIC COMPOUND and NITRIC OXIDE (NO) 1990 Biogenic Emissions by County 9-3
10-1. 1950 to 1991 Global CARBON DIOXIDE Emissions from Fossil Fuel Burning, Cement Production, and Gas Flaring 10-8
10-2. Comparison of Per Capita CARBON DIOXIDE Emissions 10-10
10-3. CARBON DIOXIDE Emissions for the United States 10-11
10-4. CARBON DIOXIDE Emissions for Canada 10-12
10-5. CARBON DIOXIDE Emissions for Mexico 10-13
D-1. Density Maps of 1994 CARBON MONOXIDE Emissions D-2
D-2. Density Maps of 1994 NITROGEN OXIDE and VOLATILE ORGANIC COMPOUND Emissions D-3
D-3. Density Maps of 1994 SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions D-4
D-4. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Major Sources and Locations D-5

Acronyms and Abbreviations

2BHDDV	class 2B heavy-duty diesel vehicles
AIRS/AFS	Aerometric Information Retrieval System Facility Subsystem
ARCINFO	name of commercial Graphical User Interface (GUI) product
BEA	Bureau of Economic Analysis
BEIS	Biogenics Emissions Inventory System
BENNET	Btu Efficiency Neural Network
BLS	Bureau of Labor Statistics
Btu	British thermal unit
BUSES	buses
C_2H_6	ethane
CAA	Clean Air Act
CAAA	1990 Clean Air Act Amendments
CEC	European Commission
CEFIC	Conseil European de l'Industrie Chimique (European Chemical Industry Council)
CFC	chlorofluorocarbons
CH_4	methane
CHIEF	Clearinghouse of Inventories and Emission Factors
CITEPA	Centre Interprofessionnel Technique d'Etudes de la Polution Atmopherique (currently, the main contractor for the CORINAIR program)
CO	carbon monoxide
CO_2	carbon dioxide
CORINAIR	CORINE AIR
CORINE	COoRdination d'INformation Environnementale
CTG	Control Techniques Guidelines
DDE	p,p'-dichlorodiphenyldichlorethylene
DGXI	Directorate General Environment, Nuclear Safety and Civil Protection
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOT	U.S. Department of Transportation
EEA	European Environment Agency
EFIG	Emission Factors and Inventory Group
EFTA	European Free Trade Association
EIA	Energy Information Administration
E-GAS	Economic Growth Analysis System
EOM	extractable organic matter
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
ERCAM	Emission Reduction and Cost Analysis Model
EU-12	12 European Union countries
EUROTRAC	EUROpean experiment on TRAnsport and transformation of environmentally relevant trace Constituents in the troposphere over Europe (a scientific research program)
FCCC	Framework Convention on Climate Change
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FTP	Federal Test Procedure

GDP	Gross Domestic Product
gpm	grams per mile
GT	gas turbines
HAPs	hazardous air pollutants
HC	hydrocarbon
HCB	hexachlorobenzene
HDDT	heavy-duty diesel truck
HDDV	heavy-duty diesel vehicle
HDGT	heavy-duty gasoline truck
HDT	heavy-duty truck
HEW	Health, Education, and Welfare
HFC	hydrofluorocarbon
HHDDV	heavy heavy-duty diesel vehicle
HNO_3	nitric acid
HPMS	Highway Performance Monitoring System
IC	internal combustion
I/M	inspection and maintenance
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
JEIOG	Joint Emissions Inventory Oversight Group
kWh	kilowatt hour
L&E	Locating & Estimating (documents)
lbs	pounds
LDDT	light-duty diesel truck
LDDV	light-duty diesel vehicle
LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LDT	light-duty truck
LDV	light-duty vehicle
LHDDV	light heavy-duty diesel vehicle
LRTAP	long range transboundary air pollution
MACs	mobile air conditioners
MACT	maximum achievable control technology
MC	motorcycle
MHDDV	medium heavy-duty diesel vehicles
MOBILE5a	EPA's mobile source emission factor model
MPS	Multiple Projections System
MSA	Metropolitan statistical area
N_2O	nitrous oxide
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standards
NACE	nomenclature generale des activites economiques de la Communaute europeenne
NAPAP	National Acid Precipitation Assessment Program
nec	not elsewhere classified
NEDS	National Emissions Data System
NESHAP	National Emission Standard for Hazardous Air Pollutants
NMHC	nonmethane hydrocarbons
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NSPS	New Source Performance Standards
NSTU	Nomenclature of Statistical Territorial Units
O_3	ozone

OAQPS	Office of Air Quality Planning and Standards
OECD	Organization for Economic Cooperation and Development
OMS	Office of Mobile Sources
Pb	lead
PCB	polychlorinated biphenyl
PFC	perfluorinated carbon
PHOXA	PHotochemical OXidants study (a scientific research program)
PM-10	particulate matter less than 10 microns in aerodynamic diameter
POM	polycyclic organic matter
POTW	publicly owned treatment works
ppm	parts per million
RACT	Reasonably Available Control Technology
ROM	Regional Oxidant Model
ROP	rate of progress
RVP	Reid vapor pressure
SCC	Source Classification Code
SEDS	State Energy Data System
SIC	Standard Industrial Classification (code)
SIP	State Implementation Plan
SNAP90	source sector split
SO_2	sulfur dioxide
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF	2,3,7,8-tetrachlorodibenzofuran
TEL	tetraethyl lead
TF	task force
TML	tetramethyl lead
TP	total particulates
TPY	tons per year
TRI	Toxics Release Inventory
TSDF	treatment storage and disposal facility
TSP	total suspended particulate
TTN	Technology Transfer Network
UAM	Urban Airshed Model
UNECE	United Nations Economic Commission for Europe
UNICE	UNion des Confederations de l'Industrie et des employeurs d'Europe (union of industrial and employers' confederations of Europe)
U.S.	United States
USDA	U.S. Department of Agriculture
VMT	vehicle miles traveled
VOC	volatile organic compounds

Acknowledgement

This report was prepared with the help of many people. The EPA wishes to acknowledge the assistance of Sharon V. Nizich, Thomas McMullen, and David Mobley of the Emission Factors and Inventory Group, Mark Wolcott and Lois Platte of the Office of Mobile Sources, Bill Hohenstein of the Climate Change Division, Tom Pierce of Atmospheric Research and Exposure Assessment Lab, as well as staff at E.H. Pechan & Associates, Inc. who assisted in preparing the emission estimates and producing this report. The agency also wishes to acknowledge the data and information that were provided by numerous people from Government agencies and private institutions and organizations, especially Marc Deslauriers of Environment Canada and Gordon McInnes of the European Environmental Agency, Denmark.

Executive Summary

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national and regional emissions for criteria air pollutants:[a] carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOC), sulfur dioxide (SO_2), fine particulate matter less than 10 microns (PM-10), lead (Pb), and total suspended particulate matter (TSP [only in appendix C]). Estimates are presented for the years 1900 to 1994, with greater detail in more recent years.

National emissions are estimated annually by the EPA based on statistical information about each source category, emission factor, and control efficiency. The estimates are made for over 450 individual source categories that include all major sources of anthropogenic emissions for the years 1900 through 1984.

Note: Methodologies to estimate pre-1985 and 1985 to the present emissions differ. Differences in methodologies for allocating emissions among source categories could result in significant changes in the emissions, particularly at the more detailed source category level. CAUTION SHOULD BE EXERCISED WHEN COMPARING TRENDS FOR TOTALS OF PRE-1985 AND 1985 TO THE PRESENT YEAR VALUES.

Starting with 1985, the estimates are based on a modified National Acid Precipitation Assessment Program (NAPAP)[1] inventory. This will allow for future inclusion of emissions data compiled and submitted by individual State pollution control agencies. As these detailed source emissions data progressively replace the broader, economic-activity based emissions, the accuracy of the national and regional estimates should improve, but comparisons with previously published estimates must take into account this changing complexion of the data base. This change in methodology is only an intermediate step, however, so caution should be used when using this report for comparative purposes. More details on the changing methodology are described in chapter 6. The emissions for individual source categories are aggregated to show the emission trends at the national and regional levels and by major source category.

ES.1 EMISSIONS SUMMARY

The level and composition of economic activity in the nation, demographic influences, meteorological conditions, and regulatory efforts to control emissions affect the trends in criteria air pollutant emissions. Up until the 1950s, the greatest influence on emissions were economic and demographic. Emissions grew as the economy and population increased; emissions declined in periods of economic recession. Dramatic declines in emissions in the 1930s were due to the Great Depression. More recent recession in the mid/late-1970s (largely a result from disruptions in the world oil markets) and early 1990s also led to decreases in emissions.

Emissions also increase as a result of a shift in the demand for various products. For example, the tremendous increase in demand for refined petroleum products, especially motor gasoline after World War II, increased emissions associated with petroleum refining and on-road vehicles. Increased economic production as a result of World War II raised emissions to levels higher than those of the pre-Depression Era. The declines in the 1940s through 1970s in residential wood combustion resulted from the abundant supply, low relative prices, and convenience of fossil fuel-generated electricity.

In the 1950s the States issued air pollution statutes generally targeted toward smoke and particulate emissions. It was not until passage of the Clean Air Act (CAA) as amended in 1970 (Congress passed the original CAA in 1963) that major strides were made in reducing air pollution. The 1970 Amendments created the EPA and charged it with three major tasks: 1) set National Ambient Air Quality Standards (NAAQS); 2) develop motor vehicle emission standards; and 3) set New Source Performance Standards (NSPS). As a result of these standards, CO, NO_x, VOC, SO_2, and Pb emissions were reduced in the mid-1970s.

The 1990 Clean Air Act Amendments (CAAA) are only beginning to effect emission levels. For some source categories (such as non-road engines), standards are scheduled to begin in 1996, but significant emission reductions are not expected until after the year 2000.

Some emission sources such as wildfires and fugitive dust have been influenced more by meteorological conditions than economic forces. Controls to reduce fugitive dust emissions resulting from the CAAA are beginning to take effect, but are only applied in the particulate matter (PM) nonattainment areas (NAAs). The amount of land burned in wildfires varies greatly from year-to-year. Overall emission reductions from wildfires are a result of the U.S. Department of Agriculture's (USDA) Forest Service support of State efforts in fire prevention and early control. For example, in the year 1910, 5,201 fires burned approximately 5 million acres of land, whereas in the year 1990, 11,950 fires burned only one-third of a million acres of land.

More details on the effects of economic, demographic, and regulatory forces on emission levels are explained in chapter 3. Of special note is figure 3-23, which displays criteria air pollutant emissions versus pollutant abatement expenditures. Criteria air pollutant abatement expenditures peaked in 1986 and have declined markedly since, while pollutant emissions continue to decline. This indicates increased efficiency in reducing criteria air pollutant emissions.

The emissions resulting from these economic, demographic, and regulatory influences are presented in figures ES-1 and ES-2, and table ES-1. The changes in emissions are presented in table ES-2 for several time periods.

Figure ES-3 shows the trend in population[2] and per capita emissions for NO_x, VOC, and SO_2 over the period 1900 to 1994. Although the emission trend for these pollutants shows variability over the entire time period, figure ES-3 clearly shows that, since the initial passage of the 1970 Clean Air Act Amendments, per capita emissions have been steadily declining, with the exception of NO_x. Since 1980, NO_x emissions (on a per capita basis) have been declining.[b]

The following sections present a brief description of the changes in total emissions of each pollutant from 1940 to 1994.

ES.2 EMISSIONS SUMMARY BY POLLUTANT

ES.2.1 Carbon Monoxide Emissions

Most anthropogenic CO is generated in combustion processes. Internal combustion engines, both in on-road vehicles and in diverse non-road source uses, comprise the principal sources, contributing about 62 and 16 percent, respectively, of the estimated 98 million short tons of CO emissions in the United States in 1994. The majority of the carbon in gasoline and diesel fuel is oxidized to carbon dioxide (CO_2), a concern in its own right as a greenhouse gas (see chapter 10). A small fraction (up to 8 percent in an uncontrolled gasoline engine) is incompletely oxidized to CO, which is poisonous to humans.

The national trend in CO emissions since 1940 has been influenced primarily by changing emissions from on-road vehicles. In 1940, on-road vehicles contributed some 32 percent (30 million short tons) of the 94 million total short tons emitted; total CO emissions peaked in the early 1970s at around 130 million short tons, of which almost 69 percent (88 million short tons) came from on-road vehicles. By 1994, the national total had declined to 98 million short tons, 62 percent of which (61 million short tons) came from on-road vehicles, despite increases in vehicle miles traveled (VMT) during the same period. In other notable categories, over the same 54 year period, non-road sources engine emissions of CO increased by 94 percent and now stand at 16 percent of the total; CO from residential wood combustion decreased by 68 percent (from 11 million to 4 million short tons) and is now 4 percent of the total; the contribution from wildfires decreased 84 percent (from 25 million to 4 million short tons) and is currently 4 percent of the total.

ES.2.2 Nitrogen Oxide Emissions

Nitrogen oxides are formed during high temperature fuel combustion, principally in fossil fuel-fired electric utility and industrial boilers and in internal combustion engines. The principal components of NO_x, nitric oxide (NO) and nitrogen dioxide (NO_2), participate in the photochemical reactions producing tropospheric ozone, can be further oxidized to nitric acid (HNO_3), a component of acid rain, and can induce respiratory effects in humans and also form particulate nitrates.

From 1940 through 1970, NO_x emissions increased by over 180 percent (from 7 million to 21 million short tons). Since 1980, annual national NO_x emissions have leveled off at about 23 million short tons. In 1940, industrial fuel combustion was the largest of the four major contributors, adding 34 percent (3 million short tons) to the national total; fuel combustion by electric utilities added less than 9 percent (two thirds of a million short tons). On-road vehicles contributed 18 percent (1 million short tons); non-road sources and machinery (principally coal-fueled railroad locomotives), added 13 percent (just under 1 million short tons). By 1994, NO_x emissions from electric utilities and on-road vehicles had risen markedly, each now contributing about one third to the national total (approximately 8 million short tons each). Emissions from industrial combustion and non-road sources have risen more slowly, in fact, industrial combustion emissions are now about 26 percent below their 1940 level; each now comprises about 13 percent (approximately 3 million short tons each) of the national total for NO_x.

ES.2.3 Volatile Organic Compound Emissions

Volatile organic compounds[c] are a principal component in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants. Emissions of VOC increased for the nation from 1900 to 1970, peaking in the early 1970s, but have decreased steadily until 1992 with a slight increase in 1993 and 1994. Some categories have increased while others have decreased. Variability of emission levels is based on pollution controls, population, and economic factors. For instance, in 1900, emissions from all fuel combustion sources represented 68 percent of the total national VOC emissions, but by 1994 the contribution was 4 percent. These decreases, occurring despite large population growth, are due to increased controls on the burning of fossil fuels for utilities and industry. While emissions of petroleum product storage and marketing operations increased during the mid-1970s as a result of increased demand for petroleum products, especially motor gasoline, emissions from these sources began to decrease after 1978 as a result of more effective control measures. Another reason for the overall decrease in the emissions between 1970 and

1994 is the substitution of water-based emulsified asphalt for asphalt liquified with petroleum distillates.

With the advent of wider use of the automobile and aircraft, VOC emissions for transportation sources increased 159 percent from 1940 to 1970. After 1970, the Federal Motor Vehicle Control Program (FMVCP) initiative resulted in a drastic decline in vehicle emissions, even with the enormous increase in VMT. From 1970 to 1994, on-road vehicle emissions dropped approximately 51 percent. Inspection/maintenance, reformulated fuels programs, and other control programs are expected to contribute to a continuing decline in emission rates for on-road vehicles, despite increasing VMT.

ES.2.4 Sulfur Dioxide Emissions

The majority of SO_2 emissions are from the combustion of fossil-fuels containing sulfur. Various particulate sulfate compounds can be formed, as well. Once emitted into the atmosphere, SO_2 can be further oxidized to sulfuric acid, a component of acid rain.

In 1940, national SO_2 emissions were almost 20 million short tons. In the early 1970s, the total reached some 31 million short tons; by 1994 it had declined again to approximatelythe 1940 level. In 1940, the major contributor was industrial fuel combustion, producing 30 percent (6 million short tons) of the total. The next three ranking categories were "other combustion sources" (consisting primarily of residential and commercial coal furnaces), 18 percent (4 million short tons), metals refining and processing, and non-road sources (largely coal-fueled locomotives), each adding about 16 percent (some 3 million short tons each). Fifth among the major categories was electric power generation; coal-fueled steam generators added about 12 percent (2 million short tons) to the national total of SO_2 emissions.

By 1994, decreases were seen in the first four categories in varying degrees. Emissions of SO_2 from electric power generation, on the other hand, rose markedly with the demand for electric power; by the 1970s, SO_2 emissions from electric utilities had increased sevenfold and dominated the national total at 56 percent (17 million short tons). By 1994, the electric utility companies had installed emission controls and/or switched to low sulfur fuels, reducing their emissions to under 15 million short tons, but because of reductions in other categories as well, electric utilities now constitute some 70 percent of the total national SO_2 emissions. The second ranking contributor is the industrial combustion category at 14 percent (3 million short tons). The remaining three categories that were significant in 1940 each now account for 3 percent or less of the national total ($\leq$ 0.7 million short tons each).

ES.2.5 Particulate Matter (PM-10) Emissions

Air pollutants called particulate matter include dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust as well as particles formed in the atmosphere by condensation or transformation of emitted gases such as VOC and SO_2.

On July 1, 1987 EPA promulgated new annual and 24-hour standards for particulate matter using a new indicator, PM-10, that includes only those particles with an aerodynamic diameter smaller than 10 micrometers. These smaller particles are likely responsible for most adverse health effects of particulate because of their ability to reach the thoracic or lower regions of the respiratory tract. Because of the new standard, EPA now only reports TSP in appendix C of this report. Unless otherwise noted, all references in this report to particulate matter emissions are for PM-10. Trends in the PM-10 portion of historically inventoried point and area (generally from sources referred to as "Point and Fugitive Processes") particulate matter emissions are presented for the years 1940 to 1994 in this report. National emissions are also provided for PM-10 fugitive dust emissions[d] from 1985 to 1994. In total, these fugitive emissions are 10 to 13 times more than the historically inventoried categories.

In 1940, emissions from fuel combustion represented 25 percent of the total national PM-10 emissions. Despite continuing increases in coal consumption, PM-10 emissions from electric utilities decreased after 1970, as a result of installing air pollution control equipment required by new facilities constructed in the 1970s. Fuel combustion sources contributed 24 percent to the total national emissions from historically inventoried sources in 1970, and 28 percent in 1994. In 1940, emissions from transportation emissions accounted for 17 percent of the total national PM-10 emissions from historically inventoried. Railroad and on-road vehicles represented 15 and 1 percent, respectively, of the 1940 emissions from historically inventoried sources. From 1940 to 1994, railroad emissions have decreased by 98 percent. In contrast, emissions from on-road vehicles have increased 48 percent. In 1994 emissions from the transportation sources represented 2 percent of the total national PM-10 emissions and 19 percent of PM-10 emissions from historically inventoried sources.

The PM-10 emissions from industrial processes increased from 1940 through 1950, primarily as a result of increases in industrial production. From 1950 to 1970, industrial output continued to grow, but the emissions from industrial processes decreased due to the installation of pollution control equipment mandated by air pollution control programs. The reduction of emissions by these control devices more than offset the increase in emissions due to production increases. In 1970, industrial processes contributed 59 percent to the total national PM-10 emissions, while in 1994, this source contributed 2 percent to total national PM-10 emissions (18 percent of emissions from historically inventoried sources), thus indicating considerable progress in reducing emissions. In 1940, wildfires contributed 14 percent to the total national emissions, but in 1994 this source contributed only 1 percent to the total.

The PM-10 emissions from fugitive dust sources increased by 2 percent from 1985 to 1994. Particulate matter (PM-10) emissions due to wind erosion are very sensitive to regional soil conditions and year-to-year changes in total precipitation and wind speeds. For example, the total national emissions from wind erosion in 1993 are estimated to be 2 million short tons, compared to 18 million short tons in 1988. The lack of precipitation in 1988 prior to spring crop planting, especially in the central and western United States, contributed to greater wind erosion for that year. In 1993, unusually heavy spring rains in Kansas and Oklahoma, where wind erosion is normally very significant, resulted in a 57 percent decrease in the wind erosion emissions from the previous year.

ES.2.6 Lead Emissions

Lead gasoline additive, nonferrous smelters, and battery plants are the most significant contributors to atmospheric Pb emissions. Total Pb emissions from all sources dropped from 219 thousand short tons in 1970 to 5 thousand short tons in 1994. The decrease in lead emissions from on-road vehicles accounts for essentially all of this drop. The reasons for this drop are noted in chapter 3.7.3 of this report.

Electric utility, industrial, and other fuel combustion emissions in 1970 represented 5 percent of the total national Pb emissions. The Pb emissions decreased by 95 percent from 1970 to 1994. By 1994, fuel combustion emissions accounted for 10 percent of the total emissions. Industrial processes in 1970 represented 12 percent of the total national Pb emissions. The industrial emissions decreased by 92 percent from 1970 to 1994. By 1994, industrial process estimates accounted for 41 percent of the total emissions. Emissions from highway vehicles accounted for 78 percent of the total emissions in 1970. Total national Pb emissions decreased sharply from 1970 to 1986 as a result of the widespread use of catalytic converters on automobiles to reduce CO, NO_x, and VOC emissions and the use of unleaded gasoline for vehicles with these converters. From 1975 to 1994, the percent of unleaded gasoline sales increased from 13 to 99 percent, while the Pb emissions from on-road vehicles decreased from 130 thousand short tons in 1975 to 1 thousand short tons in 1994, or about 99 percent. In 1994, on-road vehicle emissions accounted for 28 percent of the total national Pb emissions. The 1993 and 1994 emissions have increased as a result of increased production and processing by industry and increased consumption by electric utilities.

ES.3 CURRENT NONATTAINMENT AREAS

The numbers of areas designated in nonattainment of air quality standards, as of mid-1995, are listed in table ES-3. This list provides information on how the States are meeting their goals set forth in Title I of the CAAA. As State data are federally approved for these NAAs, they will be incorporated into the 1996 *Trends* Report.

ES.4 REFERENCES

1. *The 1985 NAPAP Emissions Inventory (Version 2): Development of the Annual Data and Modeler's Tapes.* EPA-600/7-89-012a. U.S. Environmental Protection Agency, Research Triangle Park, NC. November 1989.
2. *National Data Book and Guide to Sources, Statistical Abstract of the United States - 1993.* U.S. Department of Commerce, Bureau of the Census, Washington, DC. 1989.
3. *Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980.* EPA-600/7-85-009a and b. U.S. Environmental Protection Agency, Cincinnati, OH. April 1985.
4. *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985.* EPA-600/7-88-008a. U.S. Environmental Protection Agency, Cincinnati, OH. May 1988.

---

[a] The CAA requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, NAAQS are set at levels which, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. These regulated pollutants are therefore referred to as "criteria pollutants."

[b] Please note that the apparently encouraging downward trend is probably due as much to the increase in population as to the decrease in emissions.

[c] It should be noted that EPA's definition of VOC (40CFR51.100) excludes methane (CH_4), ethane (C_2H_6), and certain other nonphotochemically reactive organic compounds.

[d] Fugitive dust, as discussed in this chapter, refers to the source categories as listed in table 3-5 and table A-5 of miscellaneous - fugitive dust, miscellaneous - agriculture & forestry, and natural sources - wind erosion.

Figure ES-1. Trend in National Emissions, NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, SULFUR DIOXIDE (1900 to 1994), and PARTICULATE MATTER ([PM-10]: nonfugitive dust sources; 1940 to 1994)

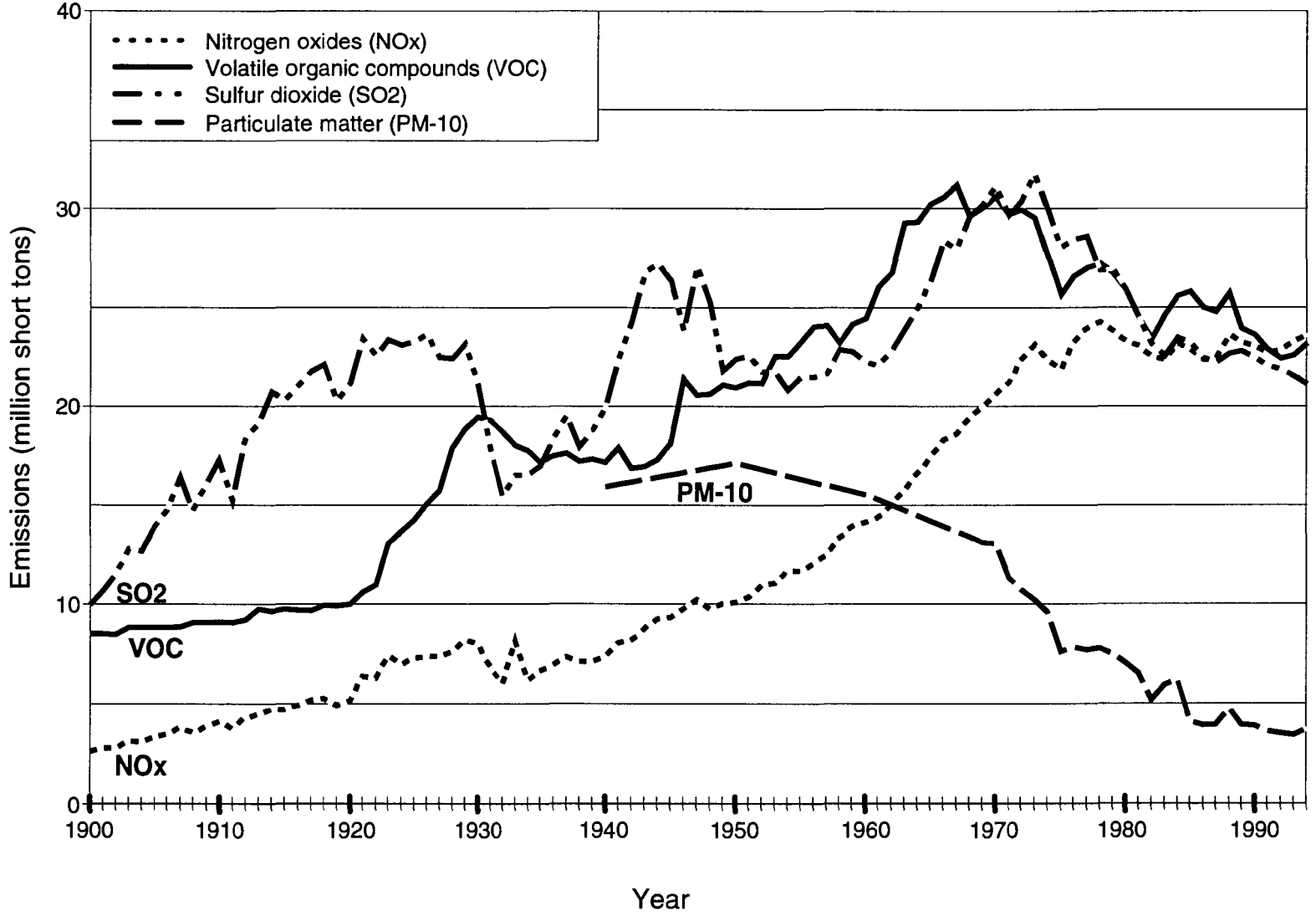
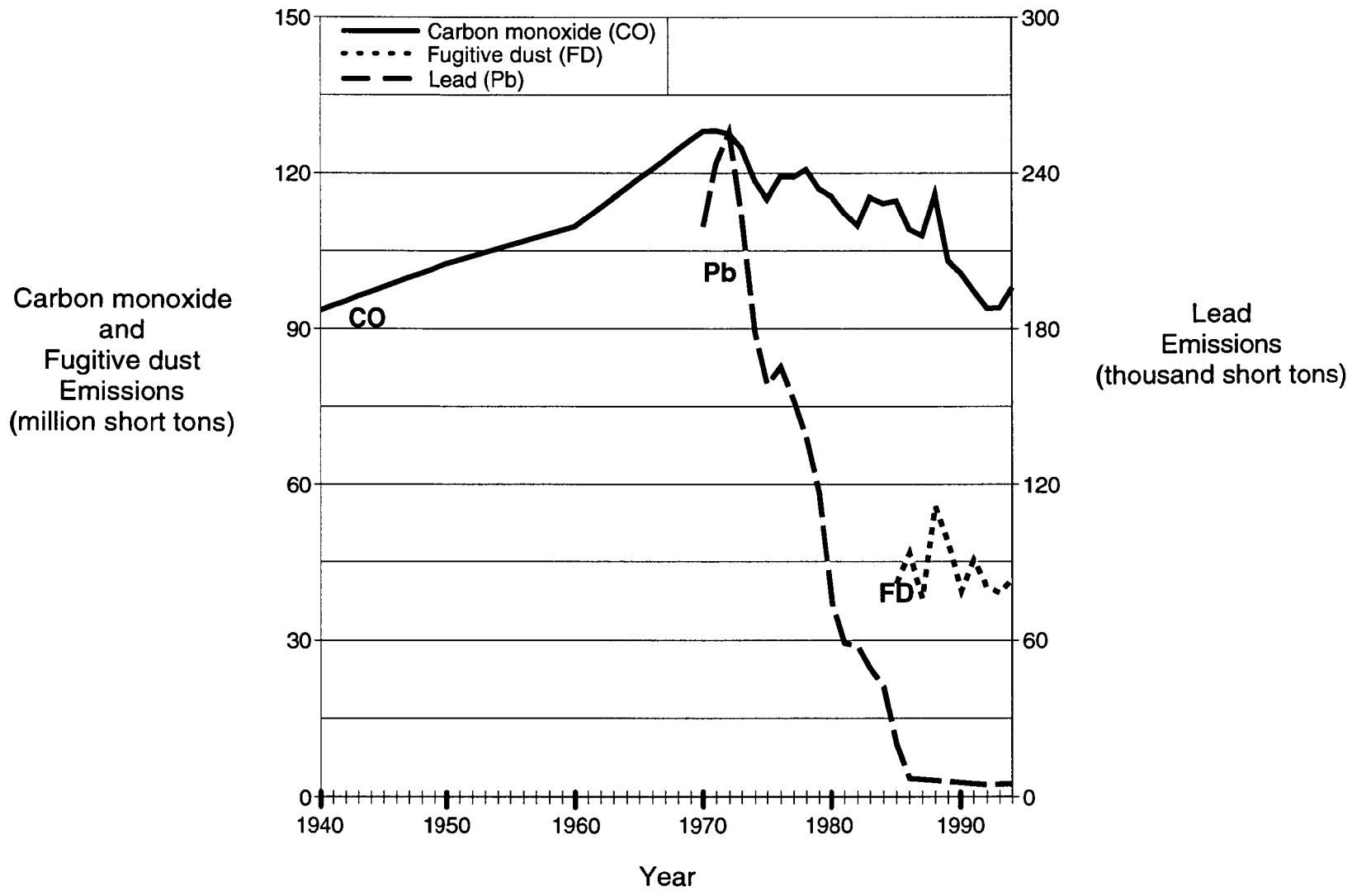


Figure ES-2. Trend in National Emissions, CARBON MONOXIDE (1940 to 1994), FUGITIVE DUST (1985 to 1994), and LEAD (1970 to 1994)



Note(s): Fugitive dust emissions include natural source-wind erosion, miscellaneous-agriculture & forestry, and miscellaneous-fugitive dust sources.

Table ES-1. Summary of National Emissions

(thousand short tons, 1.1 million short tons equals 1 million metric tons)

Year	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM-10) w/o fugitive dust	Fugitive Dust (PM-10)*	Lead (short tons)
1900**	NA***	2,611	8,503	9,988	NA	NA	NA
1905**	NA	3,314	8,850	13,959	NA	NA	NA
1910**	NA	4,102	9,117	17,275	NA	NA	NA
1915**	NA	4,672	9,769	20,290	NA	NA	NA
1920**	NA	5,159	10,004	21,144	NA	NA	NA
1925**	NA	7,302	14,257	23,264	NA	NA	NA
1930**	NA	8,018	19,451	21,106	NA	NA	NA
1935**	NA	6,639	17,208	16,978	NA	NA	NA
1940	93,615	7,374	17,161	19,953	15,956	NA	NA
1945****	98,112	9,332	18,140	26,373	16,545	NA	NA
1950	102,609	10,093	20,936	22,358	17,133	NA	NA
1955****	106,177	11,667	23,249	21,453	16,346	NA	NA
1960	109,745	14,140	24,459	22,227	15,558	NA	NA
1965****	118,912	17,424	30,247	26,380	14,198	NA	NA
1970*****	128,079	20,625	30,646	31,161	13,044	NA	219,471
1975	115,110	21,889	25,677	28,011	7,617	NA	158,541
1980	115,625	23,281	25,893	25,905	7,050	NA	74,956
1984	114,262	23,172	25,572	23,470	6,220	NA	42,217
1985******	114,690	22,860	25,798	23,230	4,094	40,889	20,124
1986	109,199	22,348	24,991	22,442	3,890	46,582	7,296
1987	108,012	22,403	24,778	22,204	3,931	38,041	6,857
1988	115,849	23,618	25,719	22,647	4,750	55,851	6,513
1989	103,144	23,222	23,935	22,785	3,927	48,650	6,034
1990*******	100,650	23,038	23,599	22,433	3,882	39,451	5,666
1991*******	97,376	22,672	22,877	22,068	3,594	45,310	5,279
1992*******	94,043	22,847	22,420	21,836	3,485	40,233	4,899
1993*******	94,133	23,276	22,575	21,517	3,409	39,139	4,938
1994*******	98,017	23,615	23,174	21,118	3,705	41,726	4,956

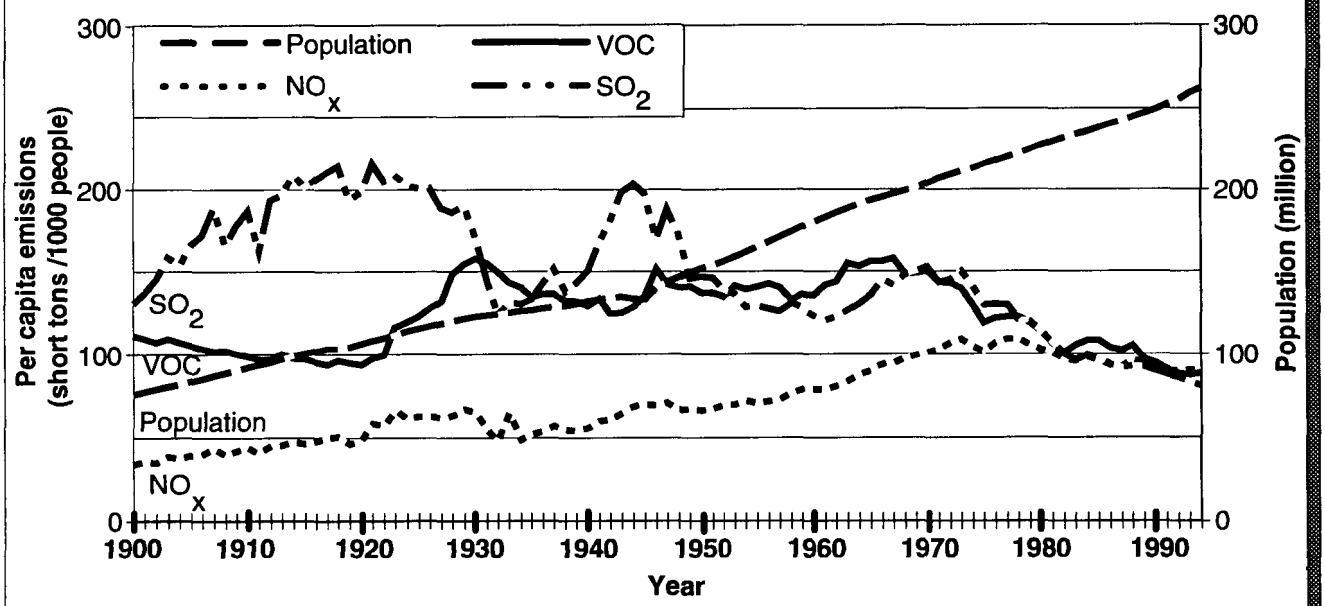
Note(s):
- * Fugitive dust emissions not estimated prior to 1985. They include miscellaneous-agriculture & forestry, miscellaneous-fugitive dust, and natural sources-wind erosion.
- ** NAPAP historical emissions[3,4]
- *** NA denotes not available.
- **** Combination of revised transportation values and NAPAP historical emissions.
- ***** There is a change in methodology for determining on-road vehicle and non-road sources emissions (see chapter 6).
- ****** There is a change in methodology in all sources except on-road vehicles and non-road sources and all pollutants except lead, as reflected by the dotted line.
- ******* 1990 through 1994 estimates are preliminary. The emissions can be converted to metric tons by multiplying the values by 0.9072.

Table ES-2. Percentage Change in National Emissions

Year	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM-10)	Fugitive Dust*	Lead
1900 to 1994	NA**	805	173	111	NA	NA	NA
1940 to 1994	5	220	.5	6	-77	NA	NA
1970 to 1994	-23	14	-24	-32	-72	NA	-98
1984 to 1994	-14	2	-9	-10	-40	NA	-88
1990 to 1994	-3	3	-2	-6	-5	6	-13
1993 to 1994	4	1	3	-2	9	7	0

Note(s): * Fugitive dust includes miscellaneous-agriculture & forestry, miscellaneous-fugitive dust, and natural sources-wind erosion.
** NA denotes not available. *1990 to 1994 estimates are preliminary; negative percent change indicates a decrease.*

Figure ES-3. Trend in National Per Capita Emissions of NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, and SULFUR DIOXIDE, 1900 to 1994



Note(s): The apparent encouraging downward trend in emissions is probably due as much to an increase in population as to the decrease in emissions
Source: U.S. Department of Commerce's Statistical Abstract of the United States.

Table ES-3. Current Nonattainment Areas

Category	As of 1990 CAAA*	Areas Added or Subtracted	In Attainment	Current	Redesignation Status**
OZONE	**98**			**82**	
Serious and above	24	-1***	-1	22	1996-2010, area dependent
Moderate	31	+1***	-4	28	1996
Marginal	43		-11	32	Currently in process of redesignation to attainment
Unclassified	59		-5	54	
CO	**42**			**41**	
Serious	1	+1****		2	2000
Moderate	41	+9	-11	39	1996
Unclassified	34	-2*****	-1	31	
PM10	**70**			**83**	
Serious				6	10 years from nonattainment designation
Moderate				64	4 years from nonattainment designation
Moderate		+13		13	6 years from nonattainment designation
SO_2	**51**	**3**	**-5**	**49**	5 years from nonattainment designation
Pb	**12**	**+1**		**13**	5 years from nonattainment designation
Unclassified				9	

Note(s):
- * Column presents original number in nonattainment as of passage of the CAAA.
- ** Column presents expected dates that areas will be in attainment.
- *** One ozone area redesignated from Serious to Moderate.
- **** One CO area redesignated from Moderate to Serious.
- ***** Two unclassified CO areas redesignated Moderate.

Chapter 1.0 Introduction

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national emissions for criteria air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs [excludes certain nonreactive organic compounds]), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM-10), lead (Pb), and total suspended particulate matter (TSP [only in appendix C]). The Clean Air Act (CAA) requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria documents are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards (NAAQS) are set at levels that, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. Regulated pollutants are therefore referred to as "criteria pollutants." Some of the health effects are described in section 1.1.

Criteria pollutant emissions are presented through this report since 1900 with increasing detail in the current year. This report also contains information on the improved methodology for estimating emissions from 1985 to the present. Revised international emissions from Europe and Canada, air toxic emissions, and biogenic emissions are also presented.

1.1 HEALTH EFFECTS

Carbon monoxide enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected but only at higher levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.[1]

Nitrogen dioxide (NO_2) can irritate the lungs and lower resistance to respiratory infection (such as influenza). Nitrogen oxides are an important precursor both to ozone and to acidic precipitation and may affect both terrestrial and aquatic ecosystems. Atmospheric deposition of NO_x is a potentially significant contributor to ecosystem effects including algal blooms in certain estuaries such as the Chesapeake Bay. In some western areas, NO_x is an important precursor to particulate concentrations.[2]

Volatile organic compounds are a principal component in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants. The reactivity of ozone (O_3) causes health problems because it damages biological tissues and cells. Ozone is also responsible each year for agricultural crop yield loss in the United States of several billion dollars and causes noticeable foliar damage in many crops and species of trees. Forest and ecosystem studies indicate that damage is resulting from current ambient O_3 levels.[3]

The major health effects of concern associated with exposures to high concentrations of SO_2 include effects on breathing, respiratory illness and symptoms, alterations in the lung's defenses, aggravation of existing respiratory and cardiovascular disease, and mortality. Children and the elderly may also be sensitive. Also, SO_2 can produce foliar damage on trees and agricultural crops. Together NO_x and SO_2 are the major precursors to acidic deposition (acid rain), which is associated with a number of effects including acidification of lakes and streams, accelerated corrosion of buildings and monuments, and visibility impairment.[4]

Based on studies of human populations exposed to ambient particle pollution (sometimes in the presence of SO_2), and laboratory studies of animals and humans, the major effects of concern for human health include effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature mortality. Particulate matter causes damage to materials and soiling; it is a major cause of substantial visibility impairment in many parts of the United States.[4]

Exposure to Pb can occur through multiple pathways, including inhalation of air, diet and ingestion of Pb in food, water, soil, or dust. Lead accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, Pb also affects the kidneys, liver, nervous system, and blood-forming organs. Excessive exposure to Pb may cause neurological impairments such as seizures, mental retardation and/or behavioral disorders. Even at low doses, Pb exposure is associated with changes in fundamental enzymatic, energy transfer and homeostatic mechanisms in the body. Fetuses, infants, and children are especially susceptible to low does of Pb, often suffering central nervous system damage. Recent studies have also shown that Pb may be a factor in high blood pressure and subsequent heart disease in middle-aged caucasian males.[5]

1.2 REPORT ENHANCEMENTS

Since 1973, EPA has prepared estimates of annual national emissions in order to assess historic trends in criteria pollutant emissions. While these estimates were prepared using consistent methodologies and were useful for evaluating emission changes from year to year, they did not provide an absolute indication of emissions for any given year. Beginning with the 1900 to 1992 report (published in October 1993), EPA established a goal of preparing emission trends that would also represent the best available annual estimates of emissions.[e]

The EPA's Emission Factors and Inventory Group (EFIG) is developing procedures and criteria for replacing *Trends* emissions data with O_3 State Implementation Plan (SIP) submitted data. The 1996 report will contain the resulting 1990 Base Year Inventory that consists of State data for nonattainment areas (NAAs) and EPA-generated data for all other areas.

The EFIG is also developing a data management and reporting system of emissions data. When the system is complete, the EFIG will be able to extract the most current State inventories of emissions and supplement the gaps with EPA-generated attainment area emission inventories. The EFIG has already made several changes to the *Trends* methodology to make the transition smoother.

In this report, there are three distinct time periods: 1900 to 1939, 1940 to 1984, and 1985 forward. Since the accuracy and availability of historical data is limited, revisions to earlier years' estimates are not generally made (pre-1984 [some exceptions are discussed in chapter 6]). However, numerous changes in current year totals will be incorporated into the reported estimates using SIP and modeling data as it becomes available. Please note that methodologies within a given time period (especially more recent periods) will also vary, as more accurate data are included in the *Trends* data base.

Although there are many changes to the *Trends* methodology, some methods have remained constant. For example, the 1900 through 1939 NO_x, VOC, and SO_2 estimates are extracted from the NAPAP historical emissions report.[6,7] In addition, Pb estimates (1970 to present), and all CO, NO_x, VOC, SO_2, and PM-10 estimates from 1940 to 1984 reported in *Trends* are based upon the previous national "top-down" methodology. Below is a summary of the changes made this past year in support of achieving EPA's goal of preparing the best available annual estimates of emissions.

The SO_2 and PM-10 on-road emissions were revised by utilizing EPA's Office of Mobile Sources (OMS) emission factor model, PART5. This model was also used to improve the PM-10 fugitive dust paved and unpaved road emissions. To improve the residential wood combustion emissions, an EPA model for determining residential wood consumption at the county level is used. The wildfire emissions are updated by incorporating estimates prepared by the U.S. Department of Agriculture (USDA) for the 10 western States in the Grand Canyon Visibility Transport Region. The PM-10 control efficiencies and particle size distributions for point sources are also revised. Chapter 6 describes exceptions to the methodologies listed above, and modifications made to previous *Trends* emission estimates.

1.3 REPORT STRUCTURE

Changes instituted in the format of last year's report, intended to make the report more comprehensible and informative, are maintained for this report. The executive summary presents a brief overview of each chapter of the report. In the introduction, chapter 1, the reader is informed of changes to the report, the health effects of criteria air pollutants, and the structure of the report. A detailed account of the current year emissions by pollutant, source category, State, NAA, county, and season and by a listing of top-emitting facilities is given in chapter 2. Chapter 2 also discusses the reasons why emissions increased for all criteria pollutants except SO_2. National trends in emissions from 1900 (where available) to the current year and demographic, economic, and regulatory influences on emission trends are discussed in chapter 3. Regional trends in emissions from 1985 through the current year are presented in chapter 4. The total emission projections for the nation from 1996 to 2010 are reported in chapter 5. An explanation of the methodologies used to estimate emissions is found in chapter 6. Emissions from sources, noncriteria pollutants, or countries not traditionally part of the *Trends* report are displayed in chapters 7, 8, and 10. These emissions were developed by the EPA and other governmental agencies. Biogenic NO_x and VOC emissions are presented in chapter 9. In each of the chapters, numeric superscrips represent references and alphabetic superscripts represent endnotes.

As in last year's report, all emissions reported in tables and figures in the body of the report are in multiples of thousand short tons, except Pb.[f] The pollutants are presented in the order of CO, NO_x, VOC, SO_2, PM-10, and Pb throughout this report. Emissions were developed at the county and Source Classification Code (SCC) level for the years 1985 to 1994 for most source categories. These emissions were then summed to the national Tier level. There are four levels in the tier categorization. The first and second level, respectively referred to as Tier 1 and Tier 2, are the same for each of the six criteria pollutants. The third level, Tier 3, is unique for each of the six pollutants. The fourth level, Tier 4, is the SCC level. The match-up between SCC and all three tier levels is located on EPA's Office of Air Quality Planning and Standards' (OAQPS) Technology Transfer Network (TTN), Clearinghouse for Inventories and Emission Factors (CHIEF) electronic bulletin board. Table 1-1 lists the Tier 1 and Tier 2 categories used in chapters 1 through 6 to present the emission estimates. Tables and figures appear at the end of each chapter in the order in which they are discussed within the chapter. Appendix A contains tables listing emissions for each of the criteria pollutants and ammonia by Tier 3 source categories. If emissions are reported as zero, the emissions are less than 0.5 thousand tons (or 0.5 tons for Pb). "NA" indicates that the

apportionment of the historic emissions to these subcategories is not possible. If a tier category does not appear, then emissions are not currently estimated for that category (either EPA estimates the emissions as zero or does not currently estimate the emissions due to time or resource limitations). The State total emissions for each of the criteria pollutants except Pb are located in appendix B. Lead emissions are presented at the regional level in appendix B. The PM-10 fugitive dust emissions are also shown separately by State. Emissions of TSP (calculated in the 1993 *Trends* Report and not updated since) by Tier 3 source categories are presented in appendix C while black and white copies of some county-level color maps in chapter 2 are presented in appendix D.

Emissions of NO_x are expressed as weight-equivalent NO_2. Thus, the actual tons of NO emitted have been inflated to report them as if they were NO_2. The molecular weight of NO_x should therefore be assumed to be that of NO_2 when using numbers in this report.[g] The VOC emissions are reported as the actual weight of a multitude of different compounds. The relative amounts of the individual compounds emitted will determine the average molecular weight of a given source category's emissions. Therefore, no equivalent molecular weight standard exists for VOC. The VOC emissions referred to in this report exclude those organic compounds which are considered negligibly photochemically reactive, in accordance with the EPA definition of VOC at 40CFR51.100. Thus, methane (CH_4), ethane (C_2H_6), and certain other organic compounds are not included in the VOC totals.

1.4 REFERENCES

1. *Air Quality Criteria for Carbon Monoxide.* EPA/600/8-90/045F (NTIS PB93-167492). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
2. *Air Quality Criteria for Oxides of Nitrogen.* EPA/600/8-91/049aF-cF.3v. Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1993.
3. *Air Quality Criteria for Ozone and Other Photochemical Oxidants.* EPA/600/8-84/020aF-eF.5v (NTIS PB87-142949). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
4. *Air Quality Criteria for Particulate Matter and Sulfur Oxides.* EPA/600/8-82/029aF-cF.3v (NTIS PB84-156777). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
5. *Air Quality Criteria for Lead.* EPA/600/8-83/028aF-dF.4v (NTIS PB87-142378). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
6. *Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980.* EPA-600/7-85-009a and b. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1985.
7. *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985.* EPA-600/7-88-008a. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1988.

[e] All data are estimates only, true values of emissions are not known.

[f] Lead emissions are measured in short tons. Short tons can be converted to metric tons by dividing the emissions by a factor of 1.1023.

[g] When stating nitrogen oxide emissions, the author is referring to emissions of nitrogen oxides (NO_x).

Table 1-1. Major Source Categories

TIER 1 CODE*	TIER 1 NAME	TIER 2 CODE	TIER 2 NAME
01	FUEL COMBUSTION-ELECTRIC UTILITIES		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
02	FUEL COMBUSTION-INDUSTRIAL		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
03	FUEL COMBUSTION-OTHER		
		01	Commercial / Institutional Coal
		02	Commercial / Institutional Oil
		03	Commercial / Institutional Gas
		04	Misc. Fuel Combustion (except residential)
		05	Residential Wood
		06	Residential Other
04	CHEMICAL & ALLIED PRODUCT MFG.		
		01	Organic Chemical Mfg.
		02	Inorganic Chemical Mfg.
		03	Polymer & Resin Mfg.
		04	Agricultural Chemical Mfg.
		05	Paint, Varnish, Lacquer, Enamel Mfg.
		06	Pharmaceutical Mfg.
		07	Other Chemical Mfg.
05	METALS PROCESSING		
		01	Nonferrous
		02	Ferrous
		03	Metals Processing not elsewhere classified (NEC)
06	PETROLEUM & RELATED INDUSTRIES		
		01	Oil & Gas Production
		02	Petroleum Refineries & Related Industries
		03	Asphalt Manufacturing
07	OTHER INDUSTRIAL PROCESSES		
		01	Agriculture, Food, & Kindred Products
		02	Textiles, Leather, & Apparel Products
		03	Wood, Pulp & Paper, & Publishing Products
		04	Rubber & Miscellaneous Plastic Products
		05	Mineral Products
		06	Machinery Products
		07	Electronic Equipment
		08	Transportation Equipment
		09	Construction
		10	Miscellaneous Industrial Processes
08	SOLVENT UTILIZATION		
		01	Degreasing
		02	Graphic Arts
		03	Dry Cleaning
		04	Surface Coating
		05	Other Industrial
		06	Nonindustrial
		07	Solvent Utilization (nec**)
09	STORAGE & TRANSPORT		
		01	Bulk Terminals & Plants
		02	Petroleum & Petroleum Product Storage
		03	Petroleum & Petroleum Product Transport
		04	Service Stations: Stage I
		05	Service Stations: Stage II
		06	Service Stations: Breathing & Emptying
		07	Organic Chemical Storage
		08	Organic Chemical Transport
		09	Inorganic Chemical Storage
		10	Inorganic Chemical Transport
		11	Bulk Materials Storage
		12	Bulk Materials Transport
10	WASTE DISPOSAL & RECYCLING		
		01	Incineration
		02	Open Burning
		03	Publicly Owned Treatment Works
		04	Industrial Waste Water
		05	Treatment Storage and Disposal Facility
		06	Landfills
		07	Other
11	ON-ROAD VEHICLES		
		01	Light-Duty Gasoline Vehicles & Motorcycles
		02	Light-Duty Gasoline Trucks
		03	Heavy-Duty Gasoline Vehicles
		04	Diesels
12	NON-ROAD VEHICLES		
		01	Non-road Gasoline
		02	Non-road Diesel
		03	Aircraft
		04	Marine Vessels
		05	Railroads
13	NATURAL SOURCES		
		01	Biogenic
		02	Geogenic (wind erosion)
		03	Miscellaneous (lightning/freshwater/saltwater)
14	MISCELLANEOUS		
		01	Agriculture & Forestry
		02	Other Combustion (wildfires)
		03	Catastrophic / Accidental Releases
		04	Repair Shops
		05	Health Services
		06	Cooling Towers
		07	Fugitive Dust

Note(s): * Code numbers are presented for The Representative Emissions National Data System (TRENDS) user.
The Source Classification Code (SCC) definitions and assignment to Tier category are available on the Technology Transfer Network's (TTN [919-541-5742]) Emission Inventories/Emission Factors Information (CHIEF) Technical Information Area.
**not elsewhere classified.

Chapter 2.0 Summary of 1994 Emissions

Although the EPA has produced an annual estimate of emission trends since 1973, this report is the third in a series which presents emissions at the State, O_3 NAA, and seasonal level for CO, NO_x, VOC, and SO_2 for the current year. This report presents PM-10 for the second year at the same level of detail as CO, NO_x, VOC, and SO_2. The more detailed information (State, county, and NAA) is presented for the current year of emissions. The 14 major source categories for which emissions are presented are: fuel combustion-electric utilities, fuel combustion-industrial, fuel combustion-other, chemical and allied product manufacturing, metals processing, petroleum and related industries, other industrial processes, solvent utilization, storage and transport, waste disposal and recycling, on-road vehicles, non-road sources, natural sources, and miscellaneous (see also table 1-1).

The 1994 emissions of Pb were estimated by the same methodology used to produce the 1993 emissions in the last report.[1] The 1994 estimates are based on extending the trend of the Pb activity data from previous years (details are provided in chapter 6), which are then multiplied by the current emission factors and control efficiencies. This methodology makes estimating State and seasonal emissions very resource intensive; therefore, only national emissions are presented here.

This report is the fourth in a series that tracks the changes in the top-emitting sources from the Aerometric Information Retrieval System Facility Subsystem (AIRS/AFS) of CO, NO_x, VOC, and SO_2 emissions and the third in a series that tracks PM-10, Pb, and industrial SO_2. The AIRS/AFS was used to determine the types of plants that emit large quantities of criteria pollutants. Emissions were extracted from AIRS/AFS using an ad hoc report[2] which excluded plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error after conferring with appropriate State and EPA Region personnel.

2.1 EMISSIONS FOR 1994 BY SOURCE CATEGORY

The 1994 emissions of all criteria pollutants except Pb were calculated using one of four major methodologies depending on the source category. These estimates were generated using a similar manner as in the previous report. The exceptions are detailed in chapter 6. The methodology differs for on-road vehicles, electric utilities, fugitive dust, and all other sources. Estimation methods are similar to the methodologies used to produce the 1993 emissions presented in this report. Some modifications to the 1993 methodology were made in cases where information could not be obtained to generate the 1994 estimates. Other changes in methodology were required in order to make the best estimate with available data. These emissions are preliminary and will be modified in the next *Trends* report.

The 1994 emissions increased for all criteria pollutants except SO_2. The increases are a result of increased consumption of industrial fuels and production of industrial goods except petroleum products. In general, this increased fuel use is the direct result of increased economic activity rather than a change to less fuel efficient technologies. Utilities consumed less coal and oil but increased consumption of gas in 1994. This resulted in decreased utility SO_2 emissions which resulted in reduced total SO_2 emissions. Residential consumption of wood also decreased in 1994.

The increase in CO, NO_x, and VOC on-road emissions is a result of higher vehicle miles traveled (VMT) and higher Reid vapor pressure (RVP). (Changes in RVP do not affect all pollutants equally.) The decrease in SO_2 and PM-10 on-road emissions resulted from the desulfurization of diesel motor fuel. (See section 3.5.3 for details.) The 1994 emissions from non-road sources increased as a result of increased use of non-road engines and vehicles.

The miscellaneous emissions increased significantly over the 1993 emissions. This is due to the increased number of acres of land burned in the United States by wildfires. Wildfire severity (i.e., how many and how intense) is due in part to meteorological conditions such as: temperatures, humidity, thunderstorms, and relative amount of rain.

2.1.1 Carbon Monoxide Emissions

Currently only 13 of the 14 Tier 1 source categories are estimated for CO. In Tier 1, the natural sources category contains minimal CO emissions and, thus, is not estimated for the *Trends* report. (Studies are currently underway, however, on isoprene oxidation, monoterpene, and other organic compound emissions which are likely to significantly change the current estimates.) Figure 2-1 presents a pie chart of the 13 Tier 1 categories, 3 of which (solvent utilization, storage and transport, and electric utility fuel combustion) constitute less than 0.5 percent of the total and are combined with petroleum and related industries, industrial fuel combustion, other industrial processes, waste disposal and recycling, and chemical and allied chemical manufacturing in the

"remaining categories" grouping. As the figure shows, on-road vehicles are the major contributor to CO emissions. In 1994, they represented 62 percent of the total CO emissions. Of the total on-road vehicle emissions, 65 percent are from cars (light-duty gasoline vehicles [LDGV], motorcycles [MC], and light-duty diesel vehicles [LDDV]). The second major contributor to CO emissions is non-road sources, which constitute approximately 16 percent of total CO estimates. These emissions result primarily from the gasoline consumption by construction, industrial and farm equipment, and recreational marine vessels. Table A-1, in appendix A, presents a complete breakdown of CO emissions.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 93 percent of total CO emissions in 1994.

2.1.2 Nitrogen Oxide Emissions

Currently only 13 of the 14 Tier 1 source categories are estimated for NO_x. Natural source emissions are not included in chapters 2 through 5 of this report, although biogenics, a subcategory of natural sources, are presented in chapter 9 for the year 1990. Figure 2-1 presents a pie chart of the remaining 13 categories, 4 of which (solvent utilization, storage and transport, waste disposal and recycling, and metals processing) constitute less than 1 percent of the total and are combined with chemical and allied product manufacturing, other industrial processes, miscellaneous, and petroleum and related industries in the "remaining categories" grouping. As shown, electric utility emissions represent 33 percent, of the total 1994 NO_x emissions. Ninety percent of the emissions estimated for electric utilities are attributed to coal combustion, of which 64 percent are emissions from bituminous coal combustion. As with CO emissions, LDGV are a major contributor (50 percent) to 1994 on-road vehicle NO_x emissions. Table A-2, in appendix A, presents a complete breakdown of NO_x emissions.

Table 2-1 presents the point and area source split of the Tier 1 source categories. Area source emissions, including on-road vehicles, contributed slightly more than half (55 percent) of the total NO_x emissions in 1994.

2.1.3 Volatile Organic Compound Emissions

Currently only 13 of the 14 Tier 1 source categories are estimated for VOC. Natural sources are not included, although biogenics, a subcategory of natural sources, are considered a major source of VOC emissions. Biogenic emissions for 1990 are included in chapter 9. Figure 2-2 presents a pie chart of the remaining 13 categories. Two of the source categories (electric utility fuel combustion and metals processing) constituted less than 0.5 percent of the total emissions and are combined with chemical and allied products, petroleum and related industries, miscellaneous, other industrial processes, and fuel combustion (industrial, other) in the "remaining categories" grouping. The "remaining categories" grouping contributed 18 percent to the total VOC estimate in 1994. As shown, solvent utilization contributed 27 percent and on-road vehicles contributed 27 percent to the total 1994 VOC emissions. Light-duty gasoline vehicles produced 62 percent of the on-road vehicle 1994 VOC emissions. Surface coating represents 44 percent of the solvent utilization emissions. There are 26 subcategories of surface coating. Their contribution to surface coating emissions are presented in figure 2-3. The emissions from all categories are presented in table A-3, in appendix A. The contributions made to the "remaining categories" grouping by Tier 1 source categories are also presented in figure 2-3.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including on-road vehicles, constituted 85 percent of total VOC emissions in 1994.

2.1.4 Sulfur Dioxide Emissions

Currently only 13 of the 14 Tier 1 source categories were estimated for SO_2. Only the natural sources category is not currently estimated for *Trends* (there are sulfur emissions from marine sources and volcanoes, but they are considered minor). Figure 2-4 presents a pie chart of the remaining 13 categories, 5 of which (solvent utilization, storage and transport, waste disposal and recycling, non-road sources, and miscellaneous) constitute less than 2 percent of the total and are combined with non-road sources, petroleum and related industries, and other industrial processes in the "remaining categories" grouping. As shown, electric utilities are the major contributor to SO_2 emissions. In 1994 they represented 70 percent of the total SO_2 emissions. The second largest contributor is industrial fuel combustion, which produced 14 percent of the 1994 SO_2 emissions. Coal combustion produces 96 percent of the electric utility emissions. Bituminous coal combustion is 83 percent of the electric utility coal combustion emissions.

Table 2-1 presents the point and area split of the Tier 1 source categories. Point source emissions constituted 92 percent of the total SO_2 emissions in 1994.

2.1.5 Particulate Matter (PM-10) Emissions

Currently, emissions for all 14 Tier 1 source categories were estimated for PM-10. Figure 2-3 presents a pie chart in which all categories, with the exclusion of fugitive dust sources, have been combined in the point and fugitive process sources grouping. Fugitive dust sources constitute 92 percent of the 1994 total PM-10 emissions. Unpaved roads (29 percent) are the greatest contributor to 1994 PM-10 fugitive dust emissions. The remaining 5 top categories are construction (27 percent), paved roads (14 percent), agricultural tilling (14 percent), wind erosion (6 percent), and mining and quarrying (1 percent). The point source fugitive dust emissions are minimal and are included in the "remaining fugitive dust" category presented in figure 2-4.

Table 2-1 presents the point and area source split of the Tier 1 source categories. Area source emissions, dominated by the fugitive dust category, contributed 97 percent to the total PM-10 emissions in 1994.

2.1.6 Lead Emissions

The 1994 emissions of Pb were estimated by the same methodology used to produce the 1993 emissions in the last report.[1] The 1994 estimates are based on extending the trend of the Pb activity data from previous years (details are provided in chapter 6) which are then multiplied by current emission factors and control efficiencies. This methodology makes estimating point and area emissions very resource intensive; therefore, only national emissions are presented here.

Of the 14 Tier 1 source categories, the following 5 are not estimated for Pb, since they are thought to be negligible: solvent utilization, storage and transport, petroleum and related industries, natural sources, and miscellaneous. The remaining 9 categories are presented in a pie chart in figure 2-5. The "remaining categories" grouping includes chemical and allied product manufacturing, other industrial processes, and fuel combustion (electric utility and industrial). Metal processing, the major contributor of Pb emissions in 1994, represents 38 percent of the total emissions. Nonferrous metal processing represents 63 percent of the 1994 metals processing Pb emissions. Primary and secondary Pb products are responsible for 51 and 38 percent, respectively, of the nonferrous metals processing Pb emissions in 1994.

2.2 SPATIAL EMISSIONS

The 1994 criteria pollutant emissions were estimated for all pollutants except lead at the county level and summed to the state level. These estimates are presented in tables 2-2 to 2-7 and figures 2-6 to 2-11.

2.2.1 State Level

Tables 2-2 through 2-6 present the total emissions and ranking per pollutant by major source category for each State in alphabetical order. The estimates for Alaska and Hawaii include only on-road vehicle and fossil-fuel steam electric utility emissions. PM-10 estimates listed in table 2-6 also include some fugitive dust estimates for Alaska and Hawaii. (A base year inventory similar to NAPAP was not available for these States.)

Figure 2-6 presents the top 10 States with the largest emissions, by pollutant, for 1994 (22 States in total). These top 10 States represent a range of 46 to 61 percent of the national emissions, depending on the particular pollutant.

2.2.2 County Level

For all criteria pollutants except Pb, the emissions are derived at the county level. The exceptions explained in detail in chapter 6 are fugitive dust sources and wildfires. Figures 2-7 to 2-9 presents the total 1994 emissions per square mile for each county. As figure 2-7 shows, the eastern third and west coast emit more CO than the western two-thirds of the continental United States. In contrast, figures 2-8 to 2-9 illustrate that the eastern half and the west coast emit more NO_x, VOC, and SO_2 than the western half of the continental United States. The emissions of PM-10 are dominated by the fugitive dust emissions that are predominant in the rural and agricultural areas. Carbon monoxide emissions from residential wood burning are presented in figure 2-7.[h]

2.2.3 Nonattainment Areas

Table 2-7 presents 53 O_3 NAAs and CO, NO_x, and VOC emission estimates for the year 1990 in order of EPA regions. The 32 NAAs with a check mark (√) have been designated to attainment as of the writing of this report. The other 21 areas have had their 1990 base year emissions approved. Figure 2-10 presents CO, NO_x, and VOC emissions grouped by O_3 NAA classifications. The emissions presented by location and major source category are provided in figure 2-11. A summary of the current status and changes since the 1990 CAAA for the NAAs (O_3, CO, SO_2, PM-10, and Pb) are presented in table ES-3.

2.3 LARGEST POINT SOURCES IN AIRS/AFS

This report is the fourth in a series that tracks the changes in the top-emitting sources of CO, NO_x, VOC, and SO_2 emissions and the third in a series that tracks PM-10, Pb, and industrial SO_2. The data in AIRS/AFS were developed by the respective States using methodologies of their choosing. The AIRS/AFS[i] was also used to determine the types of plants that emit large quantities of criteria pollutants. Emissions were extracted on May 19, 1995 from AIRS/AFS using an ad hoc report which excluded plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. Details on how the data was extracted from AIRS is provided in section 6.7.

NOTE: Depending on the day the data are extracted, the list of top emitters may change. Because these lists are based on several different extractions and some additional adjustments have been made, the data in tables in this report may not correspond precisely to the data currently in AIRS/AFS. However, this report has presented the top 50 sources based to the maximum extent possible, on AIRS/AFS.

The most common industries by pollutant contained in the list of top 50 emitting sources are defined in table 2-8. Figure 2-12

and tables 2-9 to 2-15 present the plant-level emissions of the top 50 largest point source emitters of these pollutants.

2.4 REFERENCES

1. *National Air Pollutant Emission Trends, 1900-1993*. EPA-454/R-94-027, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1994.
2. *AIRS Facility Subsystem*. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 1992.

---

[h] The high emissions presented in figure 2-8 for Mississippi are a result of high estimates of unpaved road emissions as reported in table 2-6. According to the U.S. Department of Transportation (DOT), past estimates of unpaved road VMT in Mississippi were too low.

[i] The AIRS data is not the main basis for the data in this report.

Table 2-1. 1994 National Point and Area Emissions by Source Category and Pollutant
(thousand short tons)

Source Category	CO			NO_x			VOC			SO_2			PM-10		
	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total
FUEL COMB.-ELECTRIC UTILITY	325	0	325	7,795	0	7,795	36	0	36	14,869	0	14,869	265	1	266
FUEL COMB.-INDUSTRIAL	470	201	671	1,891	1,315	3,206	117	17	135	2,404	625	3,029	207	30	237
FUEL COMB.-OTHER	90	3,798	3,888	100	627	727	10	705	715	199	399	599	16	513	529
CHEMICAL & ALLIED PRODUCT MFG	2,048	0	2,048	291	0	291	1,121	456	1,577	457	0	457	64	0	64
METALS PROCESSING	2,166	0	2,166	84	0	84	77	0	77	692	0	692	141	0	141
PETROLEUM & RELATED INDUSTRIES	390	0	390	95	0	95	214	417	630	406	0	406	26	0	26
OTHER INDUSTRIAL PROCESSES	749	2	751	324	5	328	332	79	411	429	2	431	377	13	390
SOLVENT UTILIZATION	2	0	2	3	0	3	1,162	5,151	6,313	1	0	1	2	0	2
STORAGE & TRANSPORT	58	0	58	3	0	3	514	1,259	1,773	5	0	5	59	0	59
WASTE DISPOSAL & RECYCLING	76	1,671	1,746	20	65	85	8	2,265	2,273	21	16	37	8	242	250
ON-ROAD VEHICLES	0	61,070	61,070	0	7,530	7,530	0	6,295	6,295	0	295	295	0	311	311
NON-ROAD SOURCES	0	15,657	15,657	0	3,095	3,095	0	2,255	2,255	0	283	283	0	411	411
MISCELLANEOUS*	0	9,245	9,245	0	374	374	1	684	685	0	14	14	10	42,733	42,743
Total	*6,372*	*91,645*	*98,017*	*10,604*	*13,011*	*23,615*	*3,590*	*19,584*	*23,174*	*19,484*	*1,634*	*21,118*	*1,176*	*44,255*	*45,431*

Emissions (percent)

Source Category	CO			NO_x			VOC			SO_2			PM-10		
	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total
FUEL COMB.-ELECTRIC UTILITY	5.10	0.00	0.33	73.51	0.00	33.01	1.00	0.00	0.16	76.32	0.00	70.41	22.56	0.00	0.58
FUEL COMB.-INDUSTRIAL	7.38	0.22	0.68	17.83	10.11	13.58	3.27	0.09	0.58	12.34	38.22	14.34	17.64	0.07	0.51
FUEL COMB.-OTHER	1.40	4.14	3.97	0.94	4.82	3.08	0.27	3.60	3.08	1.02	24.44	2.83	1.37	1.14	1.15
CHEMICAL & ALLIED PRODUCT MFG	32.14	0.00	2.09	2.74	0.00	1.23	31.22	2.33	6.80	2.35	0.00	2.16	5.44	0.00	0.14
METALS PROCESSING	33.99	0.00	2.21	0.80	0.00	0.36	2.13	0.00	0.33	3.55	0.00	3.28	11.96	0.00	0.31
PETROLEUM & RELATED INDUSTRIES	6.11	0.00	0.40	0.89	0.00	0.40	5.95	2.13	2.72	2.09	0.00	1.92	2.23	0.00	0.06
OTHER INDUSTRIAL PROCESSES	11.75	0.00	0.77	3.05	0.04	1.39	9.24	0.41	1.77	2.20	0.11	2.04	32.10	0.03	0.85
SOLVENT UTILIZATION	0.03	0.00	0.00	0.02	0.00	0.01	32.37	26.30	27.24	0.00	0.00	0.00	0.18	0.00	0.00
STORAGE & TRANSPORT	0.91	0.00	0.06	0.02	0.00	0.01	14.31	6.43	7.65	0.02	0.00	0.02	5.00	0.00	0.13
WASTE DISPOSAL & RECYCLING	1.19	1.82	1.78	0.19	0.50	0.36	0.22	11.57	9.81	0.11	0.99	0.18	0.68	0.54	0.54
ON-ROAD VEHICLES	0.00	66.64	62.31	0.00	57.87	31.88	0.00	32.14	27.16	0.00	18.07	1.40	0.00	0.69	0.68
NON-ROAD SOURCES	0.00	17.08	15.97	0.00	23.79	13.10	0.00	11.51	9.73	0.00	17.33	1.34	0.00	0.92	0.89
MISCELLANEOUS*	0.00	10.09	9.43	0.00	2.88	1.59	0.02	3.49	2.96	0.00	0.83	0.06	0.85	96.56	94.08
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Note(s): Miscellaneous includes PM-10 natural sources.

Table 2-2. 1994 State-level Carbon Monoxide Emissions and Rank by Major Category in Alphabetical Order of State Name
(thousand short tons)

Rank	State	On-Road Vehicles	Non-Road Sources	Miscellaneous	Fuel Comb.- Other	Metals Processing	Remaining Categories	Total
14	Alabama	1,331	278	435	86	106	194	2,431
41	Alaska	144	0	353	12	0	0	510
23	Arizona	802	334	553	45	0	43	1,778
31	Arkansas	642	141	113	115	1	132	1,145
1	California	5,329	1,767	675	306	1	321	8,399
28	Colorado	1,004	287	84	39	0	36	1,450
37	Connecticut	636	156	5	24	1	19	841
48	Delaware	161	38	1	5	0	45	252
51	District of Columbia	88	24	1	1	0	3	117
3	Florida	3,220	927	524	62	0	109	4,842
6	Georgia	2,103	444	924	92	9	230	3,801
49	Hawaii	223	0	27	0	0	1	250
32	Idaho	333	73	619	58	0	18	1,101
9	Illinois	2,541	524	19	51	106	146	3,386
10	Indiana	1,791	288	20	99	607	124	2,929
35	Iowa	755	162	10	33	2	46	1,007
19	Kansas	686	154	912	27	0	110	1,888
26	Kentucky	1,062	221	39	127	35	81	1,565
13	Louisiana	905	457	275	44	1	860	2,541
42	Maine	363	23	5	68	0	30	490
29	Maryland	1,017	288	7	43	2	28	1,385
22	Massachusetts	1,354	321	13	39	1	53	1,781
8	Michigan	2,648	286	12	173	197	140	3,456
24	Minnesota	1,171	296	20	81	3	115	1,686
27	Mississippi	724	262	303	88	0	122	1,500
16	Missouri	1,473	481	48	147	40	165	2,354
38	Montana	252	62	425	40	19	32	829
39	Nebraska	440	98	126	14	0	22	701
40	Nevada	330	107	107	11	58	11	624
43	New Hampshire	311	22	3	43	0	22	402
21	New Jersey	1,423	373	21	21	0	38	1,875
33	New Mexico	635	135	181	34	0	34	1,019
5	New York	2,841	722	23	160	0	99	3,846
11	North Carolina	1,923	451	128	225	38	149	2,914
46	North Dakota	193	39	56	4	0	19	311
4	Ohio	2,889	569	17	116	128	327	4,046
30	Oklahoma	976	192	47	62	3	106	1,385
20	Oregon	680	197	779	163	9	48	1,876
7	Pennsylvania	2,561	636	18	158	230	112	3,715
47	Rhode Island	208	51	2	7	0	7	273
25	South Carolina	973	233	207	81	8	81	1,583
45	South Dakota	222	51	26	11	0	17	326
17	Tennessee	1,458	357	47	178	49	153	2,243
2	Texas	4,486	1,856	278	75	7	881	7,583
36	Utah	587	142	192	21	34	28	1,004
50	Vermont	186	11	1	41	0	7	245
15	Virginia	1,716	360	49	179	24	62	2,390
12	Washington	1,176	331	443	186	358	114	2,609
34	West Virginia	451	97	46	73	75	276	1,018
18	Wisconsin	1,450	294	10	106	14	109	1,982
44	Wyoming	198	41	15	13	0	64	332
	National	***61,070***	***15,657***	***9,245***	***3,888***	***2,166***	***5,990***	***98,017***

Table 2-3. 1994 State-level Nitrogen Oxide Emissions and Rank by Major Category in Alphabetical Order of State Name
(thousand short tons)

Rank	State	Fuel Comb.- Electric Utility	On-Road Vehicles	Fuel Comb.- Industrial	Non-Road Sources	Fuel Comb.- Other	Remaining Categories	Total
16	Alabama	231	162	63	60	16	41	574
49	Alaska	3	15	0	0	0	10	28
23	Arizona	142	114	42	61	4	29	392
34	Arkansas	83	88	45	27	6	15	263
2	California	139	714	179	364	57	80	1,532
26	Colorado	131	108	36	54	14	7	351
41	Connecticut	12	88	6	22	15	1	143
46	Delaware	23	22	10	5	2	1	63
51	District of Columbia	0	10	0	5	3	0	20
7	Florida	344	361	31	125	8	36	905
12	Georgia	215	261	51	79	13	52	671
47	Hawaii	10	23	0	0	0	1	34
42	Idaho	0	43	12	15	2	37	110
5	Illinois	389	297	127	122	44	22	1,001
4	Indiana	535	216	122	87	22	29	1,011
32	Iowa	119	95	27	33	10	13	297
20	Kansas	151	87	110	69	8	39	463
11	Kentucky	368	139	66	73	10	17	672
9	Louisiana	141	114	313	144	6	60	778
44	Maine	1	47	14	5	6	2	75
27	Maryland	102	138	19	44	17	12	331
31	Massachusetts	58	145	15	53	26	4	301
8	Michigan	316	290	76	69	39	17	806
22	Minnesota	166	152	26	46	18	8	416
28	Mississippi	53	97	63	50	6	52	321
13	Missouri	283	191	23	60	15	45	616
39	Montana	66	34	13	29	2	29	174
37	Nebraska	75	55	8	44	5	5	192
40	Nevada	67	38	3	24	3	9	143
43	New Hampshire	23	39	6	2	5	1	75
24	New Jersey	57	177	26	63	33	25	381
33	New Mexico	101	68	79	20	5	18	291
10	New York	123	353	59	96	79	11	722
14	North Carolina	185	241	53	69	14	18	581
38	North Dakota	124	24	20	14	2	3	187
3	Ohio	524	331	91	97	41	27	1,111
21	Oklahoma	146	123	115	43	7	25	460
36	Oregon	16	100	15	58	6	37	232
6	Pennsylvania	346	305	94	95	43	32	915
48	Rhode Island	0	22	3	4	4	0	33
29	South Carolina	94	128	38	37	5	16	317
45	South Dakota	22	30	3	6	2	2	66
15	Tennessee	206	180	60	75	10	48	579
1	Texas	716	540	766	366	34	189	2,611
35	Utah	105	58	30	28	6	25	251
50	Vermont	0	23	1	1	3	0	28
17	Virginia	77	222	54	84	16	23	475
25	Washington	46	156	31	63	11	59	365
19	West Virginia	308	63	54	32	5	12	473
18	Wisconsin	180	177	44	50	17	6	473
30	Wyoming	173	27	67	24	2	14	307
	National	***7,795***	***7,530***	***3,206***	***3,095***	***727***	***1,263***	***23,615***

Table 2-4. 1994 State-level Volatile Organic Compound Emissions and Rank by Major Category in Alphabetical Order of State Name
(thousand short tons)

Rank	State	Solvent Utilization	On-Road Vehicles	Waste Recycling	Non-Road Sources	Storage and Transport	Remaining Categories	Total
18	Alabama	112	138	68	42	25	117	503
47	Alaska	0	13	0	0	0	51	64
29	Arizona	69	93	14	42	22	31	272
31	Arkansas	69	66	9	24	34	59	261
2	California	588	628	109	234	83	220	1,862
32	Colorado	73	94	5	35	21	20	248
34	Connecticut	67	68	7	26	12	14	194
39	Delaware	25	18	1	6	5	62	116
51	District of Columbia	11	9	0	3	1	0	25
7	Florida	229	344	10	135	67	94	878
11	Georgia	140	217	99	62	50	106	674
50	Hawaii	0	27	0	0	0	4	31
38	Idaho	23	32	2	11	11	41	120
4	Illinois	347	256	28	74	73	153	931
13	Indiana	223	178	38	46	44	99	628
33	Iowa	95	74	7	26	26	13	242
25	Kansas	78	65	7	26	33	153	361
24	Kentucky	90	107	12	40	25	100	374
12	Louisiana	75	95	132	76	49	215	641
41	Maine	25	34	3	5	11	19	97
28	Maryland	96	106	3	38	26	15	284
23	Massachusetts	166	131	8	54	28	18	406
9	Michigan	280	256	41	88	41	69	775
21	Minnesota	159	117	9	49	44	35	413
26	Mississippi	88	76	12	40	39	84	340
19	Missouri	158	143	12	49	37	98	497
40	Montana	20	24	2	9	11	35	100
35	Nebraska	51	42	4	17	18	21	153
42	Nevada	20	35	9	15	8	9	95
45	New Hampshire	25	30	2	5	7	11	80
16	New Jersey	160	161	67	50	66	83	586
36	New Mexico	25	60	3	17	17	28	150
3	New York	348	304	26	87	97	136	997
8	North Carolina	278	196	27	63	63	187	813
43	North Dakota	33	18	3	6	11	14	86
6	Ohio	304	287	68	72	53	104	888
27	Oklahoma	68	95	18	32	28	60	301
30	Oregon	63	69	6	29	17	80	265
5	Pennsylvania	307	259	98	84	54	104	907
46	Rhode Island	29	20	1	9	4	6	70
10	South Carolina	94	103	377	32	22	79	707
44	South Dakota	31	22	2	8	11	6	80
14	Tennessee	165	146	14	49	25	199	600
1	Texas	370	473	535	254	297	835	2,764
37	Utah	36	55	4	17	15	20	148
49	Vermont	14	17	2	2	4	8	47
15	Virginia	214	169	12	48	48	107	597
22	Washington	100	120	11	49	35	96	412
17	West Virginia	76	45	334	15	14	92	576
20	Wisconsin	188	141	14	48	31	33	455
48	Wyoming	9	19	1	5	8	20	61
	National	***6,313***	***6,295***	***2,273***	***2,255***	***1,773***	***4,265***	***23,174***

Table 2-5. 1994 State-level Sulfur Dioxide Emissions and Rank by Major Category in Alphabetical Order of State Name
(thousand short tons)

Rank	State	Fuel Comb.- Electric Utility	Fuel Comb.- Industrial	Metals Processing	Fuel Comb.- Other	Chemical and Allied	Remaining Categories	Total
11	Alabama	527	59	9	50	17	78	740
51	Alaska	1	0	0	0	0	1	2
19	Arizona	136	4	145	1	40	10	336
34	Arkansas	66	22	0	1	2	17	108
27	California	4	40	0	9	5	146	204
35	Colorado	88	6	0	3	0	10	106
44	Connecticut	26	9	0	16	0	4	55
36	Delaware	44	23	0	3	3	22	95
48	District of Columbia	2	0	0	4	0	1	7
9	Florida	713	25	2	9	30	53	831
10	Georgia	683	60	4	2	5	39	793
47	Hawaii	19	0	0	0	0	1	20
46	Idaho	0	8	0	3	17	9	37
6	Illinois	849	179	16	23	37	83	1,188
2	Indiana	1,310	327	49	40	4	23	1,754
23	Iowa	165	62	0	17	0	11	255
33	Kansas	70	17	0	0	2	27	117
7	Kentucky	959	54	8	7	4	31	1,063
16	Louisiana	120	152	14	5	84	58	434
38	Maine	5	55	0	13	0	6	80
17	Maryland	271	28	5	29	6	23	363
26	Massachusetts	138	27	0	29	0	11	205
14	Michigan	386	86	4	13	0	34	523
31	Minnesota	89	25	2	9	3	14	143
24	Mississippi	94	86	0	2	22	30	234
12	Missouri	532	58	67	13	3	44	717
37	Montana	22	17	28	1	3	10	82
40	Nebraska	55	5	0	0	0	9	70
42	Nevada	55	3	0	1	0	5	63
41	New Hampshire	51	6	0	6	0	2	64
29	New Jersey	88	16	0	21	6	32	163
22	New Mexico	66	13	137	2	14	32	264
15	New York	251	140	4	83	1	21	500
13	North Carolina	389	103	0	15	8	22	536
25	North Dakota	144	56	0	3	8	3	214
1	Ohio	2,075	239	18	33	5	38	2,409
30	Oklahoma	100	24	0	1	2	20	146
43	Oregon	15	14	3	5	0	18	55
3	Pennsylvania	1,111	83	33	46	1	55	1,328
49	Rhode Island	0	1	0	4	0	1	6
21	South Carolina	187	63	1	4	0	22	277
45	South Dakota	33	3	0	1	0	3	41
8	Tennessee	753	110	23	7	9	23	925
4	Texas	533	359	40	14	95	259	1,300
39	Utah	34	22	12	6	0	5	78
50	Vermont	0	1	0	3	0	1	5
18	Virginia	178	112	7	20	5	34	355
28	Washington	74	30	28	8	0	32	172
5	West Virginia	1,087	64	30	3	4	16	1,204
20	Wisconsin	191	101	1	10	1	17	321
32	Wyoming	78	32	2	2	9	9	132
	National	***14,869***	***3,029***	***692***	***599***	***457***	***1,473***	***21,118***

Table 2-6. 1994 State-level Particulate Matter (PM-10) Emissions and Rank by Major Category in Alphabetical Order of State Name
(thousand short tons)

Rank	State	Unpaved Roads*	Construction	Agricultural Tilling	Paved Roads**	Wind Erosion	Remaining Categories	Total
22	Alabama	268	215	44	148	0	149	825
42	Alaska	97	71	0	12	0	37	217
37	Arizona	92	136	14	122	0	86	448
29	Arkansas	194	108	147	82	0	107	638
2	California	125	1,452	92	676	19	290	2,654
24	Colorado	135	368	144	104	0	59	811
41	Connecticut	13	149	2	58	0	16	238
49	Delaware	6	28	6	18	0	9	68
51	District of Columbia	0	17	0	7	0	2	25
9	Florida	308	763	11	285	0	190	1,557
14	Georgia	352	330	65	211	0	206	1,164
47	Hawaii	6	71	0	21	0	4	103
32	Idaho	321	53	103	48	6	94	625
8	Illinois	201	578	503	251	1	118	1,651
21	Indiana	76	205	255	183	0	110	830
19	Iowa	196	84	533	91	1	33	937
7	Kansas	364	87	520	97	470	123	1,661
33	Kentucky	70	137	124	119	0	128	579
26	Louisiana	102	335	68	103	0	134	742
45	Maine	25	34	8	37	0	26	131
39	Maryland	41	242	24	90	0	41	439
38	Massachusetts	69	230	2	101	13	28	444
16	Michigan	285	305	108	203	14	102	1,017
13	Minnesota	463	172	397	117	12	85	1,246
4	Mississippi	1,614	48	101	71	0	106	1,939
6	Missouri	901	237	298	168	0	120	1,725
3	Montana	249	44	222	39	1,473	91	2,118
15	Nebraska	347	49	357	56	201	29	1,040
44	Nevada	10	80	8	49	0	51	199
48	New Hampshire	12	39	2	28	0	14	94
36	New Jersey	0	324	6	132	0	39	501
10	New Mexico	983	109	29	64	170	59	1,414
12	New York	188	627	63	237	0	131	1,247
23	North Carolina	58	340	61	193	0	163	815
27	North Dakota	93	39	473	31	16	20	672
11	Ohio	422	405	218	250	0	112	1,407
5	Oklahoma	1,149	168	195	115	154	51	1,833
25	Oregon	323	210	54	82	0	132	801
18	Pennsylvania	136	368	88	230	0	129	950
50	Rhode Island	0	33	0	17	0	5	55
35	South Carolina	179	157	25	97	0	81	539
34	South Dakota	80	38	365	37	18	37	575
28	Tennessee	38	221	103	145	0	144	651
1	Texas	1,046	1,600	475	543	24	298	3,986
40	Utah	102	150	22	55	1	68	397
46	Vermont	47	21	7	17	0	16	106
31	Virginia	96	199	43	171	0	124	632
17	Washington	153	482	109	121	0	123	988
43	West Virginia	66	24	13	47	0	66	217
30	Wisconsin	62	179	174	155	0	64	635
20	Wyoming	701	36	35	24	0	52	847
	National	***12,865***	***12,397***	***6,716***	***6,358***	***2,593***	***4,501***	***45,431***

Note(s): * Unpaved road excludes unpaved airstrips and miscellaneous point sources which are included in table 3-5 and appendix A, table A-5.
** Paved road excludes miscellaneous point sources which are included in table 3-5 and appendix A, table A-5.

Table 2-7. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions or Areas Designated to Attainment (tons/day)

Nonattainment Area Name		Carbon Monoxide					Nitrogen Oxides					Volatile Organic Compounds					
		Stationary Point	Stationary Area	On-Road Vehicles	Non-Road Sources	Total	Stationary Point	Stationary Area	On-Road Vehicles	Non-Road Sources	Total	Stationary Point	Stationary Area	On-Road Vehicles	Non-Road Sources	Biogenics	Total
Scranton-Wilkes-Barre, PA		283	2	435	193	913	235	1	72	38	346	115	26	56	24	121	341
Charleston, WV	√	17	37	222	49	324	306	29	27	14	375	16	21	30	7	75	150
Greenbrier Co, WV		0	6	16	7	30	0	7	3	1	11	0	3	2	1	99	106
Huntington, WV	√	15	21	285	31	351	5	25	23	12	64	21	12	38	5	42	118
Parkersburg, WV	√	8	12	64	18	101	11	14	7	5	36	87	7	9	3	17	122
Birmingham, AL		180	43	450	135	808	359	31	55	24	469	62	43	71	16	200	392
Jacksonville, FL	√								no data available								
Miami-Fort Lauderdale-W. Palm Beach, FL	√	27	183	2,566	838	3,613	180	17	255	94	546	29	295	337	129	325	1,116
Tampa-St. Petersburg-Clearwater, FL		34	16	943	366	1,358	278	13	113	41	444	20	99	118	52	98	387
Ashland, KY	√								no data available								
Edmonson Co, KY	√	NA	1	2	2	5	NA	NA	NA	1	1	NA	1	1		29	31
Lexington-Fayette, KY		NA	4	84	59	146	2	0	29	8	39	14	14	16	11	24	80
Owensboro, KY	√	37	3	26	21	86	82	0	4	3	90	17	5	5	4	53	83
Paducah, KY	√	14	2	10	7	31	6	0	2	1	10	97	2	2	1	41	143
Charlotte-Gastonia, NC	√	45	24	346	122	537	30	1	54	21	107	25	38	41	20	51	176
Greensboro-Winston Salem-High Point, NC	√	5	41	558	152	757	23	0	80	20	123	82	63	62	21	118	346
Raleigh-Durham, NC	√	1	33	384	108	526	4	0	56	18	78	13	41	46	18	123	241
Cherokee Co, SC	√	0	6	65	3	74	1	0	8	1	9	2	4	6	0	31	43
Knoxville, TN	√	3	8	296	69	376	9	4	42	10	64	8	29	41	10	32	120
Memphis, TN	√	6	94	295	169	564	140	4	63	27	233	75	76	72	19	43	285
Jersey Co, IL	√	NA	1	10	6	16		0	2	3	4	0	3	2	1	15	21
Kansas City, MO-KS	√								no data available								
St. Louis, MO-IL		114	4	282	108	508	96	2	45	24	167	74	34	43	24	54	228
Evansville, IN		1	2	155	41	199	3	2	14	8	27	13	13	25	8	8	67
Chicago-Gary-Lake County, IL-IN		709	5	771	78	1,564	303	6	83	28	420	79	42	135	12	21	289
Indianapolis, IN	√	221	38	732	148	1,138	54	31	63	29	177	29	49	107	19	25	230
Louisville, KY-IN		8	3	107	37	155	45	1	13	5	64	8	11	19	7	38	82
South Bend-Elkhart, IN	√	1	6	250	56	313	11	6	31	18	66	14	42	40	10	20	126
Detroit-Ann Arbor, MI	√	146	45	3,058	863	4,112	735	56	437	108	1,336	167	252	327	531	114	1,391
Grand Rapids, MI		6	9	445	124	584	118	14	66	17	214	42	39	48	23	47	199
Muskegon, MI		5	1	115	37	157	17	1	15	4	37	7	10	13	9	20	59
Canton, OH [1]	√	7	2	189	63	261	40	1	16	16	73	12	19	32	24	37	124
Cincinnati-Hamilton, OH-KY [1]	√	89	5	793	275	1,162	280	2	131	35	447	71	65	126	38	109	408
Cleveland-Akron-Lorain, OH [1]	√	707	13	1,402	808	2,930	245	10	177	71	502	80	121	248	80	195	725
Columbiana County, OH	√								no data available								
Columbus, OH [1]	√	NA	9	581	438	1,028	NA	7	79	89	175	NA	54	95	48	106	303
Dayton-Springfield, OH [1]	√	6	0	534	25	565	32	0	55	7	94	37	23	106	2	115	284
Preble County, OH	√								no data available								
Steubenville, OH	√								no data available								
Toledo, OH [1]	√	5	1	378	14	398	85	0	38	3	127	59	5	69	2	72	207
Youngstown, OH [1]	√	19	13	294	88	413	23	7	30	11	71	16	28	49	13	50	157
Door Co, WI		NA	1	19	21	40	NA	0	4	2	6	NA	6	2	4	26	38
Kewaunee Co, WI		0	1	9	5	14	0	0	2	1	3	1	2	1	1	21	26
Manitowoc Co, WI		1	3	52	16	71	3	1	12	4	20	1	9	6	3	34	52
Milwaukee-Racine, WI		20	36	976	300	1,332	131	19	112	42	304	40	133	147	40	69	430
Sheboygan, WI		11	3	53	19	86	56	1	11	5	74	7	10	6	3	27	52
Walworth Co, WI		0	2	64	22	89	1	1	8	4	13	2	8	8	4	11	32
Lake Charles, LA		42	1	117	75	235	119	0	20	41	181	58	7	15	13	16	110
Dallas-Fort Worth, TX		13	5	2,838	1,117	3,973	109	20	293	166	588	67	174	307	97	126	771
El Paso, TX		7	3	327	112	449	33	2	37	15	88	10	27	39	12	13	100
Houston-Galveston-Brazoria, TX		334	28	2,413	1,270	4,045	781	14	337	237	1,369	480	229	252	195	336	1,492
Victoria County, TX	√								no data available								
San Francisco Bay Area, CA	√	NA	NA	2,529	665	3,194	116	15	251	159	541	NA	NA	270	78	243	591

Note(s): NA = not available. "√" means the ozone nonattainment areas have been designated to attainment as of July 14, 1995. [1]Expected to be redesignated to attainment by October 1, 1995.

Table 2-8. Predominant Industries Listed Among the Top 50 Plants from AIRS/AFS

Pollutant	Industry	SIC	Number of Plants	% Emissions
CO	Steel mills	3312	15	46
	Carbon black	2895	13	26
	Primary aluminum	3334	7	9
	Petroleum refining	2911	6	8
	Paper mills	26x1	3	3
	Other	various	6	8
NO_x	Electric utility	4911	50	100
VOC	Petroleum refining	2911	19	37
	Organic chemicals	2869	9	14
	Cellulose	282x	7	18
	Steel mills	3312	7	12
	Other	various	8	19
SO_2	Electric utility	4911	50	100
Industrial SO_2	Petroleum refining	29xx	15	23
	Copper smelters	333x	8	21
	Steel mills	3312	6	12
	Chemical & allied products	28xx	6	10
	Paper mills	2621	3	6
	Cement/concrete	32xx	3	4
	Other	various	9	24
PM-10	Electric utility	49x1	11	18
	Steel mills	3312	9	19
	Metal mining	10x1 & 1211	8	28
	Stone, clay, glass, concrete	32xx	8	11
	Other	various	14	24
Lead	Secondary nonferrous smelting	3341	11	45
	Steel mills	331x	8	31
	Gray iron: foundries	3321	6	2
	Copper smelters	333x	5	8
	Electric utility	4911	5	2
	Stone, clay, glass, concrete	32xx	5	2
	Chemical & allied products	28xx	4	6
	Other	various	5	4

Note(s): x represents any digit 0 through 9
% emissions is the percentage of the plants emissions compared to the total emissions of the 50 plants.
The emissions in this table and tables 2-9 through 2-15 have not been incorporated into the emission report throughout the rest of the report.

Table 2-9. Top 50 AIRS/AFS Plants Emitting Carbon Monoxide - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
1	1	USX Corporation - Edgar Thomson Works	PA	003	Allegheny	0009	3312	91	227,989
2	2	Wheeling Pittsburgh Steel Steubenville	OH	081	Jefferson	5006	3312	90	185,571
3	3	U.S. Steel Co Gary Works Part 2	IN	089	Lake	9999	3312	92	175,432
4	4	Columbian Chemicals Co	WV	051	Marshall	0019	2895	90	142,575
6	5	Bethlehem Steel	MD	005	Baltimore	0147	3312	93	130,507
8	6	ACME Steel Company	IL	031	Cook	0823	3312	94	100,507
9	7	Cabot Corp Canl Plt	LA	101	St. Mary	0004	2395	90	98,008
10	8	Gulf States Steel, Inc.	AL	055	Etowah	0008	3312	93	97,000
11	9	Bethlehem Steel Corp.	PA	095	Northampton	0048	3312	90	91,305
5	10	USX Corporation - Clairton Works	PA	003	Allegheny	0011	3312	91	89,476
12	11	Columbian Chemical	LA	101	St. Mary	0005	2895	90	86,089
13	12	Cabot Corp	LA	039	Evangeline	0001	2895	90	66,615
15	13	Degussa Carbon Black Co	LA	101	St. Mary	0018	2895	90	64,258
16	14	Cabot Corporation	TX	179	Gray	0001	2895	90	63,232
17	15	Alcoa (Aluminum Co. of America)	IN	173	Warrick	0007	3334	92	61,582
14	16	Sid Richardson Carbon Company	TX	227	Howard	0002	2895	85	55,818
	17	Phillips 66 Company	TX	233	Hutchinson	0015	2911	90	54,916
	18	J.M. Huber Corporation	TX	201	Harris	0021	2895	90	54,688
18	19	Ashland Petroleum - St. Paul Park	MN	163	Washington	0003	2911	92	54,686
20	20	Addis Plant Sid Richardson Rd	LA	121	West Baton Rouge	0006	2895	90	54,322
22	21	Ormet Corporation	OH	111	Monroe	5001	3334	90	52,947
23	22	LTV Steel Company	IN	089	Lake	0318	3312	92	52,640
24	23	Noranda Aluminum, Incorporated	MO	143	New Madrid	0008	3334	89	50,808
25	24	Degussa Corporation	OH	167	Washington	5015	2895	90	48,745
26	25	E. I. Du Pont De Nemours and Company	TN	085	Humphreys	0007	2816	93	46,928
27	26	Weirton Steel Corporation	WV	029	Hancock	0001	3312	90	46,153
	27	Exxon Co USA Refinery	LA	033	East Baton Rouge	0015	2911	90	44,492
29	28	United Refining Co.	PA	123	Warren	0003	2911	90	43,104
	29	AK Steel Corporation	OH	017	Butler	5002	3312	90	40,636
	30	Witco Corp, Concarb Division	OK	071	Kay	0703	2895	93	39,330
	31	Columbian Chemicals Company	KS	067	Grant	0007	2895	93	38,825
	32	LTV Steel Company - Pittsburgh Works	PA	003	Allegheny	0022	3312	91	36,592
	33	Armco Inc	PA	019	Butler	0007	3559	90	35,831
	34	Bethlehem Steel Corporation	IN	127	Porter	0001	3312	90	34,565
	35	Inland Steel Flat Products	IN	089	Lake	0316	3312	90	32,199
	36	Murphy Oil USA	WI	031	Douglas	0095	2911	91	31,203
	37	SCM Chemicals, Inc.-Ashtabula Plant 2	OH	007	Ashtabula	5007	2816	90	31,147
	38	Great Southern Paper Woodlands Oper	GA	099	Early	0001	2631	90	30,584
	39	Geneva Steel	UT	049	Utah	0027	3312	92	30,142
	40	Witco Corporation	TX	341	Moore	0003	2895	90	30,023
	41	Union Camp Corp	GA	051	Chatham	0007	2621	90	29,295
	42	Inland-Rome Inc	GA	115	Floyd	0021	2631	90	28,758
	43	Alcoa	NC	167	Stanly	0004	3334	90	27,138
	44	Rhone-Poulenc Chem	WY	037	Sweetwater	0001	1474	94	25,347
	45	Columbian Chemicals	AR	139	Union	0014	2895	93	25,304
	46	Alcan Ingot & Recycling	KY	101	Henderson	0029	3334	91	24,703
	47	Columbia Falls Aluminum	MT	029	Flathead	0012	3334	94	24,408
	48	GM Powertrain Div.	OH	039	Defiance	5008	3321	90	24,296
	49	Intalco Aluminum	WA	073	Whatcom	0001	3334	94	23,929
28	50	Total Petroleum, Inc.	MI	057	Gratiot	0009	2911	90	23,812

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

Table 2-10. Top 50 AIRS/AFS Plants Emitting Nitrogen Oxides - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
2	1	TVA	KY	177	Muhlenberg	0006	4911	91	110,766
	2	Texas Utilities Electric Company	TX	449	Titus	0003	4911	88	107,741
1	3	TVA Cumberland Steam Plant	TN	161	Stewart	0011	4911	93	106,928
4	4	Detroit Edison Monroe	MI	115	Monroe	0020	4911	90	105,287
3	5	General James M. Gavin Plant	OH	053	Gallia	5002	4911	90	86,748
5	6	James M Stuart Elec Generating Station	OH	001	Adams	5001	4911	90	76,905
6	7	Com Ed - Powerton Station	IL	179	Tazewell	0053	4911	94	72,628
7	8	Indiana Kentucky Electric Corporation	IN	077	Jefferson	0001	4911	90	70,705
9	9	Appalachian Power Co. John E. Amos Plant	WV	079	Putnam	0006	4911	90	65,460
11	10	Illinois Power Co - Baldwin Power Plant	IL	157	Randolph	0033	4911	94	63,212
12	11	Georgia Power Co Bowen Stm Elec Gen Station	GA	015	Bartow	0011	4911	90	63,131
13	12	Alabama Power Co E.C. Gaston	AL	117	Shelby	0005	4911	93	62,359
10	13	Com Ed - Kincaid Generating Station	IL	021	Christian	0048	4911	94	61,323
26	14	CP&L Roxboro	NC	145	Person	0029	4911	92	58,339
14	15	Penn Power-Mansfield	PA	007	Beaver	0005	4911	90	57,962
15	16	Central Illinois Public Service	IL	135	Montgomery	0038	4911	94	57,687
16	17	Kyger Creek Station Ohio Valley Elec Cor	OH	053	Gallia	5001	4911	90	57,462
17	18	PSI - Gibson	IN	051	Gibson	0013	4911	90	57,063
18	19	Ohio Edison Company W H Sammis Plant	OH	081	Jefferson	5010	4911	90	54,153
19	20	Associated Electric Coop	MO	143	New madrid	0004	4911	93	53,299
21	21	Alabama Power Co Barry	AL	097	Mobile	1001	4911	93	52,409
23	22	Monongahela Power - Harrison	WV	033	Harrison	0015	4911	90	50,726
30	23	Duke Power Co Belews Creek Steam Station	NC	169	Stokes	0004	4911	91	50,560
	24	Texas Utilities Mining Company	TX	401	Rusk	0011	4911	85	49,392
27	25	Pennsylvania Electric Co.-Conemaugh	PA	063	Indiana	0001	4911	91	47,648
25	26	Pennsylvania Electric Co.-Homer City	PA	063	Indiana	0003	4911	91	47,227
28	27	Pen Elec - Keystone	PA	005	Armstrong	0012	4911	90	46,069
29	28	Muskingum River Plant	OH	167	Washington	5001	4911	90	45,409
	29	Georgia Power Co Branch Stm Elec Gen Station	GA	237	Putnam	0008	4911	90	43,258
	30	West Penn Power Co.	PA	059	Greene	0006	4911	91	42,044
	31	PP&L - Montour	PA	093	Montour	0003	4911	90	39,638
	32	TVA Widows Creek	AL	071	Jackson	0008	4911	93	39,203
	33	Detroit Edison St. Clair	MI	147	St. Clair	0024	4911	90	38,871
	34	TVA Colbert	AL	033	Colbert	0010	4911	93	38,246
	35	PP & L - Brunner Island	PA	133	York	0020	4911	90	37,975
	36	Arizona Public Service, 4 Corners	NM	045	San Juan	0002	4911	91	37,917
	37	Georgia Power Co Wansley Stm Elec Gen Station	GA	149	Heard	0001	4911	90	36,925
	38	Union Electric Company	MO	071	Franklin	0003	4911	93	36,797
	39	New England Power Co	MA	120	South East Massach	0061	4911	90	36,030
	40	Badger Paper Mills Inc., Dayton Div.	OH	113	Montgomery	5008	2621	90	35,504
	41	Ohio Power-Kammer Plant	WV	051	Marshall	0006	4911	90	34,560
	42	Indiana Michigan Power Company	IN	029	Dearborn	0002	4911	90	34,387
	43	PSE & G Co.	NJ	017	Hudson	0021	4911	90	34,132
	44	Salt River Project- Navajo Station	AZ	005	Coconino	0423	4911	90	32,771
	45	Alabama Power Gorgas	AL	127	Walker	0001	4911	93	32,663
	46	Ipalco - Petersburg	IN	125	Pike	0002	4911	90	31,551
	47	Monongahela Power - Pleasants	WV	073	Pleasants	0005	4911	90	31,257
	48	Pacificorp - Jim Bridger	WY	037	Sweetwater	1002	4911	94	30,975
	49	Virginia Power - Mount Storm	WV	023	Grant	0003	4911	90	30,690
	50	Houston Lighting & Power Company	TX	157	Fort Bend	0005	4911	90	30,496

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.
1994 Rank numbers 25 and 26 are the same plant but have different NEDS ID's.

Table 2-11. Top 50 AIRS/AFS Plants Emitting Volatile Organic Compounds - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
2	1	Courtaulds No. America Inc	AL	097	Mobile	5002	2823	92	22,349
3	2	Tenn Eastman Co	TN	163	Sullivan	1007	2819	93	17,824
4	3	Chemi-trol Chemical Co	OH	143	Sandusky	5017	3443	90	17,190
5	4	BP Oil Company	OH	095	Lucas	5046	2911	90	15,337
	5	BASF Fibers	TN	063	Hamblen	0022	2824	90	12,789
	6	Exxon Company USA	TX	201	Harris	0027	2911	90	12,601
7	7	BP Chemicals Inc.	OH	003	Allen	5006	2819	90	12,583
9	8	Lenzing Fibers Corporation	TN	063	Hamblen	0197	2823	92	11,850
	9	Star Enterprise	TX	245	Jefferson	0020	2911	90	11,341
15	10	Farmland Industries, Inc. (Ref. Div.)	KS	125	Montgomery	0003	2911	93	11,241
25	11	Chevron U.S.A. Products Company	TX	245	Jefferson	0004	2911	90	10,983
30	12	Shell Oil Company	TX	201	Harris	0039	2911	90	10,485
19	13	E.I. Dupont De Nemours & Company Inc	TX	245	Jefferson	0003	2869	90	9,233
	14	Coastal Refining And Marketing, Inc.	TX	355	Nueces	0018	2911	85	9,216
14	15	AK Steel Corporation	OH	017	Butler	5002	3312	90	9,006
1	16	Air Products & Chemicals	KY	157	Marshall	0009	2821	91	8,552
16	17	ACME Steel Company-Chicago Coke Plant	IL	031	Cook	1302	3312	94	8,386
	18	Koch Refining	MN	037	Dakota	0011	2911	92	8,250
21	19	Roanoke Cement Company	VA	023	Botetourt	0003	3241	94	7,941
	20	Lion Oil Company	AR	139	Union	0016	2911	94	7,831
11	21	Wheeling-Pitt (Follansbee)	WV	009	Brooke	0002	3312	93	7,821
23	22	Impression Coatings	OH	091	Logan	5008	3079	90	7,486
17	23	Exxon Co USA Refinery	LA	033	East Baton Rouge	0015	2911	90	7,416
13	24	LTV Steel Company - Pittsburgh Works	PA	003	Allegheny	0022	3312	91	6,986
24	25	Tenn Eastman Co	TN	163	Sullivan	1004	2824	93	6,978
	26	Eastman Chemical Company	TX	203	Harrison	0019	2869	90	6,956
	27	BASF Corporation	TX	039	Brazoria	0017	2869	90	6,802
	28	Cape Industries	NC	129	New Hanover	0083	2869	90	6,684
	29	Mobil Oil Corporation	TX	245	Jefferson	0018	2911	90	6,634
	30	Amoco Chemicals Co	AL	103	Morgan	0002	2869	92	6,427
	31	The Dow Chemical Company	TX	039	Brazoria	0041	2869	90	6,259
	32	Dupont Washington Works	WV	107	Wood	0001	2821	90	6,098
	33	Shell Oil Co Wood River Mfg Complex	IL	119	Madison	0104	2911	94	6,037
19	34	E. I. Dupont De Nemours and Company	TX	361	Orange	0002	2869	90	6,025
	35	Amoco Oil Company	TX	167	Galveston	0001	2911	90	5,972
	36	Witco Corp, Concarb Division	OK	071	Kay	0703	2895	93	5,721
	37	Weirton Steel Corporation	WV	029	Hancock	0001	3312	90	5,624
	38	Huntsman Corporation	TX	245	Jefferson	0006	2869	90	5,560
	39	Kodak Park Div	NY	055	Monroe	0258	3861	90	5,510
	40	Sun Refining & Marketing Co.	PA	045	Delaware	0025	2911	91	5,489
	41	F.M. Thorpe Manfacturing	MO	011	Barton	0006	2541	86	5,421
	42	Union Carbide Corporation	TX	057	Calhoun	0003	2869	90	5,314
18	43	E.I. Dupont	NC	019	Brunswick	0013	2824	90	5,262
	44	Citgo Petroleum Corp	LA	019	Calcasieu	0016	2911	90	5,231
	45	Inland Steel Flat Products	IN	089	Lake	0316	3312	90	5,166
	46	Bethlehem Steel Corporation	IN	127	Porter	0001	3312	90	5,158
	47	Fina Oil and Chemical Company	TX	227	Howard	0001	2911	90	5,152
	48	Phibro Energy USA, Inc.	TX	167	Galveston	0007	2911	90	4,748
	49	Phillips 66 Company	TX	233	Hutchinson	0015	2911	90	4,724
	50	Shell Oil Co Refinery	LA	089	St. Charles	0002	2911	90	4,708

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

Table 2-12. Top 50 AIRS/AFS Plants Emitting Sulfur Dioxide - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
1	1	General James M. Gavin Plant	OH	053	Gallia	5002	4911	90	373,413
2	2	TVA Cumberland Steam Plant	TN	161	Stewart	0011	4911	93	346,171
3	3	Georgia Power Co Bowen Stm Elec Gen Station	GA	015	Bartow	0011	4911	90	305,302
4	4	Monongahela Power - Harrison	WV	033	Harrison	0015	4911	90	292,039
5	5	Indiana Kentucky Electric Corporation	IN	077	Jefferson	0001	4911	90	281,423
6	6	PSI - Gibson	IN	051	Gibson	0013	4911	90	273,037
8	7	Kyger Creek Station Ohio Valley Elec Corp	OH	053	Gallia	5001	4911	90	249,143
9	8	Georgia Power Co Wansley Stm Elec Gen Station	GA	149	Heard	0001	4911	90	248,651
10	9	Muskingum River Plant	OH	167	Washington	5001	4911	90	245,099
11	10	Illinois Power Co - Baldwin Power Plant	IL	157	Randolph	0033	4911	94	233,768
17	11	West Penn Power Co.	PA	059	Greene	0006	4911	91	194,558
12	12	Pennsylvania Electric Co.	PA	063	Indiana	0001	4911	91	186,356
14	13	James M Stuart Elec Generating Station	OH	001	Adams	5001	4911	90	173,828
15	14	Ohio Edison Company W H Sammis Plant	OH	081	Jefferson	5010	4911	90	169,131
16	15	Central Illinois Public Service	IL	135	Montgomery	0038	4911	94	166,111
18	16	Alabama Power Co E.C. Gaston	AL	117	Shelby	0005	4911	93	156,480
	17	Ohio Power-Kammer Plant	WV	051	Marshall	0006	4911	90	155,170
20	18	Cardinal Operating Company	OH	081	Jefferson	5002	4911	90	148,751
21	19	Virginia Power - Mount Storm	WV	023	Grant	0003	4911	90	141,490
23	20	Alcoa Generating Corp.	IN	173	Warrick	0002	4911	90	135,281
24	21	Pen Elec - Keystone	PA	005	Armstrong	0012	4911	90	134,880
25	22	PP&L - Montour SES	PA	093	Montour	0003	4911	90	132,450
26	23	Georgia Power Co Yates Stm Elec Gen Station	GA	077	Coweta	0001	4911	90	129,844
27	24	TVA-Gallatin	TN	165	Sumner	0025	4911	89	128,724
28	25	CEI - Eastlake	OH	085	Lake	5012	4911	90	128,547
29	26	Detroit Edison Monroe	MI	115	Monroe	0020	4911	90	128,539
30	27	Columbus Southern Power - Conesville	OH	031	Coshocton	5001	4911	90	128,227
7	28	Union Electric Company	MO	071	Franklin	0003	4911	93	119,139
	29	TVA Kingston Steam Plant Kingston	TN	145	Roane	0013	4911	93	117,387
	30	PP & L - Brunner Island	PA	133	York	0020	4911	90	117,104
	31	Texas Utilities Electric Company	TX	449	Titus	0003	4911	88	112,882
13	32	Associated Electric Coop	MO	143	New Madrid	0004	4911	93	111,338
	33	PSI - Cayuga	IN	165	Vermillion	0001	4911	92	109,973
	34	TVA Johnsonville Steam Plant	TN	085	Humphreys	0011	4911	93	108,643
	35	Com Ed - Kincaid Generating Station	IL	021	Christian	0048	4911	94	107,327
	36	Kentucky Utilities	KY	041	Carroll	0010	4911	91	107,213
	37	Pennsylvania Electric Co.	PA	063	Indiana	0003	4911	91	105,308
	38	CG&E W.C. Beckjord Station	OH	025	Clermont	5001	4931	90	104,643
	39	Cincinnati Gas & Electric Co.	OH	061	Hamilton	5052	4931	90	103,015
	40	Alabama Power Gorgas	AL	127	Walker	0001	4911	93	102,259
	41	Georgia Power Co Branch Stm Elec Gen Station	GA	237	Putnam	0008	4911	90	101,222
	42	CP&L Roxboro	NC	145	Person	0029	4911	92	97,043
	43	Texas Utilities Mining Company	TX	401	Rusk	0011	4911	85	94,228
	44	Indiana Michigan Power Company	IN	029	Dearborn	0002	4911	90	90,636
	45	Duke Power Co Belews Creek Steam Station	NC	169	Stokes	0004	4911	91	90,144
	46	Electric Energy, Inc. - Joppa Steam Elec. Station	IL	127	Massac	0014	4911	94	87,890
	47	Monongahela Power - Fort Martin	WV	061	Monongalia	0001	4911	90	84,906
	48	Lilco - Northport	NY	103	Suffolk	1922	4911	90	84,639
	49	Appalachian Power Co. John E. Amos Plant	WV	079	Putnam	0006	4911	90	84,517
	50	Atlantic City Elec	NJ	009	Cape May	0001	4911	87	83,987

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

Table 2-13. Top 50 AIRS/AFS Plants Emitting Sulfur Dioxide from Industrial Sources - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
1	1	Aluminum Company of America	TX	331	Milam	0001	3334	90	67,364
2	2	Copper Range Company	MI	131	Ontonagon	0002	1021	90	65,156
4	3	Asarco, Inc.	MO	093	Iron	0008	3332	93	47,709
3	4	Asarco, Inc.	TX	141	El Paso	0001	3331	90	47,341
5	5	Shell Oil Co Wood River Mfg Complex	IL	119	Madison	0104	2911	94	40,063
11	6	Asarco, Inc.	AZ	007	Gila	0615	3331	93	36,961
6	7	Dakota Gasification Company	ND	057	Mercer	0013	1311	94	36,596
7	8	Phelps Dodge/Hidalgo Smelter	NM	023	Hidalgo	0003	3331	91	34,592
8	9	USS/Kobe Steel Co. - Lorain Works	OH	093	Lorain	5004	3312	90	34,467
	10	The Doe Run Company - Smelting Division	MO	099	Jefferson	0003	2819	93	34,254
10	11	Star Enterprise, Delaware City Plant	DE	003	New Castle	0016	2911	92	33,923
9	12	Mead Corporation	OH	141	Ross	5001	2621	90	33,921
12	13	Kodak Park Div	NY	055	Monroe	0258	3861	90	32,718
15	14	Kennecott Main Stack, Smelter	UT	035	Salt Lake	0030	3331	92	30,047
16	15	AK Steel Corporation	OH	017	Butler	5002	3312	90	29,132
17	16	Phelps Dodge/Chino Mines	NM	017	Grant	0001	3331	95	28,058
20	17	Exxon Co., U.S.A.-Big Escambia CK	AL	053	Escambia	0007	1311	93	27,194
18	18	Mobil Oil Corp	NJ	015	Gloucester	0006	2911	87	26,240
19	19	Bethlehem Steel Corporation	IN	127	Porter	0001	3312	90	26,029
	20	Agrico - Uncle Sam Plant	LA	093	St. James	0004	2874	90	25,727
21	21	Mobil Joliet Refining Corp	IL	197	Will	0089	2911	94	24,837
22	22	Wheeling Pittsburgh Steel Steubenville	OH	081	Jefferson	5006	3312	90	22,714
	23	Inland Steel Flat Products Part 2	IN	089	Lake	0317	3312	90	21,242
	24	Eastman Chemical Company / Main Facility	TN	163	Sullivan	0003	4961	93	19,236
25	25	Lafarge Corporation Great Lakes Region	MI	007	Alpena	0010	3241	90	18,851
	26	Fort Howard Corporation	WI	009	Brown	0328	2621	91	18,836
28	27	Uno-ven Company	IL	197	Will	0077	2911	94	18,021
29	28	Shell Western E & P	MS	121	Rankin	0036	2819	86	17,116
	29	Adm Corn Processing - Clinton	IA	045	Clinton	0030	2075	85	17,017
	30	Ampro Fisheries	VA	133	Northumberland	0018	2077	94	17,010
	31	Reynolds Metals Co.	LA	033	East Baton Rouge	0021	2999	90	16,628
	32	Union Camp Corp/Fine Paper Div	VA	093	Isle of Wight	0006	2621	94	16,141
	33	Chevron U.S.A. Products Company	TX	245	Jefferson	0004	2911	90	15,500
	34	Pekin Energy Company	IL	179	Tazewell	0044	2869	94	14,859
	35	Clark Oil & Refining Corporation	IL	031	Cook	2448	2911	94	14,791
	36	Asarco, Inc.	MT	049	Lewis and Clark	0001	3332	94	14,746
	37	Mobil Oil Corporation	TX	245	Jefferson	0018	2911	90	14,628
	38	PPG Industries	WV	051	Marshall	0002	2819	85	14,422
	39	Phillips 66 Company	TX	233	Hutchinson	0015	2911	90	14,063
	40	Magma Copper Co.	AZ	021	Pinal	0102	3331	93	14,051
	41	Conoco, Inc.	OK	071	Kay	0202	2911	90	13,631
	42	Grain Processing Corp	IA	139	Muscatine	0025	2869	85	13,605
	43	Texas Industries, Inc.	TX	139	Ellis	0009	3241	90	13,068
	44	US DOE Y-12 Plant	TN	001	Anderson	1020	3499	93	12,800
	45	Total Petroleum, Inc.	OK	019	Carter	0209	2911	88	12,360
	46	Wheeling Pitts Stl Steubenville North	OH	081	Jefferson	5008	3312	90	11,815
	47	Great Lakes Carbon Corporation	TX	245	Jefferson	0023	2999	90	11,587
	48	Fina Oil And Chemical Company	TX	227	Howard	0001	2911	90	11,531
	49	Citgo Petroleum Corp	LA	019	Calcasieu	0016	2911	90	11,466
	50	Lafarge Corporation	TX	439	Tarrant	0024	3273	85	11,308

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

Table 2-14. Top 50 AIRS/AFS Plants Emitting Particulate Matter (PM-10) - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
4	1	Nemo Coal, Inc.	MO	175	Randolph	0015	1211	87	11,562
1	2	LTV Steel Mining - Hoyt Lakes Taconite	MN	137	St. Louis	0009	1011	92	8,852
5	3	Inland Steel Flat Products Part 2	IN	089	Lake	0317	3312	90	6,404
6	4	Asarco, Inc.	AZ	019	Pima	0001	1021	92	5,920
	5	Eveleth Mines - Fairlane Plant	MN	137	St. Louis	0113	1011	92	4,778
8	6	Bethlehem Steel Corporation	IN	127	Porter	0001	3312	90	4,161
9	7	Pacificorp - Jim Bridger	WY	037	Sweetwater	1002	4911	94	3,972
	8	Trade Waste Incinerator Inc	IL	163	St. Clair	0103	4953	94	3,936
11	9	Kennecott Main Stack, Smelter	UT	035	Salt Lake	0030	3331	92	3,616
12	10	Inland Steel Flat Products	IN	089	Lake	0316	3312	90	3,553
13	11	Peabody Coal Co Midwest Division	IL	157	Randolph	0034	1222	94	3,371
17	12	Central Soya Company Inc	IN	001	Adams	0005	2075	90	3,129
19	13	Pacificorp - Centralia Plant	WA	041	Lewis	0010	4911	93	2,944
26	14	Imperial Products Corp	MO	035	Carter	0004	2861	93	2,789
21	15	Bethlehem Steel Corp.	PA	095	Northampton	0048	3312	90	2,721
	16	Lafarge Corporation Great Lakes Region	MI	007	Alpena	0010	3241	90	2,712
	17	KPL Gas Service (JEC)	KS	149	Pottawatomie	0001	4911	93	2,662
24	18	PP&L - Montour SES	PA	093	Montour	0003	4911	90	2,585
25	19	A E Staley Manufacturing Co	IL	115	Macon	0018	2046	94	2,568
30	20	ACME Steel Company	IL	031	Cook	0823	3312	94	2,326
	21	Cumberland Municipal Utility	WI	005	Barron	0586	4931	92	2,307
	22	Inland Steel Mining	MN	137	St. Louis	0062	1011	92	2,301
	23	Champion International Corp.	MI	043	Dickinson	0014	2611	90	2,261
	24	Caruthersville Shipy	MO	155	Pemiscot	0030	3731	87	2,249
	25	Copper Range Company	MI	131	Ontonagon	0002	1021	90	2,181
	26	Northern States Power	MN	141	Sherburne	0004	4911	92	2,141
2	27	US Steel - Ore Operation	MN	137	St. Louis	0005	1011	92	2,074
	28	Pacificorp Naughton Power Plant	WY	023	Lincoln	0004	4911	94	2,029
	29	Lone Star Industries, Inc	IN	133	Putnam	0002	3272	92	1,992
	30	Craig Industries	MO	203	Shannon	0006	2861	93	1,974
	31	Pacificorp - Dave Johnston	WY	009	Converse	0001	4911	94	1,949
	32	Rouge Steel Company	MI	163	Wayne	0188	3312	90	1,910
	33	Cargill Inc - Commodity Marketing Div	IL	031	Cook	1225	5153	94	1,876
	34	Granite City Steel Company	IL	119	Madison	0153	3312	94	1,875
	35	Harborlite Corp, Superior Plant	AZ	021	Pinal	0108	3295	90	1,874
	36	Glasgow, Inc.	PA	091	Montgomery	0021	1422	91	1,862
	37	U S Steel Co Gary Works Part 2	IN	089	Lake	9999	3312	92	1,826
	38	GAF Chemicals Corporation	WI	075	Marinette	0435	3999	90	1,785
	39	Corson Lime Co., Div. of Rangaire	PA	091	Montgomery	0034	3274	91	1,779
	40	Lehigh Portland Cement Co	IA	033	Cerro Gordo	0035	3241	90	1,761
	41	Garnett Wood Products	MO	091	Howell	0010	2421	93	1,703
	42	PP & L - Brunner Island	PA	133	York	0020	4911	90	1,677
	43	Carolina Power and Light	NC	021	Buncombe	0628	4911	89	1,658
	44	LTV Steel Company, Inc. (Republic)	IL	031	Cook	1221	3312	94	1,653
	45	Lehigh Portland Cement Co	IN	093	Lawrence	0002	3241	90	1,648
	46	Asarco, Inc. Ray Mine	AZ	021	Pinal	0066	1021	93	1,620
	47	Pacific P&I Wyodak	WY	005	Campbell	0046	4911	94	1,603
	48	Medusa Cement Co.	PA	073	Lawrence	0024	3272	91	1,594
	49	Roanoke Cement Company	VA	023	Botetourt	0003	3241	94	1,593
	50	International Paper Company-Androscoggin	ME	007	Franklin	0021	2611	90	1,592

Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

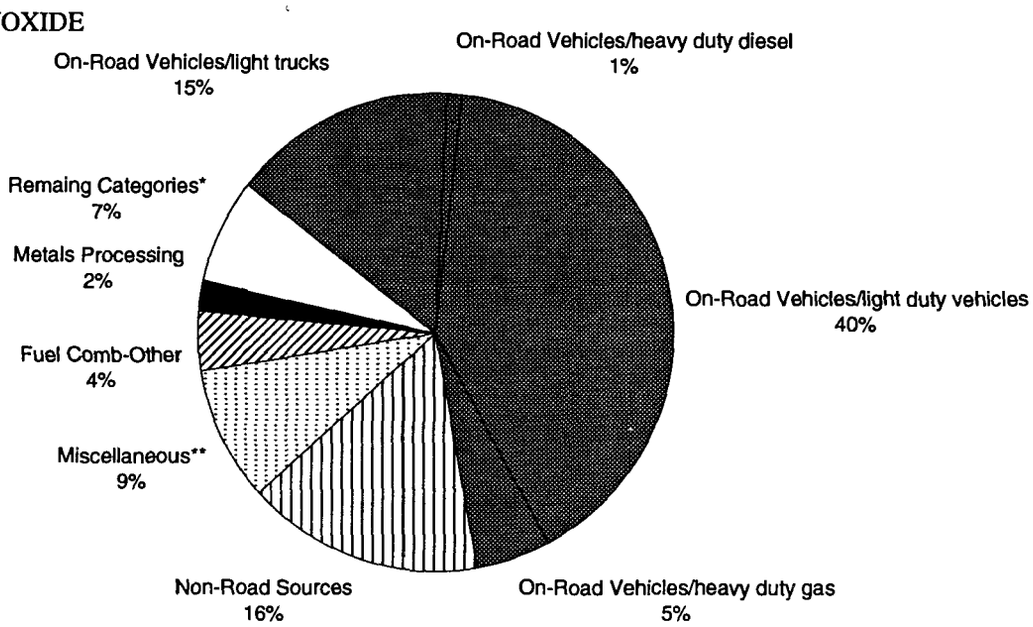
Table 2-15. Top 50 AIRS/AFS Plants Emitting Lead - 1994

1993 Rank	1994 Rank	Plant Name	State	County Code	County	NEDS ID	SIC	Year	Emissions (tons/year)
	1	Refined Metals Corp	IN	097	Marion	0036	3341	87	715
1	2	Granite City Steel Company	IL	119	Madison	0153	3312	94	689
2	3	Horsehead Resource Development Co., Inc.	IL	031	Cook	1199	3341	94	303
3	4	Northwestern Steel & Wire Co.	IL	195	Whiteside	0070	3315	94	144
4	5	The Doe Run Company - Smelting Division	MO	099	Jefferson	0003	2819	93	122
10	6	Asarco, Inc.	MO	093	Iron	0008	3332	93	115
5	7	Chemetco	IL	119	Madison	0128	3341	94	108
12	8	The Doe Run Company	MO	093	Iron	0009	3332	90	53
13	9	R. Lavin & Sons, Inc.	IL	097	Lake	0084	3341	94	48
	10	Gopher Smelting & Refining	MN	037	Dakota	0016	3341	92	48
	11	Tnemec Company Inc	MO	047	Clay	0075	2851	93	41
16	12	Continental Cement	IL	031	Cook	0035	5039	85	37
18	13	PPG Industries Inc., Works No 14	IL	115	Macon	0104	3211	94	35
20	14	Asarco, Inc.	TX	141	El Paso	0001	3331	90	34
23	15	Asarco, Inc.	NE	055	Douglas	0020	3341	93	27
24	16	C R Huntley Steam Station	NY	029	Erie	1700	4911	85	24
25	17	Haeger Potteries, Inc.	IL	089	Kane	0065	3269	94	22
29	18	Refined Metals Corp	TN	157	Shelby	0212	3341	85	20
30	19	Northwest Waste To Energy	IL	031	Cook	1478	4953	94	19
	20	Asarco, Inc.	MT	049	Lewis and Clark	0001	3332	94	18
	21	Niagara Mohawk Power Corp. Dunkirk	NY	013	Chautauqua	0325	4911	85	18
	22	Keystone Steel & Wire Division	IL	143	Peoria	0136	3315	94	18
	23	Wirco Casting	IL	163	St. Clair	0128	3321	94	16
	24	Briggs Plumbingware, Inc.	IL	095	Knox	0001	3261	94	14
	25	ACME Steel Company-Chicago Coke Plant	IL	031	Cook	1302	3312	94	13
	26	Pilot Battery Inc	IL	091	Kankakee	0088	3691	94	13
	27	Northern States Power	MN	141	Sherburne	0004	4911	92	13
	28	Taracorp Industries, Inc.	IL	119	Madison	0039	3341	94	12
	29	ACME Steel Company	IL	031	Cook	1220	3312	94	11
	30	Copper Range Company	MI	131	Ontonagon	0002	1021	90	11
	31	Ford Motor Co Cleve Casting Plant	OH	035	Cuyahoga	5100	3321	85	11
	32	Gaston Copper Recycling	SC	063	Lexington	0023	3341	91	8
	33	Clow Corp Cast Iron Pipe Foundry Div	OH	031	Coshocton	5003	3321	85	8
	34	Steel Of W Va Inc	WV	011	Cabell	0009	3312	85	8
	35	Ipalco - Stout	IN	097	Marion	0033	4911	90	7
	36	Illinois Power Co - Baldwin Power Plant	IL	157	Randolph	0033	4911	94	6
	37	Dal-tile Corporation	TX	113	Dallas	0025	3253	90	6
	38	Cyprus Copper Company	AZ	007	Gila	0898	3331	93	6
	39	Akzo Coatings, Inc	IL	031	Cook	0622	2893	85	6
	40	Central Foundry Division G M C	OH	039	Defiance	5008	3321	85	6
	41	Goudey Station Johnson	NY	007	Broome	0292	3573	85	6
	42	Eagle-Picher Industries Inc	MO	097	Jasper	0020	2816	93	5
	43	Coastal Eagle Poi	NJ	015	Gloucester	0004	2911	85	5
	44	General Battery Corp. (Exide Corporation)	IN	035	Delaware	0028	3341	92	5
	45	Bremen Castings Inc	IN	099	Marshall	0001	3321	90	4
	46	GM-Powertrain Division	IL	183	Vermilion	0078	3321	94	4
	47	National Steel Corp Great Lakes Division	MI	163	Wayne	0092	3312	90	4
	48	Briggs, Plumbingware, Inc	IL	033	Crawford	0030	3261	94	4
	49	G.N.B., Inc.	TX	085	Collin	0001	3341	90	4
	50	Rouge Steel Company	MI	163	Wayne	0188	3312	90	4

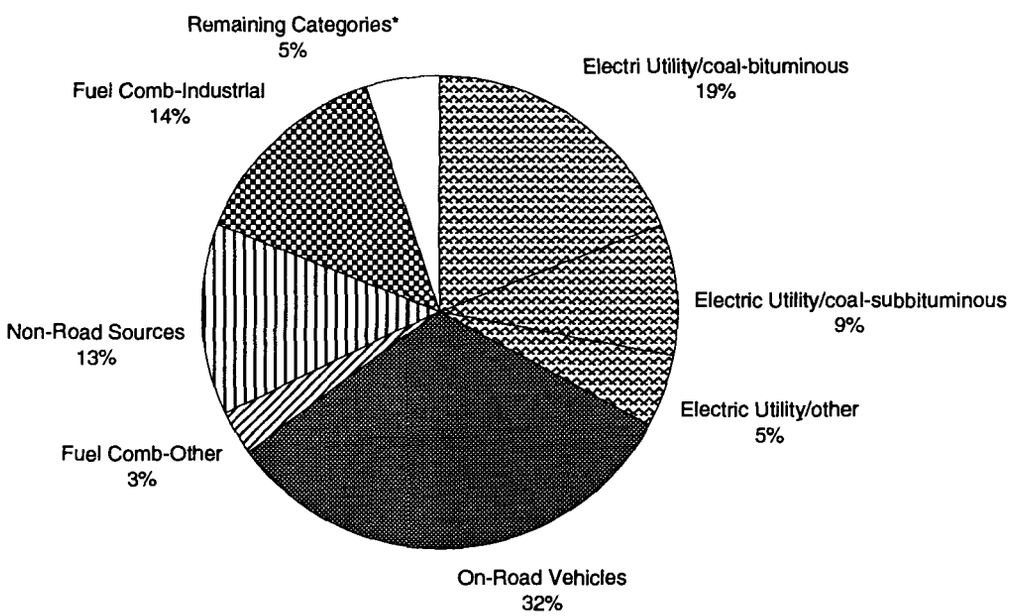
Note(s): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. However, it is the most recent information available from States.
The values presented in the "County Code" column are FIPS county codes.
The AIRS data are not the main basis for the emission estimates presented elsewhere in this report.

Figure 2-1. 1994 National CARBON MONOXIDE and NITROGEN OXIDE Emissions by Principal Source Categories

CARBON MONOXIDE

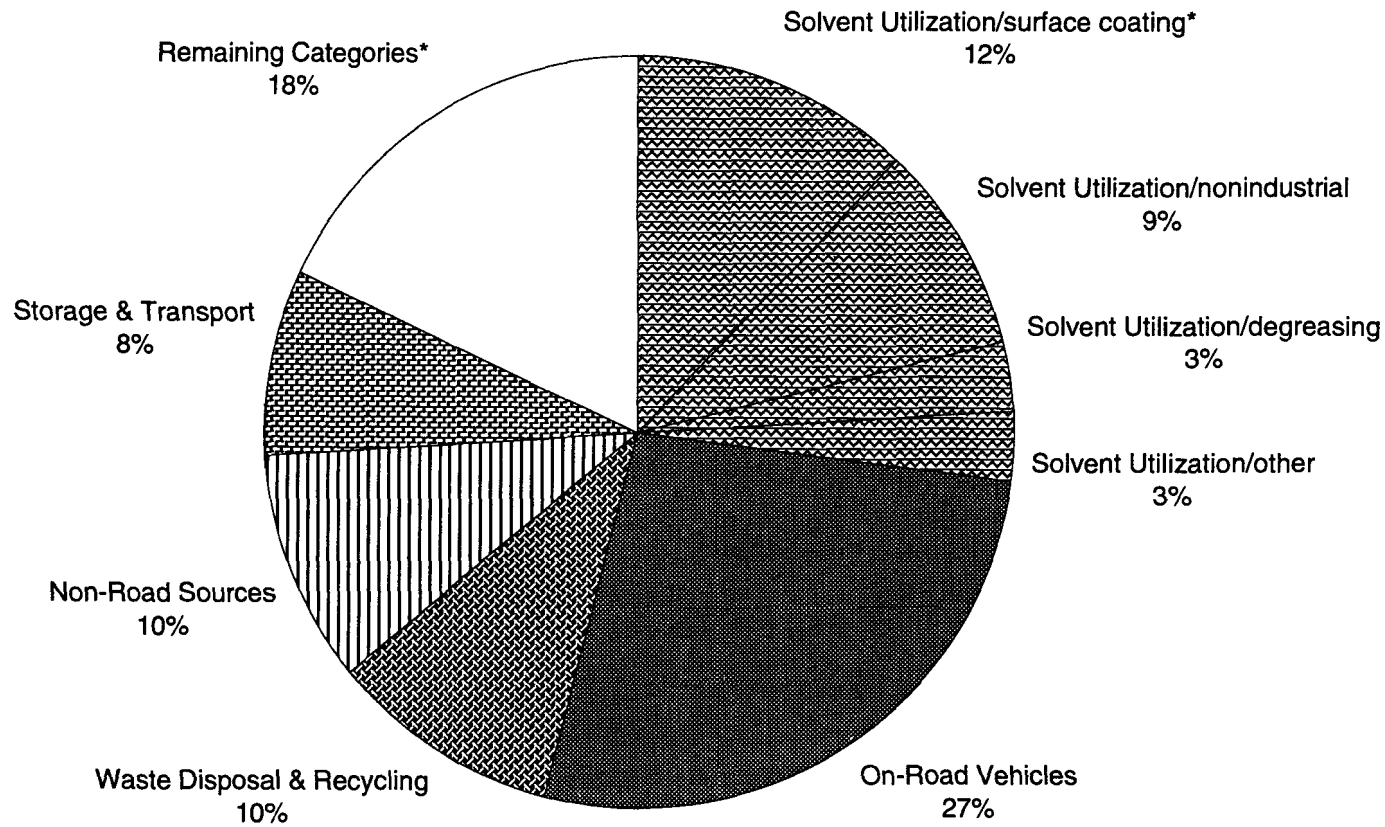


NITROGEN OXIDES



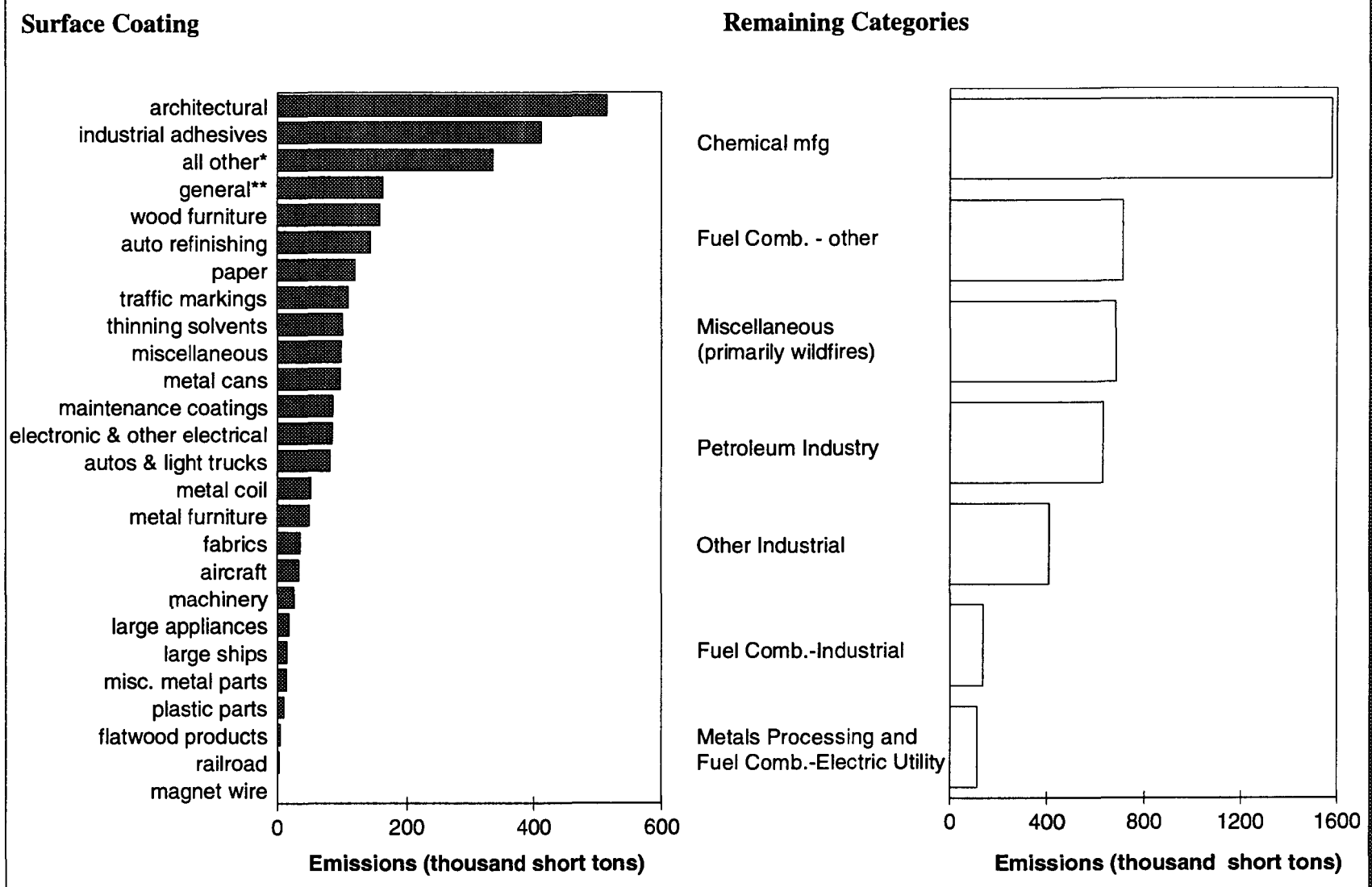
* Remaining Categories are defined in section 2.1.
** Miscellaneous is primarily wildfire emissions.

Figure 2-2. 1994 National VOLATILE ORGANIC COMPOUND Emission Estimates by Source Category



* More details are displayed in figure 2-3.

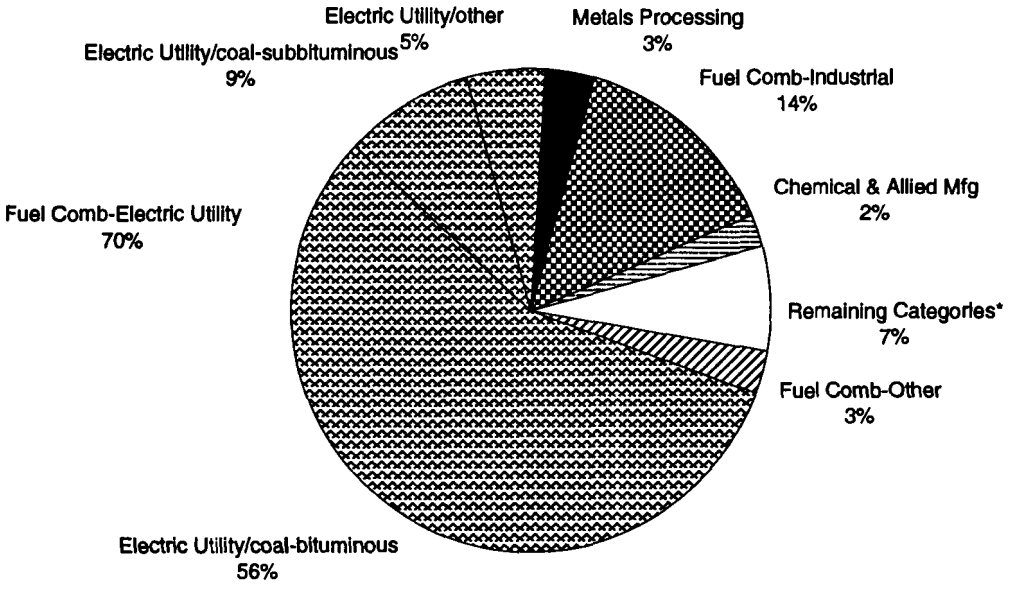
Figure 2-3. Breakdown of Major 1994 National VOLATILE ORGANIC COMPOUND Emission Sources



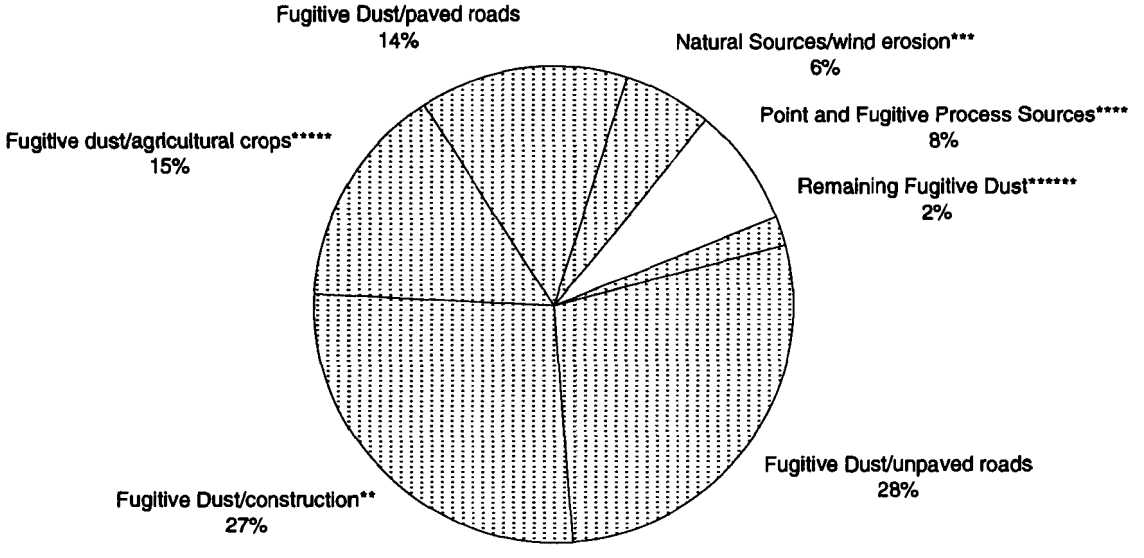
* all other: sources that use specific solvents on nonspecific surfaces
** general: sources that use nonspecific solvents on nonspecific surfaces

Figure 2-4. 1994 National SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions by Principal Source Categories

SULFUR DIOXIDE



PARTICULATE MATTER (PM-10)



Note(s):

* Remaining categories are defined in section 2.1.

** Construction emissions represent the majority of the miscellaneous-fugitive dust-other category as presented in appendix A, table A-5.

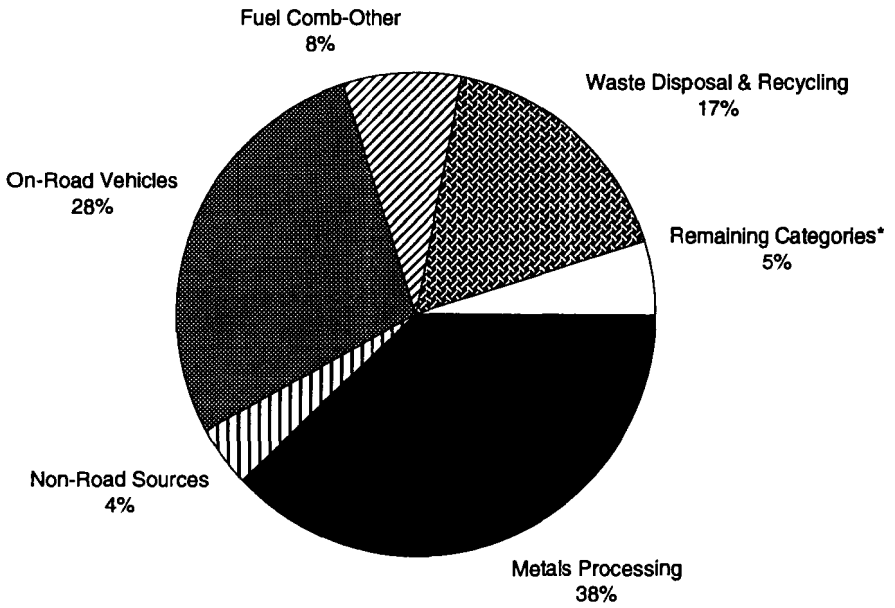
*** Natural sources/wind erosion emissions are discussed as fugitive dust sources throughout this report.

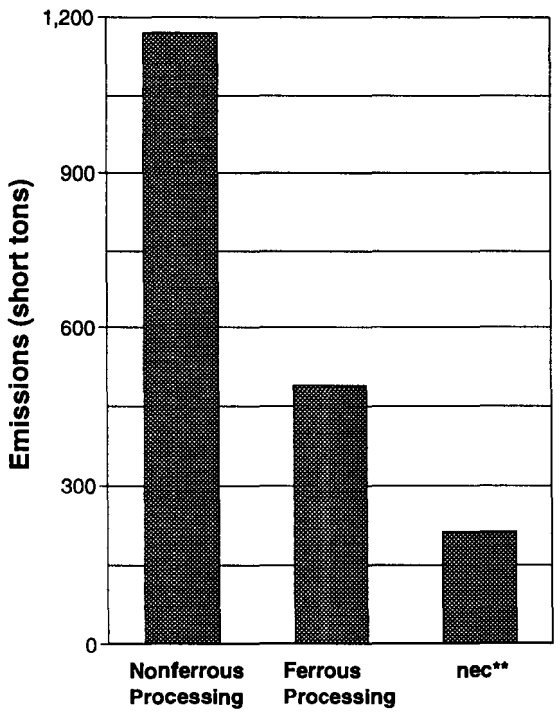
**** Point and fugitive process sources are all sources except the fugitive dust sources.

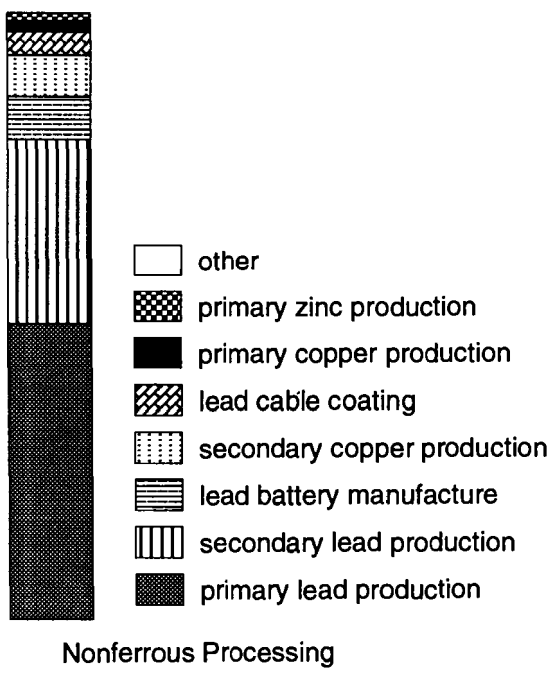
***** Presented in appendix A, table A-5 as miscellaneous-agriculture & forestry-agricultural crops.

****** Includes miscellaneous-agriculture & forestry-agricultural livestock and miscellaneous-fugitive dust-other excluding construction.

Figure 2-5. 1994 National LEAD Emissions by Principal Source Categories







* Remaining Categories are defined in section 2.1.6.
** not elsewhere classified

Figure 2-6. 1994 Emission Estimates by State and Pollutant for the Top 10 States Emitting Each Pollutant

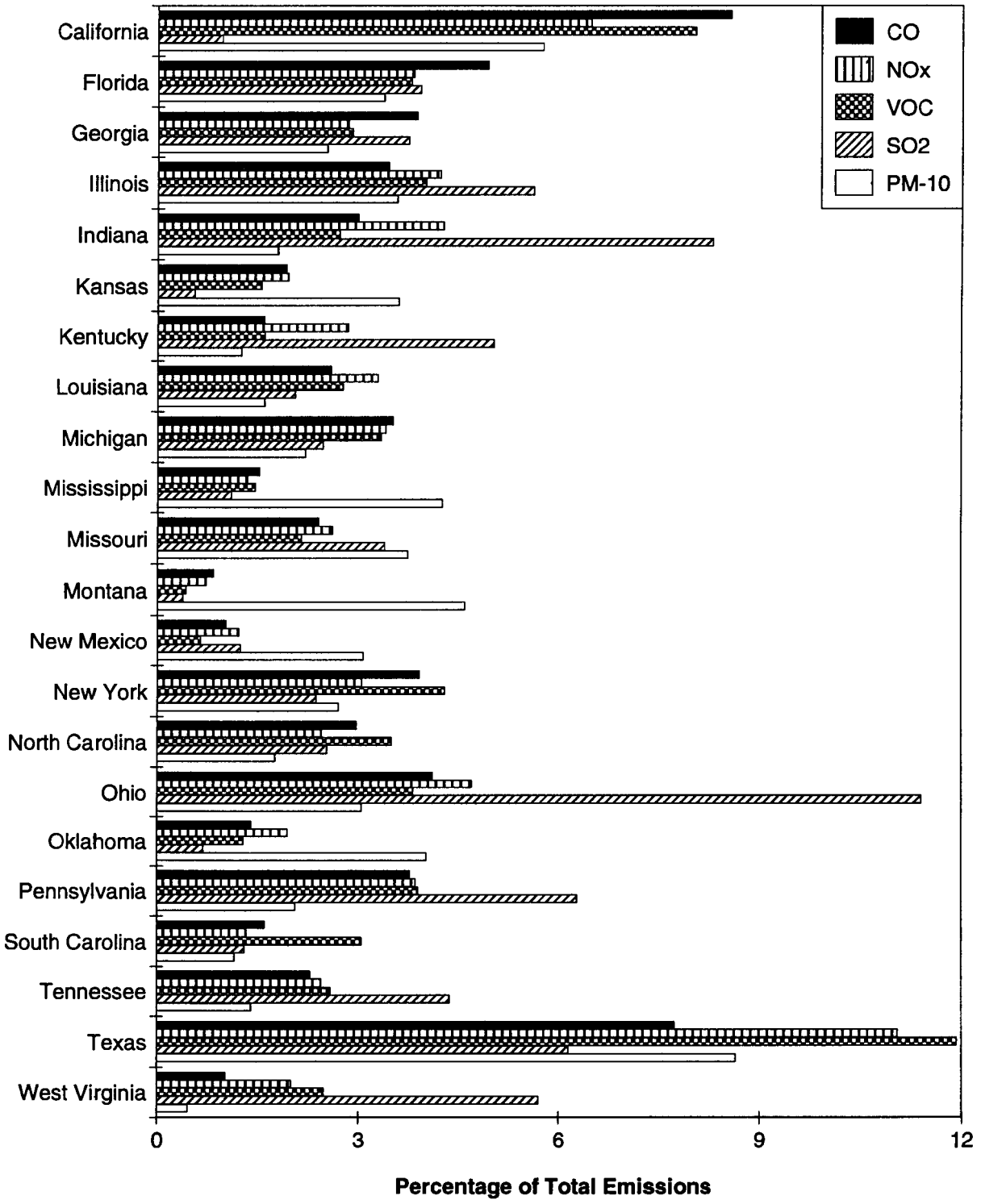


Figure 2-7. Density Map of 1994 CARBON MONOXIDE Emissions

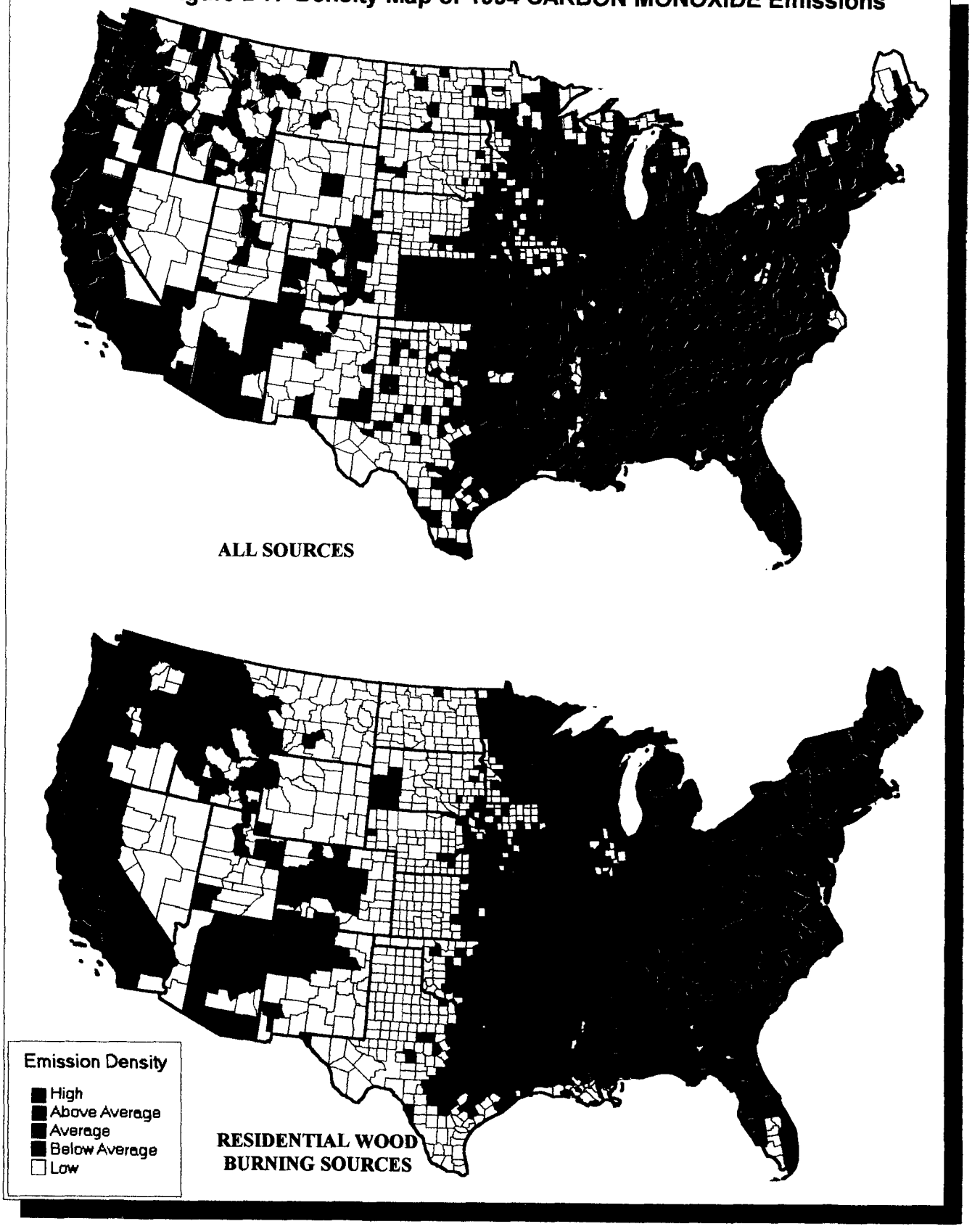
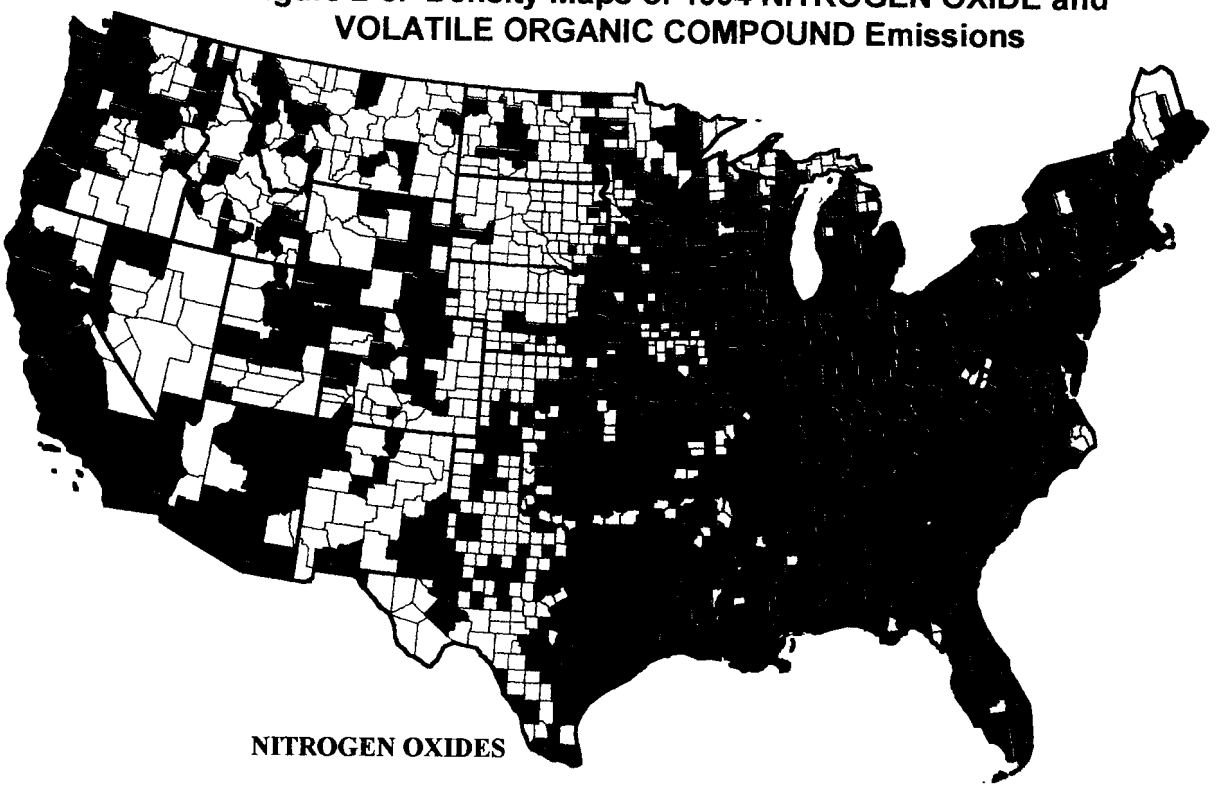


Figure 2-8. Density Maps of 1994 NITROGEN OXIDE and VOLATILE ORGANIC COMPOUND Emissions



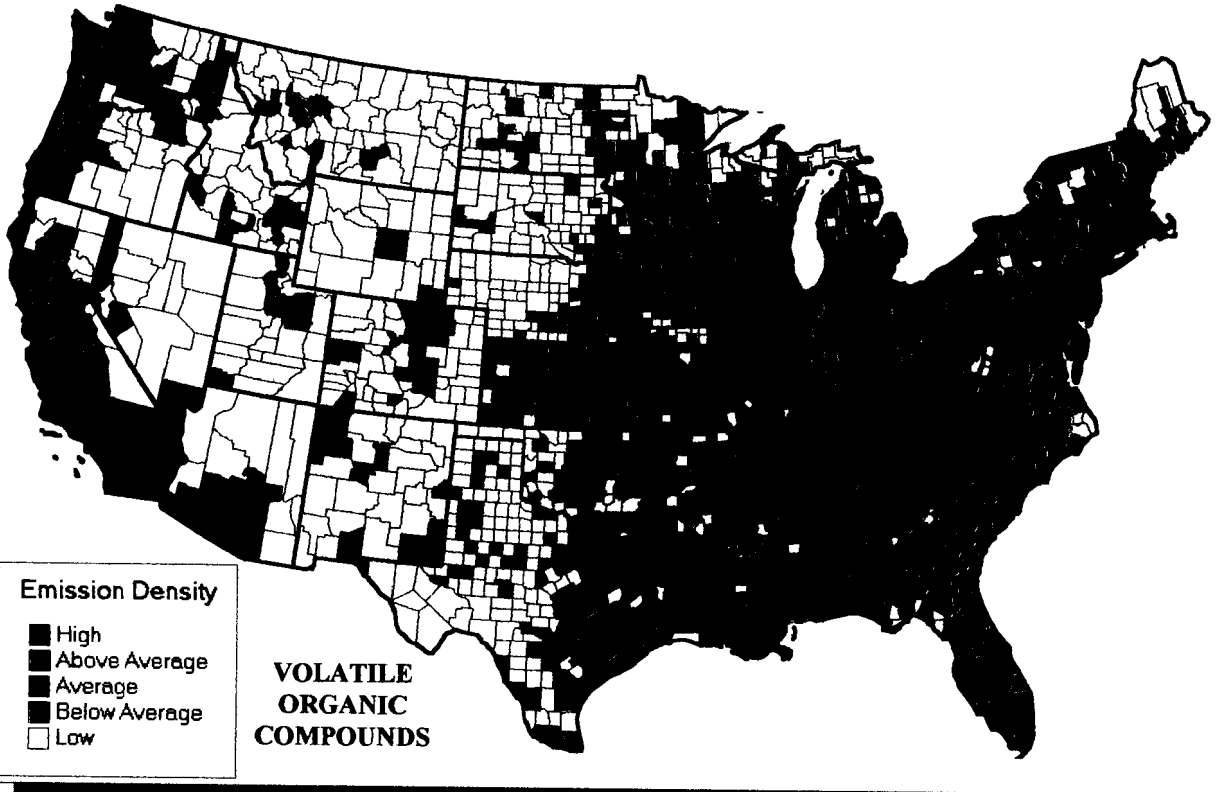
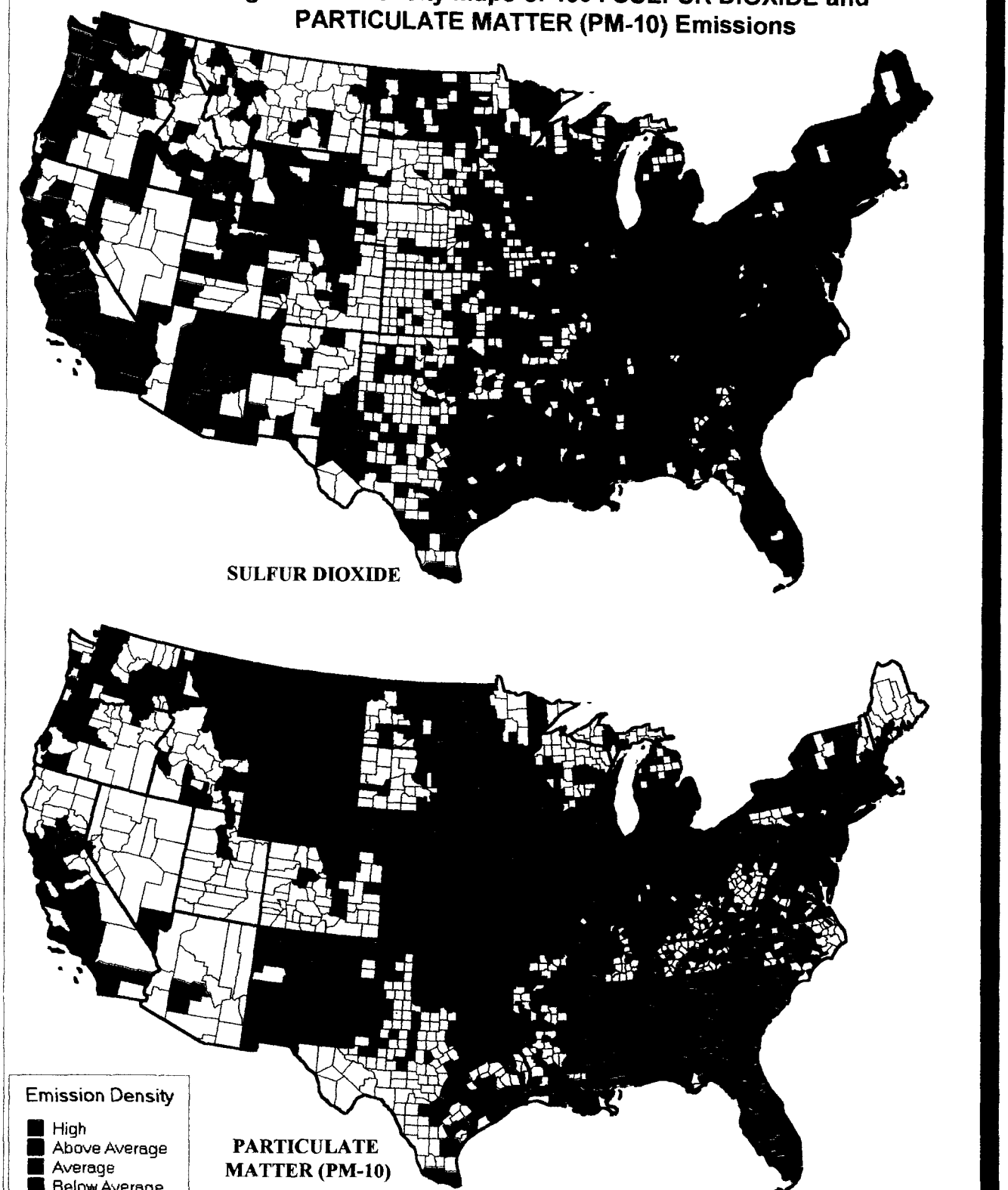
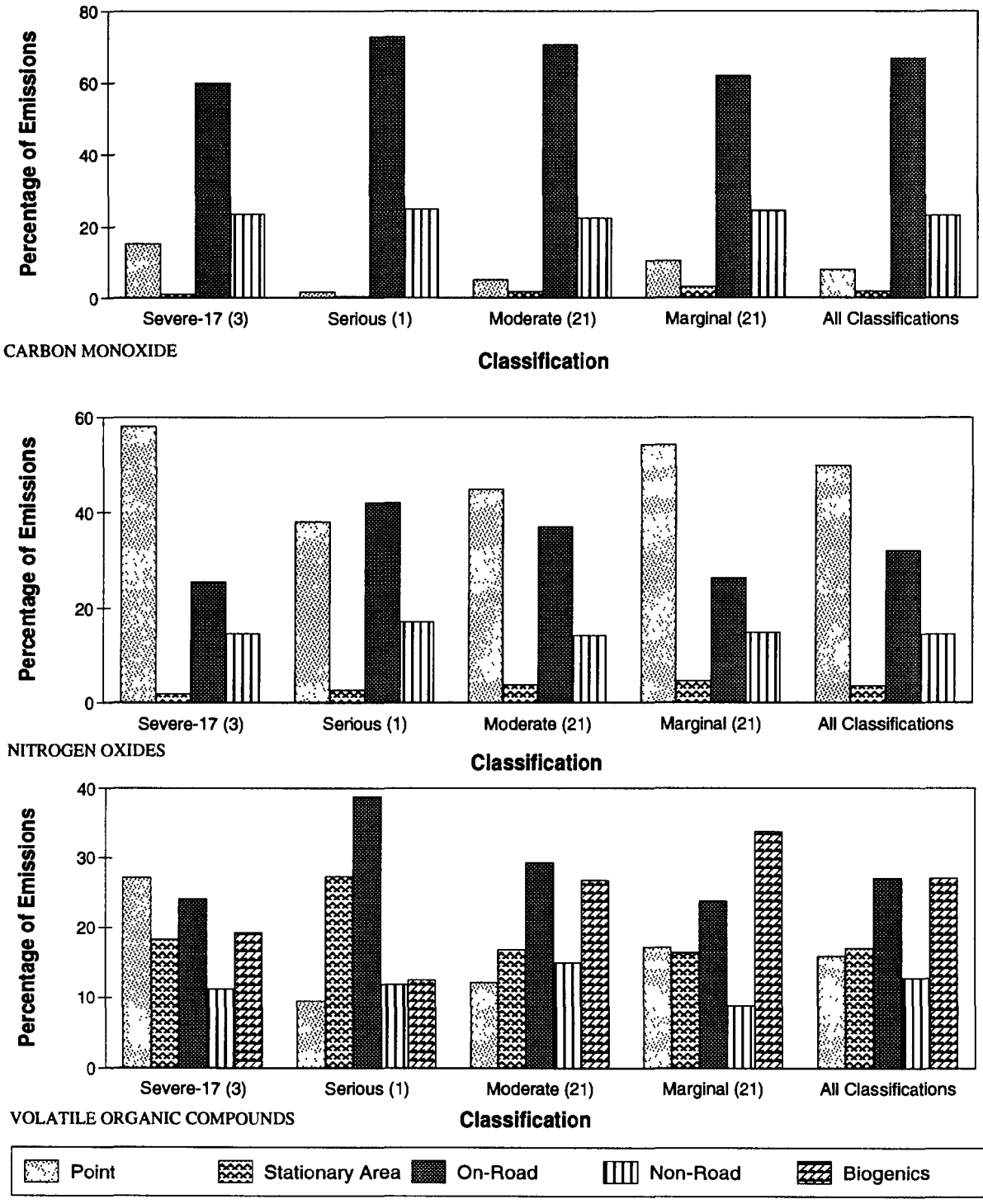


Figure 2-9. Density Maps of 1994 SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions



Note(s): 1994 emissions except 1990 PM-10 Fugitive Dust-paved and unpaved road emissions for Mississippi. The data used to estimate emissions for Mississippi is currently under review.

Figure 2-10. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Classification and Major Sources



Note(s): Numbers in parenthesis are the number of areas within each classification.

Figure 2-11. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Major Sources and Locations

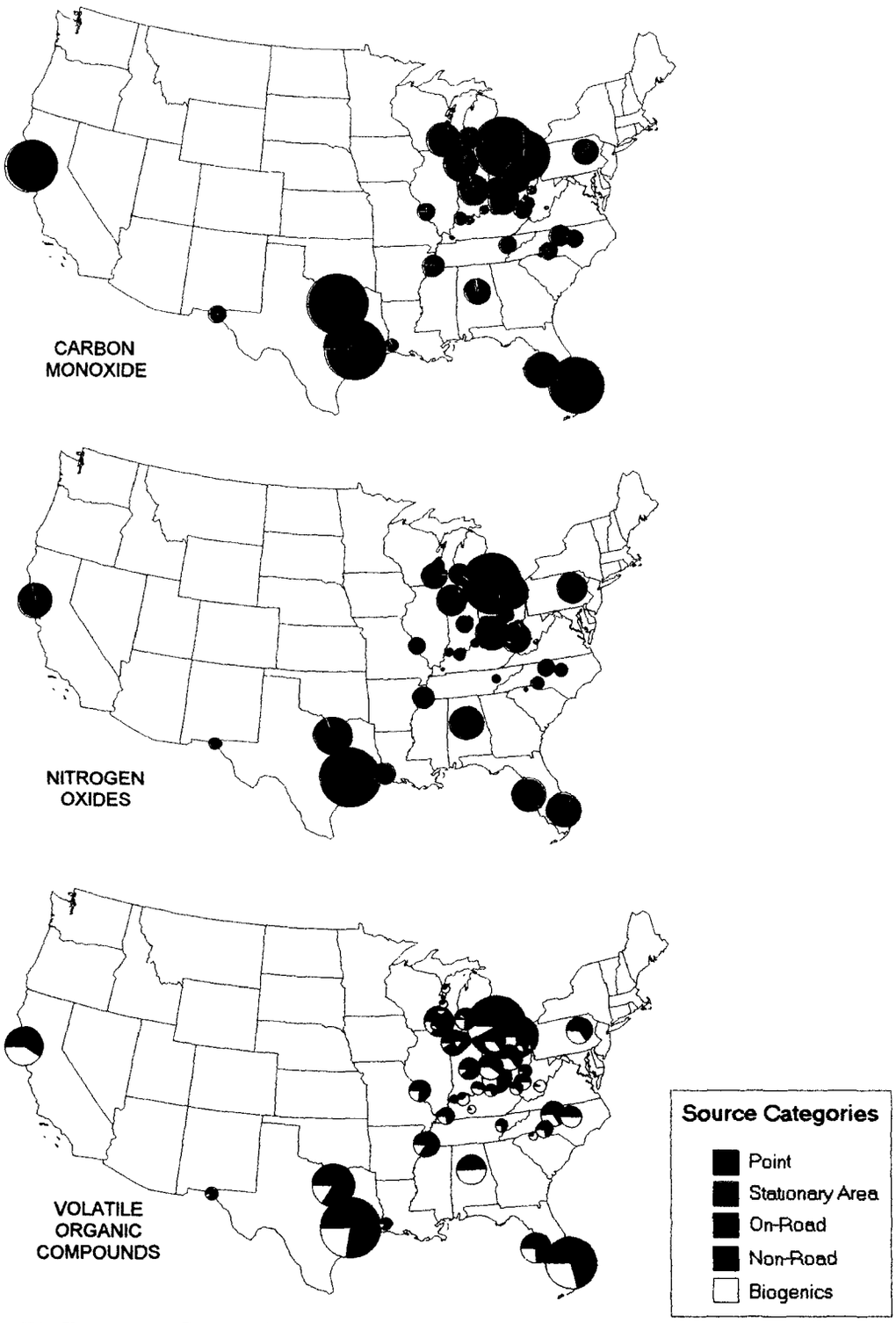
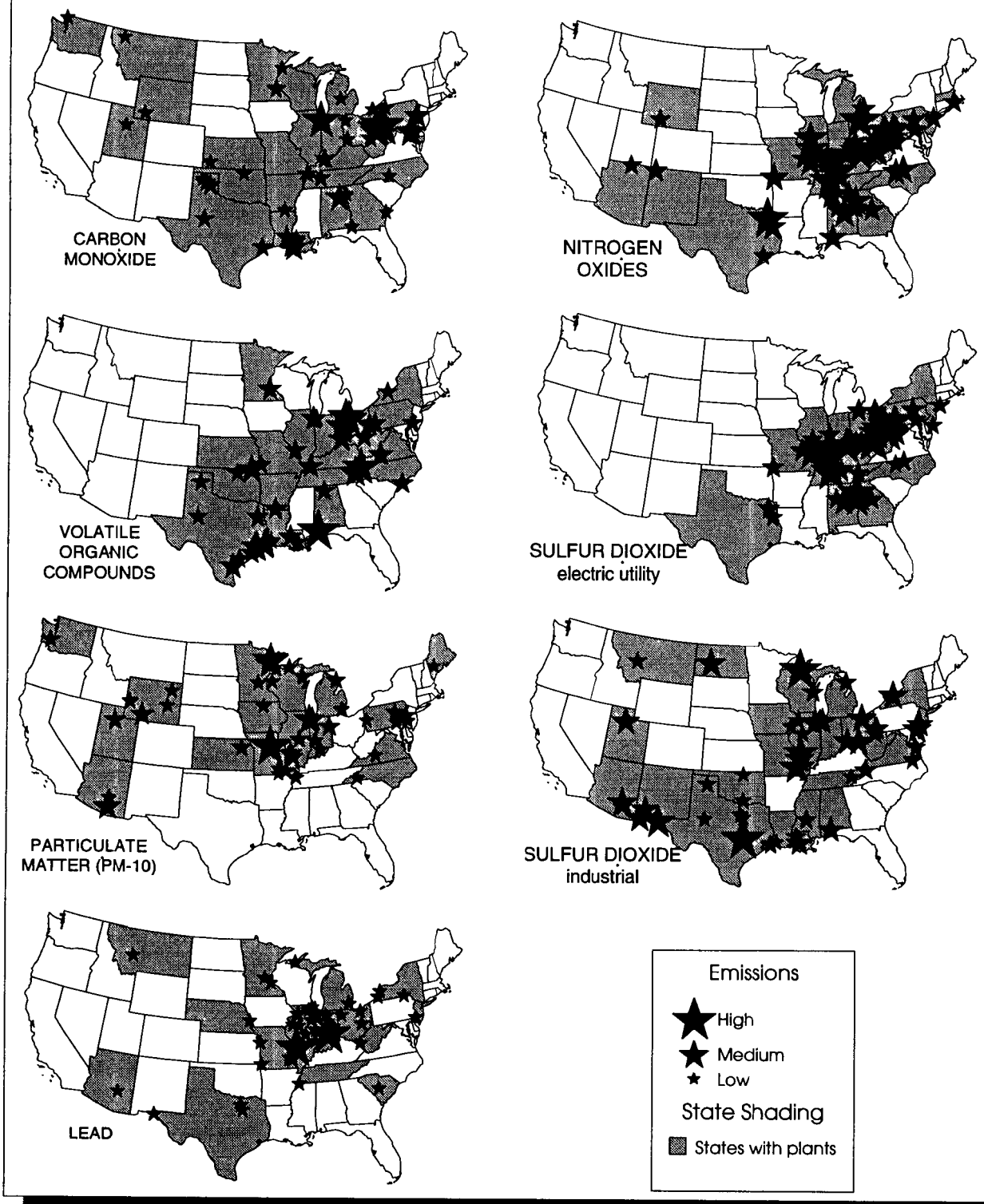


Figure 2-12. Top 50 Plant Emissions as Reported to AIRS/AFS by Pollutant



Chapter 3.0 Summary of National Emission Trends and Economic, Demographic, and Regulatory Influences on Historic Trends in Emissions

This chapter of the report summarizes estimates of historical trends in criteria air pollutant emissions for the period 1900 through 1994. The CO, NO_x, VOC, SO_2, and PM-10 emissions for the years 1990 through 1994 are preliminary and will be revised as ozone SIP inventory information becomes available. The 1994 emissions for Pb are also preliminary and will be revised for the 1996 *Trends* report. The 1993 Pb emissions, reported as preliminary emissions in the previous report, have been revised.[1]

The level and composition of economic activity in the nation, demographic influences, and the impact of regulatory efforts to control emissions affect historic trends in criteria air pollutant emissions. A general discussion and figures depicting significant economic, demographic, and regulatory influences on emission trends are included in the following section to provide additional insight to air pollutant emissions trends.

3.1 INTRODUCTION

The national emissions for each of the criteria air pollutants are presented in tables 3-1 through 3-6. For CO, NO_x, VOC, SO_2, and PM-10 emissions are shown for the beginning year in each decade for the period 1940 through 1990 and for the years 1993 and 1994. Emissions of Pb are reflected in table 3-6 for every 5 years between 1970 and 1990 and for the years 1993 and 1994. The emissions are provided by Tier 1 source category and for Tier 2 and Tier 3 source categories for sources that are major contributors to total emission levels.

Figures 3-1 through 3-6 depict historical emission trends for each air pollutant by principal source category. For NO_x, VOC, and SO_2, these trends are presented for the period 1900 through 1994. Carbon monoxide and PM-10 emissions are shown by major source category for the period 1940 through 1994. Lead emissions are shown by principal source category in figure 3-6 for the period 1970 to 1994.

Several different methods are used to estimate the emissions reported in these tables and figures. In order to assess the trends in the emissions, it is important to know when changes in methodology occur. The NO_x, VOC, and SO_2 emissions for the years 1900 through 1969, with the exception of the years 1940, 1950, and 1960 are estimated using the methodology described in section 6.2. The CO, NO_x, VOC, SO_2, and PM-10 emissions for the years 1940, 1950, and 1960 and for the years 1970 through 1984, are estimated by the methodology described in section 6.3. This methodology is also used to produce the Pb emissions for all source categories for the years 1940, 1950, 1960, and 1970 through 1994. The methodology described in section 6.4 is used to estimate the CO, NO_x, VOC, SO_2, and PM-10, emissions for all source categories for the years 1985 through 1994 and for transportation sources for the years 1970 through 1994.

Figures 3-7 through 3-12 present trends in historical emissions, per capita emissions, and emissions normalized by real Gross Domestic Product (GDP) for each of the criteria air pollutants. Emissions values are in thousands of short tons. For comparison purposes, emissions normalized by real GDP are stated as short tons per billion dollars real GDP and per capita emissions are short tons per 100,000 persons. With the exception of lead emissions, these trends are presented for the period 1940 to 1994. Lead emission comparisons reflect the period 1970 to 1994. Per capita emission trends are used as a tool to assess the impact of demographic factors or population growth on emission trends.[2,3] Since most air pollution is created by human activities, it is reasonable to assume that as the population grows, emissions will increase (all other factors affecting emissions remaining unchanged). Per capita variations in emission trends are indicative of changes in emissions for each resident in the nation, on average.

Changes in the general state of the economy will also impact air pollution emissions. The annual productivity of the nation's economy is typically measured using real GDP. Gross domestic product is defined as the market value of all goods and services produced in the nation within a year, and in this report real GDP refers to GDP stated in constant 1987 price levels.[4,5] If all other factors affecting emissions remain constant, it is reasonable to assume that as the economy grows (i.e., real GDP increases) emissions will also increase. The production of goods and services

and other socioeconomic behavior (e.g., vehicle usage) are primary sources of emissions. Assuming pollution control is constant, increased production of goods using productive processes that create pollution results in more pollution. Thus, as more goods and services are produced in the nation emissions can be expected to rise, all other factors held constant. In an effort to view emission trends on a basis that normalizes variations in national production levels, annual emissions are also presented per dollar of real GDP in figures 3-7 through 3-12.

In addition to the general level of annual economic activity, the composition of economic activity (i.e., the mix of goods and services produced in the nation) may also affect emission levels. Over time the mix of goods and services produced in the nation varies due to many factors, including the introduction of technological innovations and changes in consumer tastes and preferences. Emission trends are compared to historical trends in economic and related activities in figures 3-13 through 3-21 [e.g., historical CO emissions are compared to VMT, fuel use, and gasoline prices in figure 3-17], as a method of relating significant contributing activities to emissions.

A general discussion of important historical regulatory efforts to control air pollutant emissions is also presented. Significant regulatory milestones in air pollution control and the likely impact of these controls on emission levels are highlighted. Historical information concerning the number of jurisdictions with air pollution control regulation is presented in figure 3-22. Figure 3-23 compares emission trends for the period 1972 through 1992 with annual expenditures for air pollution abatement, air regulation and monitoring, and research and development for air pollution.[6]

A synopsis of regulatory activities in air pollution is presented in section 3.2. Emission trends and economic, demographic, and regulatory factors influencing emission levels for each of the criteria air pollutants are the focus of sections 3.3 through 3.7.

3.2 OVERVIEW OF AIR POLLUTION CONTROL HISTORY

3.2.1 Pre-1970 Efforts

The very first air pollution statutes in the United States were passed by the cities of Chicago and Cincinnati in 1881 to control smoke and soot from furnaces and locomotives. County governments began to pass their own pollution control laws in the early 1900's. The first State to legislatively control air pollution was Oregon in 1952. Other States followed, with air pollution statutes generally targeted toward smoke and particulates. Figure 3-22 presents the number of jurisdictions with air pollution control legislation during the 100-year period starting in 1880.[7]

The Federal government's involvement in air pollution control began in 1955 with the passage of the Air Pollution Control Act. This law limited the extent of Federal involvement to funding assistance for the States' air pollution research and training efforts. The shift toward greater involvement of the Federal government in air pollution control began in the mid-1960s. In 1963 Congress passed the original Clean Air Act, which provided for permanent Federal support for air pollution research, continued and increased federal assistance to the States for the development of their air pollution control agencies, and introduced a mechanism through which the Federal government could assist the States with cross-boundary air pollution problems. In 1965, Congress amended the Clean Air Act for the first time, directing the Secretary of Health, Education, and Welfare (HEW) to set the first Federal emissions standards for motor vehicles.

In 1967 Congress passed the Air Quality Act, which required that States establish air quality control regions and that HEW publish information about the adverse health effects associated with several common air pollutants. This information was to be used by the States in setting air quality standards. In addition, HEW was to identify viable pollution control technologies for States to use to attain the air quality standards that each was to have established.

There were several perceived problems with this early period of air pollution control. The HEW had been slow in issuing guidance documents detailing the adverse health effects associated with common air pollutants; where these had been prepared, States had either failed to set air quality standards or were slow in developing implementation plans. Also, the automobile manufacturers appeared able to disregard the emissions standards set by HEW.

3.2.2 1970 Clean Air Act and Post-1970 Activities

With the CAA, as amended in 1970, a major change took place in air pollution policy. First, a new Federal government agency, EPA, was charged with the responsibility of setting the NAAQS. In 1971, the EPA promulgated primary and secondary NAAQS for photochemical oxidants, CO, SO_2, TSP, and hydrocarbons (HCs). Second, EPA was given authority to develop national emissions standards for cars, trucks, and buses. Finally, Congress gave the EPA power to set emissions standards for all new sources of the common air pollutants (NSPS). Under the CAA, the major responsibility left to the States was how to control existing sources. States were charged with the task of complying by 1975 with each of the NAAQS by developing and implementing SIPs that would demonstrate how existing sources would be controlled. Additional modifications were made to the Act in 1977, with the most significant changes occurring with passage of the CAAA.

Figure 3-23 depicts a comparison of annual criteria air pollutant emission trends with annual national expenditures for air pollution abatement, air regulation and monitoring, and research and development for pollution abatement and control. Emission levels represent the sum of emissions in short tons for all of the criteria air pollutants excluding PM-10 from fugitive dust sources.

Data to estimate fugitive dust PM-10 emissions were unavailable for the entire 21-year period. For the period depicted, increasing expenditures correspond to decreasing total criteria air pollutant emissions, an indication of the impact of regulatory measures in reducing emission levels. A linear trend line has been fit to the data indicating that increasing expenditures for pollution control corresponds with decreasing emission levels. Interestingly, the last 4 years of available data (1989 through 1992) indicate that fewer dollars are being spent than during the 1980s, although emission levels have continued to decline.

Trends in each of the criteria air pollutants by principal source categories and the impact of economic, demographic, and regulatory influences on these emission trends are discussed in the following sections. Because the emissions reduction impact of the CAAA mandates is only beginning to take effect, the discussion highlights pre-1990 regulatory activities that targeted specific criteria air pollutant emission reductions. It is important to note that the regulatory discussion is not comprehensive. Instead, these sections emphasize the regulatory efforts that have targeted the major source categories for each air pollutant. In addition, the lack of detail available for all of the data precludes the possibility of analyzing some of the stationary source control measures (e.g., state-specific regulations such as Reasonably Available Control Technology [RACT] provisions).

3.3 CARBON MONOXIDE EMISSION TRENDS, 1940 THROUGH 1994

Table 3-1 and figure 3-1 reflect historical trends in CO emissions by principal source categories. The "remaining categories" grouping shown in figure 3-1 refers to the following Tier 1 categories: fuel combustion - electric utility; fuel combustion - industrial; petroleum and related industries; other industrial processes; solvent utilization; and storage and transport. The miscellaneous category relates primarily to wildfires. Total CO emissions increased to peak levels around 1970 and have decreased thereafter. A significant decrease in CO emissions occurred between 1973 and 1975 as a result of disruptions in world oil markets and a subsequent recession in the United States. This short-term decrease in emissions is exhibited in NO_x and VOC emission trends during the 1973 to 1975 period also for similar reasons. On-road vehicle emissions, the major source of CO emissions followed a similar trend of increasing significantly (203 percent) through 1972 and decreasing (over 33 percent) subsequently. In contrast, non-road source emissions have increased 100 percent during the period. Emissions from other source categories have declined over the period with the exception of fuel combustion - electric utility and industrial and other industrial processes. Carbon monoxide emissions for 1994 have increased somewhat over the 1993 levels due primarily to increased emissions from wildfires.

In figure 3-7, total CO emissions, CO emissions normalized by real GDP, and per capita CO emissions are displayed. Per capita CO emissions follow a general downward trend through the 1949 to 1994 period. Similarly, CO emissions normalized by real GDP follow a downward trend during the 1949 to 1994 period reflecting fewer emissions being produced per dollar of output.

3.3.1 Fuel Combustion Carbon Monoxide Emissions: Electric Utility, Industrial, and Other

For the source categories of fuel combustion - electric utility, fuel combustion - industrial, and fuel combustion - other, residential wood combustion is the most significant source, accounting for 16 percent of total CO national emissions in 1940, but declining to 5 percent in 1994. During the period 1940 to 1970, the residential consumption of wood declined steadily as a result of the abundant supply, low relative prices, and convenience of fossil fuels relative to wood for home heating, cooking, and heating water. The 1970 to 1980 period exhibited a resurgence in the use of wood for home heating and a corresponding increase in emissions from residential wood combustion. The increase in the use of wood for home heating during this period occurred as the result of disruptions in crude oil deliveries and related product markets that resulted in increases in the price for fossil fuel products. Since 1980, prices of fossil fuel products have declined in real terms and a reduction in the use of wood for home heating has occurred. Carbon monoxide emissions from residential wood combustion have decreased by 40 percent since 1980.

Carbon monoxide emissions from residential fuel combustion using fuels other than wood have also undergone substantial changes since 1940. An 82 percent reduction in emissions during the 1940 to 1970 period occurred as a result of the steady decline in the use of anthracite and bituminous coal for home heating. Emissions from residential combustion of fuels other than wood are currently less than 1 percent of total national CO emissions.

3.3.2 Industrial Process Carbon Monoxide Emissions

Industrial processes accounted for 8 percent of total CO national emissions in 1940, but decreased to 6 percent of total emissions by 1994. Emissions from chemical and allied product manufacturing declined during the period. Metals processing emissions increased through 1970, but have declined since. Emissions from the petroleum refining industry increased by a factor of 10 through 1970 as a result of an increase in refinery throughput and an increase in demand for refined petroleum products. Emissions from the petroleum refining industry have decreased 82 percent since 1970 due to the retirement of obsolete high polluting processes such as the manufacture of carbon black by channel process and the installation of emission control devices such as fluid catalytic cracking units. Petroleum refining accounted for less than 1 percent of total CO emissions in 1994.

3.3.3 Transportation Carbon Monoxide Emissions: On-Road Vehicles and Non-Road Sources

On-road vehicles have been the predominant source of CO emissions in the U.S. since World War II, contributing 69 percent to total national emissions in 1970 and 62 percent in 1994. As part of the effort to reduce CO emissions, emission standards have been developed for on-road vehicles. Table 3-7 provides a list of standards for light-duty vehicle (LDV) and light-duty truck (LDT) CO emissions, expressed in grams per mile (gpm). In addition to these standards, the CAAA require cars to meet a standard of 10 gpm at 20 degrees Fahrenheit, starting with the 1994 model year to ensure that emission control devices work efficiently at low temperatures. The federal standards through 1975 applied only to gasoline-powered LDTs. Federal standards for 1976 and later applied to both gasoline and diesel-powered LDTs. In addition, a CO standard of 0.50 percent at idle was established for 1984 and later model years; effective at high altitudes starting with the 1988 model year. Other CO standards apply to LDTs more than 6,000 pounds (lbs), heavy-duty engines and vehicles, and non-road sources.

Figure 3-13 presents the trends in on-road vehicle CO emissions, VMT, vehicle fuel use, and gasoline prices.[8] Gasoline prices have been adjusted to constant 1987 general price levels for comparison purposes. It is reasonable to assume that a decline in gasoline price is associated with an increase in the quantity of gasoline demanded, VMT, and CO emissions (i.e., a decrease in the price of gasoline will result in greater VMT, fuel use, and CO emissions), all other factors remaining unchanged. This figure indicates that on-road vehicle CO emissions have declined approximately 32 percent between 1970 and 1993, although fuel use increased approximately 50 percent, VMT increased over 100 percent, and real gasoline prices decreased 17 percent in this same period. This decrease in CO emissions can be attributed to the impact of regulatory measures previously noted.

Non-road CO emissions represented 9 percent of the national total in 1940, with emissions from railroad locomotives accounting for approximately 51 percent of this amount. CO emissions from non-road sources have increased by 94 percent since 1940 and accounted for 16 percent of the national total in 1994. While emissions from locomotives have declined 97 percent during the analysis period (through technology shifts rather than emission controls), emissions from aircraft and non-road gasoline equipment have increased substantially during the period.

3.3.4 Remaining Sources

Carbon monoxide emissions from other sources decreased from 1940 to 1994. In 1940, the emissions from waste disposal and recycling, and miscellaneous other combustion - wildfires accounted for 4 and 27 percent, respectively of total CO emissions. Emissions from wildfires are relatively erratic from year to year due the uncontrolled nature of wildfires, but declined from 1940 levels to 4 percent of total CO emissions in 1994. In contrast, CO emissions from waste disposal and recycling increased by 94 percent between 1940 and 1970. Since 1970, CO emissions from waste disposal and recycling have declined 75 percent and accounted for 2 percent of total CO emissions in 1994.

3.4 NITROGEN OXIDE EMISSION TRENDS AND VOLATILE ORGANIC COMPOUND TRENDS, 1900 THROUGH 1994

Nitrogen oxides and VOCs are grouped together here because they comprise the principal emitted primary pollutants that are acted upon by sunlight to produce the secondary pollutant, tropospheric ozone. While there is currently no ambient air quality standard for VOCs, from the standpoint of modeling ozone formation the category of VOC emissions is as important as the so-called criteria pollutants for which there are ambient air quality standards.

The trend in NO_x emissions is presented in table 3-2 and figure 3-2. The NO_x "remaining categories" include the following Tier 1 categories: petroleum and related industries; solvent utilization; metal processing; waste disposal and recycling; miscellaneous; and storage and transport. The trend in VOC emissions is presented in table 3-3 and figure 3-3. The VOC "remaining categories" grouping includes the following Tier 1 categories: fuel combustion - electric utility; fuel combustion - industrial; fuel combustion - other; petroleum and related industries; and other industrial process. The VOC emissions for the miscellaneous category are primarily from wildfires.

3.4.1 Regulatory History for Nitrogen Oxide and Volatile Organic Compound Emissions

The 1971 photochemical oxidants standard was based on an hourly average level that was not to be exceeded more than once per year; the hydrocarbon standard was also first promulgated in 1971. In 1979, the photochemical oxidants standard was revised and restated as ozone, and the hydrocarbon standard was reviewed and withdrawn in 1983. The ozone standard was revised to 0.12 parts per million (ppm [from 0.08 ppm]), not to be exceeded more than three times in a 3-year period. Ozone is formed thorough a photochemical process in the presence of VOCs and NO_x.

On-road vehicles have been one of the top contributors to each of these pollutants (e.g., in 1970, on-road vehicles accounted for 42 percent of total VOC and 36 percent of total NO_x emissions). Table 3-8 presents the VOC and NO_x emission limits that have been set over the last two decades for LDVs. The VOC and NO_x emission standards for LDTs are presented in table 3-9. In addition to these standards, LDTs over 6,000 lbs and heavy-duty trucks (HDTs) also have NO_x standards.

3.4.2 Nitrogen Oxide Emissions Trends

As indicated in table 3-2 and figure 3-2, NO_x emissions have increased over 220 percent between 1940 and 1994, with a 14 percent increase over the 1970 and 1994 period. All Tier 1 principal source categories show increases for this period with the exception of petroleum and related industries, waste disposal and recycling, and miscellaneous sources. Total NO_x emissions, per capita NO_x emissions, and NO_x emissions normalized by real GDP are presented in figure 3-8. In general, the per capita NO_x emissions reflect a much less dramatic increase during the 1940 to 1978 period than is present in the total NO_x emission trend. Per capita NO_x emissions have declined since 1978. Nitrogen oxide emissions normalized by real GDP declined and then increased during the 1940s but declined thereafter, an indication that fewer NO_x emissions are released per dollar of real GDP.

3.4.2.1 Fuel Combustion Nitrogen Oxide Emissions: Electric Utility, Industrial, and Other

In 1900, electric utilities accounted for 4 percent of the total national NO_x emissions. By 1930, electric utility NO_x emissions increased by a factor of 6. Emissions from this source have continued to increase to 8 million short tons in 1994, accounting for 33 percent of total NO_x emissions in that year. Figure 3-17 shows NO_x emissions from electric utilities, coal used to produce electricity, and the average retail price for electricity per kilowatt hour (kWh) sold for the period 1970 through 1994.[9] NO_x is emitted when fossil fuels are used to generate electricity; however, emissions using coal as an energy source represented 90 percent of fuel combustion - electric utility NO_x emissions in 1993. Although emissions and coal used to produce electricity have increased over the period, with the price of electricity declining in real terms since 1982, NO_x emissions have increased much less than coal use (60 percent compared to 150 percent, respectively).

3.4.2.2 Transportation Nitrogen Oxide Emissions: On-Road Vehicles and Non-Road Sources

In 1900, on-road vehicles made an insignificant contribution to total national NO_x emissions. By 1920, emissions from on-road sources had increased to 5 percent of total NO_x emissions and continued to increase by a factor of 3 from 1920 to 1940. Emissions from on-road vehicles peaked in 1978 and have declined since then. Currently, on-road vehicle emissions constitute approximately 32 percent of total NO_x emissions.

Figure 3-14 displays trends in on-road NO_x emissions, vehicle miles traveled, fuel use, and real gasoline prices for the period 1940 through 1993. One would anticipate that NO_x emissions from on-road vehicles will increase as VMT and fuel use increase and as gas prices decline (all other factors remaining unchanged). This pattern does exist from the period 1940 through 1978; however, NO_x emissions begin to decline after 1978 while VMT and fuel use continue rising and gasoline prices decline in real terms.

The effects of previously noted regulations account for the declines in NO_x emissions occurring after 1978. Although VMT has more than doubled since 1970, NO_x emissions from on-road vehicles are nearly equal to their 1970 levels.

In contrast to the on-road vehicle NO_x emission trends, emissions from non-road sources increased over the entire period of 1940 to 1994. Emission control measures for selected non-road engine categories are scheduled to begin in 1996; significant emission reductions are not expected until after the year 2000.

3.4.2.3 Remaining Sources

The NO_x emissions for the years 1900 through 1939 were generated by five source categories (electric utility, industrial, commercial-residential, on-road vehicle, and other), making comparisons prior to 1940 on a source category basis difficult. In general, however, the emissions for the remaining sources of industrial processes, waste disposal, and miscellaneous sources increased from 1900 to 1920 and continued to increase from 1920 to 1940, but at a slower rate. Emissions from these sources accounted for 18 percent of the total 1940 NO_x emissions. The emissions for the waste disposal and recycling category steadily increased by a factor of 4 from 1940 to 1970, but have decreased 81 percent since 1970. Emissions from industrial processes steadily increased by a factor of 3 from 1940 to 1970. The emissions then decreased by 28 percent from 1970 to 1980. The increase from 1980 to 1994 of 44 percent was due in part to a change in the methodology used to estimate emissions between 1984 and 1985. In 1994, the total emissions for the remaining sources were 5 percent of national NO_x emissions.

3.4.3 Volatile Organic Compound Emission Trends

Volatile organic compounds are a principal component in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants. The emissions of VOC species that primarily contribute to the formation of ozone are included in total VOC emissions, while emissions of methane, a nonreactive compound, are not included. No adjustments are made to include chlorofluorocarbons or to exclude ethane and other VOCs with negligible photochemical reactivity. On-road vehicle emissions were estimated as nonmethane hydrocarbons (NMHCs). Emissions of organic compounds from biogenic sources such as trees and other vegetation, are presented in chapter 9. The 1990 VOC emissions from biogenic sources were 30 percent greater than the emissions from anthropogenic sources, according to recent research, but the extent to which biogenic emissions contribute to oxidant formation has not been clearly established.

Total national VOC emissions, per capita VOC emissions, and VOC emissions normalized by real GDP are presented in figure 3-9. During the 1900 to 1970 period, VOC emissions increased over 200 percent, reaching a peak in 1970. Since 1970, VOC emissions have declined approximately 24 percent. The VOC emissions for individuals in the nation, on average remained relatively unchanged through 1970 and have declined 41 percent since 1970. Volatile organic compound emissions normalized by the level of goods and services produced in the nation reflect a decreasing trend after 1949 (declining approximately 60 percent).

3.4.3.1 Fuel Combustion Volatile Organic Compound Emissions: Electric Utility, Industrial, and Other

In 1900, emissions from all fuel combustion sources represented 68 percent of the total national VOC emissions. Wood combustion accounted for 90 percent of the emissions from these sources. By 1940, emissions from fuel combustion sources had decreased to 12 percent of total emissions and these emissions account for less than 3 percent of total emissions currently. The decline in residential wood combustion was discussed previously in section 3.3.1.

3.4.3.2 Industrial Process Volatile Organic Compound Emissions

The emissions from industrial processes (i.e., chemical & allied products, petroleum & related industries, other industrial processes, solvent utilization, and storage & transport) accounted for 17 percent of the total national VOC emissions in 1900. By 1940, the emissions from industrial processes had risen to 26 percent of the total. The VOC emissions from these sources increased to 12 million short tons accounting for 40 percent of VOC emissions in 1970. Since 1970, emissions from these sources have decreased 13 percent, to approximately 47 percent of total national VOC emissions. Emission control devices and process changes have helped limit the growth in these emissions since 1970. Emissions from petroleum and related industries and petroleum product storage and marketing operations increased during the mid-1970s as a result of increased demand for petroleum products, especially motor gasoline. After 1978, the emissions from these sources decreased as the result of product reformulation and other control measures. For example, VOC emissions from solvent utilization sources decreased due to the substitution of water-based emulsified asphalt for asphalt liquefied with petroleum distillates. Chemical and allied products and other industrial process categories reflect increases in emissions during the reporting period.

3.4.3.3 Transportation Volatile Organic Compound Emissions: On-Road Vehicles and Non-Road Sources

In 1900, transportation sources accounted for 4 percent of the total national VOC emissions; railroad emissions were 99 percent of these emissions. Railroad VOC emissions peaked in 1920 when these emissions were 20 percent of the national total and have decreased since then to less than 1 percent currently. The total VOC emissions from the transportation sector increased 160 percent during the 1940 to 1970 period.

Volatile organic compound emissions from on-road vehicles peaked in 1970 at 13 million short tons, or 42 percent of the national VOC emission total. Figure 3-15 presents the trends in on-road VOC emissions, VMT, fuel usage, and gasoline prices for the period 1940 through 1993.[8] It is reasonable to assume that, absent regulation, VOC emissions will increase as VMT and fuel usage increase and as gasoline prices decrease. This trend was present for the period prior to 1970. Since 1970, however, VOC emissions from on-road vehicles have declined 51 percent while VMT and fuel usage increased. Gasoline prices decreased in real terms after 1980. These trends indicate the influence of regulation in reducing national VOC emissions from on-road vehicles.

In contrast, emissions from non-road sources continued an increasing trend through the entire reporting period. Non-road VOC emissions have increased over 46 percent since 1970.

3.4.3.4 Remaining Sources

In 1900, emissions from the solid waste disposal and miscellaneous sources categories represented 10 percent and 24 percent of total VOC emissions. Although wildfires are somewhat erratic from year to year, fire prevention programs have been successful at decreasing wildfire emissions to 2 percent of the national total VOC emissions in 1994. In 1994, solid waste disposal emissions accounted for 10 percent of the national VOC emissions.

3.5 SULFUR DIOXIDE EMISSION TRENDS, 1900 THROUGH 1994

The trend in SO_2 emissions between 1940 and 1994 is presented in table 3-4, and between 1900 and 1994 in figure 3-4. The "remaining categories" grouping includes the following Tier 1 categories: petroleum and related industries, other industrial processes, solvent utilization, waste disposal and recycling, chemical and allied product manufacturing, and storage and transport. Figure 3-10 presents total national SO_2 emissions, per capita SO_2 emissions, and SO_2 emissions normalized by real GDP. Total national SO_2 emissions increased by more than 218 percent during the period 1900 to 1973, but have decreased since 1973 by approximately 33 percent. Per capita SO_2 emissions reached a

peak in 1943, declined during the 1950s, increased during the 1960s, and have declined since 1970. In contrast, SO_2 emissions normalized by real GDP have declined steadily since 1946. The normalized trends indicate that emissions per individual, and per dollar value of goods and services produced in the nation, have followed a general declining trend since 1970.

3.5.1 Fuel Combustion Sulfur Dioxide Emissions: Electric Utility, Industrial, and Other

In 1900 electric utilities accounted for 4 percent of total national SO_2 emissions. Emissions from electric utilities steadily increased over the period 1900 to 1925 by a factor of 5. The SO_2 emissions from utilities decreased during the early portion of the 1930 decade due to the Great Depression. The 1940 emissions levels approximated those existing prior to the Depression. From 1940 to 1970, SO_2 emissions from electric utilities doubled every decade as a result of increased coal consumption. In 1970, emissions from coal combustion accounted for 62 percent of total SO_2 emissions from all fuel combustion sources. From 1970 to 1994, SO_2 emissions from electric utilities using all types of energy sources decreased approximately 15 percent. Sulfur dioxide emissions from fuel combustion - electric utilities account for 70 percent of the total national SO_2 emissions in 1994.

The SO_2 NAAQS was promulgated in 1971. Also in that year, the EPA developed a NSPS requiring that all new coal-fired power plants emit no more than 1.2 pounds of SO_2 per each million British thermal units (BTUs) of electricity produced. Most new plants chose to meet this NSPS by shifting to lower-sulfur coals. An amendment to the CAA in 1977 effectively required any new coal-fired power plant not only to meet the original NSPS, but also to use some form of scrubbing equipment, even when using low-sulfur coal.

Figure 3-18 presents the trends in coal consumed to produce electricity and SO_2 emissions from electric power (coal) facilities for the period 1970 to 1993.[9] This figure indicates that between 1970 and 1993, SO_2 emissions declined 8 percent from coal-fired electric power facilities; this contrasts with a 150 percent increase in coal consumed to produce electricity. In contrast, the average price per kWh of electric increased in real terms between 1970 and 1982 and decreased thereafter.

Emissions from fuel combustion - industrial and other sources increased through the 1940 to 1970 period. Since 1970 SO_2 emissions have declined by 34 percent and 60 percent for fuel combustion - industrial and other sources, respectively. The decreases in SO_2 emissions from these sources reflect decreases in coal burning by industrial, commercial, and residential consumers.

3.5.2 Industrial Process Sulfur Dioxide Emissions

The SO_2 emissions for metals processing increased by 44 percent over the period 1940 to 1970 and accounted for 15 percent of the total national emissions in 1970. During the period 1970 through 1994, emissions declined from this source by 86 percent due to the increased use of emission control devices for the industry. Metals processing accounted for 3 percent of total national SO_2 emissions in 1994. In particular, SO_2 emissions were greatly reduced at nonferrous smelters. By-product recovery of sulfuric acid at these smelters has increased since 1970, resulting in the recovered sulfuric acid not being emitted as SO_2.

Processing copper is one major type of metal processing that contributes to SO_2 emissions. A NSPS was issued by the EPA to regulate SO_2 emissions from copper smelters that are new, modified, or reconstructed after October 16, 1974. Figure 3-20 presents the trends in copper production and SO_2 emissions from copper production over the 1940-1993 period.[10] This figure shows that a 15 percent reduction in copper production took place between 1970 and 1993, while SO_2 emissions from copper production facilities declined 91 percent.

Emissions from other industrial processes, chemical and allied manufacturing, and petroleum and related industries accounted for 4 percent of total SO_2 emissions in 1940 and 7 percent in 1970. Since 1970, emissions from these sources have declined by 44 percent. One factor contributing to the decline in SO_2 emissions from these sources is the NSPS for sulfuric acid manufacturing plants built, modified, or reconstructed after 1972.

3.5.3 Remaining Sources

In 1940, the emissions from the remaining sources of waste disposal and recycling, on-road vehicles, non-road sources, and miscellaneous sources were 19 percent of total national SO_2 emissions. Emissions from railroads accounted for approximately 80 percent of the remaining source emissions in 1940. From 1940 to 1970, railroad emissions decreased 99 percent as a result of the obsolescence of coal-fired locomotives. Over the same period, emissions from the waste disposal and recycling and on-road vehicle categories increased by factors of 3 and 136, respectively. Between 1970 and 1994, the emissions for: waste disposal and recycling increased by a factor of 5 while on-road vehicle emissions decreased by 28 percent. The remaining source SO_2 emissions constituted 3 percent of the national total in 1994.

On August 21, 1990, EPA published regulations (54 FR 35276) that govern desulfurization of diesel motor fuel. Beginning October 1, 1993 all diesel fuel that contains a concentration of sulfur in excess of 0.05 percent by weight or which fails to meet a minimum cetane index of 40 cannot be used in motor vehicles. Reductions in SO_2 emissions from diesel motor vehicles of

approximately 75 percent are expected to result from the desulfurization regulations.[12]

3.6 PARTICULATE MATTER (PM-10) EMISSION TRENDS, 1940 THROUGH 1994

The 1940 to 1994 trend in PM-10 emissions is presented in table 3-5 and figure 3-5. The emission trends for PM-10 sources are discussed separately for the point and fugitive process sources and for the fugitive dust sources. The PM-10 fugitive dust sources are categorized as natural sources (geogenic - wind erosion) and some miscellaneous sources. Within the miscellaneous category are agriculture and forestry (agricultural crops and livestock) and fugitive dust [construction, mining and quarrying, point source, paved roads and unpaved roads (unpaved airstrips)]. The PM-10 point and fugitive process sources include all other PM-10 sources.

3.6.1 Point and Fugitive Process Sources

The PM-10 point and fugitive process sources include all PM-10 sources except the fugitive dust sources listed above. The totals for both categories are presented in table 3-5 for the period 1940 through 1994. The "remaining categories" grouping includes the following Tier 1 categories: fuel combustion - industrial; fuel combustion - other; petroleum and related industries; other industrial processes; chemical and allied product manufacturing; and waste disposal and recycling. The miscellaneous category consists primarily of wildfires and managed burning. Figure 3-11 depicts total national PM-10 emissions, per capita PM-10 emissions, and PM-10 emissions normalized by real GDP for the period 1940 to 1994 for point and fugitive process sources. Each of these indicators declines over the 1950 to 1994 period, an indication that total PM-10 emissions, PM-10 emissions per individual, and PM-10 emissions per dollar of goods and services produced in the nation have declined since 1950.

3.6.1.1 Fuel Combustion Particulate Matter (PM-10) Emissions: Electric Utility, Industrial, and Other

In 1940, emissions from fuel combustion represented 25 percent of point and fugitive process PM-10 emissions. Electric utility PM-10 emissions result primarily from the combustion of coal. Emissions from this source increased by approximately 85 percent between 1940 and 1970. The increase in emissions during the 1940 to 1970 period corresponds with an increase in electric production using coal as an energy source. A NAAQS for TSP was first promulgated in 1971. In 1987, the TSP standard was reviewed and revised to include only PM with an aerodynamic diameter less than or equal to 10 microns (referred to as PM-10). Beginning in December 1976, a NSPS for new, modified, or reconstructed fossil-fuel-fired steam generators became effective.

Figure 3-19 presents the trends in coal consumed to produce electricity, and PM-10 emissions from electric power (coal) facilities for the period 1970 to 1993.[9] This figure indicates that between 1970 and 1994, PM-10 emissions declined 85 percent from coal-fired electric power facilities while coal consumption to produce electricity increased approximately 150 percent.

In 1940, fuel combustion from the residential sector was the primary source of PM-10 fuel combustion - other emissions. Since 1940, PM-10 emissions from residential fuel combustion have declined by 72 percent due to a decrease in the use of coal and wood as an energy source in the residential sector.

3.6.1.2 Transportation Particulate Matter (PM-10) Emissions: On-Road Vehicles and Non-Road Sources

In 1940, emissions from transportation sources accounted for 17 percent of total point and fugitive process PM-10 emissions. Railroads and LDGVs contributed significantly to total 1940 emissions. From 1940 to 1970, railroad emissions decreased by 99 percent. Over the same period, LDGV emissions decreased by 49 percent. Although the 1994 emissions from transportation sources represent 19 percent of the total national PM-10 emissions from point and fugitive sources, PM-10 emissions from on-road vehicles and non-road sources have declined approximately 73 percent during the 1940 to 1994 period.

3.6.1.3 Remaining Sources

PM-10 emissions from industrial processes increased from 1940 to 1950, primarily as a result of increases in industrial production. From 1950 to 1970, industrial output continued to grow, but emissions from industrial processes were reduced due to the installation of pollution control equipment mandated by State and local air pollution control programs. The reduction of emissions by these control devices was more than offset by the increase in emissions due to production increases. In 1970, industrial processes contributed 59 percent to the total national PM-10 from point and fugitive source emissions, while in 1994, these emissions had decreased to 18 percent, reflecting significant progress achieved in reducing emissions from this source category.

One NSPS contributing to the decline in PM-10 emissions from industrial processes applies to new, modified, or reconstructed portland cement facilities beginning in August 1971. Figure 3-21 presents the trends in cement production and PM-10 emissions from cement production over the 1970 to 1993 period. Although a 3 percent increase occurred in cement production between 1970 and 1993, there was a 98 percent decrease in PM-10 emissions from cement manufacturing facilities. It should be noted that a significant change occurred in the PM-10 emissions estimation methodology in 1985, resulting in lower emissions.

Another source of PM emissions is wildfires. Annual emissions from wildfires are quite variable depending upon the incidence of wildfires and on weather conditions in forested areas. However, due to the success of fire prevention programs, wildfire emissions have declined to less than 1 percent of total PM-10 emissions in 1994.

3.6.2 Fugitive Dust Sources

Fugitive dust source emissions were first estimated in the 1991 *Trends* report. These emissions are based on old emission factors and were developed based on limited data. The methodology to develop the emissions relies on state-level default data for most source categories. These emissions are presented in table 3-5 and figure 3-5 for the period 1985 through 1994. The "remaining categories" grouping includes the Tier 3 miscellaneous category (see section 3.6 for more detail). More detailed presentations for the years 1985 through 1994 are in appendix A, table A-5.

For several source categories, the methodology for estimating fugitive dust emissions utilizes meteorological data such as the number of days with greater than 0.01 inches of precipitation and average monthly wind speed. These data can vary significantly from year-to-year, resulting in highly varying emissions.

The PM-10 emissions from fugitive dust sources increased by 2 percent from 1985 to 1994. During this time period, the emissions ranged from 56 to 38 million short tons in 1988 and 1987, respectively. Emissions from wind erosion are highly variable on an annual basis. For example, the total national emissions from wind erosion were estimated to be 18 million short tons in 1988 compared with 2 million short tons in 1993. A lack of precipitation prior to the spring crop planting season, especially in the central and western parts of the United States contributed to greater wind erosion in 1988. In 1993, unusually heavy spring rains in Kansas and Oklahoma resulted in a 68 percent decrease in wind erosion emissions for these two States from the 1992 values.

For 1994, total national fugitive dust PM-10 emissions were estimated to be about 11 times greater than the total emissions from point and fugitive process sources.

3.7 LEAD EMISSION TRENDS, 1970 THROUGH 1994

The trend in Pb emissions is presented in table 3-6 and figure 3-6 for the period 1970 through 1994. The "remaining categories" grouping includes the following Tier 1 categories: fuel combustion - electric utility; fuel combustion - industrial; other industrial processes; and chemical and allied product manufacturing. Figure 3-12 shows the trend in national Pb emissions, per capita Pb emissions, and Pb emissions normalized by real GDP. National total Pb emissions decreased 98 percent during the 1970 to 1994 period. Per capita Pb emissions and Pb emissions normalized by real GDP reflect a similar trend.

3.7.1 Fuel Combustion Lead Emissions: Electric Utility, Industrial, and Other

Fuel combustion emissions in 1970 accounted for 5 percent of total lead emissions. While emissions from these sources have decreased 95 percent during the 1970 to 1994 period, these sources contributed 10 percent to the total national Pb emissions in 1994.

3.7.2 Industrial Process Lead Emissions

Industrial process emissions contributed 12 percent to total national Pb emissions in 1970. Since that time these emissions have decreased 92 percent, but accounted for 41 percent of total Pb emissions in 1994.

3.7.3 Transportation Lead Emissions: On-Road Vehicles and Non-Road Sources

The overwhelming majority of lead emissions has historically been attributable to one major source — on-road vehicles. Lead emissions from on-road vehicles accounted for 78 percent of total emissions in 1970. Total national Pb emissions decreased sharply from 1970 to 1994 as the result of regulatory actions. The lead NAAQS was promulgated in October 1978. The lead phase-down program has required the gradual reduction of the lead content of all gasoline over a period of many years. The lead content of leaded gasoline was reduced dramatically from an average of 1.0 gram per gallon (gpg) to 0.5 gpg on July 1, 1985, and still further to 0.1 gpg on January 1, 1986. In addition, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices. These devices reduce CO, VOC, and NO_x emissions. In 1975, unleaded gasoline's share of the total gasoline market was 13 percent. In 1982, the unleaded share of the total gasoline market was approximately 50 percent. By 1994, unleaded gasoline sales accounted for 99 percent of the gasoline market. In 1994, on-road vehicles contributed 28 percent of annual lead emissions, down substantially from 87 percent in 1983. The CAAA mandates that leaded gasoline be prohibited for use in highway vehicles after December 31, 1995.

Figure 3-16 presents the trends in fuel use, VMT, gasoline prices, and on-road vehicle lead emissions over the 1970-1993 period.[8] Absent regulation, one would predict that lead emissions from vehicles would increase as VMT and fuel use increase and as gasoline prices decline. Between 1970 and 1993, fuel consumption and VMT increased approximately 50 percent and 100 percent, respectively, while on-road lead emissions declined by 99 percent. Gasoline prices have declined since 1980 in real

terms.[1] The downward trend in Pb emissions is the direct result of regulatory actions reducing the lead content of gasoline.

3.8 REFERENCES

1. *National Air Pollutant Emission Trends, 1900 - 1993.* EPA-454/R-94-027, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1994.
2. U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States Colonial Times to 1970. 1989.*
3. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Census, *Current Population Reports, "Population Projections of the United States, by Age, Sex, Race and Hispanic Origin: 1993 to 2050."*
4. U.S. Department of Commerce, Economics and Statistics Administration, *National Income and Product Accounts of the United States, Volume I and II, 1929-1988.* February 1993.
5. President's Council of Economic Advisors, *Economic Indicators*, Prepared for the Joint Economic Committee, 103rd Congress, 2nd session. December 1994.
6. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, "Pollution Abatement and Control Expenditures 1972-1992," *Survey of Current Business.* May 1994.
7. Portney, Paul, "Air Pollution Policy," in *Public Policies for Environmental Protection.* Resources for the Future, Washington, DC. 1990.
8. Pennwell Publishing, *Energy Statistics Sourcebook*, Ninth Edition. August 1994.
9. U.S. Department of Energy, Energy Information Administration, *Electric Power Monthly*, Washington, DC, various editions.
10. U.S. Department of Interior, Bureau of Mines, "Cement," *Minerals Yearbook*, Washington, DC, various years.
11. *National Air Pollutant Emission Trends, 1900 - 1992.* EPA-454/R-93-032, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1993.
12. *Development of an Industrial SO_2 Emissions Inventory Baseline and 1995 Report to Congress.* U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1994.

[1] Gasoline prices have been adjusted to consider the change in prices occurring on average for all goods and services in the economy. A decline in gasoline prices in real terms means that gasoline prices have declined, on average, relative to all other goods in the economy during the 1970 to 1993 period.

Table 3-1. Total National Emissions of Carbon Monoxide, 1940 through 1994
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***4***	***110***	***110***	***237***	***322***	***314***	***322***	***325***
FUEL COMB.-INDUSTRIAL	***435***	***549***	***661***	***770***	***750***	***677***	***670***	***671***
FUEL COMB.-OTHER	***14,890***	***10,656***	***6,250***	***3,625***	***6,230***	***4,072***	***3,961***	***3,888***
Residential Wood	11,279	7,716	4,743	2,932	5,992	3,781	3,679	3,607
CHEMICAL & ALLIED PRODUCT MFG	***4,190***	***5,844***	***3,982***	***3,397***	***2,151***	***1,940***	***1,998***	***2,048***
Other Chemical Mfg	4,139	5,760	3,775	2,866	1,417	1,522	1,574	1,619
carbon black mfg	4,139	5,760	3,775	2,866	1,417	1,126	1,170	1,207
METALS PROCESSING	***2,750***	***2,910***	***2,866***	***3,644***	***2,246***	***2,080***	***2,091***	***2,166***
Ferrous Metals Processing	2,714	2,792	2,540	2,991	1,404	1,394	1,410	1,465
gray iron cupola	1,174	1,551	1,123	1,203	340	262	261	271
PETROLEUM & RELATED INDUSTRIES	***221***	***2,651***	***3,086***	***2,179***	***1,723***	***435***	***398***	***390***
Petroleum Refineries & Related Industries	221	2,651	3,086	2,168	1,723	425	388	380
fcc units	210	2,528	2,810	1,820	1,680	389	352	344
OTHER INDUSTRIAL PROCESSES	***114***	***231***	***342***	***620***	***830***	***717***	***732***	***751***
Wood, Pulp & Paper, & Publishing Products	110	220	331	610	798	657	672	689
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***2***	***2***	***2***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***55***	***56***	***58***
WASTE DISPOSAL & RECYCLING	***3,630***	***4,717***	***5,597***	***7,059***	***2,300***	***1,686***	***1,732***	***1,746***
Incineration	2,202	2,711	2,703	2,979	1,246	849	872	879
conical wood burner	1,316	1,613	1,366	1,431	228	18	18	18
Open Burning	1,428	2,006	2,894	4,080	1,054	836	859	867
commmercial/institutional	863	1,139	1,509	2,148	47	5	5	5
ON-ROAD VEHICLES	***30,121***	***45,196***	***64,266***	***88,034***	***78,049***	***62,858***	***60,202***	***61,070***
Light-Duty Gas Vehicles & Motorcycles	22,237	31,493	47,679	64,031	53,561	40,502	39,163	39,303
Light-Duty Gas Trucks	3,752	6,110	7,791	16,570	16,137	15,084	15,196	15,139
Heavy-Duty Gas Vehicles	4,132	7,537	8,557	6,712	7,189	5,930	4,476	5,244
Diesels	0	54	239	721	1,161	1,342	1,367	1,383
NON-ROAD SOURCES	***8,051***	***11,610***	***11,575***	***10,605***	***12,681***	***14,642***	***15,269***	***15,657***
Non-Road Gasoline	3,777	7,331	8,753	9,478	11,004	12,655	13,162	13,452
construction	1,198	2,409	2,262	250	368	395	423	453
industrial	780	1,558	1,379	732	970	1,228	1,285	1,340
lawn & garden	NA	NA	NA	4,679	5,366	6,001	6,212	6,276
farm	1,351	2,716	3,897	46	77	63	70	73
light commercial	NA	NA	NA	2,437	2,680	3,254	3,402	3,519
recreational marine vessels	60	120	518	976	1,102	1,207	1,245	1,256
Non-Road Diesel	32	53	65	543	801	841	903	954
Aircraft	4	934	1,764	506	743	966	1,019	1,063
Railroads	4,083	3,076	332	65	96	122	124	124
MISCELLANEOUS	***29,210***	***18,135***	***11,010***	***7,909***	***8,344***	***11,173***	***6,700***	***9,245***
Other Combustion	29,210	18,135	11,010	7,909	8,344	11,173	6,700	9,245
forest wildfires	25,130	11,159	4,487	5,620	5,396	6,079	1,586	4,115
TOTAL ALL SOURCES	**93,615**	**102,609**	**109,745**	**128,079**	**115,625**	**100,650**	**94,133**	**98,017**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-2. Total National Emissions of Nitrogen Oxides, 1940 through 1994
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***660***	***1,316***	***2,536***	***4,900***	***7,024***	***7,516***	***7,773***	***7,795***
Coal	467	1,118	2,038	3,888	6,123	6,698	7,008	7,007
bituminous	255	584	1,154	2,112	3,439	4,600	4,535	4,497
subbituminous	125	288	568	1,041	1,694	1,692	2,054	2,098
Oil	193	198	498	1,012	901	210	169	151
FUEL COMB.-INDUSTRIAL	***2,543***	***3,192***	***4,075***	***4,325***	***3,555***	***3,256***	***3,197***	***3,206***
Coal	2,012	1,076	782	771	444	613	550	568
bituminous	1,301	688	533	532	306	445	399	412
Gas	365	1,756	2,954	3,060	2,619	1,656	1,650	1,634
natural	337	1,692	2,846	3,053	2,469	1,436	1,440	1,427
FUEL COMB.-OTHER	***529***	***647***	***760***	***836***	***741***	***712***	***726***	***727***
Residential Other	177	227	362	439	356	352	363	364
CHEMICAL & ALLIED PRODUCT MFG	***6***	***63***	***110***	***271***	***216***	***276***	***286***	***291***
METALS PROCESSING	***4***	***110***	***110***	***77***	***65***	***81***	***81***	***84***
Ferrous Metals Processing	4	110	110	77	65	53	54	56
PETROLEUM & RELATED INDUSTRIES	***105***	***110***	***220***	***240***	***72***	***100***	***95***	***95***
OTHER INDUSTRIAL PROCESSES	***107***	***93***	***131***	***187***	***205***	***306***	***315***	***328***
Mineral Products	105	89	123	169	181	216	222	234
cement mfg	32	55	78	97	98	121	124	131
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***2***	***3***	***3***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***2***	***3***	***3***
WASTE DISPOSAL & RECYCLING	***110***	***215***	***331***	***440***	***111***	***82***	***84***	***85***
ON-ROAD VEHICLES	***1,330***	***2,143***	***3,982***	***7,390***	***8,621***	***7,488***	***7,510***	***7,530***
Light-Duty Gas Vehicles & Motorcycles	970	1,415	2,607	4,158	4,421	3,437	3,680	3,750
light-duty gas vehicles	970	1,415	2,606	4,156	4,416	3,425	3,668	3,737
Light-Duty Gas Trucks	204	339	525	1,278	1,408	1,341	1,420	1,432
light-duty gas trucks 1	132	219	339	725	864	780	828	830
light-duty gas trucks 2	73	120	186	553	544	561	592	603
Heavy-Duty Gas Vehicles	155	296	363	278	300	335	315	333
Diesels	NA	93	487	1,676	2,493	2,375	2,094	2,015
heavy-duty diesel vehicles	NA	93	487	1,676	2,463	2,332	2,047	1,966
NON-ROAD SOURCES	***991***	***1,538***	***1,443***	***1,628***	***2,423***	***2,843***	***2,985***	***3,095***
Non-Road Gasoline	122	249	312	81	102	124	122	125
Non-Road Diesel	103	187	247	941	1,374	1,478	1,433	1,494
construction	70	158	157	599	854	944	1,007	1,076
industrial	NA	NA	40	75	99	125	131	136
farm	33	29	50	166	280	230	256	265
airport service	NA	NA	NA	78	113	144	152	159
Aircraft	0	2	4	72	106	139	147	153
Marine Vessels	109	108	108	40	110	173	183	188
Railroads	657	992	772	495	731	929	945	947
MISCELLANEOUS	***990***	***665***	***441***	***330***	***248***	***373***	***219***	***374***
TOTAL ALL SOURCES	**7,374**	**10,093**	**14,140**	**20,625**	**23,281**	**23,038**	**23,276**	**23,615**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-3. Total National Emissions of Volatile Organic Compound Emissions, 1940 through 1994
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***2***	***9***	***9***	***30***	***45***	***36***	***36***	***36***
FUEL COMB.-INDUSTRIAL	***108***	***98***	***106***	***150***	***157***	***135***	***134***	***135***
FUEL COMB.-OTHER	***1,867***	***1,336***	***768***	***541***	***848***	***749***	***729***	***715***
Residential Wood	1,410	970	563	460	809	718	698	684
CHEMICAL & ALLIED PRODUCT MFG	***884***	***1,324***	***991***	***1,341***	***1,595***	***1,526***	***1,557***	***1,577***
Organic Chemical Mfg	58	110	245	629	884	554	562	567
METALS PROCESSING	***325***	***442***	***342***	***394***	***273***	***72***	***74***	***77***
PETROLEUM & RELATED INDUSTRIES	***571***	***548***	***1,034***	***1,194***	***1,440***	***643***	***631***	***630***
OTHER INDUSTRIAL PROCESSES	***130***	***184***	***202***	***270***	***237***	***401***	***406***	***411***
SOLVENT UTILIZATION	***1,971***	***3,679***	***4,403***	***7,174***	***6,584***	***5,975***	***6,156***	***6,313***
Surface Coating	1,058	2,187	2,128	3,570	3,685	2,619	2,687	2,773
Nonindustrial	490	NA	1,189	1,674	1,002	1,900	1,982	2,011
consumer solvents	NA	NA	NA	NA	NA	1,083	1,116	1,126
STORAGE & TRANSPORT	***639***	***1,218***	***1,762***	***1,954***	***1,975***	***1,759***	***1,757***	***1,773***
Bulk Terminals & Plants	185	361	528	599	517	658	614	606
area source: gasoline	158	307	449	509	440	560	512	501
WASTE DISPOSAL & RECYCLING	***990***	***1,104***	***1,546***	***1,984***	***758***	***2,262***	***2,271***	***2,273***
ON-ROAD VEHICLES	***4,817***	***7,251***	***10,506***	***12,972***	***8,979***	***6,854***	***6,103***	***6,295***
Light-Duty Gas Vehicles & Motorcycles	3,647	5,220	8,058	9,193	5,907	4,285	3,812	3,921
light-duty gas vehicles	3,646	5,214	8,050	9,133	5,843	4,234	3,777	3,884
Light-Duty Gas Trucks	672	1,101	1,433	2,770	2,059	1,769	1,647	1,664
Heavy-Duty Gas Vehicles	498	908	926	743	611	470	326	393
Diesels	NA	22	89	266	402	330	318	317
heavy-duty diesel vehicles	NA	22	89	266	392	316	301	299
NON-ROAD SOURCES	***778***	***1,213***	***1,215***	***1,542***	***1,869***	***2,120***	***2,206***	***2,255***
Non-Road Gasoline	208	423	526	1,284	1,474	1,646	1,704	1,730
lawn & garden	NA	NA	NA	574	655	728	753	761
MISCELLANEOUS	***4,079***	***2,530***	***1,573***	***1,101***	***1,134***	***1,069***	***516***	***685***
Other Combustion				1,101	1,134	1,068	515	684
wildfires	3,420	1,510	768	770	739	768	212	379
TOTAL ALL SOURCES	**17,161**	**20,936**	**24,459**	**30,646**	**25,893**	**23,599**	**22,575**	**23,174**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-4. Total National Emissions of Sulfur Dioxide, 1940 through 1994
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***2,427***	***4,515***	***9,264***	***17,398***	***17,469***	***15,898***	***15,191***	***14,869***
Coal	2,276	4,056	8,883	15,799	16,073	15,227	14,546	14,312
bituminous	1,359	2,427	5,367	9,574	NA	13,365	12,199	11,904
subbituminous	668	1,196	2,642	4,716	NA	1,425	1,796	1,854
anthracite & lignite	249	433	873	1,509	NA	438	551	555
Oil	151	459	380	1,598	1,395	639	612	523
residual	146	453	375	1,578	NA	629	602	512
FUEL COMB.-INDUSTRIAL	***6,060***	***5,725***	***3,864***	***4,568***	***2,951***	***3,106***	***2,942***	***3,029***
Coal	5,188	4,423	2,703	3,129	1,527	1,843	1,661	1,715
bituminous	3,473	2,945	1,858	2,171	1,058	1,382	1,248	1,289
subbituminous	1,070	907	574	669	326	29	26	26
anthracite & lignite	645	571	272	289	144	81	72	75
Oil	554	972	922	1,229	1,065	823	848	882
residual	397	721	663	956	851	633	662	692
Gas	145	180	189	140	299	352	346	345
FUEL COMB.-OTHER	***3,642***	***3,964***	***2,319***	***1,490***	***971***	***595***	***599***	***599***
Commercial/Institutional Coal	695	1,212	154	109	110	176	171	169
Commercial/Institutional Oil	407	658	905	883	637	233	241	242
Residential Other	2,517	2,079	1,250	492	211	175	178	177
distillate oil	60	163	295	212	157	137	145	145
bituminous/subbituminous coal	2,267	1,758	868	260	43	30	25	25
CHEMICAL & ALLIED PRODUCT MFG	***215***	***427***	***447***	***591***	***280***	***440***	***450***	***457***
Inorganic Chemical Mfg	215	427	447	591	271	333	341	345
sulfur compounds	215	427	447	591	271	325	332	336
METALS PROCESSING	***3,309***	***3,747***	***3,986***	***4,775***	***1,842***	***663***	***667***	***692***
Nonferrous Metals Processing	2,760	3,092	3,322	4,060	1,279	486	488	506
copper	2,292	2,369	2,772	3,507	1,080	300	300	312
lead	80	95	57	77	34	112	114	119
aluminum	4	28	38	80	95	60	60	62
Ferrous Metals Processing	550	655	664	715	562	160	162	168
PETROLEUM & RELATED INDUSTRIES	***224***	***340***	***676***	***881***	***734***	***440***	***409***	***406***
OTHER INDUSTRIAL PROCESSES	***334***	***596***	***671***	***846***	***918***	***401***	***413***	***431***
Wood, Pulp & Paper, & Publishing Products	0	43	114	169	223	137	141	145
Mineral Products	334	553	557	677	694	257	265	279
cement mfg	318	522	524	618	630	169	176	186
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***1***	***1***	***1***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***5***	***5***	***5***
WASTE DISPOSAL & RECYCLING	***3***	***3***	***10***	***8***	***33***	***36***	***37***	***37***
ON-ROAD VEHICLES	***3***	***103***	***114***	***411***	***521***	***571***	***517***	***295***
NON-ROAD SOURCES	***3,190***	***2,392***	***321***	***83***	***175***	***265***	***278***	***283***
Marine Vessels	215	215	105	43	117	190	201	206
Railroads	2,975	2,174	215	36	53	68	69	69
MISCELLANEOUS	***545***	***545***	***554***	***110***	***11***	***14***	***8***	***14***
Other Combustion	545	545	554	110	11	14	8	14
TOTAL ALL SOURCES	**19,953**	**22,358**	**22,227**	**31,161**	**25,905**	**22,433**	**21,517**	**21,118**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-5. Total National Emissions of Particulate Matter (PM-10), 1940 through 1994
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***962***	***1,467***	***2,117***	***1,775***	***879***	***282***	***268***	***266***
Coal	954	1,439	2,092	1,680	796	269	255	254
bituminous	573	865	1,288	1,041	483	187	184	182
FUEL COMB.-INDUSTRIAL	***708***	***604***	***331***	***641***	***679***	***240***	***234***	***237***
FUEL COMB.-OTHER	***2,338***	***1,674***	***1,113***	***455***	***887***	***553***	***539***	***529***
Commercial/Institutional Coal	235	224	21	13	8	14	13	13
Residential Wood	1,716	1,128	850	384	818	501	488	478
Residential Other	368	288	194	3	27	18	18	18
CHEMICAL & ALLIED PRODUCT MFG	***330***	***455***	***309***	***235***	***148***	***62***	***63***	***64***
METALS PROCESSING	***1,208***	***1,027***	***1,026***	***1,316***	***622***	***136***	***136***	***141***
Nonferrous Metals Processing	588	346	375	593	130	45	45	46
copper	217	105	122	343	32	3	3	3
Ferrous Metals Processing	246	427	214	198	322	86	87	90
Metals Processing NEC	374	254	437	525	170	4	4	5
PETROLEUM & RELATED INDUSTRIES	***366***	***412***	***689***	***286***	***138***	***28***	***27***	***26***
Asphalt Manufacturing	364	389	639	217	97	4	4	4
OTHER INDUSTRIAL PROCESSES	***3,996***	***6,954***	***7,211***	***5,832***	***1,846***	***374***	***377***	***390***
Agriculture, Food, & Kindred Products	784	696	691	485	402	30	31	32
Wood, Pulp & Paper, & Publishing Products	511	798	958	727	183	104	107	111
sulfate (kraft) pulping	470	729	886	668	142	69	71	73
Mineral Products	2,701	5,460	5,563	4,620	1,261	212	211	220
cement mfg	1,363	1,998	2,014	1,731	417	32	33	35
surface mining	62	108	140	134	127	17	17	17
stone quarrying/processing	482	663	1,039	957	421	84	80	83
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***2***	***2***	***2***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***57***	***57***	***59***
WASTE DISPOSAL & RECYCLING	***392***	***505***	***764***	***999***	***273***	***242***	***248***	***250***
ON-ROAD VEHICLES	***210***	***314***	***554***	***443***	***397***	***357***	***321***	***311***
Diesels	NA	9	15	136	208	250	215	206
NON-ROAD SOURCES	***2,480***	***1,788***	***201***	***223***	***329***	***372***	***395***	***411***
Railroads	2,464	1,742	110	25	37	47	48	48
NATURAL SOURCES-wind erosion	***NA***	***NA***	***NA***	***NA***	***NA***	***4,362***	***1,978***	***2,593***
MISCELLANEOUS	***2,968***	***1,934***	***1,244***	***839***	***852***	***36,267***	***37,905***	***40,150***
Agriculture & Forestry	NA	NA	NA	NA	NA	7,364	7,231	7,121
agricultural crops	NA	NA	NA	NA	NA	6,983	6,837	6,716
agricultural livestock	NA	NA	NA	NA	NA	381	394	405
Other Combustion	2,968	1,934	1,244	839	852	1,178	743	1,017
wildfires	2,179	1,063	428	385	514	590	152	424
managed burning	591	662	606	390	315	529	532	535
Fugitive Dust	NA	NA	NA	NA	NA	27,725	29,930	32,012
unpaved roads	NA	NA	NA	NA	NA	11,338	12,482	12,883
paved roads	NA	NA	NA	NA	NA	5,992	6,095	6,358
other	NA	NA	NA	NA	NA	10,396	11,353	12,771
TOTAL ALL SOURCES	**15,956**	**17,133**	**15,558**	**13,044**	**7,050**	**43,333**	**42,548**	**45,431**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-6. Total National Emissions of Lead, 1970 through 1994
(short tons)

Source Category	1970	1975	1980	1985	1990	1993	1994
FUEL COMB.-ELEC. UTIL.	***327***	***230***	***129***	***64***	***64***	***61***	***63***
Coal	300	189	95	51	46	49	49
FUEL COMB.-INDUSTRIAL	***237***	***75***	***60***	***30***	***18***	***15***	***15***
Coal	218	60	45	22	14	11	11
FUEL COMB.-OTHER	***10,052***	***10,042***	***4,111***	***421***	***418***	***415***	***415***
Misc. Fuel Comb. (Except Residential)	10,000	10,000	4,080	400	400	400	400
CHEMICAL & ALLIED PRODUCT MFG	***103***	***120***	***104***	***118***	***136***	***96***	***93***
Inorganic Chemical Mfg	103	120	104	118	136	96	93
lead oxide and pigments							
METALS PROCESSING	***24,224***	***9,923***	***3,026***	***2,097***	***2,169***	***1,887***	***1,873***
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,409	1,195	1,171
primary lead production	12,134	5,640	1,075	874	728	604	566
primary copper production	242	171	20	19	19	21	22
primary zinc production	1,019	224	24	16	9	13	14
secondary lead production	1,894	821	481	288	449	353	360
secondary copper production	374	200	116	70	75	70	80
lead battery manufacture	41	49	50	65	78	86	85
lead cable coating	127	55	37	43	50	47	44
Ferrous Metals Processing	7,395	2,196	911	577	576	499	489
coke manufacturing	11	8	6	3	4	3	3
ferroalloy production	219	104	13	7	18	12	13
iron production	266	93	38	21	18	20	19
steel production	3,125	1,082	481	209	138	145	150
gray iron production	3,773	910	373	336	397	319	304
Metals Processing NEC	960	535	289	144	184	193	213
metal mining	353	268	207	141	184	193	212
OTHER INDUSTRIAL PROCESSES	***2,028***	***1,337***	***808***	***316***	***169***	***54***	***55***
Mineral Products	540	217	93	43	26	27	26
cement manufacturing							
Miscellaneous Industrial Processes	1,488	1,120	715	273	143	28	28
WASTE DISPOSAL & RECYCLING	***2,200***	***1,595***	***1,210***	***871***	***804***	***829***	***847***
Incineration							
municipal waste	581	396	161	79	67	67	74
other	1,619	1,199	1,049	792	738	762	774
ON-ROAD VEHICLES	***171,961***	***130,206***	***62,189***	***15,978***	***1,690***	***1,401***	***1,403***
Light-Duty Gas Vehicles & Motorcycles	142,918	106,868	48,501	12,070	1,263	1,046	1,048
Light-Duty Gas Trucks	22,683	19,440	11,996	3,595	400	336	336
Heavy-Duty Gas Vehicles	6,361	3,898	1,692	313	28	19	19
NON-ROAD SOURCES	***8,340***	***5,012***	***3,320***	***229***	***197***	***179***	***193***
Non-Road Gasoline	8,340	5,012	3,320	229	197	179	193
TOTAL ALL SOURCES	**219,471**	**158,541**	**74,956**	**20,124**	**5,666**	**4,938**	**4,956**

Note(s): Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
1994 emission estimates are preliminary and will be updated in the next report.
Tier 1 source categories and emissions are shaded.

Table 3-7. Carbon Monoxide Emission Standards, 1970 to Present

	Emission Limit (grams of CO per mile)	
Model year	Light-duty Vehicles	Light-duty Trucks (0 to 6,000 lbs.)
1970-1971	23	
1972-1974	39	39
1975-1979	15	20[1]
1980-1993	3.4[2]	18[3],10[4]
1994+	3.4[5]	4.4[5]
1994+	4.2[6]	5.5[6]

Note(s):
1. Standard applies for 1975-1978 model years.
2. Certain vehicles were subject to a less stringent requirement of 7.0 gpm from model years 1980-1984.
3. Standard applies for 1979-1983 model years.
4. Standard applies for 1984-1993 model years.
5. Standards applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
6. Standards applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

Table 3-8. Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Vehicles

	Emission Limit (grams per mile)	
Model Year	NO_x	VOC[1]
1972-1974	3.0[2]	3.4
1975-1979	3.1[3], 2.0[4]	1.5
1980-1993	1.0[5]	0.41
[6]1994+	0.4	0.25
[7]1994+	0.6	0.31

Note(s):
1. These are exhaust emission standards for VOC.
2. Standard applies for 1973-1974 model years.
3. Standard applies for 1975-1976 model years.
4. Standard applies for 1977-1980 model years.
5. Standard applies for 1981-1993 model years.
6. Standard applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
7. Standard applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

Table 3-9. Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Trucks

Model Year	Emission Limit (grams per mile)	
	NO_x	VOC[1]
1972-1974	3.0[2]	3.4
1975-1978	3.1[3]	2.0
1979-1984	2.3[4]	1.7
1985-1993	1.2[5,6]	0.8
[7]1994+	0.7	0.32
[8]1994+	0.97	0.4

Note(s):
1 These are exhaust emission standards for VOC.
2 Standard applies for 1973-1974 model years.
3 Standard applies for 1975-1978 model years.
4 Standard applies for 1979-1987 model years.
5 Standard applies for 1988-1993 model years.
6 Light-duty trucks with a loaded-vehicle weight more than 3,750 pounds are subject to a 1.7 gpm standard for these model years.
7 Standard applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
8 Standard applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

Figure 3-1. Trend in CARBON MONOXIDE Emissions by 7 Principal Source Categories, 1940 to 1994

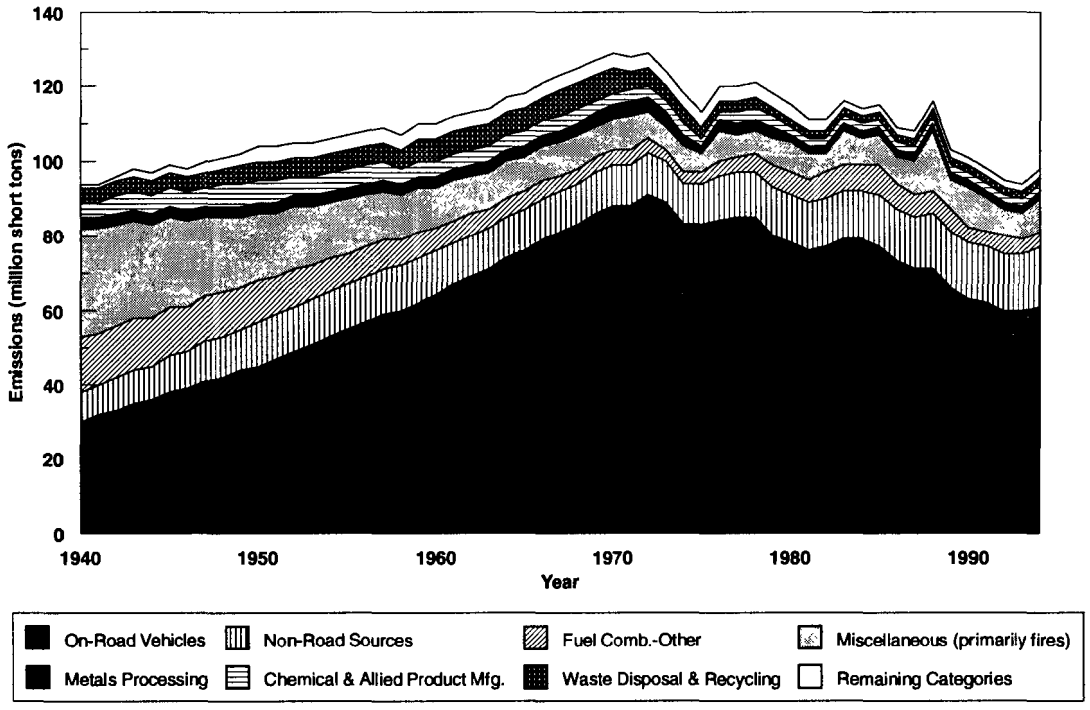


Figure 3-2. Trend in NITROGEN OXIDE Emissions by 7 Principal Source Categories, 1900 to 1994

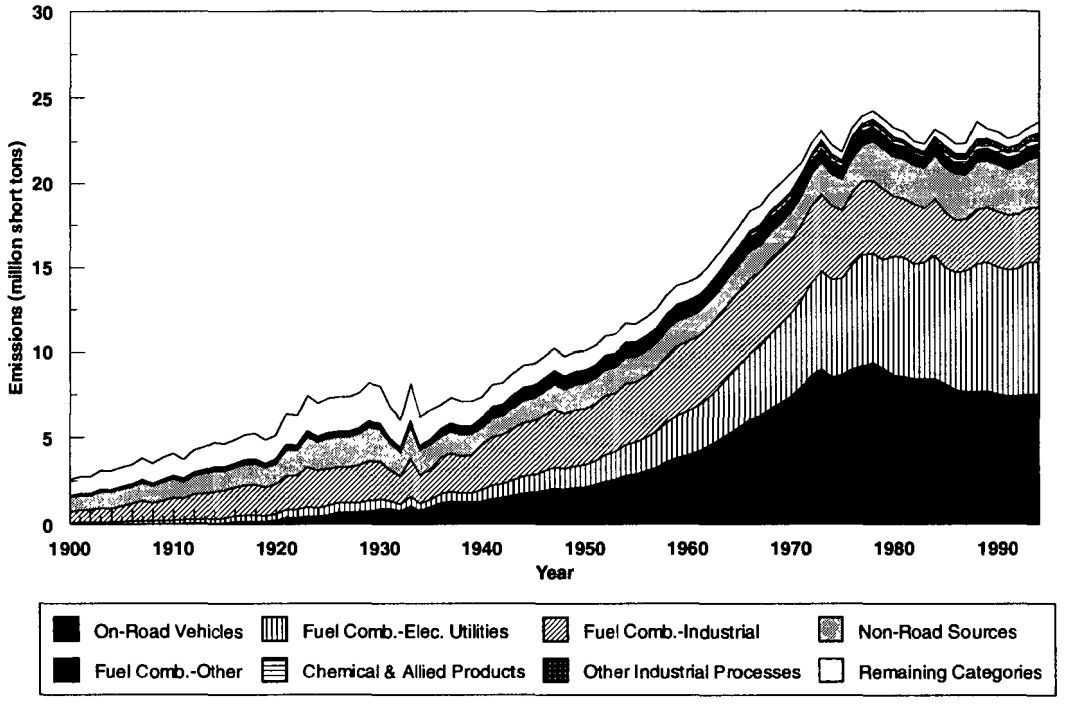


Figure 3-3. Trend in VOLATILE ORGANIC COMPOUND Emissions by 7 Principal Source Categories, 1900 to 1994

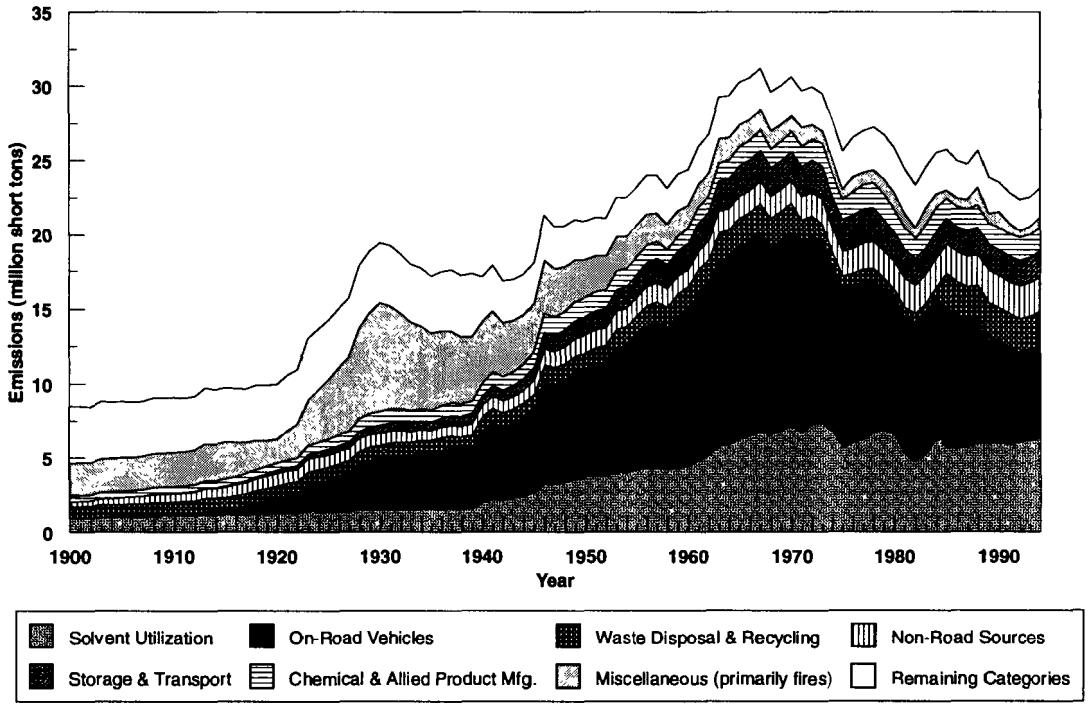


Figure 3-4. Trend in SULFUR DIOXIDE Emissions by 6 Principal Source Categories, 1900 to 1994

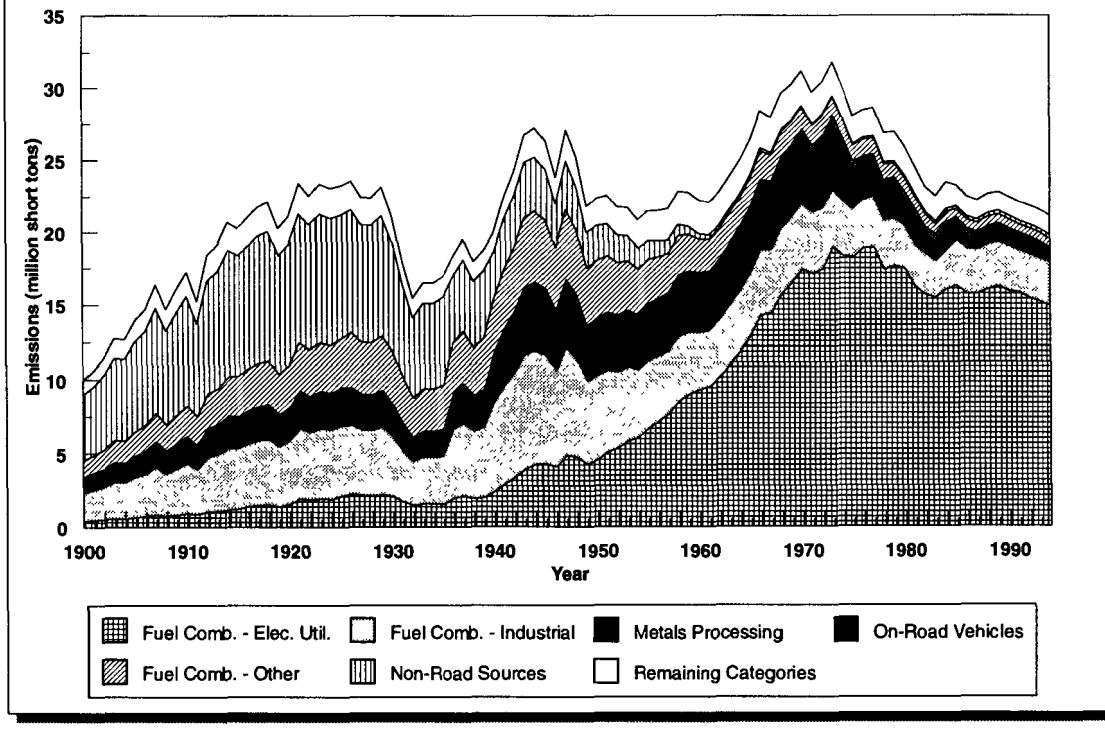


Figure 3-5. Trend in PARTICULATE MATTER (PM-10) by Point and Fugitive Process Sources (1940 to 1994), and by Fugitive Dust Sources (1985 to 1994)

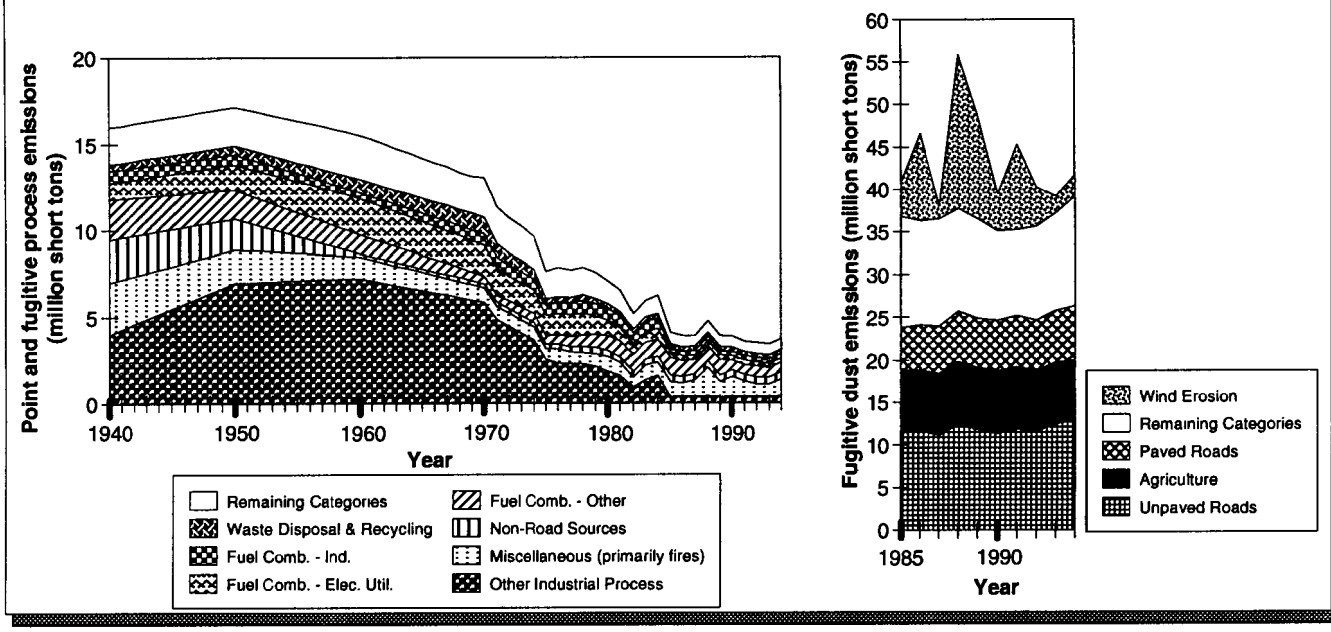


Figure 3-6. Trend in LEAD Emissions by 5 Principal Source Categories, 1970 to 1994

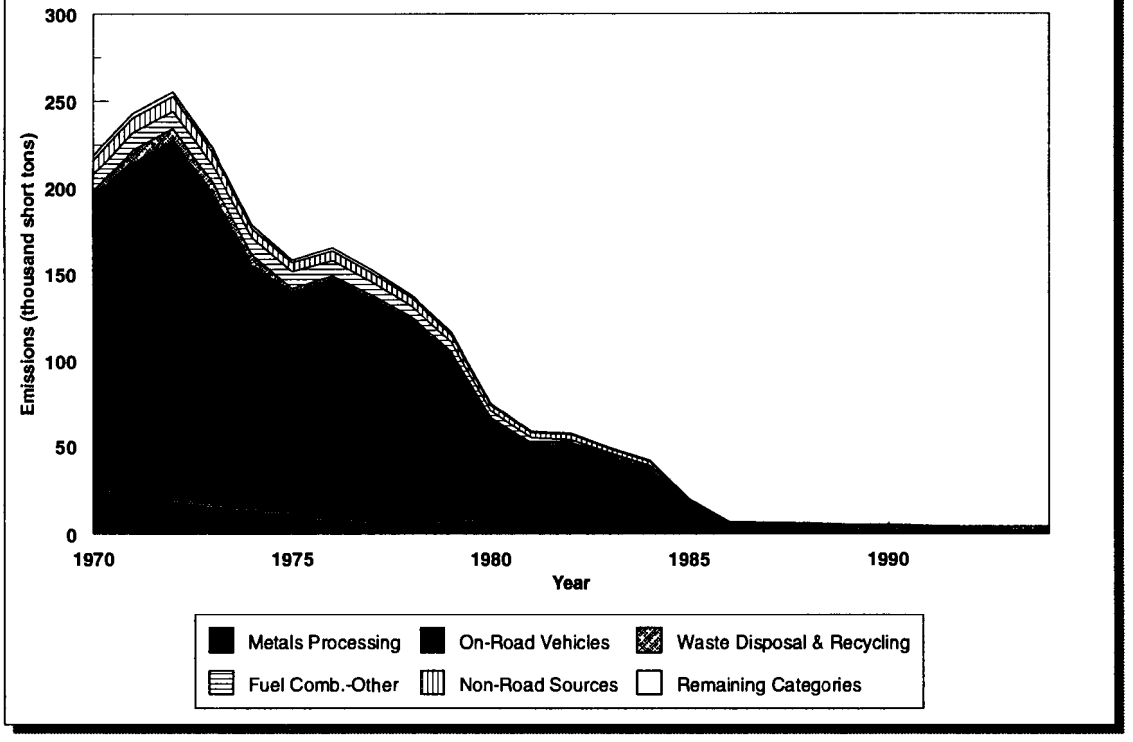
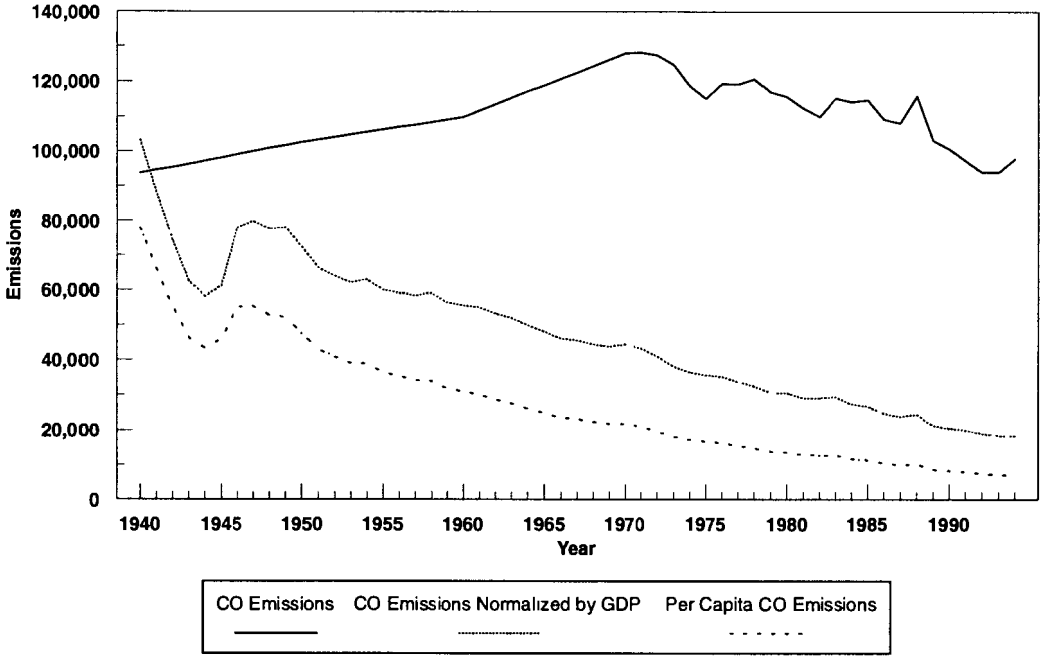
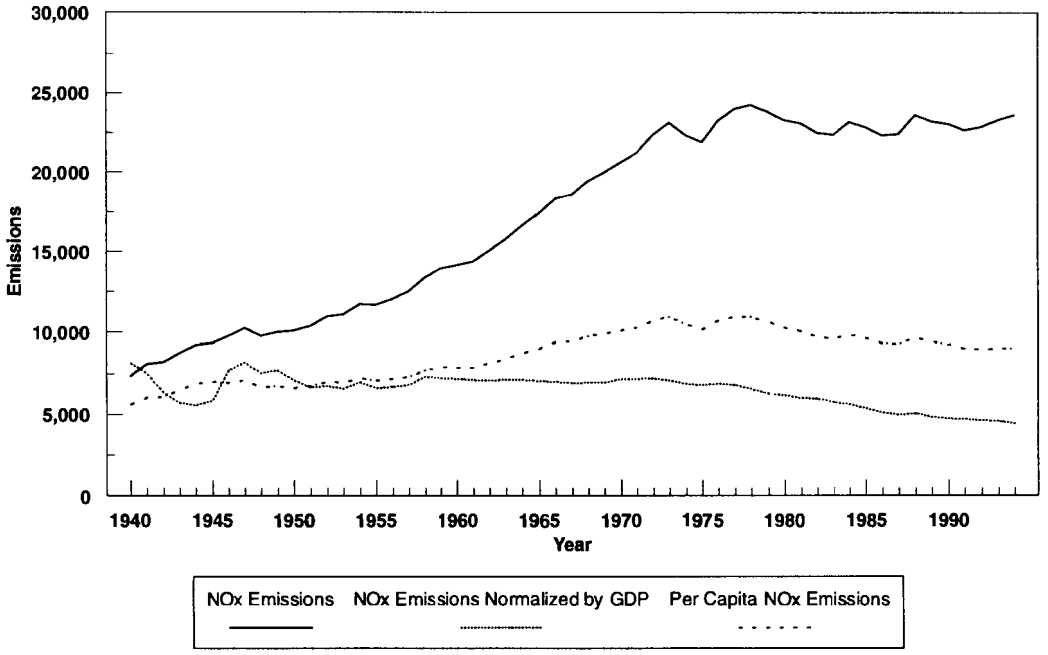


Figure 3-7. Trend in CARBON MONOXIDE Emissions for the Period 1940 to 1994



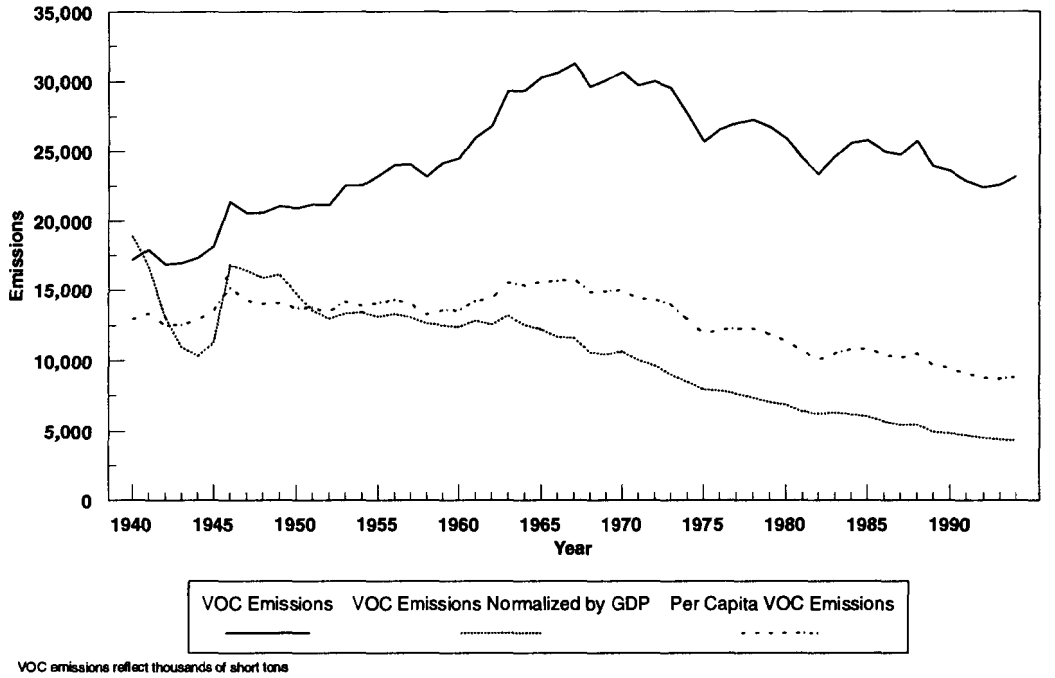
CO emissions reflect thousands of short tons
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices)
Per capita emissions are short tons per 100,000 persons
Source U.S Department of Commerce, population data,[2,3] GDP data[3,4]

Figure 3-8. Trend in NITROGEN OXIDE Emissions for the Period 1940 to 1994



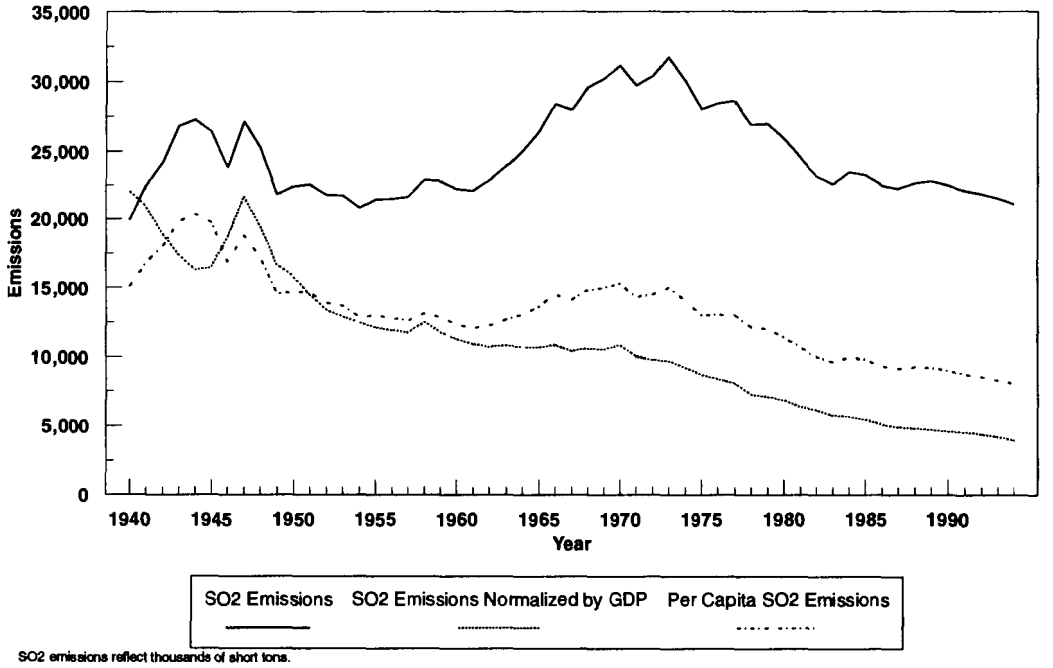
NOx emissions reflect thousands of short tons
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices).
Per capita emissions are short tons per 100,000 persons
Source U S Department of Commerce, population data,[2,3] GDP data[3,4]

Figure 3-9. Trend in VOLATILE ORGANIC COMPOUND Emissions for the Period 1940 to 1994



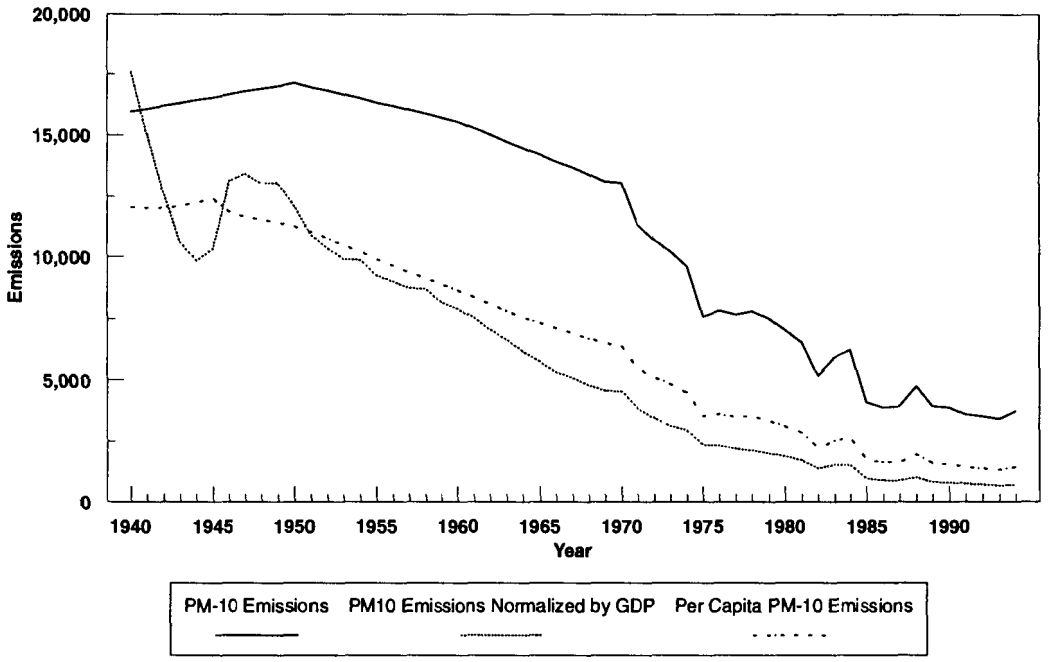
VOC emissions reflect thousands of short tons
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices).
Per capita emissions are short tons per 100,000 persons
Source: U S Department of Commerce, population data,[2,3] GDP data[3,4]

Figure 3-10. Trend in SULFUR DIOXIDE Emissions for the Period 1940 to 1994



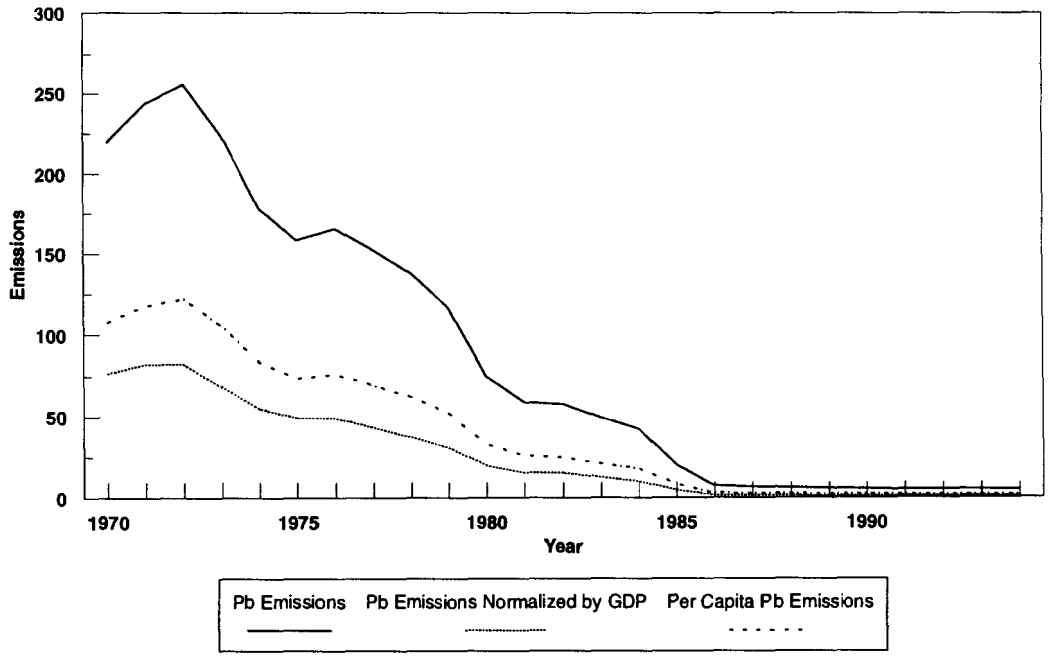
SO2 emissions reflect thousands of short tons.
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices)
Per capita emissions are short tons per 100,000 persons.
Source: U.S. Department of Commerce, population data,[2,3] GDP data[3,4]

Figure 3-11. Trend in PARTICULATE MATTER (PM-10) Emissions from Point and Fugitive Processes for the Period 1940 to 1994



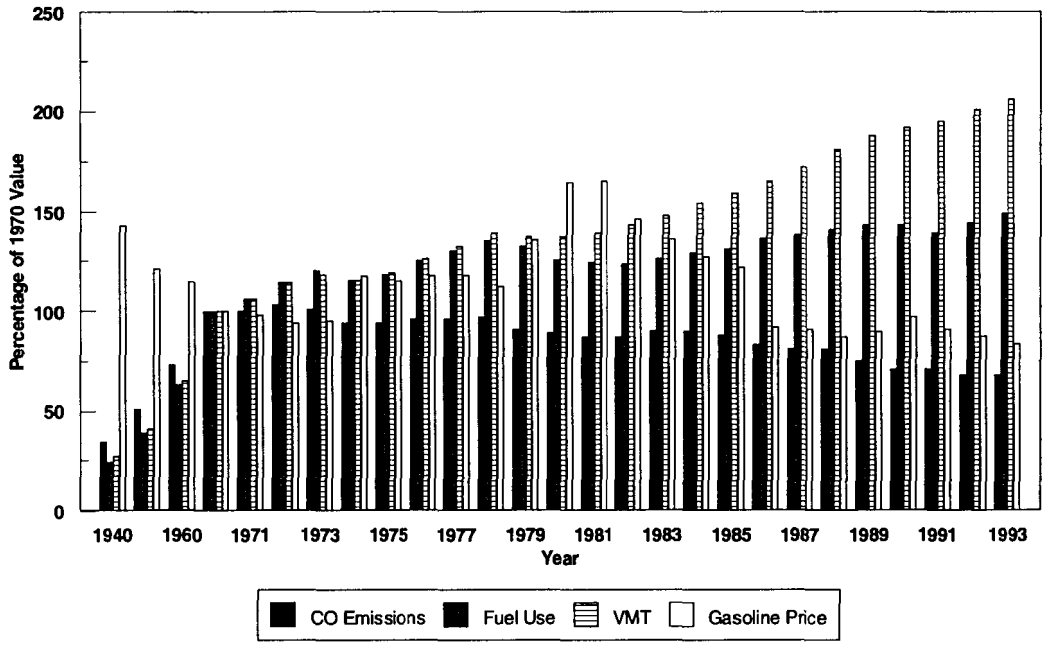
PM-10 emissions reflect thousands of short tons
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices)
Per capita emissions are short tons per 100,000 persons
Source U.S. Department of Commerce, population data,[2,3] GDP data [3,4]

Figure 3-12. Trend in LEAD Emissions for the Period 1970 to 1994



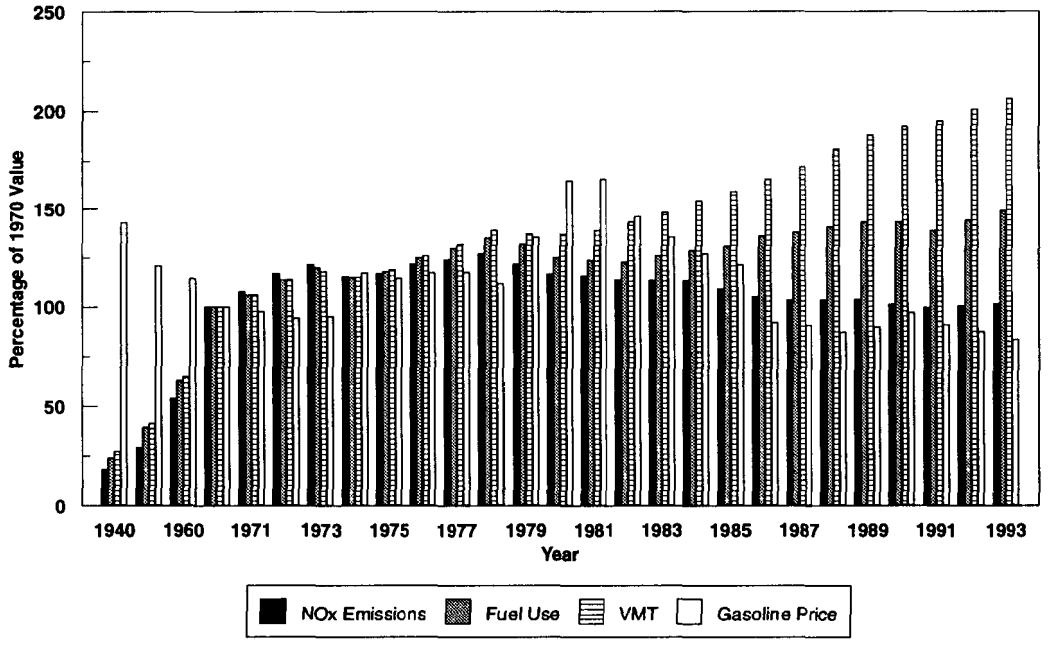
Pb emissions reflect thousands of short tons
Emissions normalized by GDP are shown as short tons per billion dollars of real GDP (stated in constant 1987 prices).
Per capita emissions are short tons per 100,000 persons
Source: U S. Department of Commerce, population data,[2,3] GDP data [3,4]

Figure 3-13. Trend in On-Road CARBON MONOXIDE Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price



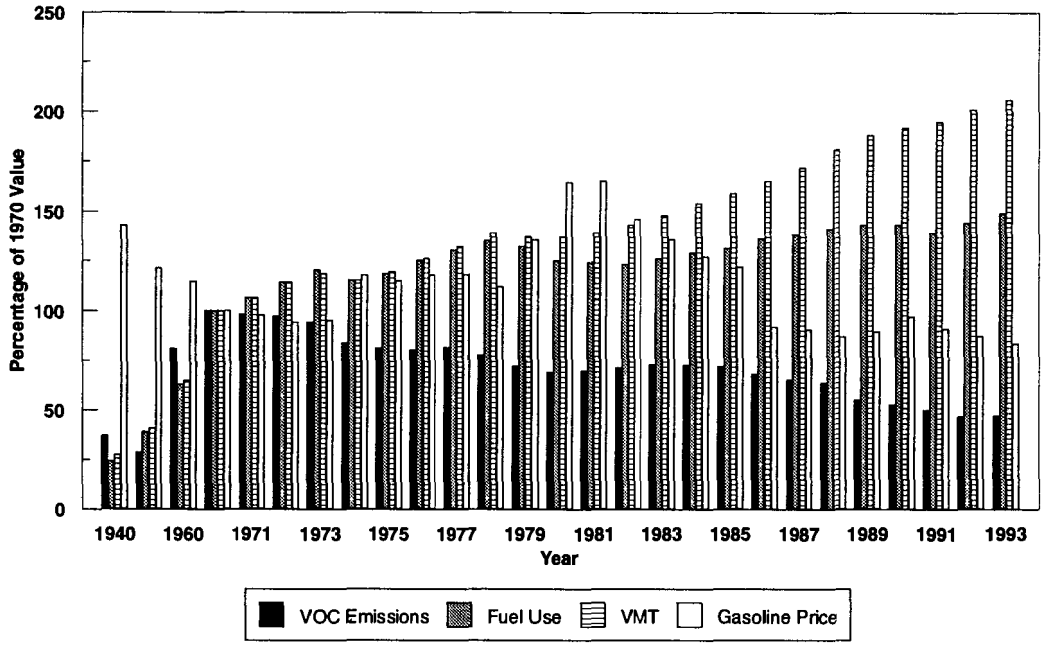
Gasoline prices are stated in constant 1987 price levels.
Source: Energy Statistics Sourcebook[8]

Figure 3-14. Trend in On-Road NITROGEN OXIDE Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price



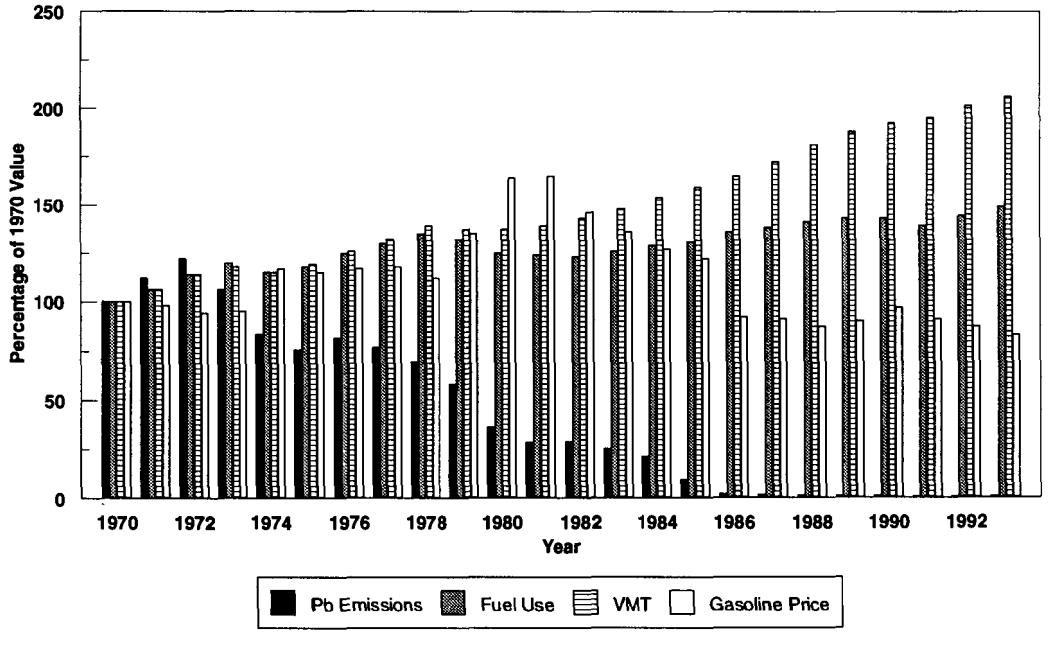
Gasoline prices are stated in constant 1987 price levels
Source: Energy Statistics Sourcebook[8]

Figure 3-15. Trend in On-Road VOLATILE ORGANIC COMPOUND Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Price



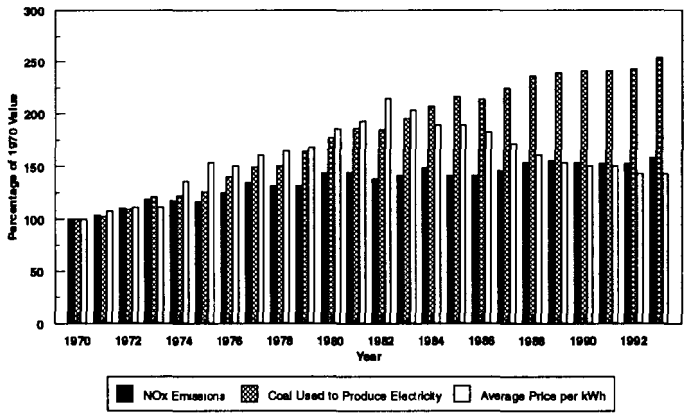
Gasoline prices are stated in constant 1987 price levels
Source: Energy Statistics Sourcebook[8]

Figure 3-16. Trend in Highway LEAD Emissions, Vehicle Miles Traveled, Fuel Use, and Gasoline Prices



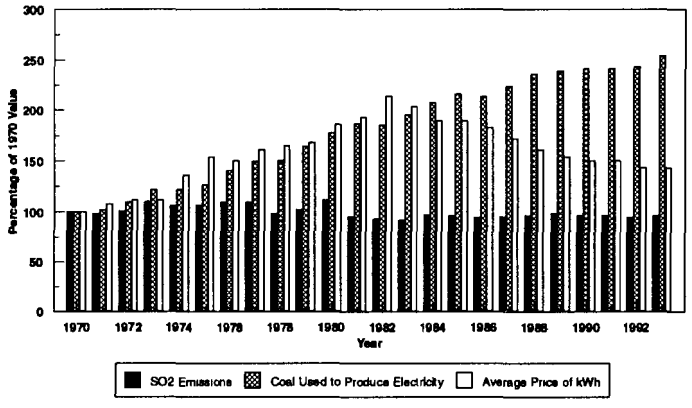
Gasoline prices are stated in constant 1987 price levels
Source: Energy Statistics Sourcebook[8]

Figure 3-17. Trend in NITROGEN OXIDE Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold



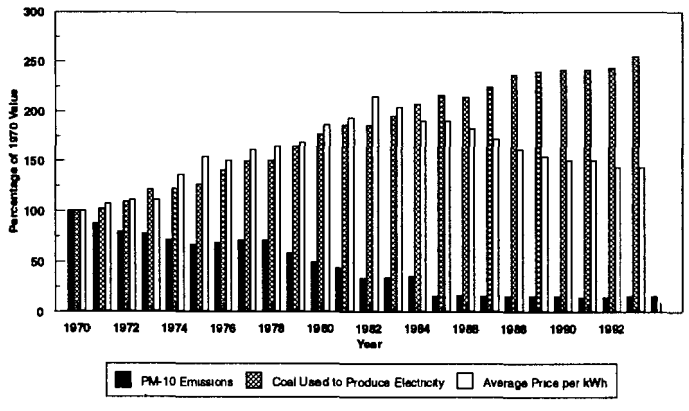
Prices are measured in constant 1987 dollars.
Source: U.S. Department of Energy[9]

Figure 3-18. Trend in SULFUR DIOXIDE Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold



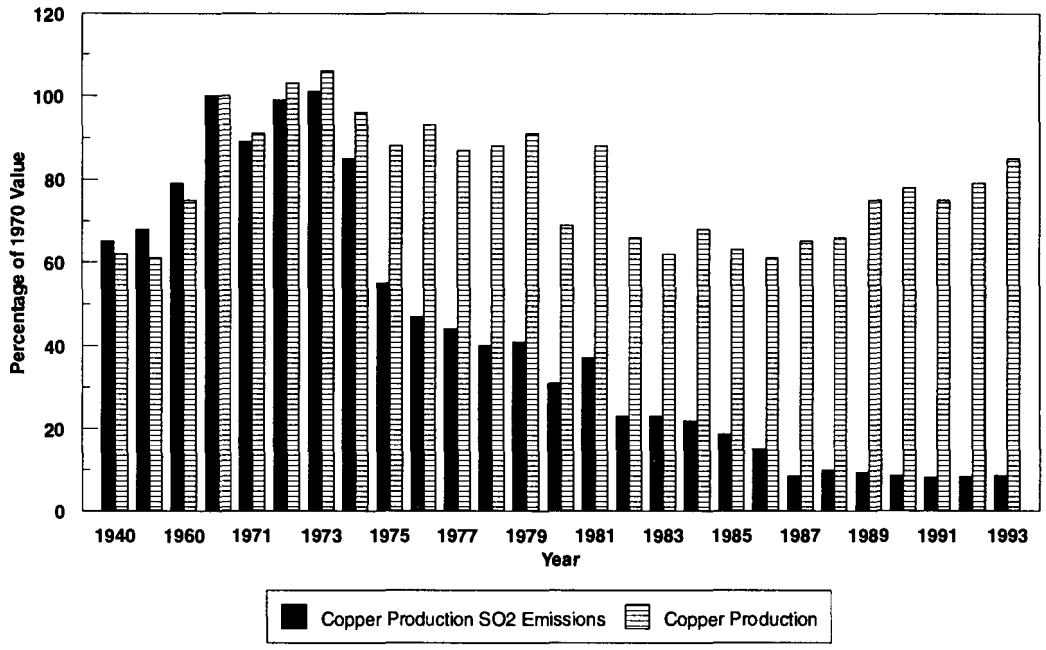
Emissions methodology change occurred in 1985.
Source: U.S. Department of Energy[9]

Figure 3-19. Trend in PARTICULATE MATTER (PM-10) Emissions from Electric Utility Fuel Combustion, Coal Used to Produce Electricity, and Average Retail Price of Electricity Sold



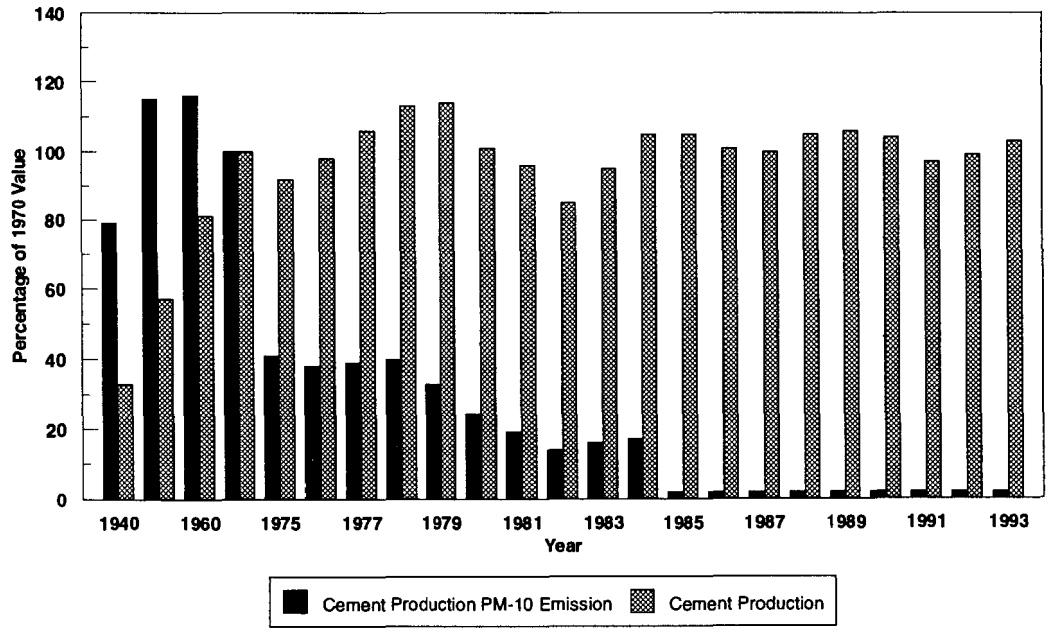
Emissions methodology change occurred in 1985
Source: U.S. Department of Energy[9]

Figure 3-20. Trend in Copper Production and SULFUR DIOXIDE Emissions from Copper Production



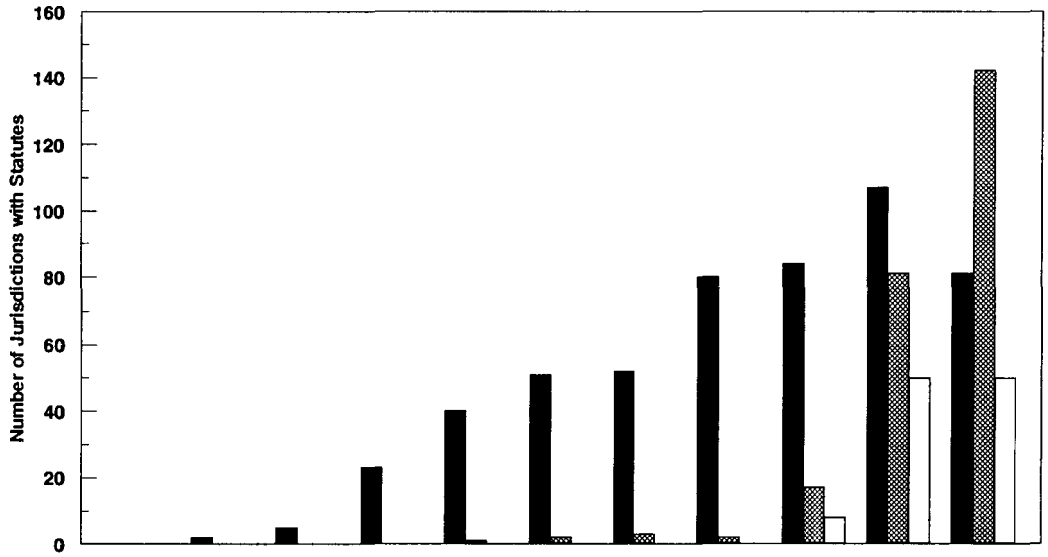
Emissions methodology change occurred in 1985
Source U S Department of Interior.[10]

Figure 3-21. Trend in Cement Production and PARTICULATE MATTER (PM-10) Emissions from Cement Production



Emissions methodology change occurred in 1985
Source: U.S Department of Interior[10]

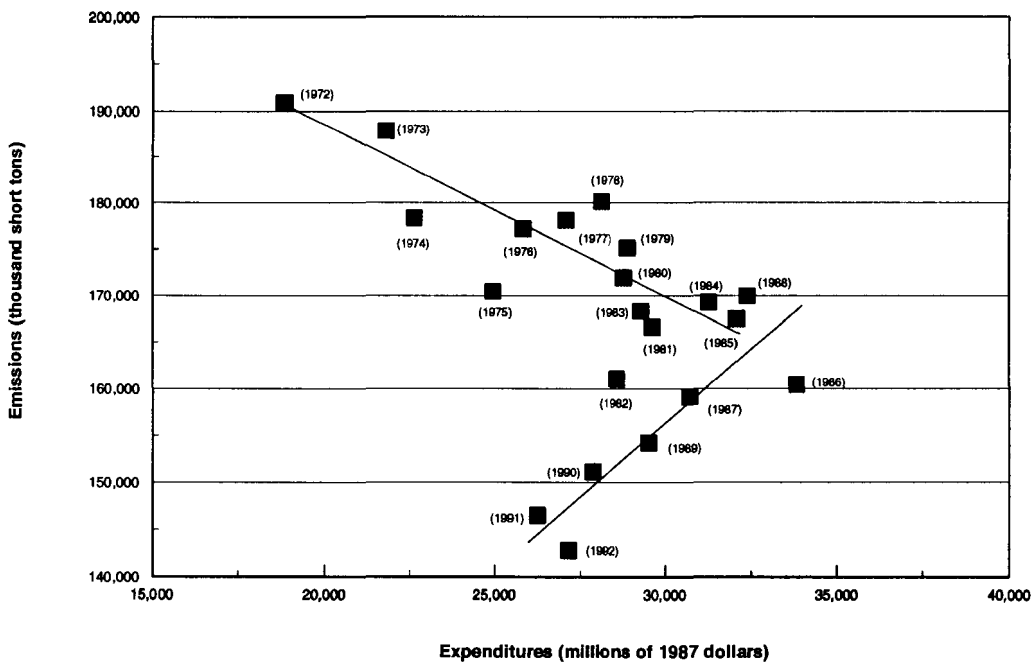
Figure 3-22. History of U.S. Municipal, County, and State Air Pollution Control Legislation



Year	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
Municipal		2	5	23	40	51	52	80	84	107	81
County					1	2	3	2	17	81	142
State									8	50	50

Source: *Public Policies for Environmental Protection.*[7]

Figure 3-23. Criteria Air Pollutant Emissions and Pollution Abatement Expenditures



Criteria air pollutant emissions excluding PM-10 emissions from fugitive dust.
Source: U S Department of Commerce.[6]

Chapter 4.0 Emission Trends, 1985 through 1994

This chapter presents emission summaries for each of the 10 EPA regions and national seasonal emissions by major source category. Definitions for EPA Administrative regions are presented in table 4-1. When comparing emissions from different regions, it is important to consider the size of the region, population, economic activity, predominant types of industry, soil type, and other factors that affect air pollution. Total regional emissions for 1985 through 1994 are presented by pollutant and year in appendix B, tables B-1 through B-6.[1] Table A-7 presents the regional emissions of ammonia. The 1996 *Trends* report will present and discuss ammonia emissions in more detail.

It should be noted that the regional emissions shown in the previous report[1] have been revised. As described in chapter 6, regional emissions for lead are calculated as a fraction of the total national emissions of each source category. Regional emissions of CO, NO_x, VOC, SO_2, and PM-10 are the sum of county emissions in each region.

The trends in regional emissions follow the trends in national emissions for most categories. This effect is largely due to the fact that each region has a diversity of source categories which reflect the national diversity. Some source categories, however, such as wildfires, prescribed burning, wind erosion, and certain industrial processes, produce significant regional effects and, therefore, do not necessarily follow national trends within the source category. These source categories will generally account for large changes at the regional level from one year to the next.

Of special note are the 1990 CO and VOC Region X emission changes. These changes are the result of a large number of wildfires in Alaska. Also of interest is the variation in the PM-10 emissions for Regions VI and VII and to a lesser extent Region VIII. These changes are the result of wind erosion estimates being very sensitive to regional soil conditions and year-to-year changes in total precipitation and wind speeds.

Tables 4-2 through 4-4 present the 10-year trend in CO, NO_x, and VOC seasonal emissions. These seasonal emissions were estimated using four methods for three pollutants. The methodology was specific to on-road vehicles, electric utility, residential wood burning, other area sources, and all other point sources. The three pollutants are CO, NO_x, and VOC. On-road vehicle and electric utility emissions were estimated for each month, and then summed to the four seasons. Residential wood burning emissions were distributed to the seasons based on heating degree days. Area source emissions were temporally apportioned using State point and area factors obtained from the NAPAP methodology.[2] The point emissions were distributed to the seasons based on the 1985 NAPAP seasonal throughput percentages for each point. The seasons are defined as winter (December, January, February), spring (March, April, May), summer (June, July, August), and autumn (September, October, November). Several source categories emit evenly throughout the year. This may be because national production is constant (industrial sources) or lack of specific seasonal indicators (area sources). Sources with noticeable variation are fuel combustion - electric utility and other, on-road vehicles, non-road sources, and miscellaneous sources.

Electric utility seasonal emissions vary slightly depending on pollutant. This variation is due to the fact that different fuels (i.e., coal, oil, gas) emit differing amounts of pollutants. In general, for the 10 years and 3 pollutants presented, the emissions are highest in the summer and lowest in the spring.

The combustion of wood by residential users affects the seasonal variation in fuel combustion - other. As is expected, emissions are highest in the winter and lowest in the summer. For the years 1985 to 1994, the percentages vary depending on temperatures, with winter emissions ranging from 56 to 64 percent of the total fuel combustion emissions.

On-road NO_x emissions vary little from season to season or year to year. The on-road CO emissions have been highest in the winter for the years 1985 to 1994. Emissions of VOC are highest in the summer for the years 1985 to 1991. In 1992 and 1993, VOC emissions are approximately evenly distributed. For the winter of 1994, VOC on-road emissions were higher than any other season. The shifting of VOC emissions to the winter months is caused in part by the decrease in the RVP limit in fuels sold during the summer months.

The same seasonal allocation factor was used for all years to apportion the annual non-road emissions. Non-road engine emissions (non-road diesel and gasoline) are higher in the summer than in the winter since weather prohibits the use of these engines; such as construction, lawn & garden, recreational, and light commercial.

In 1994, the miscellaneous category is comprised of wildfires (45 percent), prescribed burning (47 percent), and other burning (agricultural burning, structural fires, etc., [8 percent]). The numerical average seasonal percentages in 1994 for prescribed burning and wildfires are listed below.

Season	Prescribed Burning (%)	Wildfires (%)
Winter	10	5
Spring	70	5
Summer	0	50
Autumn	20	40

Spring percentages for the 10-year period are the lowest. The emissions in the other three seasons vary depending on the magnitude of the source subcategories. For example, in the 10-year range, wildfires emissions are the highest in 1988 and the lowest in 1993 and the prescribed burning emissions are constant. In 1988, the summer and autumn proportion of annual miscellaneous emissions are the largest, but in 1993 the spring proportion is the largest.

4.1 REFERENCES

1. *National Air Pollutant Emission Trends, 1900 - 1993.* EPA-454/R-94-027, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1994.
2. Fratt, D.B., D.F. Mudgett, and R.A. Walters. *The 1985 NAPAP Emissions Inventory: Development of Temporal Allocation Factors.* EPA-600/7-89-010d. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1990.

[1] A discussion of emission trends during the last decade is located in chapter 3.

Table 4-1. 10 U.S. Environmental Protection Agency Administrative Regions

Region I	Region II	Region III	Region IV	Region V	Region VI	Region VII	Region VIII	Region IX	Region X
Connecticut Maine Massachusetts New Hampshire Rhode Island Vermont	New Jersey New York	Delaware District of Columbia Maryland Pennsylvania Virginia West Virginia	Alabama Florida Georgia Kentucky Mississippi North Carolina South Carolina Tennessee	Illinois Indiana Michigan Minnesota Ohio Wisconsin	Arkansas Louisiana New Mexico Oklahoma Texas	Iowa Kansas Missouri Nebraska	Colorado Montana North Dakota South Dakota Utah Wyoming	Arizona California Hawaii Nevada	Alaska Idaho Oregon Washington

Table 4-2. Seasonal Emissions for Carbon Monoxide, 1985 through 1994
(thousand short tons)

Source Category	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Fuel Comb.-Electric Utility	***292***	***291***	***300***	***313***	***319***	***314***	***315***	***313***	***322***	***325***
Winter	76	74	74	80	83	72	76	76	78	78
Spring	68	66	69	70	74	72	73	74	72	72
Summer	79	81	87	89	86	91	89	87	93	95
Autumn	70	69	71	74	77	79	77	76	79	80
Fuel Comb.-Industrial	***670***	***650***	***649***	***669***	***672***	***677***	***667***	***672***	***670***	***671***
Winter	172	168	167	172	173	174	172	173	172	173
Spring	165	159	159	164	165	166	164	165	165	165
Summer	162	157	156	162	162	163	161	162	162	162
Autumn	171	166	166	171	172	173	170	171	171	171
Fuel Comb.-Other	***7,525***	***5,607***	***6,011***	***6,390***	***6,450***	***4,072***	***4,373***	***4,618***	***3,961***	***3,888***
Winter	4,834	3,837	3,463	3,737	3,826	2,290	2,428	2,576	2,213	2,302
Spring	1,388	1,413	1,310	1,359	1,420	982	910	1,044	885	840
Summer	94	103	94	96	89	57	87	65	70	64
Autumn	1,209	1,254	1,144	1,198	1,114	744	948	930	794	682
Chemical & Allied Product Mf.	***1,845***	***1,853***	***1,798***	***1,917***	***1,925***	***1,940***	***1,944***	***1,964***	***1,998***	***2,048***
Winter	463	465	451	481	483	486	488	493	501	514
Spring	461	463	449	479	481	484	486	490	499	511
Summer	460	462	448	477	480	483	484	489	498	510
Autumn	462	464	450	480	482	486	487	492	500	513
Metals Processing	***2,223***	***2,079***	***1,984***	***2,101***	***2,132***	***2,080***	***1,992***	***2,044***	***2,091***	***2,166***
Winter	617	577	549	581	591	578	554	568	580	601
Spring	548	513	491	519	526	512	490	503	515	534
Summer	524	490	468	496	503	491	470	483	494	512
Autumn	533	499	477	505	512	499	478	490	502	520
Petroleum & Related Industries	***462***	***451***	***455***	***441***	***436***	***435***	***412***	***410***	***396***	***390***
Winter	117	114	115	112	110	110	104	104	101	99
Spring	118	116	116	113	112	111	105	105	102	100
Summer	117	114	115	112	111	110	104	104	101	99
Autumn	110	107	108	104	104	104	98	97	95	92
Other Industrial Processes	***694***	***715***	***713***	***711***	***716***	***717***	***710***	***719***	***732***	***751***
Winter	174	179	179	178	180	180	178	180	184	188
Spring	174	180	179	178	180	180	178	180	184	188
Summer	173	178	178	177	178	179	177	179	183	187
Autumn	173	178	177	177	178	178	177	179	182	187
Solvent Utilization	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***
Winter	0	0	0	0	0	0	0	0	0	0
Spring	0	0	0	0	0	0	0	0	0	0
Summer	0	0	0	0	0	0	0	0	0	0
Autumn	0	0	0	0	0	0	0	0	0	0
Storage & Transport	***49***	***51***	***50***	***56***	***55***	***55***	***54***	***55***	***56***	***58***
Winter	12	13	12	14	14	14	13	14	14	14
Spring	12	13	12	14	14	14	13	14	14	15
Summer	12	13	12	14	14	14	14	14	14	15
Autumn	12	13	12	14	14	14	14	14	14	15
Waste Disposal & Recycling	***1,941***	***1,915***	***1,850***	***1,806***	***1,747***	***1,686***	***1,701***	***1,717***	***1,732***	***1,746***
Winter	484	478	461	450	436	420	424	428	432	435
Spring	485	479	463	452	437	422	426	429	433	437
Summer	486	479	463	452	437	422	426	430	433	437
Autumn	486	479	463	452	437	422	426	430	433	437
On-Road Vehicles	***77,387***	***73,347***	***71,250***	***71,081***	***66,050***	***62,858***	***62,074***	***59,859***	***60,202***	***61,070***
Winter	21,267	19,375	18,941	19,155	18,923	17,289	17,433	16,947	16,981	17,522
Spring	18,534	17,830	17,460	17,342	16,421	15,925	15,402	15,170	15,177	15,397
Summer	19,686	18,811	18,165	18,039	15,411	14,894	14,574	13,630	13,837	13,942
Autumn	17,900	17,330	16,684	16,545	15,295	14,750	14,665	14,112	14,208	14,209
Non-Road Sources	***13,706***	***13,984***	***14,131***	***14,500***	***14,518***	***14,642***	***14,601***	***14,900***	***15,269***	***15,657***
Winter	2,601	2,663	2,695	2,766	2,772	2,793	2,770	2,828	2,901	2,978
Spring	3,378	3,448	3,484	3,576	3,578	3,608	3,589	3,662	3,752	3,847
Summer	4,234	4,310	4,353	4,465	4,471	4,511	4,510	4,601	4,713	4,830
Autumn	3,493	3,562	3,600	3,693	3,698	3,729	3,732	3,809	3,903	4,002
Miscellaneous	***7,895***	***7,254***	***8,820***	***15,863***	***8,121***	***11,173***	***8,530***	***6,774***	***6,700***	***9,245***
Winter	678	648	728	1,087	698	850	717	630	627	755
Spring	3,496	3,493	3,598	4,034	3,620	3,761	3,627	3,545	3,551	3,688
Summer	1,539	1,196	1,958	5,415	1,565	3,100	1,780	897	853	2,118
Autumn	2,183	1,917	2,535	5,327	2,238	3,462	2,406	1,702	1,669	2,684
Total All Sources	***114,690***	***109,199***	***108,012***	***115,849***	***103,144***	***100,650***	***97,376***	***94,043***	***94,133***	***98,017***
Winter	31,499	28,601	27,839	28,799	28,287	23,562	25,392	25,031	24,783	25,641
Spring	28,840	28,170	27,796	28,283	27,017	25,965	25,477	25,356	25,348	25,795
Summer	27,554	26,399	26,478	29,992	23,510	26,345	22,888	21,163	21,451	22,982
Autumn	26,797	26,029	25,900	28,775	24,330	24,778	23,620	22,494	22,550	23,600

Table 4-3. Seasonal Emissions for Nitrogen Oxides, 1985 through 1994
(thousand short tons)

Source Category	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Fuel Comb.-Electric Utility	***6,916***	***6,909***	***7,128***	***7,530***	***7,607***	***7,516***	***7,488***	***7,475***	***7,773***	***7,795***
Winter	1,801	1,757	1,748	1,928	1,980	1,804	1,858	1,864	1,914	1,913
Spring	1,603	1,568	1,627	1,679	1,760	1,729	1,722	1,768	1,779	1,772
Summer	1,862	1,935	2,055	2,137	2,034	2,104	2,064	2,019	2,188	2,207
Autumn	1,650	1,648	1,698	1,786	1,833	1,879	1,843	1,825	1,893	1,904
Fuel Comb.-Industrial	***3,209***	***3,065***	***3,063***	***3,187***	***3,209***	***3,256***	***3,175***	***3,216***	***3,197***	***3,206***
Winter	825	789	788	820	825	837	816	827	822	825
Spring	794	758	757	789	794	806	786	796	791	793
Summer	785	749	748	779	784	796	777	786	782	784
Autumn	805	769	769	800	805	817	796	806	802	804
Fuel Comb.-Other	***712***	***694***	***706***	***740***	***736***	***712***	***719***	***730***	***726***	***727***
Winter	343	328	332	349	349	334	338	344	341	343
Spring	163	162	165	172	172	167	167	171	170	170
Summer	56	56	59	61	59	59	59	60	60	60
Autumn	149	148	151	158	155	151	155	156	155	154
Chemical & Allied Product Mf.	***262***	***264***	***255***	***274***	***273***	***276***	***278***	***284***	***286***	***291***
Winter	65	66	64	69	69	71	71	73	73	74
Spring	72	72	70	75	74	75	75	77	77	79
Summer	62	62	60	64	64	65	65	66	67	68
Autumn	63	63	61	66	66	66	67	68	69	70
Metals Processing	***87***	***80***	***75***	***82***	***83***	***81***	***78***	***80***	***81***	***84***
Winter	22	20	19	20	21	20	19	20	20	21
Spring	22	21	19	21	21	21	20	20	21	22
Summer	21	20	18	20	20	20	19	20	20	21
Autumn	21	20	19	20	21	20	19	20	20	21
Petroleum & Related Industries	***124***	***109***	***101***	***100***	***97***	***100***	***97***	***96***	***95***	***95***
Winter	31	27	25	25	24	25	24	24	23	23
Spring	31	27	25	25	24	25	24	24	24	24
Summer	31	27	25	25	24	25	24	24	24	24
Autumn	31	27	25	25	24	25	24	24	24	24
Other Industrial Processes	***327***	***328***	***320***	***315***	***311***	***306***	***297***	***305***	***315***	***328***
Winter	79	79	77	76	75	74	72	74	76	79
Spring	83	83	81	80	79	77	75	77	80	83
Summer	83	83	81	80	79	77	75	77	80	83
Autumn	82	83	81	79	78	77	75	77	79	83
Solvent Utilization	***2***	***3***	***3***	***3***	***3***	***2***	***2***	***3***	***3***	***3***
Winter	1	1	1	1	1	1	1	1	1	1
Spring	1	1	1	1	1	1	1	1	1	1
Summer	1	1	1	1	1	1	1	1	1	1
Autumn	1	1	1	1	1	1	1	1	1	1
Storage & Transport	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***3***	***3***	***3***
Winter	1	1	1	1	1	1	1	1	1	1
Spring	1	1	1	1	1	1	1	1	1	1
Summer	1	1	1	1	1	1	1	1	1	1
Autumn	1	1	1	1	1	1	1	1	1	1
Waste Disposal & Recycling	***87***	***87***	***85***	***85***	***84***	***82***	***83***	***83***	***84***	***85***
Winter	21	22	21	21	21	20	20	21	21	21
Spring	22	22	21	21	21	21	21	21	21	21
Summer	22	22	21	21	21	21	21	21	21	21
Autumn	22	22	21	21	21	21	21	21	21	21
On-Road Vehicles	***8,089***	***7,773***	***7,651***	***7,661***	***7,682***	***7,488***	***7,373***	***7,440***	***7,510***	***7,530***
Winter	2,063	1,962	1,938	1,949	1,956	1,881	1,863	1,873	1,907	1,925
Spring	2,046	1,974	1,939	1,942	1,938	1,907	1,857	1,880	1,896	1,897
Summer	1,997	1,920	1,885	1,879	1,903	1,864	1,834	1,855	1,856	1,866
Autumn	1,983	1,918	1,889	1,892	1,885	1,836	1,820	1,833	1,851	1,841
Non-Road Sources	***2,734***	***2,777***	***2,664***	***2,914***	***2,844***	***2,843***	***2,796***	***2,885***	***2,985***	***3,095***
Winter	587	596	574	625	610	610	600	618	638	660
Spring	674	685	657	720	704	704	691	713	737	764
Summer	780	793	759	830	810	809	796	822	852	886
Autumn	693	703	674	738	720	720	709	732	758	786
Miscellaneous	***309***	***257***	***351***	***726***	***292***	***373***	***283***	***249***	***219***	***374***
Winter	25	22	27	46	24	28	24	22	20	28
Spring	122	120	125	146	123	127	123	121	120	128
Summer	72	46	92	278	62	103	57	40	25	103
Autumn	91	70	107	256	83	115	79	66	53	116
Total All Sources	***22,860***	***22,348***	***22,403***	***23,618***	***23,222***	***23,038***	***22,672***	***22,847***	***23,276***	***23,615***
Winter	5,861	5,668	5,615	5,928	5,955	5,747	5,705	5,757	5,856	5,910
Spring	5,624	5,485	5,483	5,665	5,704	5,761	5,572	5,680	5,717	5,760
Summer	5,775	5,718	5,807	6,180	5,864	5,830	5,797	5,796	5,976	6,128
Autumn	5,599	5,476	5,499	5,845	5,700	5,700	5,597	5,613	5,725	5,817

Table 4-4. Seasonal Emissions for Volatile Organic Compounds,1985 through 1994
(thousand short tons)

Source Category	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Fuel Comb.-Electric Utility	***32***	***34***	***34***	***37***	***37***	***36***	***36***	***35***	***36***	***36***
Winter	8	9	8	9	10	9	9	9	9	9
Spring	7	8	8	8	9	8	8	8	8	8
Summer	9	9	10	10	10	10	10	9	10	10
Autumn	8	8	8	9	9	9	9	8	9	9
Fuel Comb.-Industrial	***134***	***133***	***131***	***136***	***134***	***135***	***135***	***135***	***134***	***135***
Winter	35	34	34	35	35	35	35	35	35	35
Spring	33	33	32	34	33	33	33	33	33	33
Summer	33	32	32	33	33	33	33	33	33	33
Autumn	34	33	33	34	34	34	34	34	34	34
Fuel Comb.-Other	***1,403***	***1,230***	***1,117***	***1,188***	***1,200***	***749***	***807***	***853***	***729***	***715***
Winter	906	717	646	698	715	423	450	478	409	426
Spring	257	262	243	252	264	181	167	193	162	154
Summer	15	17	16	16	15	9	14	10	11	10
Autumn	224	233	212	222	206	136	175	172	146	125
Chemical & Allied Product Mf.	***1,358***	***1,412***	***1,410***	***1,513***	***1,506***	***1,526***	***1,533***	***1,546***	***1,557***	***1,577***
Winter	340	354	353	379	377	382	384	387	390	395
Spring	340	354	354	379	377	382	384	388	390	395
Summer	338	351	351	377	375	380	382	385	387	392
Autumn	339	353	352	378	376	381	383	386	389	394
Metals Processing	***76***	***73***	***70***	***74***	***74***	***72***	***69***	***72***	***74***	***77***
Winter	19	19	18	19	19	19	18	18	19	20
Spring	19	19	18	19	19	19	18	18	19	20
Summer	19	18	17	18	18	18	17	17	18	19
Autumn	18	18	17	18	18	18	17	17	18	19
Petroleum & Related Industries	***703***	***666***	***655***	***645***	***639***	***643***	***634***	***638***	***631***	***630***
Winter	175	166	163	161	159	160	158	159	157	157
Spring	176	166	164	161	160	161	159	159	158	157
Summer	176	167	164	161	160	161	159	160	158	158
Autumn	176	167	164	161	160	161	159	160	158	158
Other Industrial Processes	***390***	***395***	***394***	***408***	***403***	***401***	***398***	***403***	***406***	***411***
Winter	98	99	99	102	101	100	100	101	102	103
Spring	97	99	98	102	101	100	99	100	101	103
Summer	97	99	98	102	100	100	99	100	101	103
Autumn	98	99	99	102	101	100	100	101	102	103
Solvent Utilization	***5,699***	***5,626***	***5,743***	***5,945***	***5,964***	***5,975***	***5,918***	***6,031***	***6,156***	***6,313***
Winter	1,398	1,382	1,410	1,458	1,463	1,466	1,451	1,479	1,509	1,547
Spring	1,405	1,388	1,416	1,466	1,471	1,474	1,460	1,487	1,518	1,557
Summer	1,451	1,430	1,461	1,514	1,518	1,521	1,507	1,536	1,569	1,609
Autumn	1,444	1,426	1,456	1,507	1,512	1,514	1,499	1,528	1,560	1,600
Storage & Transport	***1,747***	***1,673***	***1,801***	***1,842***	***1,753***	***1,759***	***1,720***	***1,745***	***1,757***	***1,773***
Winter	436	417	449	459	437	438	428	435	438	442
Spring	437	418	450	460	438	440	430	436	439	443
Summer	438	419	451	462	440	441	431	437	440	445
Autumn	437	418	450	460	438	440	430	436	439	443
Waste Disposal & Recycling	***2,310***	***2,293***	***2,256***	***2,310***	***2,290***	***2,262***	***2,265***	***2,268***	***2,271***	***2,273***
Winter	577	573	564	577	572	565	566	567	568	568
Spring	577	573	564	577	572	565	566	567	568	568
Summer	577	573	564	578	573	566	566	567	568	568
Autumn	578	573	564	578	573	566	566	567	568	568
On-Road Vehicles	***9,376***	***8,874***	***8,477***	***8,290***	***7,192***	***6,854***	***6,499***	***5,072***	***5,103***	***5,295***
Winter	2,019	1,910	1,839	1,831	1,791	1,702	1,631	1,474	1,595	1,668
Spring	2,317	2,194	2,107	2,037	1,796	1,705	1,626	1,444	1,532	1,583
Summer	2,849	2,700	2,557	2,515	1,921	1,825	1,723	1,577	1,544	1,573
Autumn	2,191	2,070	1,974	1,906	1,683	1,623	1,520	1,577	1,432	1,471
Non-Road Sources	***2,008***	***2,039***	***2,038***	***2,106***	***2,103***	***2,120***	***2,122***	***2,159***	***2,206***	***2,255***
Winter	384	391	391	405	405	408	406	414	423	433
Spring	493	501	501	518	517	521	520	529	540	552
Summer	619	627	626	646	646	651	653	664	678	693
Autumn	512	520	519	537	536	540	543	552	564	577
Miscellaneous	***562***	***544***	***652***	***1,227***	***639***	***1,069***	***741***	***466***	***516***	***685***
Winter	49	48	54	84	54	75	59	45	48	56
Spring	189	192	202	242	209	229	212	199	203	213
Summer	153	141	192	470	179	395	231	94	117	201
Autumn	171	163	205	431	197	370	238	128	148	215
Total All Sources	***25,798***	***24,991***	***24,778***	***25,719***	***23,935***	***23,599***	***22,877***	***22,420***	***22,575***	***23,174***
Winter	6,445	6,113	6,028	6,218	6,139	5,783	5,696	5,722	5,701	5,860
Spring	6,350	6,207	6,156	6,255	5,965	5,817	5,682	5,646	5,672	5,786
Summer	6,773	6,584	6,540	6,902	5,987	6,108	5,826	5,513	5,635	5,813
Autumn	6,230	6,087	6,053	6,344	5,844	5,891	5,673	5,539	5,566	5,714

Chapter 5.0 National Emission Projections, 1996 to 2010

Emission projections by pollutant through the year 2010 are shown in tables 5-1 through 5-5 for CO, NO_x, VOC, SO_2, and PM-10, respectively. For most source categories, emission projections are based on growth factors from EPA's Economic Growth Analysis System (E-GAS).[1] (Department of Energy electricity generation projections[2] are used for utilities and MOBILE Fuel Consumption Model[3] VMT projections are used for motor vehicles.) Changes in emission controls are modeled to project the effects of the CAAA on future emission levels. The growth factors project growth in activity only and do not include changes that might result from new technology (i.e., improved efficiency). The control factors will capture changes in control technology mandated by the CAAA but may not capture new technologies and increased efficiency of process which are not mandated by the CAAA.

Emission projections are a function of growth factors and future control level estimates, both of which have associated uncertainties. Growth factors, in general, are more uncertain the further into the future the growth is projected. In any given projection year, unexpected upturns or downturns in the economy may occur which are unaccounted for in projections of trends in activity. While the control factors applied may account for control initiatives resulting from CAAA requirements, increased production efficiency and technological changes (which may be a result of initiatives to decrease production costs) may not be taken into account.

National projections are shown in the following tables for each pollutant. These projections can be used to show which pollutants are expected to increase or decline, and to show which sectors have the greatest impact on total emissions and future emission levels. While the future levels may give an indication of whether air quality can be expected to improve, it should be noted that air quality indicators (e.g., ambient concentrations) vary significantly by area and that these national projections may not adequately indicate the emission changes expected in individual areas currently in nonattainment for CO, SO_2, PM-10, and ozone. Caveats associated with the controls modeled for each pollutant are discussed below.

5.1 DIFFERENCES BETWEEN PROJECTIONS, 1994 AND 1995 REPORTS

This chapter is basically a duplicate of the information presented in the October 1994 report. Changes were made to the non-road projections to adjust for errors made when the future controls were applied. Specifics on all changes are explained in section 6.5 of this report. The 1994 values presented in the last report were derived using linear regression. The 1994 emissions presented throughout this report were estimated using methodologies similar to those for the year 1993 (see section 6.4 for more details.)

The projections contained in last year's report were estimated during the summer of 1994. In particular, the estimate of 1994 emissions contained in last year's report is a linear interpolation of estimates based on actual 1993 data and the 1996 projections. Since that time several events have occurred that changed EPA's estimate of 1994 emissions. Some ozone nonattainment areas have opted out of using reformulated gasoline (began in 1995) and changes have been made in the inspection and maintenance (I/M) rule making (slated to begin in 1996). For these reasons and the assumptions that VMT will increase, RVP will remain relatively constant, and temperatures will be shown to have been somewhat higher during the summer of 1995, mobile source on-road emissions may be higher in 1995 than currently projected. On the other hand, it is unclear at this point whether 1996 and later mobile source emissions will increase or decrease, since Tier 1 emission standards are scheduled to start in 1996 while other State and EPA initiatives are slated for later years. At issue is whether, collectively, our improvements in technology can overcome the historically seemingly inexorable increase in VMT. As in past *Trends* reports, changed will be made to the emission estimates as information and resources become available.

5.2 FUTURE EXPECTED TRENDS IN CARBON MONOXIDE EMISSIONS

Trends in CO emissions through 2010 are shown in table 5-1 and illustrated in figure 5-1. Total emissions are expected to show a continued decline through 2000 with emissions showing a slight increase in 2002 continuing into the future. Emissions in 2010 likely will remain below 1990 levels. The decline through 2000

is due entirely to expected decreases in on-road vehicle emissions as a result of more stringent tailpipe standards, enhanced I/M in some ozone and CO nonattainment areas, and oxygenated fuels. These decreases in on-road vehicle emissions outweigh small increases in emissions from other source categories. As VMT increases begin to dominate any further decreases in on-road vehicle emission factors, total emissions begin to increase.

5.3 FUTURE EXPECTED TRENDS IN NITROGEN OXIDE EMISSIONS

Projected levels of NO_x emissions through 2010 are shown in table 5-2 and figure 5-2. Total emissions show a slight increase from 1990 to 1993 followed by a decrease in 1996 as stationary source NO_x RACT is implemented and enhanced I/M programs begin in some ozone nonattainment areas. Electric utility emissions show an expected decline in 1996 with RACT requirements and an additional decline between 1999 and 2000 as phase II Title IV standards become effective. While RACT control requirements for industrial fuel combustion emitters result in emission declines for this category, trends are dominated by decreases in predicted activity for coal and oil sectors. On-road vehicle emissions will likely continue to decline through 2005 as emission factor decreases due to tailpipe standards, phase II reformulated gasoline, and I/M requirements outweigh increases in VMT.

5.4 FUTURE EXPECTED TRENDS IN VOLATILE ORGANIC COMPOUND EMISSIONS

Trends in VOC emissions through 2010 are shown in table 5-3 and figure 5-3. Emission levels in 2010 are expected to remain lower than 1990 although total emissions show an upturn between 2000 and 2002. Emission projections for VOC include only the mandatory provisions of the CAAA including RACT, new Control Techniques Guidelines (CTGs), Federal measures for consumer solvents, Title I and II mobile source measures, and Title III Maximum Achievable Control Technology (MACT) standards. Provisions which are not accounted for and which may result in further emission declines (in ozone nonattainment areas) include new source offsets, progress requirements, and attainment and maintenance provisions. The largest expected decrease in emissions occurs between 1993 and 1996 as the majority of ozone nonattainment area mandatory measures are implemented. Solvent utilization emissions show a continued decline through 1999 as more stringent control requirements become effective for consumer solvents. On-road vehicle emissions show a continued decline through 2005; VMT increases then begin to dominate any additional reductions due to emission factor decreases. Effects of emission factor decreases become nil as tailpipe standards become increasingly pervasive in the course of fleet turnover.

5.5 FUTURE EXPECTED TRENDS IN SULFUR DIOXIDE EMISSIONS

Future year expected emission trends through 2010 for SO_2 are shown in table 5-4 and figure 5-4. Total emissions are predicted to continue to decline through 2010. Sulfur dioxide emissions are dominated by electric utility and industrial fuel combustion. Electric utility fuel combustion emissions show an expected continued decline through 2010 due to the lower emission cap in 2010. These projections assume that utilities bank a certain portion of their phase I allowances and use these banked allowances from 2000 to 2010. The projected 2010 utility emissions are approximately 6 million short tons greater than the 2010 electric utility SO_2 cap due to the use of the banked allowances.

Future year expected emission trends from industrial sources can be discerned from table 5-4 by combining the emissions from fuel combustion-industrial, chemical and allied products manufacturing, metals processing, petroleum and related industries, other industrial processes, solvent utilization, storage and transport, and waste disposal and recycling. When future emissions from these sources are examined, they show a slight expected decrease from 1990 to 1993, and then show a slightly increasing trend to the year 2002. From 2002 to 2010 projected emissions are basically flat. In all cases, the emissions projections show that total national industrial SO_2 emissions remain below 5 million short tons, well below the 5.60 million short ton per year cap established by section 406 of the CAAA. As with historic emissions, industrial combustion emissions continue to be the largest contributor to future industrial SO_2 emissions, although table 5-4 clearly shows that emissions from industrial combustion sources decrease in future years.

5.6 FUTURE EXPECTED TRENDS IN PARTICULATE MATTER (PM-10) EMISSIONS

Projections of future levels of PM-10 emissions are shown in table 5-5 and figure 5-5. Clean Air Act Amendment controls reduce PM-10 emissions in nonattainment areas; however, because this is such a small subset of total national emissions, overall levels show an increase in emissions. The lower expected increase between 1990 and 1996 is generally due to the nonattainment area controls. Changes in emissions after 1996 are due solely to activity level changes with the exception of on-road vehicles. On-road vehicle emission factors decrease due to diesel fuel standards and increased penetration of cleaner vehicles with fleet turnover. The further decrease between 2005 and 2008 is due to the CAAA standards for heavy duty diesel vehicles (HDDVs).

Wind erosion emissions can fluctuate substantially from year-to-year, depending on meteorological conditions which cannot be projected to the future. For this reason, all future year emissions are

assumed to be equivalent to 1990 levels. The 1993 estimate is based on actual meteorological data. The large decrease seen in 1993 is due to substantial precipitation during the spring and summer months in the midwestern United States, which resulted in midwestern flooding and also acted to substantially reduce wind erosion emissions. The "dip" observed in table 5.5 for wind erosion is a direct result of this 1993 anomaly.

5.7 REFERENCES

1. *Economic Growth Analysis System: User's Guide, Version 2.0.* EPA-600/R-94-139b. Joint Emissions Inventory Oversight Group (JEIOG), Office of Research and Development (ORD), Office of Air Quality Planning and Standards (OAQPS), U.S. Environmental Protection Agency, Research Triangle Park, NC. August 1994.
2. *Recommendations to NAPAP Regarding SO_2 Emission Projections.* Report to the National Acid Precipitation Assessment Program (NAPAP). Prepared by Resources for the Future. Washington, DC. June 15, 1994.
3. *MOBILE4.1 Fuel Consumption Model.* Computer reports from EPA, Office of Mobile Sources, Ann Arbor, MI. August 1991.

Figure 5-1. National CARBON MONOXIDE Emissions by Source Category (Projected from 1990 to 2010)

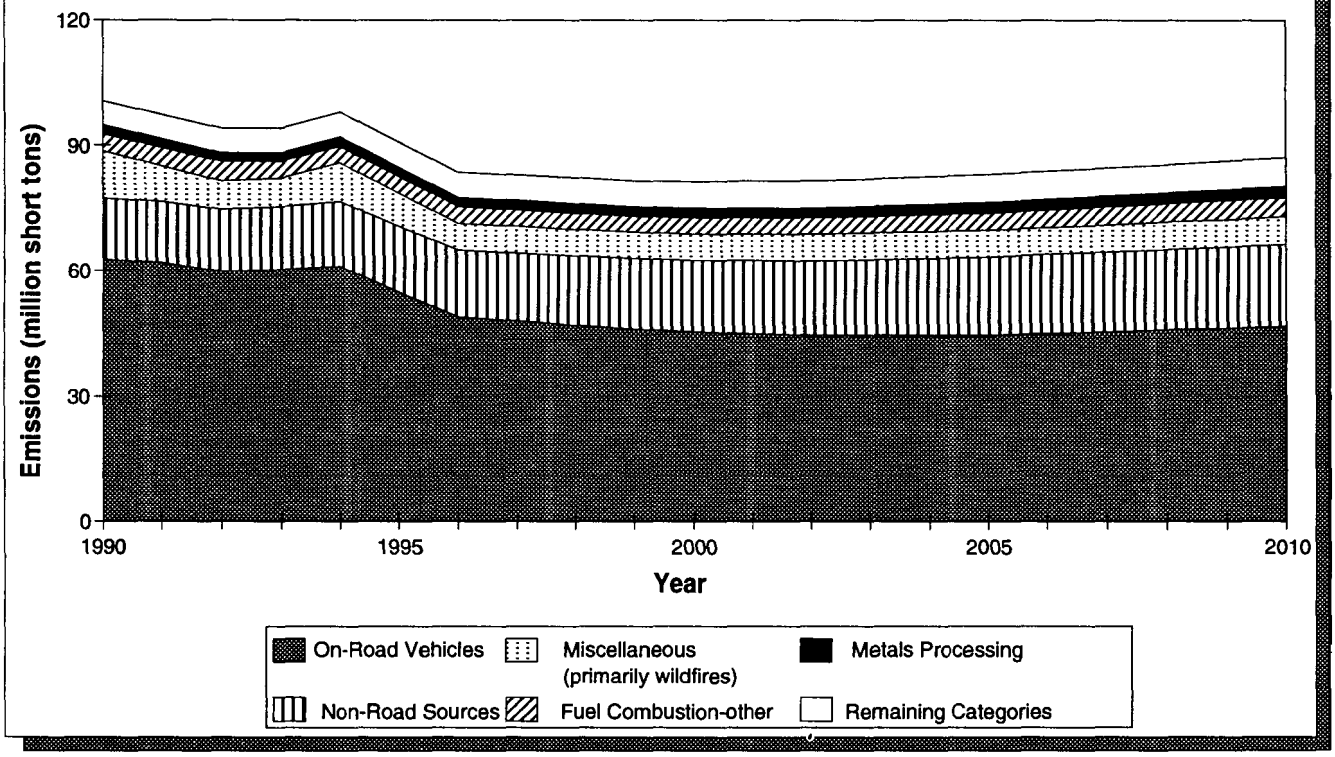


Table 5-1. National Carbon Monoxide Emissions by Source Category Projected from 1990 to 2010 (thousand short tons)

Source Category	1990	1993	1996	1999	2000	2002	2005	2008	2010
Fuel Combustion - Electric Utility	314	322	364	395	402	416	435	462	482
Fuel Combustion - Industrial	677	670	662	652	650	646	641	636	634
Fuel Combustion - Other	4,072	3,961	4,051	3,697	3,796	3,850	4,012	4,337	4,554
Chemical and Allied Prod. Mfg	1,940	1,998	2,086	2,192	2,230	2,309	2,436	2,502	2,540
Metals Processing	2,080	2,091	2,192	2,288	2,322	2,395	2,514	2,624	2,690
Petroleum & Related Industries	435	398	362	331	322	304	279	266	257
Other Industrial Processes	717	732	768	814	831	866	921	950	966
Solvent Utilization	2	2	2	2	2	2	2	2	2
Storage and Transport	55	56	60	65	66	70	75	77	79
Waste Disposal & Recycling	1,686	1,732	1,771	1,804	1,815	1,836	1,866	1,892	1,910
On-Road Vehicles	62,858	60,202	48,874	46,003	45,309	44,525	44,533	45,835	46,749
Non-Road Sources	14,642	15,269	16,173	17,033	17,329	17,945	18,919	19,460	19,800
Miscellaneous	11,173	6,700	6,331	6,372	6,387	6,418	6,468	6,493	6,507
Total	**100,650**	**94,133**	**83,697**	**81,649**	**81,461**	**81,580**	**83,100**	**85,535**	**87,169**

Figure 5-2. National NITROGEN OXIDE Emissions by Source Category (Projected from 1990 to 2010)

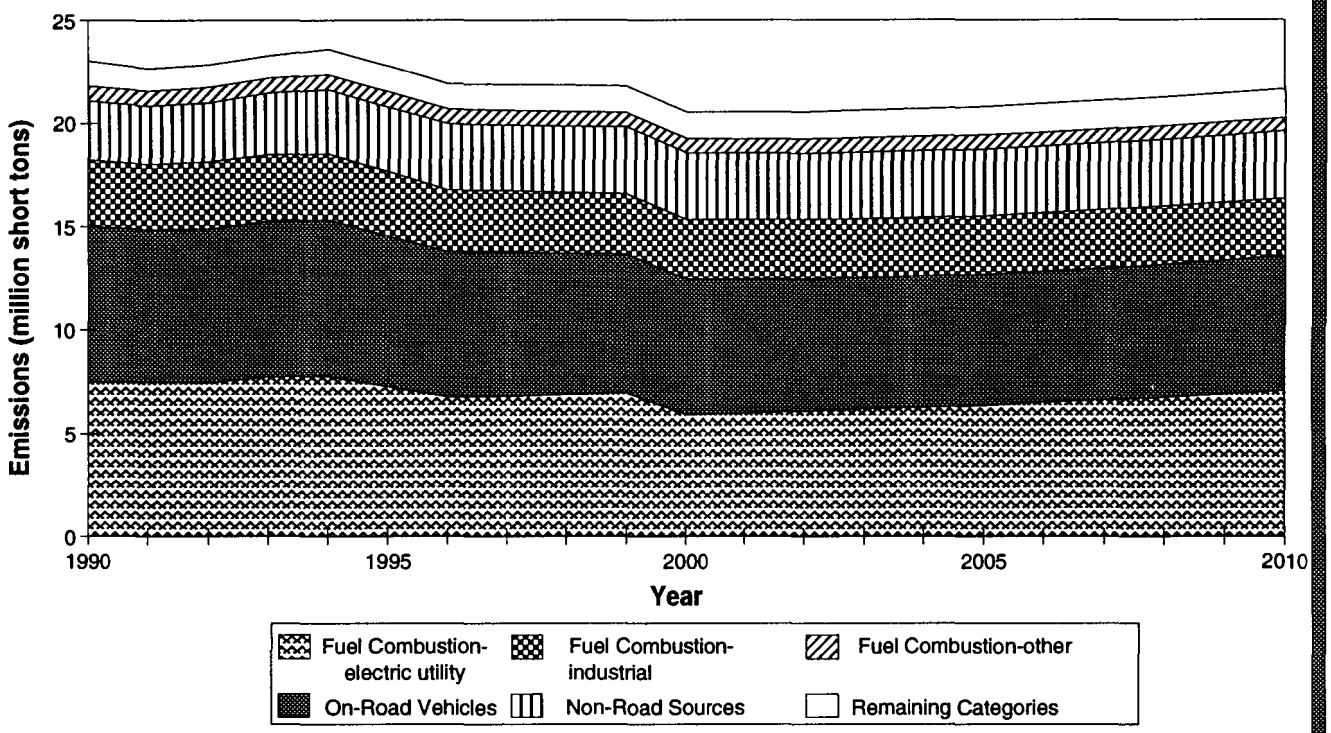


Table 5-2. National Nitrogen Oxide Emissions by Source Category Projected from 1990 to 2010
(thousand short tons)

Source Category	1990	1993	1996	1999	2000	2002	2005	2008	2010
Fuel Combustion - Electric Utility	7,516	7,773	6,761	6,978	5,921	6,102	6,379	6,781	7,072
Fuel Combustion - Industrial	3,256	3,197	2,985	2,908	2,892	2,866	2,827	2,793	2,772
Fuel Combustion - Other	712	726	718	706	702	692	678	655	639
Chemical and Allied Prod. Mfg	276	286	421	432	436	445	458	470	478
Metals Processing	81	81	86	90	91	94	99	103	106
Petroleum & Related Industries	100	95	91	88	87	86	84	83	83
Other Industrial Processes	306	315	339	366	375	395	427	445	455
Solvent Utilization	2	3	3	3	3	3	3	3	3
Storage and Transport	2	3	3	3	3	3	3	3	3
Waste Disposal & Recycling	82	84	86	88	89	90	92	93	94
On-Road Vehicles	7,488	7,510	7,041	6,700	6,531	6,349	6,281	6,387	6,495
Non-Road Sources	2,843	2,985	3,178	3,210	3,208	3,211	3,231	3,228	3,235
Miscellaneous	373	219	206	207	207	207	209	209	209
Total	**23,038**	**23,276**	**21,918**	**21,778**	**20,545**	**20,543**	**20,769**	**21,253**	**21,643**

Figure 5-3. National VOLATILE ORGANIC COMPOUND Emissions by Source Category (Projected from 1990 to 2010)

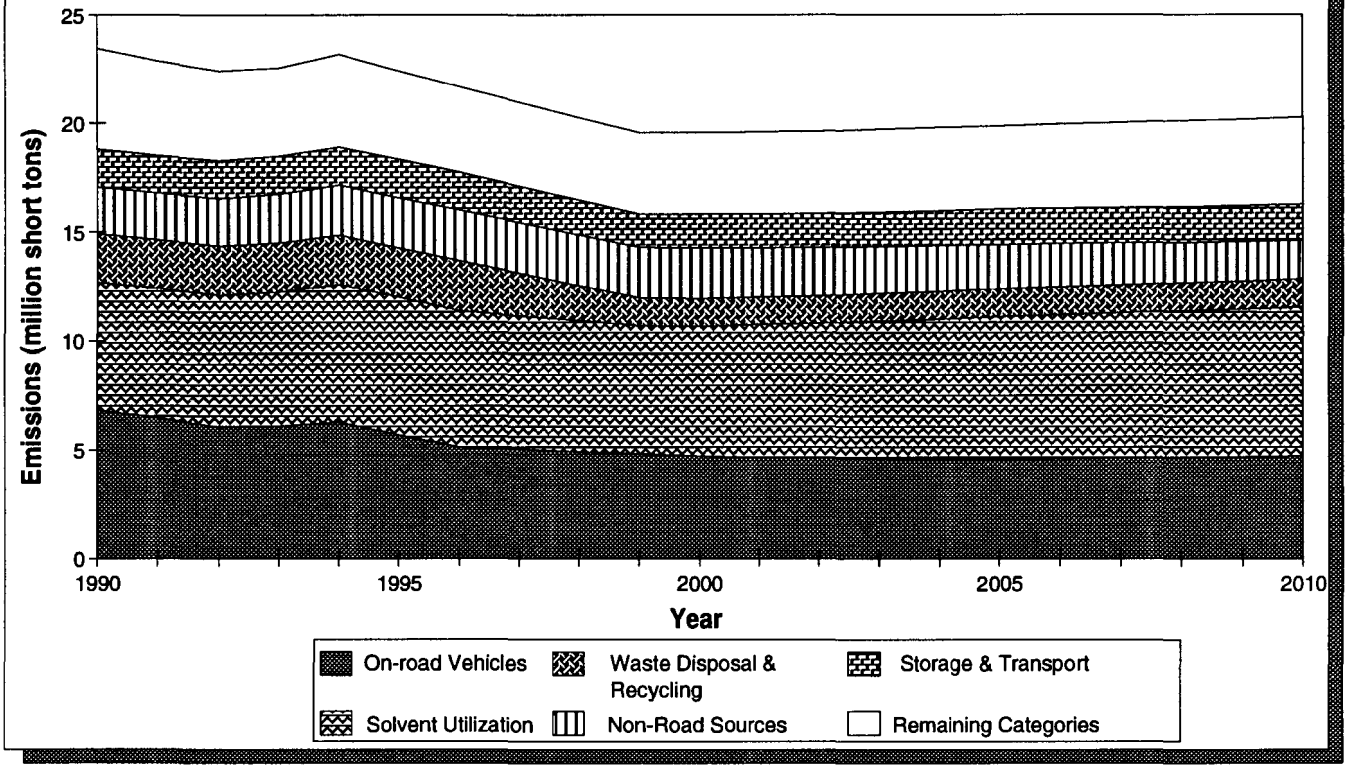
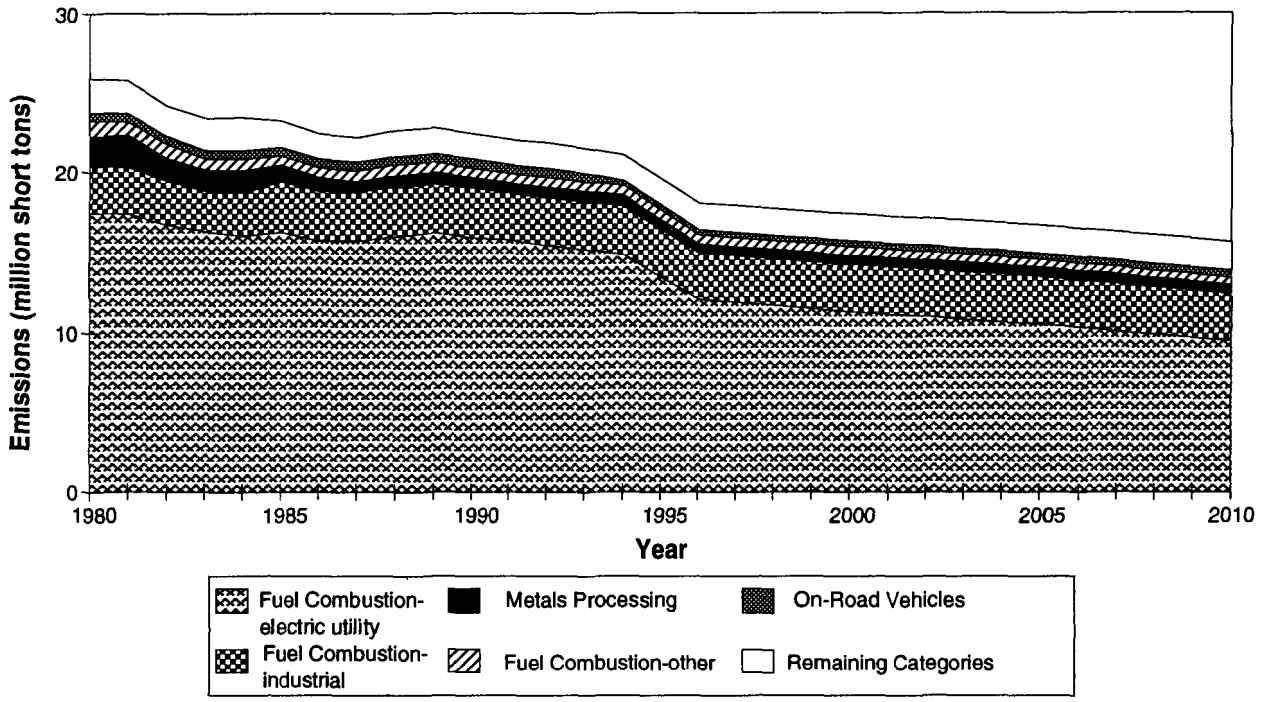


Table 5-3. National Volatile Organic Compound Emissions by Source Category Projected from 1990 to 2010
(thousand short tons)

Source Category	1990	1993	1996	1999	2000	2002	2005	2008	2010
Fuel Combustion - Electric Utility	36	36	40	42	43	44	45	48	50
Fuel Combustion - Industrial	135	134	269	267	267	267	267	270	272
Fuel Combustion - Other	749	729	311	284	292	295	306	330	346
Chemical and Allied Prod. Mfg	1,526	1,557	1,682	1,594	1,605	1,632	1,675	1,713	1,735
Metals Processing	72	74	64	68	69	72	76	79	81
Petroleum & Related Industries	643	631	633	555	550	540	526	533	537
Other Industrial Processes	401	406	465	457	447	455	469	478	483
Solvent Utilization	5,975	6,156	6,247	5,867	5,947	6,170	6,532	6,730	6,853
Storage and Transport	1,759	1,757	1,761	1,519	1,530	1,556	1,603	1,635	1,654
Waste Disposal & Recycling	2,262	2,271	2,277	1,269	1,271	1,275	1,280	1,284	1,288
On-Road Vehicles	6,854	6,103	5,147	4,846	4,742	4,632	4,578	4,657	4,726
Non-Road Sources	2,120	2,206	2,321	2,324	2,322	2,222	2,046	1,859	1,748
Miscellaneous	1,069	516	458	464	466	471	478	481	483
Total	**23,599**	**22,575**	**21,678**	**19,556**	**19,551**	**19,631**	**19,881**	**20,097**	**20,256**

Figure 5-4. National SULFUR DIOXIDE Emissions by Source Category (Projected from 1990 to 2010)



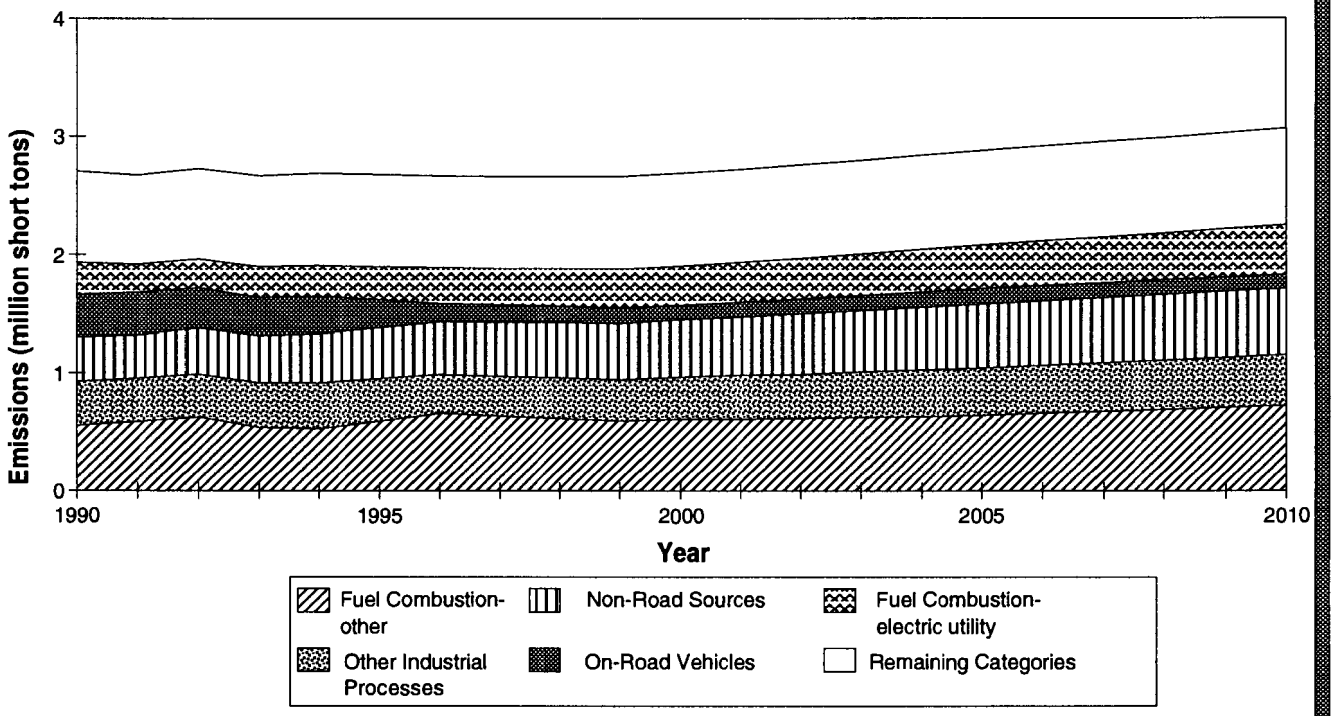
Note(s): Historic emissions shown for 1980 to illustrate Base Year "Title IV-Acid Deposition Control" emission estimates.

Table 5-4. National Sulfur Dioxide Emissions by Source Category Projected from 1990 to 2010 (thousand short tons)

Source Category	1990	1993	1996	1999	2000	2002	2005	2008	2010
Fuel Combustion - Electric Utility	15,898	15,191	12,100	11,500	11,300	10,980	10,500	9,900	9,500
Fuel Combustion - Industrial	3,106	2,942	2,866	2,887	2,908	2,958	2,962	2,912	2,882
Fuel Combustion - Other	595	599	592	566	554	530	494	455	430
Chemical and Allied Prod. Mfg	440	450	467	479	483	491	501	516	524
Metals Processing	663	667	579	579	580	580	581	582	583
Petroleum & Related Industries	440	409	390	371	364	352	335	328	323
Other Industrial Processes	401	413	445	477	488	510	545	566	578
Solvent Utilization	1	1	1	1	1	1	1	1	1
Storage and Transport	5	5	5	5	5	5	5	5	5
Waste Disposal & Recycling	36	37	38	39	39	39	40	41	41
On-Road Vehicles	571	517	315	336	344	360	385	411	429
Non-Road Sources	265	278	291	305	309	319	335	348	355
Miscellaneous	14	8	7	7	7	7	7	7	7
Total	**22,433**	**21,517**	**18,095**	**17,552**	**17,382**	**17,133**	**16,693**	**16,071**	**15,659**

Note(s): The 1990 and 1993 on-road emissions were updated using the emission factor model PART5. The 1996 to 2010 emissions were estimated for the 1994 *Trends* with a different methodology and will be updated in the 1996 *Trends* Report.

Figure 5-5. National PARTICULATE MATTER (PM-10) Emissions by Source Category (Projected from 1990 to 2010)



Note(s): Natural Source and Miscellaneous emissions are not included.

Table 5-5. National Particulate Matter (PM-10) Emissions by Source Category Projected from 1990 to 2010
(thousand short tons)

Source Category	1990	1993	1996	1999	2000	2002	2005	2008	2010
Fuel Combustion - Electric Utility	282	268	309	334	338	353	375	404	425
Fuel Combustion - Industrial	240	234	214	201	198	193	186	179	176
Fuel Combustion - Other	553	539	660	594	609	618	643	694	729
Chemical and Allied Prod. Mfg	62	63	76	78	79	80	82	84	86
Metals Processing	136	136	148	155	157	162	171	178	182
Petroleum & Related Industries	28	27	24	23	22	21	20	19	19
Other Industrial Processes	374	377	331	353	360	376	402	416	424
Solvent Utilization	2	2	2	2	2	2	2	2	2
Storage and Transport	57	57	58	61	62	65	69	71	72
Waste Disposal & Recycling	242	248	254	259	260	263	268	271	274
On-Road Vehicles	357	321	153	131	122	126	132	127	122
Non-Road Sources	372	395	438	466	476	498	532	547	556
Natural sources (wind erosion)	4,362	1,978	4,362	4,362	4,362	4,362	4,362	4,362	4,362
Miscellaneous	36,267	37,905	43,598	48,850	49,834	51,835	54,937	57,383	59,012
Total	**43,333**	**42,548**	**50,628**	**55,867**	**56,882**	**58,955**	**62,180**	**64,738**	**66,440**

Note(s): The 1990 and 1993 on-road emissions were updated using the emission factor model PART5. The 1996 to 2010 emissions were estimated for the 1994 *Trends* with a different methodology and will be updated in the 1996 *Trends* Report.

Chapter 6.0 National Criteria Pollutant Estimation Methodology

Each year the EPA prepares emission estimates for assessing trends in criteria pollutants. For *Trends* reports published prior to October 1993, the principal objective of compiling emission estimates was to identify overall changes in emissions on a national scale. National emissions provide an indicator by which to measure national progress in the control of air pollutant emissions, but the use of these estimates has limitations. The emission estimates presented in the past represent calculated estimates based on standard emission inventory procedures. These estimates do not represent the results of efforts to measure actual source emissions. Therefore, it should be recognized that these estimated national trends in emissions may not be representative of local trends in emissions or air quality.

In recent years, the objective for preparing and presenting the national estimates has been modified. In addition to presenting national progress in reducing air emissions, local trends in emissions are presented when possible. To achieve this goal, a revised methodology has been developed that will support the use of detailed SIP inventories or other local inventories (e.g., the Grand Canyon Visibility Transport Commission Study).

*Because of these changes in methodologies, comparison of values with previous **Trends** reports is not a valid exercise. The reader should use caution when comparing estimates for the years 1940 to 1994 from this report with values in any report previously published. See section 6.5.*

6.1 INTRODUCTION

Three major methods are used to estimate the emissions for successive intervals from 1900 through 1994.

The emissions presented for the years 1900 through 1939 are taken from two reports on historic emissions.[1,2] The emissions presented for these years in the *Trends* report are unchanged from the emissions presented in past *Trends* reports. The emissions presented for the years 1940 through 1984 are based on the methodology used to estimate the emissions for these years found in all prior *Trends* reports, with several exceptions and modifications to the emissions previously presented.

For the years 1985 to the current year, the emissions are based on emission inventories known as the *Interim* inventories.[3] These inventories were created for the years 1987 through 1991 for use as inputs into the Regional Oxidant Model (ROM) and the Urban Airshed Model (UAM); the use of this methodology has been expanded in this report to emissions for the years 1985 through 1994. In addition, the 1990 base year *Interim* inventory was designed to facilitate the incorporation of available SIP emissions data for nonattainment areas.

This chapter presents a general description of the methodologies used to estimate emissions for 1900 through 1984 presented in this report. A more thorough discussion is provided for the emissions estimation methodology used for the years 1985 through 1994. More detailed descriptions of all three methodologies are presented in the *Trends* Procedures Document[4] and the 1994 *Trends* report.[5] The *Trends* Procedures Document can be accessed via the TTN Bulletin Board.

The emissions presented in this report have undergone additional revisions such as the incorporation of current information, refinements in the methodology, and changes in priorities. These revisions, as well as revisions anticipated in future *Trends* reports, are presented in this chapter.

The 1994 emissions are presented in this report at the region, State, county, nonattainment, and seasonal level for various tier level categories. Brief descriptions of the methodologies used to create these spatial and temporal emissions are also presented in this chapter.

In addition to presenting emissions for the current year and prior years, the *Trends* report presents national emission projections for the years 1996 through 2010. The methodologies used to produce these projected emissions are applied according to the following source categories: on-road vehicles, electric utilities, and all other sources. This chapter includes a description of these three projection methodologies.

6.2 NATIONAL EMISSIONS, 1900 THROUGH 1939

The national SO_2, NO_x, and VOC emissions presented for the years 1900 through 1939 have been taken from two reports on historic emissions. In addition, these reports provided emission estimates for the years 1941 through 1949, 1951 through 1959, and 1961 through 1969.[k] The first report contains SO_2 and NO_x emissions for the years between 1900 and 1980.[1] Volatile organic compound emissions for the years between 1900 and 1985 are

contained in the second.[2] It should be noted that emissions for the years 1940, 1950, 1960, and 1970 in the *Trends* report were estimated according to the methodology discussed in section 6.3.

Emissions of SO_2, NO_x, and VOC were estimated every 5 years from 1900 through 1970, using appropriate activity indicators and emission factors. Emissions for all intervening years between 1900 and 1970 have been extrapolated from the aforementioned emissions based on changes in the national activity for all applicable source categories.

6.3 NATIONAL EMISSIONS, 1940 THROUGH 1984

A top-down estimating procedure has been used to produce the criteria pollutant emission estimates for the years 1940, 1950, 1960, and 1970 through 1984, with several major exceptions. For all transportation sources, both on-road vehicles and all non-road transportation, the emissions for only the years 1940, 1950, and 1960 have been produced using this methodology.[1] The lead emissions have been produced using the top-down approach for the years 1970 through 1994. In addition, the TSP emissions presented in appendix C have been produced by this methodology. The SO_2 emissions for copper smelters for the years 1975 to 1984 were obtained from the plants as documented by the Argonne National Laboratories. Finally, emission estimates for the years 1941 through 1949, 1951 through 1959, and 1961 through 1969 were estimated as described in section 6.2.

The emissions were estimated either for individual sources or groups of sources using three basic factors: (1) an activity indicator which represents the activity of a source producing emissions, (2) an emission factor which relates the quantity of emissions produced to the activity of the source, and (3) a control efficiency which quantifies the amount of pollutant not emitted due to the presence of control devices. Depending on the source category, the activity indicator was represented by the quantity of fuel consumed (or delivered), VMT, refuse burned, raw material processed, or some other measure of production activity. The emission factors are quantitative estimates of the average rate of emissions from many sources combined and are most valid when applied to a large number of sources.

National activity data for individual source categories were obtained from many different publications. Emission factors were generally obtained from the *Compilation of Air Pollutant Emission Factors* (AP-42), and from MOBILE5. Control efficiencies were derived from several sources, depending on the year for which the emissions were being estimated. For the years 1940 through 1984, the primary source was the National Emissions Data System (NEDS) archives.

6.4 NATIONAL EMISSIONS, 1985 THROUGH 1994

The CO, NO_x, SO_2, and VOC emissions presented in this report for the years 1985 through 1994 have been estimated using a methodology developed for the *Interim* Inventories, with several exceptions. The *Interim* methodology was developed to produce inventories for the years 1987 through 1991 and is presented in the *Regional Interim Emission Inventories (1987-1991)*.[3] A similar methodology was developed for the preparation of a national 1990 PM-10 inventory as documented in the *Emissions Inventory for the National Particulate Matter Study*[6] and revised as documented in the draft report entitled *The National Particulates Inventory: Phase II Emission Estimates*.[7] In order to generate the necessary emissions for the *Trends* report, the *Interim* methodology has been expanded to generate CO, NO_x, SO_2, and VOC emissions for the years 1985 and 1986, as well as PM-10 emissions for the years 1985 through 1989. Emissions for 1992 through 1994 for all pollutants, except Pb, and all source categories, except for steam generated fossil-fuel electric utility units, on-road vehicles, wildfires, and most fugitive dust sources, have been projected from the 1990 emissions using growth factors created by the EPA's E-GAS, version 2.0.

Lead emissions for the years 1985 through 1994 have been estimated using the methodologies described in section 6.3 of this report. These methodologies were applied to estimate lead emissions for all applicable source categories. The weighted emission factors and control efficiencies were assumed to be constant from 1990 to 1994. Using historic activity data, the 1994 preliminary estimates were made by one of two methods. The first of these two methods used a quadratic regression with weighted 20-year category-specific activity data. The second method used a linear regression with weighted 7-year activity data, and was applied to source categories where the trend in activity data has changed significantly over the past 10 years.

6.4.1 Fuel Combustion

The emissions included in the fuel combustion category fall under three Tier 1 source categories including: fuel combustion-electric utility; fuel combustion-industrial; and fuel combustion-other.

6.4.1.1 Electric Utility Units

Emissions from the combustion of fuel by electric utilities have been divided into two classifications: (1) steam generated fossil-fuel units (an electric utility unit is a boiler) and (2) nonsteam generated fossil-fuel units such as gas turbines (GT) and internal combustion (IC) engines.

The emissions from fossil-fuel steam electric utility units for the years 1986 through 1993 have been based on four basic

factors: (1) fuel consumption, (2) emission factor, which relates the quantity of fuel consumed to the quantity of pollutant emitted, (3) fuel characteristics, such as sulfur content, ash content, and heating value of fuels, and (4) control efficiency, which indicates the amount of pollutant not removed by the use of control devices. The fuel consumption characteristics and control efficiencies were obtained at the boiler-level from the *Steam-Electric Plant Operation and Design Report* (Form EIA-767), collected and published annually by the Energy Information Administration (EIA) of the U.S. Department of Energy (DOE). Emission factors were obtained from the (AP-42), and were both SCC- and pollutant-specific. Because EIA-767 data were not available for the year 1994, the 1994 emissions were extrapolated from the 1993 boiler-level emissions based on plant-level 1994 fuel consumption. The 1985 fuel combustion-electric utility category is based on the National Allowance Data Base Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. Allocations at the Tier 3 level for 1985 are approximations only and are based on the methodology to estimate emissions for the years 1986 through 1993.

The 1990 emissions for GT and IC engines have been estimated from the point source portion of the 1985 NAPAP Emissions Inventory for the appropriate sources. These 1990 emissions served as the base year from which emissions for the years 1985 through 1989 and the years 1991 through 1994 were estimated. The methodology used to develop the emissions for the 1990 base year and the two methodologies used to estimate the emissions from the base year emissions are discussed in section 6.4.1.2.

6.4.1.2 Industrial and Other Combustion

Industrial and other combustion includes the combustion of fuels for use by industry, commercial establishments, institutions, and residences. The 1990 emissions for these source categories were generated from both the nonutility point source and nonsolvent area source portions of the 1985 NAPAP Emissions Inventory. These 1990 emissions served as the base year from which the emissions for the years 1985 through 1989 and the years 1991 through 1994 were estimated. The emissions for the years 1985 through 1989 were estimated using historical earnings data compiled by the Bureau of Economic Analysis (BEA) or historic estimates of fuel consumption based on the DOE's State Energy Data System (SEDS). Emissions for 1991 through 1994 were estimated using growth factors produced by E-GAS, version 2.0.

6.4.1.2.1 1990 Base Year Inventory — The 1985 NAPAP Emission Inventory estimates for the nonutility point sources have been projected to the year 1990 based on the growth in BEA historic earnings for the appropriate State and industry, as identified by the 2-digit Standard Industrial Classification (SIC) code. State and SIC-level growth factors were calculated as the ratio of the 1990 earnings data to the 1985 earnings data.

The area source emissions from the 1985 NAPAP Emissions Inventory that fall within this category, with the exception of residential wood combustion, have been projected to the year 1990 based on BEA historic earnings data, BEA historic population data, DOE SEDS data, or other growth indicators. The specific growth indicator was assigned based on the source category. The BEA earnings data were converted to 1982 dollars as described above. The 1990 SEDS data were extrapolated from data for the years 1985 through 1989. All growth factors were calculated as the ratio of the 1990 data to the 1985 data for the appropriate growth indicator.

When creating the 1990 emissions inventory, changes were made to emission factors, control efficiencies, and emissions from the 1985 inventory for both the nonutility and area sources. The PM-10 control efficiencies were obtained from revisions made to the PM-10 Calculator.[c] Details of these changes are presented in the *Trends* Procedures Document.[4] In addition, rule effectiveness was applied to the 1990 emissions estimated for the nonutility point sources. The CO, NO_x, and VOC point source controls were assumed to be 80 percent effective; PM-10 and SO_2 controls were assumed to be 100 percent effective.

The 1990 emissions for CO, NO_x, SO_2, and VOC were calculated using the following steps: (1) projected 1985 controlled emissions to 1990 using the appropriate growth factors, (2) calculated the uncontrolled emissions using control efficiencies from the 1985 NAPAP Emission Inventory, and (3) calculated the final 1990 controlled emissions using revised control efficiencies and the appropriate rule effectiveness. The 1990 PM-10 emissions were calculated using the TSP emissions from the 1985 NAPAP Emission Inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. From these TSP emissions, the 1990 uncontrolled PM-10 estimates were calculated by applying SCC-specific uncontrolled particle size distribution factors. The controlled PM-10 emissions were estimated in the same manner as the other pollutants. Because the majority of area sources are uncontrolled emissions, the second and third steps were not required to estimate the 1990 area source emissions.

The 1990 residential wood combustion estimates were made using AP-42 emission factors and the EPA wood burning model. The wood burning model estimates consumption for all counties in the United States based on survey data from the northeast and several western States.

6.4.1.2.2 1985 through 1989 — 1990 served as the base year from which emissions for 1985 through 1989 were estimated. 1990 emissions from each point source in the 1985 NAPAP Emissions Inventory (excluding steam electric utilities) were projected to the years 1985 through 1989 based on the growth in earnings by industry (2-digit SIC code). Historical earnings data from BEA's table SA-5 were used to represent growth in earnings from 1985 through 1990.

Area source emissions were estimated using BEA historic earnings data, BEA historic population data, DOE SEDS data, or other growth indicators. All growth factors were calculated as the ratio of the earnings data for the specific year to the earnings data for 1990.

The emissions for all pollutants for a given year between 1985 and 1989 were calculated by applying the appropriate growth factors to the 1990 base year emissions. The 1985 emissions estimated by this method do not equal those in the 1985 NAPAP Emissions Inventory due to the changes made when creating the 1990 emissions (e.g., the application of rule effectiveness or the application of updated emission factors).

6.4.1.2.3 1991 through 1994 — The 1991 through 1994 emissions for all pollutants were estimated by applying growth factors to the 1990 emissions. The growth factors were obtained from E-GAS, version 2.0, and were applied by county and SCC to the 1990 emissions. The E-GAS generates two sets of growth factors at the SCC-level. One set is representative of counties within serious and above ozone nonattainment areas, while the other set is applied to counties within both the attainment portions and the marginal and moderate ozone nonattainment areas within each State. The overall growth factors are best illustrated by the changes in emissions presented at the Tier 3 subcategory in appendix A, tables A-1 to A-5.

6.4.2 Transportation

Transportation includes emissions from two Tier 1 source categories: on-road vehicles and non-road sources. The non-road category includes emissions from non-road sources and equipment as well as aircraft, commercial marine vessels, and railroads.

6.4.2.1 On-Road Vehicles

On-road emissions have been estimated for every year from 1970 through 1994. These annual emissions were based on county-level VMT and emission factors. Emissions were estimated for eight vehicle categories including: LDGVs; LDDVs; light-duty gasoline trucks-1 (LDGT-1 [trucks less than 6,000 lbs in weight]); LDGT-2 (6,000 to 8,500 lbs in weight); light-duty diesel trucks (LDDTs); heavy-duty diesel trucks (HDDTs); HDGTs; and MCs.

6.4.2.1.1 VMT Data — Annual VMT data for the years 1980 through 1994 were obtained from the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS) data base. The data are specified by State, vehicle type, and roadway type. Using population data from the 1980 census, the data were distributed among the counties. For the years 1970 through 1979, the state-level VMT data were obtained from FHWA's Highway Statistics and apportioned to the counties based on the distribution of the 1980 county-level VMT data. The data for all years were then apportioned from the HPMS vehicle categories to the eight vehicle classes listed above using allocations provided by EPA's OMS.

The resulting annual county-level vehicle and roadway type specific VMT data were allocated by month. Seasonal NAPAP temporal allocation factors were used to apportion the VMT to the four seasons. Monthly VMT data were obtained using a ratio between the number of days in a month and the number of days in the corresponding season.

6.4.2.1.2 CO, NO_x, VOC Emission Factors — County-level emission factors for CO, NO_x, and VOC were calculated using the MOBILE5a model, which is designed to estimate exhaust and evaporative emission factors for on-road vehicles. To calculate the emission factors for each year from 1970 through 1994, the model utilized information on state-level monthly maximum and minimum temperatures, nine vehicle speeds, national vehicle registration distributions, gasoline volatility given in terms of in-use RVP, and county-level I/M and oxygenated fuels programs. The Federal Test Procedure (FTP) operating mode was modeled at all speeds.

6.4.2.1.3 PM-10 and SO_2 Emission Factors — A detailed description of the methodology to estimate PM-10 and SO_2 emissions from on-road vehicles for the years 1970 through 1994 is located in chapter 11 of the *National Particulates Inventory: Phase II Emission Estimates.*[7] The EPA's on-road particulate matter emission factor model, PART5, was used to calculate highway vehicle PM-10 emission factors from vehicle exhaust, brake wear, tire wear, and reentrained road dust from paved and unpaved roads, and SO_2 vehicle exhaust emission factors.

The vehicle registration distribution used was also common to all PART5 model runs. PART5 uses the same vehicle classifications as the MOBILE model, except that the MOBILE HDDV class is broken into five subclasses in PART5.

To maintain consistency with the 1990 *Trends* emissions, the 1990 vehicle registration distribution used in the MOBILE modeling for the 1990 *Trends* emissions was adapted for this analysis. This registration distribution was modified by distributing the MOBILE HDDV vehicle class distribution among the five PART5 HDDV subclasses (2BHDDV [class 2B HDDV], LHDDV [light HDDV], MHDDV [medium HDDV], HHDDV [heavy HDDV], and BUSES [buses]). This was accomplished using HDDV subclass-specific sales, survival rates, and diesel market shares.

Monthly, county-level, SCC-specific PM-10 emissions from highway vehicle exhaust components were calculated by multiplying 1990 monthly county-level, SCC-specific VMT by 1990 state-level, SCC-specific exhaust PM-10 emission factors generated using PART5. None of the inputs affecting the calculation of the PM-10 exhaust emission factors vary by month, so only annual PM-10 exhaust emission factors were calculated. PART5 total exhaust emission factors are the sum of lead, soluble

organic fraction, remaining carbon portion, and direct SO_4 (sulfate) emission factors.

National annual SO_2 highway vehicle exhaust emission factors by vehicle type and speed were calculated using PART5. These emission factors calculated within PART5 vary according to fuel density, the weight percent of sulfur in the fuel, and the fuel economy of the vehicle (which varies by speed). None of these parameters vary by month or State. Monthly/county/SCC-specific SO_2 emissions were then calculated by multiplying each county's monthly VMT at the road type and vehicle type level by the SO_2 emission factor (calculated for each vehicle type and speed) that corresponds to the vehicle type and road type.

The PART5 PM-10 emission factor for brake wear is 0.013 grams per mile. This value was applied to estimate brake wear emissions for all vehicle types.

PART5 emission factors for tire wear are proportional to the average number of wheels per vehicle. The emission factor is 0.002 grams per mile per wheel. Therefore, separate tire wear emission factors were calculated for each vehicle type. Tire wear PM-10 emissions were then calculated at the monthly/county/SCC level by multiplying the monthly/county/SCC level-VMT by the tire wear emission factor for the appropriate vehicle type.

6.4.2.2 Non-Road Sources

The non-road category includes the estimated emissions from aircraft, commercial marine vessels, railroads, and all other non-road vehicles and equipment. The 1990 base year emissions from aircraft, commercial marine vessels, and railroads have been estimated from the area source portion of the 1985 NAPAP Emission Inventory by the process described in section 6.4.1.2. The basis for the 1990 non-road emissions was emission inventories prepared by OMS for 27 NAAs. These inventories were combined and used to create national county-level emissions. These emissions were classified by equipment and engine type in the OMS inventories and were distributed to the appropriate non-road SCCs. The OMS inventories did not contain emissions for SO_2 and, therefore, none were included for the non-road SCCs. It was assumed, based on the emissions from the 1985 NAPAP Emissions Inventory, that the SO_2 emissions for these SCCs were very small (< 92,000 short tons/year).

The non-road emissions for the years 1970 through 1989 have been based on the 1990 estimates. Historic E-GAS growth factors were obtained by Bureau of Labor Statistics (BLS) codes and matched with the non-road SCCs. For the years 1991 through 1994, non-road emissions were grown from the 1990 estimates using E-GAS growth factors.

6.4.3 Industrial Processes

The industrial processes category includes the estimated emissions for the following Tier 1 source categories: chemical and allied product manufacturing; metals processing; petroleum and related industries; other industrial processes; solvent utilization (industrial and nonindustrial); and storage and transport.

The CO, NO_x, VOC, SO_2, and PM-10 emissions for these source categories, excluding the area source solvent utilization sources, have been estimated by the methodology described in section 6.4.1.2. This includes all emissions based on the nonutility point source[d] and nonsolvent area source emissions from the 1985 NAPAP Emission Inventory.

Emissions from area source solvent utilization were based on a national material balance of the total point and area source solvent consumption. The national solvent emissions were calculated by subtracting the quantity of solvent transferred to waste management operations and the quantity of solvent destroyed by air pollution controls from the total national solvent consumption in 1989.

The 1989 national solvent emissions were apportioned to States and counties using data from the 1988 census data base. The 1989 county-level solvent emissions were then projected to 1990 using BEA earnings data. The resulting 1990 solvent emission inventory included emissions from both area and point sources. The 1990 county-level point source solvent emissions were subtracted from the total solvent inventory to yield the 1990 area source solvent emissions. These estimates were then projected to the years 1985 through 1989 and the years 1991 through 1994 by the method described in section 6.4.1.2.

6.4.4 Remaining Categories

"Remaining categories" include emissions for three Tier 1 source categories including: waste disposal and recycling; natural sources; and miscellaneous. The CO, NO_x, PM-10, SO_2, and VOC emissions for the years 1985 through 1994 from all source categories, except for those listed below, were produced using the methodology described in section 6.4.1.2.

6.4.4.1 Natural Sources, Geogenic, Wind Erosion

The PM-10 emissions for the years 1985 through 1994 from the wind erosion of agricultural lands were estimated using a modified version of the NAPAP methodology. Monthly emissions were estimated from the acres of crops planted, the number of seconds, and the dust flux. The expected dust flux was based on the probability distribution of wind energy, the mean wind speed and the coefficient of drag.

6.4.4.2 Miscellaneous, Agriculture and Forestry

PM-10 emissions from agricultural crops for the years 1985 through 1994 were estimated using the AP-42 emission factor equation for agricultural tilling. The activity data for this calculation were the acres of land planted. The emission factor,

expressed in terms of the mass of TSP produced per acre-tilled was corrected by parameters including the silt of the surface soil, the particle size multiplier, and the number of tillings per year.

The 1990 emissions from agricultural livestock were determined from activity data, expressed in terms of the number of heads of cattle, and a national PM-10 emission factor. The emissions for the years 1985 through 1989 were produced using the methodology described for area source emissions in section 6.4.1.2.2. Emissions for the years 1991 through 1994 were estimated using E-GAS growth factors.

6.4.4.3 Miscellaneous, Other Combustion

The miscellaneous, other combustion category includes emissions from agricultural burning, forest fires/wildfires, prescribed/slash and managed burning, and structural fires. The emissions from agricultural burning and structural fires were produced using the methodology described in section 6.4.1.2.

Forest fires/wildfires emissions were generated for the years 1985 through 1994 using information on the number of forest fires, their location, and the acreage burned. These data were obtained from the Department of Interior (DOI) and the USDA Forest Service. The amount of biomass used to determine the quantity of vegetation burned was estimated by the EPA. Average emission factors were applied to the estimated quantities of vegetation burned.

For the years 1986 through 1993, and for the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, the above emission estimates were replaced for the pollutants CO, NO_x, VOC, and PM-10 by those in the inventory produced for the Grand Canyon Visibility Transport Commission.[8] The SO_x emissions were estimated based on the methodology described below for determining prescribed burning estimates. The 1985 and 1994 emissions for the 11 States listed above were estimated based on the ratio of acres burned reported by the USDA and DOI for the years 1985, 1990, and 1994.

Emissions from prescribed burning were based on the 1989 USDA Forest Service inventory of particulate matter from prescribed burning. The NO_x and SO_2 emissions were estimated by assuming the ratio between the CO emissions to either the NO_x or SO_2 emissions in the Forest Service inventory was equal to the corresponding ratio the 1985 NAPAP Emission Inventory. The resulting 1989 emissions for CO, NO_x, VOC, SO_2, and PM-10 have been used for all years between 1985 and 1994.

6.4.4.4 Miscellaneous, Fugitive Dust

PM-10 fugitive dust emissions arise from construction activities, mining and quarrying, paved road resuspension, and unpaved roads. The general methodology used to estimate emissions for each of these categories required an activity indicator, an emission factor, and one or more correction factors. The activity indicator for a given category varied from year to year, as may the overall correction factor.

6.4.4.4.1 Construction Activities — The PM-10 emissions for the years 1985 through 1992 were calculated from an emission factor, an estimate of the acres of land under construction, and the average duration of construction activity. The acres of land under construction were estimated from the dollars spent on construction. The PM-10 emission factor was calculated from the TSP emission factor for construction obtained from AP-42 and the PM-10/TSP ratio.

The 1993 and 1994 emissions were extrapolated from the 1992 emissions using the ratio between the numbers of residential and nonresidential construction permits issued in 1992 and the numbers issued in 1993 and 1994.

6.4.4.4.2 Mining and Quarrying — The PM-10 emissions for the years 1985 through 1993 were the sum of the emissions from metallic ore, nonmetallic ore, and coal mining operations. These PM-10 emissions arise from the following activities: (1) overburden removal, (2) drilling and blasting, (3) loading and unloading, and (4) overburden replacement. Emissions from transfer and conveyance operations, crushing and screening operations, and storage and travel on haul roads were not included.

To calculate the emissions from metallic ore mining, the PM-10 emission factors for copper ore processing operations were applied to all metallic ores. The PM-10 emission factors for western surface coal mining were used to estimate the emissions from both nonmetallic ore and coal mining.

The 1994 PM-10 emissions were produced from a linear projection of the emissions for the years 1985 through 1993.

6.4.4.4.3 Paved Road Resuspension — The calculation of total PM-10 emissions for the years 1985 through 1994 were based on the paved road VMT, an AP-42 base emission factor, and two correction factors: road surface silt loading and the number of dry days. A dry day is defined as any day with less than 0.1 inches of precipitation. This term attempts to account for the effect of precipitation. Surface silt loading values by paved road functional classes and State were determined using an empirical model based on traffic volume.

Total VMT data for the years 1985 through 1992 were obtained by State and roadway functional class. The total preliminary 1994 VMT data were obtained by State and two road types (urban and rural). The rural and urban VMT data were apportioned to the road functional classes using the distribution of the 1993 VMT data. The VMT from paved roads for each year was calculated by subtracting the unpaved road VMT (see section 6.4.4.4.4) from the total VMT for each year.

6.4.4.4.4 Unpaved Roads — The total PM-10 emissions for the years 1985 through 1993 were based on the unpaved roads VMT data, an AP-42 base TSP emission factor, and the following

correction factors: particle size multiplier, silt content of road surface material, mean vehicle speed, mean vehicle weight, mean number of wheels, and the number of dry days. Mean vehicle speeds were assigned to each unpaved road functional class. The number of dry days is defined in the same manner as for estimating the paved road estimates. The VMT data for unpaved roads were obtained for rural and urban road functional classes excluding local types and for local road types.

The 1994 PM-10 emissions were produced by multiplying the projected 1994 VMT by the AP-42 emission factor and 1994 correction factors.

6.5 EMISSION REVISIONS

The estimated emissions presented in this report have in some instances been modified from those presented in previous *Trends* reports. These modifications have come about due to the use of different methodologies to estimate the emissions, the refinement of the methodologies used for the 1994 *Trends* report, the availability of updated information used to estimate emissions, and the recategorization of some emission source categories. These modifications to the emissions are documented in this chapter.

6.5.1 Methodological Changes

The emissions presented in this report reflect several major changes in the methodologies used to estimate the emissions. These changes have been described in the preceding sections of this chapter. The changes in the methodologies from those used to estimate emissions presented in the 1994 *Trends* report are summarized below.

- CO, NO_x, VOC, SO_2, and PM-10 emission estimates were improved for wildfires.
- Data developed with the Residential Wood Burning Model were incorporated into emission estimates for the period 1985 through 1994.
- PM-10 and SO_2 emissions for 1970 through 1994 were calculated using the PART5 emission factor model.
- Continuous uncontrolled particle size distribution data for source categories, as well as size-specific control efficiency data for primary PM control devices were developed. These improvements were reflected in the PM-10 NAAQS inventory.[7]

6.5.2 Other Changes

In addition to the changes in methodology affecting most, if not all, source categories and pollutants, other changes were made to the emissions for specific pollutants, source categories, and/or individual sources. Such changes are discussed below.

- Modifications such as the assumption of lower vehicle speeds, an updated AP-42 emission factor, and a revised county allocation scheme were made to paved and unpaved road fugitive dust emissions.
- The 1991, 1992, and 1993 emissions were updated using the completed version of E-GAS (2.0).
- The growth emission estimates for a smelter were deleted for the years 1987 to 1994 because the smelter was demolished. In the 1994 *Trends* report the 1985 value was deleted for all years 1987 through 1994.
- The prescribed burning estimates are from a data base provided by USDA, not their published report.
- Using an historical emission trending technique, emissions for 1940 through 1969 were adjusted to minimize the impact of year-to-year aberrations in emission trends resulting from emission estimation methodology changes.
- The 1940, 1950, and 1960 on-road vehicle emissions were modified to incorporate 1970 county-level monthly emissions data resulting in more accurate emission estimates for these years.
- The rule effectiveness was changed from 80 to 100 percent for a few plants as the result of comments received from State air agencies. This resulted in a reduction of NO_x and VOC emissions.
- The wind erosion-natural source emissions were adjusted to correct for a calculational error in previous estimates.
- For source categories that use year-specific activity data, the activity data were revised when easily accessible.
- The projected non-road emissions were also changed to correct a previous calculational error.

6.6 COUNTY AND SEASONAL EMISSIONS, 1994

Although the EPA has produced an annual national estimate of emission trends since 1973, this report is the third in a series which presents emissions at the county, State, ozone nonattainment area level, and by season for CO, NO_x, SO_2, and VOC. Starting with last year's report, PM-10 emissions were presented by various geographical areas. The methods used to produce county and seasonal emissions are presented for the current year of emissions in sections 2.2 and 2.3. The state-level and regional emissions are presented for the years 1985 through 1994 in appendix B of this report. Lead emissions are presented only at the regional level in this report. For a more detailed description of how the spatial and temporal emissions were derived, see the 1994 *Trends* report.

6.7 LARGEST POINT SOURCES IN AIRS/AFS

This report is the fourth in a series to track the top-emitting sources of CO, NO_x, VOC, and SO_2, and the third to track the top-emitting sources of PM-10, industrial SO_2, and Pb. The plant level emissions were extracted from AIRS/AFS excluding only those facilities having an operating status defined as permanently closed.

The lists for each pollutant of the 50 top-emitting sources in 1994 are presented in section 2.4 of this report. The process by which these lists were compiled is described below.

Emissions data for all inventory years were downloaded from the AIRS/AFS data base. The criteria set for the data extraction was modified in order to include all records where the year of inventory was not blank. Data extractions for each pollutant were performed on May 19, 1995 using the criteria set. The six output files were processed using the following steps: (1) retain the record for a given facility with the latest year of inventory and data in all other fields, (2) delete all closed plants (i.e., operating status = "x"), (3) rank plants by emissions, and (4) retain the 50 top-emitting facilities. The processing of the industrial sources emitting SO_2 included the additional step of removing all electric utilities after ranking the plants by emissions.

6.8 NATIONAL EMISSIONS, 1996 to 2010

Projections of future year emissions have been estimated using the following general procedure:

- Grow 1990 emissions or activity levels.
- Apply future year control efficiencies or emission factors reflecting CAAA requirements.

The application of the above procedure differs slightly by major emitting sector — on-road vehicle, utility, nonutility point, and area/non-road sources.

6.8.1 On-Road Vehicles

On-road emissions were projected using the Emission Reduction and Cost Analysis Model (ERCAM). Growth factors were first applied to 1990 VMT estimates. VMT was then allocated to the monthly level and MOBILE5a emission factors were applied. The monthly emissions were then summed to calculate annual emissions.

The 1990 VMT estimates were projected to the future years using metropolitan statistical area (MSA) level growth factors by vehicle class. These factors were developed from national growth by vehicle class from the MOBILE4.1 Fuel Consumption Model.[9] The national growth was scaled to the MSA-level based on population projections.[10] Thus, if an area shows population growth higher than the national average, VMT growth will also be higher than the national average.

The resulting annual county-level vehicle and roadway type projected VMT data were temporally allocated to months using NAPAP temporal allocation factors and the number of days in each month.[11]

The MOBILE5a emission factor model was used to calculate all CO, NO_x, and VOC on-road emission factors for all States except California.[12] California emission factors for these pollutants were calculated using an OMS-modified version of MOBILE5a that simulates the California fleet. As with the 1970 through 1994 on-road emission factors, the projection year emission factors were calculated at the county level.

Particulate matter (PM-10) emission factors were calculated at the national level by vehicle type, using the procedure discussed for the historical PM-10 emission factors in the 1994 *Trends* report. These emission factors were then applied to the national VMT totals by vehicle type.

Sulfur dioxide emission factors were calculated at the national level by vehicle type, following the procedure described for the calculation of the 1970 to 1994 SO_2 on-road emission factors in the 1994 *Trends* report. Fuel economy projections were obtained from the MOBILE4.1 Fuel Consumption Model.[7]

6.8.2 Utilities

Utility growth was projected using the ERCAM-NO_x model, and the 1990 Interim Inventory as the base for the projections.[3,13] In ERCAM-NO_x, changes in the capacity utilization of existing electric utility units are based on historical capacity utilization at the unit level. Additional growth is projected based on planned and projected electric utility units. Data on planned units and projected electric utility demand were obtained from DOE.[14,15] Generation projections from the existing and planned units have been subtracted from the projected generation demand at the regional and fuel type level. The remaining generation is assumed to be filled by projected units. Existing units were assumed to retire after 65 years of service.

Nitrogen oxides controls were applied using the ERCAM-NO_x model.[13] This model applies Title I and Title IV RACT level controls to the required units, applying the expected percentage reductions from RACT that are specific to the boiler type and fuel type. Planned and projected units coming on line in 1996 or later in nonattainment areas and the ozone transport regions were assumed to be subject to new source review and were assumed to apply selective catalytic reduction. No new controls were applied to VOC, CO, or PM-10 emissions.

Sulfur dioxide projections are based on the SO_2 electric utility allowance caps of Title IV. The emission caps per year change from 1995 to 2000 to 2010. The projections presented here are based on ICF Resources, Incorporated's projections of how utilities will use these allowances.[16] Their analysis assumes that a certain portion of the Phase I allowances from 1995 to 1999 will be banked and then used from 2000 to 2010.

6.8.3 Nonutility Point Sources

Nonutility point source emissions were projected using the Multiple Projections System (MPS).[17] MPS combines growth factors and future year control levels to calculate projection year emissions. The E-GAS growth factors were used in nonutility point source emission projections with the exception of industrial source fuel combustion emissions from coal, residual oil, and distillate oil. Growth factors for these industrial source fuel

combustion categories were generated using a Btu Efficiency Neural Network (BENNET). This neural network provides growth factors that reflect changes in fuel prices, general economic growth in the industrial sector, and that account for fuel switching in future years. These BENNET growth factors were used in place of E-GAS growth factors by MPS to develop industrial combustion point source projected emissions. Additional details concerning BENNET and how industrial source emission projections were developed are available elsewhere.[18]

6.8.3.1 Carbon Monoxide Controls

Carbon monoxide nonattainment area requirements generally focus on mobile source controls — enhanced I/M and oxygenated fuels. While there may be isolated cases of point source controls, these are not incorporated into the projections.

6.8.3.2 Nitrogen Oxide and Volatile Organic Compound Controls

Nitrogen oxide and VOC control information was based on the ROM point source control input.[19] This file simulates the mandatory control requirements of the CAAA, namely, RACT requirements. Controls are specified by source category and ozone nonattainment classification. Additional CAAA requirements which are not incorporated into these projections include: rate-of-progress (ROP) requirements, new source offsets, and controls needed for attainment demonstrations. In addition, possible substitution of NO_x for VOC to meet ROP requirements is not accounted for in the projections.

6.8.3.3 Sulfur Dioxide Controls

The CAAA does not specify any mandatory SO_2 controls. Regulations applicable to sources of SO_2 emissions are determined on a State or nonattainment area basis. A national emission cap of 5.6 million short tons of SO_2 per year was set by the CAAA for industrial sources. If the cap is exceeded, EPA may promulgate new regulations. Projections of growth to 2005 utilizing E-GAS do not show emissions exceeding this cap. Point sources of SO_2 were therefore assumed to remain at current control levels.

6.8.3.4 Particulate Matter (PM-10) Controls

Review of PM-10 SIPs indicate that control efforts are focusing primarily on area source emitters; therefore, point sources were assumed to remain at current control levels.

6.8.4 Area/Non-Road Projections

Area and nonroad pollutant sources were also projected using MPS.[17] E-GAS growth factors were used in combination with estimates of future year control efficiencies.

6.8.4.1 Carbon Monoxide Area/Non-Road Controls

Carbon monoxide control efforts mandated by the CAAA focus on on-road source controls; therefore, no new area source control initiatives were modeled. However, CO standards will be proposed for certain non-road engines, with varying effective dates beginning as early as 1996. Timing of the benefits of these CO standards will depend upon phase-in schedules and fleet turnover. Standards will be set for lawn and garden, utility, small farm and construction, light industrial applications, gasoline and marine engines. The non-road emission projections will reflect the effect of these standards in future *Trends* reports.

6.8.4.2 Nitrogen Oxide Area/Non-Road Controls

Nitrogen oxide control information was taken from the ROM area source control strategy file. Reasonably available control technology requirements are incorporated for industrial fuel combustion emissions as a result of the Title I/RACT requirements. Reasonably available control technology controls are applied to major stationary sources. The definition of major stationary source differs according to the ozone nonattainment classification (e.g., marginal, moderate, serious, severe, extreme, ozone transport region) of the area. Controls for compression ignition (diesel) engines were added. Increases in NO_x emissions due to the spark ignition standards (aimed at reducing VOC) were also incorporated.

6.8.4.3 Volatile Organic Compound Area/Non-Road Controls

Volatile organic compound control information was based on the ROM area source control strategy file.[19] Area source control requirements include RACT and new CTG requirements in ozone nonattainment areas, stage II vapor recovery, Title III control for hazardous air pollutants (HAPs), and Federal measures for consumer solvents and architectural and industrial maintenance coatings. Non-road controls for spark ignition engines (phase 1) and recreational marine vessels were added to the ROM controls. The VOC controls modeled reflect the mandatory control requirements under the CAAA.

6.8.4.4 Sulfur Dioxide Area/Non-Road Controls

Sulfur dioxide area source emitters were projected assuming no change in current control levels. Unlike nonutility point

sources, sulfur dioxide emissions from the area source component of industrial fuel combustion sources were projected using E-GAS growth factors, rather than BENNET growth factors. The E-GAS growth factors were utilized because industrial fuel combustion area sources are unlikely to switch fuels like point sources.

6.8.4.5 Particulate Matter (PM-10) Area/Non-Road Controls

Area source PM-10 controls were modeled in all PM-10 nonattainment areas. Controls applied include watering of cattle feedlots, recycled asphalt paving and chemical suppressants on unpaved roads, vacuum sweeping of paved roads, limiting tilling on windy days, dust control plans at construction sites, and replacement of non-EPA certified woodstoves with pellet stoves or EPA Phase II stoves. The controls applied to each area depend on the magnitude of emissions from the potentially controlled source categories and the severity of nonattainment.

6.9 REFERENCES

1. *Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980.* EPA-600/7-85-009a and b. U.S. Environmental Protection Agency, Cincinnati, OH. April 1985.
2. *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985.* EPA-600/7-88-008a. U.S. Environmental Protection Agency, Cincinnati, OH. May 1988.
3. *Regional Interim Emission Inventories (1987-1991), Volume I: Development Methodologies.* EPA-454/R-93-021a. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1993.
4. *National Air Pollutant Emission Trends, Procedures Document, 1900-1993.* EPA-454/R-95-002. Office of Air Quality Planning and Standards, Research Triangle Park, NC. December 1994.
5. *National Air Pollutant Emission Trends, 1900-1993.* EPA-454/R-94-027. Office of Air Quality Planning and Standards, Research Triangle Park, NC. October 1994.
6. *Emissions Inventory for the National Particulate Matter Study.* Final Draft. Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, Washington, DC. July 1994.
7. *The National Particulates Inventory: Phase II Emission Estimates.* Draft Report. EPA Contract No. 68-DE-0035, Work Assignment No. I-46. Office of Air Quality Planning and Standards, Research Triangle Park, NC. June 1995.
8. *An Emissions Inventory for Assessing Regional Haze on the Colorado Plateau.* Grand Canyon Visibility Transport Commission, Denver, CO. January 1995.
9. *MOBILE4.1 Fuel Consumption Model.* Computer reports from EPA, Office of Mobile Sources, Ann Arbor, MI. August 1991.
10. *1990 BEA Regional Projections to 2040: Volume 1: States.* U.S. Department of Commerce, Washington, DC. June 1990.
11. *The 1985 NAPAP Emissions Inventory: Development of Temporal Allocation Factors.* EPA-600/7-89-010d. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1990.
12. *User's Guide to MOBILE5 (Mobile Source Emissions Model).* Draft. Office of Mobile Source, U.S. Environmental Protection Agency, Ann Arbor, MI. 1993.
13. *The Emission Reduction and Cost Analysis Model for NO_x (ERCAM-NO_x).* Final Report. E.H. Pechan & Associates, Inc. Prepared for Ozone/CO Programs Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1994.
14. *Inventory of Power Plants in the United States 1990.* DOE/EIA-0095(90). U.S. Department of Energy, Energy Information Administration. Washington, DC. October 1991.
15. *Annual Outlook for U.S. Electric Power 1991: Projections Through 2010.* DOE/EIA-0474(91). U.S. Department of Energy, Energy Information Administration. Washington, DC. July 1991.
16. *Recommendations to NAPAP Regarding SO_2 Emission Projections.* Report to the National Acid Precipitation Assessment Program (NAPAP). Prepared by Resources for the Future. Washington, DC. June 15, 1994.
17. *Multiple Projections System (MPS): User's Manual Version 1.0.* EPA-600/R-94-085. U.S. Environmental Protection Agency, Air and Energy Engineering Research Laboratory, Research Triangle Park, NC. May 1994.

18. *Industrial SO_2 and NO_x Tracking System.* Report to the Air and Energy Engineering Research Laboratory, U.S. Environmental Protection Agency (EPA). Prepared by E.H. Pechan & Associates, Inc. Durham, NC. September 1994.
19. *Regional Oxidant Modeling of the 1990 Clean Air Act Amendments: Default Projection and Control Data.* Report to the U.S. Environmental Protection Agency (EPA). Prepared by E.H. Pechan & Associates, Inc. Springfield, VA. August 1994.

---

[a] The trend in emissions, not the actual emissions, were extracted from references 1 and 2.

[b] The 1940, 1950, and 1960 on-road estimates were adjusted for this report to compensate for the methodological changes from 1960 to 1970.

[c] Details on the PM-10 Calculator updates are available in chapter V of the National Particulates Inventory: Phase II Emission Estimates.

[d] The rule effectiveness was changed from 80 to 100 percent for a few plants as a result of comments received from State air agencies. This yielded in a reduction of NO_x and VOC emissions.

Chapter 7.0 International Criteria Pollutant Emissions

This is the second report in the *Trends* series to present international emissions. This section presents the 1985 criteria pollutant emissions that are available for Canada, and the 12 European Union (EU-12) countries: Belgium, Denmark, France, Former West Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and United Kingdom.

For these countries, 1990 estimates are also presented if emissions data were available. The 1990 emissions are presented for 18 additional European countries that now have emissions data available: Austria, Bulgaria, Croatia, Czech Republic, Estonia, Finland, Former East Germany, Hungary, Latvia, Lithuania, Malta, Norway, Poland, Romania, Slovakia, Slovenia, and Sweden.

The 1990 estimates for several countries are still preliminary. It is also important to note that to the extent that emission estimation methodologies differ between countries, intercountry comparisons may be misleading.

7.1 CANADA

Canadian emissions data were provided by Libby Greenwood and Marc Deslauriers of Environment Canada for 1985 and 1990, respectively.[1,2] The 1990 estimates are preliminary and do not correspond with those reported in the *Interim* report.[3] The 1990 NO_x and VOC estimates are from Canada's Residual Discharge Information System; the 1990 SO_2 emissions are taken from a report developed for Eastern Canada's Acid Rain Program.[4] National Canada estimates are presented in this report, as well as estimates for three provinces — Ontario, Quebec, New Brunswick. Tables 7-1 and 7-2 display the 1985 emissions by major source category for NO_x and VOC, respectively. The 1985 SO_2 emissions for Canada are presented in table 7-3. Table 7-4 shows 1990 emissions by major source category for CO, NO_x, VOC, SO_2, and total particulates (TP) for Canada.

7.2 EUROPE

There has been a considerable on-going effort in Europe to develop consistent emissions for countries in the European community. This section provides the 1985 and 1990 estimates of NO_x, VOC, and SO_2, emissions developed under this effort.

7.2.1 CORINAIR: The Atmospheric Emission Inventory for Europe [o]

On June 27, 1985, the European Council of Ministers adopted Decision 85/338/EEC on a Commission world program for gathering, coordinating, and ensuring the consistency of information on the state of the environment and natural resources in the European Community. This program was called CORINE (COoRdination d'INformation Environnementale) and one of its component projects was the CORINe AIR emission inventory (CORINAIR).[5]

When the Council Decision on CORINE was adopted, there were several air emissions data collection campaigns in progress at the international level (OECD, UNECE, and PHOXA). The methodology for the prototype 1985 CORINAIR (CORINAIR85) inventory was based on the methodology of OECD and was developed in collaboration with experts from each of the member states, as well as from the European Commissions (CEC), OECD, UNICE, Conseil European de l'Industrie Chimique [European Chemical Industry Council {CEFIC}]), EUROTRAC, and IIASA.

On May 7, 1990, the Council adopted Regulation 1210/90 which established the European Environment Agency (EEA) and the European environment information and observation network. The regulation gives the EEA responsibility for the collection, processing, and analysis of environmental data and for the continuation of work started under the CORINE decision. It also lists several areas of work to be given priority. Air quality and atmospheric emissions are included in this list.

Pending a decision on the location of the EEA, the CORINE program is being continued by the EEA Task Force (EEA-TF) formed within the Directorate General Environment, Nuclear Safety and Civil Protection (DGXI) of the CEC. The CORINAIR project is being continued through an update for 1990 (CORINAIR90).

7.2.2 CORINAIR85

The prototype emission inventory for 1985 — CORINAIR85 — was based on the following:

(1) a new nomenclature (which was technology-based, since the NACE was considered inappropriate for environmental needs);

(2) a *Default Emission Factor Handbook* (based broadly on OECD and PHOXA results but also introducing new developments);
(3) addressing major localized emission sources as point sources (large point sources) and other minor or diffuse sources as area sources, with areas based on the Community's Nomenclature of Statistical Territorial Units (NSTU); and
(4) software for data input and the calculation of emissions.

These features of the CORINAIR system were developed by the contractor (Centre Interprofessionnel Technique d'Etudes de la Polution Atmopherique [CITEPA], in Paris) in conjunction with the following:

(1) the CORINAIR Technical Unit (which included other contractors and representatives of DGXI, the customer);
(2) working groups covering specific sources/pollutants (stationary NO_x, mobile sources, stationary VOC, natural VOC, and ammonia); and
(3) the CORINAIR Expert Group, with experts from each of the member states and from related international activities.

The CORINAIR85 inventory was based on 120 activities divided into eight categories:

- combustion (other than industry),
- oil refining,
- industrial combustion,
- industrial processes,
- solvent evaporation,
- road transport,
- nature, and
- miscellaneous activities.

It also quantified three pollutants: NO_x, VOC (including CH_4), and SO_2. Tables 7-5, 7-6, and 7-7 present the summary of the results obtained.

With certain restrictions on the use of the limited subset of data held in confidence within the CORINAIR data base, CORINAIR85 data are available on request from the CITEPA in Paris or the EEA-TF in Brussels. The complete CORINAIR85 inventory (activity statistics, emission factors, emissions, etc.) is held in personal computer files in Paris and Brussels. Emissions by territorial unit are held for mapping and analysis in ARCINFO files on the CORINE data base in Brussels.

7.2.3 CORINAIR90

Atmospheric emission inventory requirements and methodologies were developed rapidly at the national and international level during the course of the CORINAIR85 project. Estimates were extended to newly quantified sources of emissions and to additional pollutants. Each international project became informed of the work being carried out elsewhere. The need to harmonize these activities became clear when overlaps were discovered in the work that was being performed.

In preparing for the CORINAIR90 project, the CORINAIR Technical Unit and Expert Group were able to collaborate closely with UNECE and OECD. The UNECE requires emission inventory data as part of the obligations under the various Protocols for the Long Range Transboundary Air Pollution (LRTAP) convention. The OECD is developing the methodology for inventorying greenhouse gas emissions on behalf of the IPCC. This collaboration has achieved these results:

(1) produced a more developed nomenclature (source sector split [SNAP90]) involving over 260 activities grouped into a three-level hierarchy of subsectors and 11 main sectors;
(2) extended the list of pollutants to be covered to eight (SO_2, NO_x, NMVOC, ammonia, CO, CH_4, NO, and CO_2);
(3) extended the number of sources to be considered as point sources (there were over 1400 large point sources in the CORINAIR85 inventory);
(4) extended the availability of the CORINAIR system to 30 countries; and
(5) increased the awareness of CORINAIR and the need to produce an inventory within a reasonable time frame to serve the requirements of the user community.

Following agreements reached with the UNECE on a common source sector split for reporting atmospheric emissions, the CORINAIR90 system has been made available to 30 European countries on a voluntary basis or with financial support from the CEC.

The CORINAIR90 system is currently available to the following:

(1) The EU-12 countries;
(2) 5 EFTA countries: Austria, Finland, Norway, Sweden, and Switzerland;
(3) 3 Baltic States: Estonia, Latvia, and Lithuania;
(4) 9 Central and Eastern European countries: Albania, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia; and
(5) Russia.

CORINAIR90 emissions for each of the 12 European Union countries, 5 EFTA countries, 3 Baltic States, and 10 additional central and eastern European countries are presented in tables 7-8 through 7-22. Data were prepared from data supplied to date by the EEA-TF.[6]

7.3 REFERENCES

1. Telefax entitled "Canadian Data for U.S. National Air Pollutant Emission Trends Report" from Libby Greenwood, Pollution Data Branch, Environment Canada, Hull, Quebec to Sharon Nizich, Emission Factors and Inventory Group, Technical Support Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. September 28, 1994.
2. File of updated 1990 emissions from Marc Deslauriers, Pollution Data Branch, Environment Canada, Hull, Quebec to Sharon Nizich, Emission Factors and Inventory Group, Technical Support Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 9, 1995.
3. *Regional Interim Emission Inventories (1987-1991), Volume I: Development Methodologies.* EPA-454/R-93-021a. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1993.
4. *Annual Report on the Federal Provincial Agreement for the Eastern Canada Acid Rain Program.* Environment Canada, Hull, Quebec. 1992.
5. *CORINAIR Newsletter.* G. McInnes, European Environment Agency Task Force, DGXI, Commission of the European Communities, Brussels, Belgium. March 1993.
6. Computer files of updated 1990 emissions from Gordon McInnes, European Environment Agency, Copenhagen, Denmark to Sharon Nizich, Emissions Inventory Branch, Technical Support Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 2, 1995.

° The acronyms found in this chapter are defined in the list of Acronyms and Abbreviations found on page xiii.

Table 7-1. 1985 Canada Nitrogen Oxide Emissions by Province
(thousand short tons)

SECTOR	Ontario	Quebec	New Brunswick	CANADA
TRANSPORTATION				
Cars	139	80	10	383
Light-Duty Trucks				
Gas	26	9	3	92
Diesel	0	0	0	0
Heavy-Duty Trucks				
Gas	10	4	1	33
Diesel	90	29	9	273
Off-Road Diesel				
Construction	10	4	1	35
Agriculture	8	5	1	59
Railroads	31	17	3	135
Other	30	23	4	160
Other	22	18	1	86
FUEL COMBUSTION				
Residential	17	8	1	45
Commercial	14	4	1	33
Industrial				
Natural Gas	0	0	0	153
Other	108	46	5	267
POWER GENERATION				
	172	2	8	330
INDUSTRIAL PROCESSES				
	33	12	3	112
INCINERATION/MISCELLANEOUS				
	5	6	1	28
TOTAL	***715***	***267***	***51***	***2,222***

Note(s): The sums may not equal total due to rounding.
The emissions presented in the last column are the totals for all of Canada.

Source: Libby Greenwood of Environment Canada, Pollution Data Branch, Hull, Quebec.

Table 7-2. 1985 Canada Volatile Organic Compound Emissions by Province
(thousand short tons [as total nonmethane hydrocarbons])

SECTOR	Ontario	Quebec	New Brunswick	CANADA
TRANSPORTATION				
Cars	175	99	12	507
Light-Duty Trucks				
Gas	44	12	5	126
Diesel	0	0	0	1
Heavy-Duty Trucks				
Gas	14	6	1	47
Diesel	11	4	1	34
Off-Road Gasoline	7	3	1	72
Other	32	14	2	74
FUEL COMBUSTION				
Fuelwood	37	44	6	119
Residential/Commercial	1	0	0	4
Industrial	6	0	0	53
INDUSTRIAL PROCESSES				
Petrochemicals	13	6	0	33
Petroleum Refining	67	40	7	179
Plastics	9	4	0	15
Other	30	11	1	68
INCINERATION/MISCELLANEOUS				
Surface Coatings	60	35	3	134
Fuel Marketing	10	4	1	31
Dry Cleaning	6	4	0	16
Solvent Use	143	76	8	325
Slash Burning	18	22	5	106
Other	5	10	1	21
POWER GENERATION				
	1	0	0	3
TOTAL	***688***	***394***	***55***	***1,968***

Note(s): The sums may not equal total due to rounding.
The emissions presented in the last column are the totals for all of Canada.

Source: Libby Greenwood of Environment Canada, Pollution Data Branch, Hull, Quebec.

Table 7-3. 1985 Canada Sulfur Dioxide Emissions by Province

(thousand short tons)

SECTOR	Ontario	Quebec	New Brunswick	CANADA
PRIMARY METALS	860	553	19	1,968
POWER GENERATION	370	1	103	811
OTHER *	408	250	29	1,389
TOTAL	***1,637***	***803***	***151***	***4,168***

Note(s): The sums may not equal total due to rounding.
The emissions presented in the last column are the totals for all of Canada.
* "Other" includes remaining Industrial Process sectors, Fuel Combustion, Transportation, and Incineration/Miscellaneous.

Source: Libby Greenwood of Environment Canada, Pollution Data Branch, Hull, Quebec.

Table 7-4. 1990 Emissions of Common Pollutants for Canada
(short tons)

Category/Sector	TP *	SO_2	NO_x	VOC	CO
INDUSTRIAL PROCESSES					
Crude Oil Production	32	50,694	3,254	19,649	573
Petroleum Refining	9,137	146,526	36,938	90,692	124,064
Natural Gas Processing	646	246,617	128,968	4,031	25,960
Coal Industry	77,415	3,149	2,011	2,708	2,535
Upstream Oil & Gas Operations	0	0	0	490,363	0
Pulp and Paper Industry	107,453	134,095	61,815	16,765	92,695
Tar Sands	4,573	163,372	17,477	33	11,558
Iron Ore Mining and Beneficiation	59,621	50,681	7,506	619	18,805
Lead and Zinc Production	3,543	163,162	891	15	62
Copper and Nickel Production	14,119	1,381,651	59,288	347	146
Iron and Steel Production	55,067	76,620	32,051	30,090	632,890
Mining and Rock Quarrying	138,642	4,248	3,575	100	870
Wood Industry	110,127	6,055	9,881	56,203	529,145
Ferrous Foundries	1,446	2,067	34	1,219	1,968
Aluminum Production	21,829	35,237	3,495	920	317,017
Other Petroleum and Coal Products	1,067	614	505	128	33
Petrochemical Industry	1,044	3,646	8,690	29,555	74,991
Other Chemicals	16,009	15,218	16,554	3,107	6,909
Plastics & Synthetic Resins Fabrication	190	467	394	13,748	909
Asphalt Production	38,468	505	284	2,461	122
Bakeries	0	0	4	3,813	0
Cement and Concrete Manufacture	24,738	38,325	28,171	209	2,119
Abrasifs Manufacture	1,236	3,847	234	1,938	701
Clay Products	10,462	181	322	29	82
Grain Industries	64,259	0	11	1	2
Paint & Varnish Manufacturing	103	1	10	1,554	2
Asbestos Production	26,333	1,927	987	50	184
Other Industrial Fuel Combustion (Area)	13,011	26,027	55,961	619	7,930
Other Industries *	109,852	45,187	38,425	95,299	24,221
Category total:	**910,422**	**2,600,122**	**517,737**	**866,267**	**1,876,495**
FUEL COMBUSTION					
Commercial Fuel Combustion	2,487	22,183	26,273	1,217	6,382
Residential Fuel Combustion	3,907	32,283	37,985	2,865	28,408
Residential Fuelwood Combustion	124,567	1,233	6,021	276,153	696,484
Electric Power Generation	169,799	760,813	290,546	2,611	73,064
Category total:	**300,758**	**816,513**	**360,825**	**282,846**	**804,340**

(continued)

Table 7-4. 1990 Emissions of Common Pollutants for Canada (continued)

Category/Sector	TP *	SO_2	NO_x	VOC	CO
TRANSPORTATION					
Automobiles	5,470	10,355	324,905	492,148	4,432,306
Light-duty Gasoline Trucks	1,825	4,168	104,883	154,496	1,445,669
Heavy-duty Gasoline Trucks	377	191	13,131	12,884	167,269
Motorcycles	22	21	596	3,333	10,559
Propane Powered Vehicles	111	8	3,090	1,845	2,867
Light-duty Diesel Trucks	541	2,557	2,763	1,198	2,309
Heavy-duty Diesel Vehicles	34,623	35,579	342,794	40,190	162,573
Other Diesel Vehicles	24,942	18,738	282,397	27,784	87,425
Light-duty Diesel Vehicles	298	2,523	2,011	731	1,726
Railroads	24,255	15,782	147,865	7,274	51,491
Marine	5,603	53,362	52,189	35,465	102,676
Aircraft	1,400	1,468	20,399	7,994	53,017
Non-Road Use of Gasoline	4,928	1,652	51,976	105,541	1,588,362
Tire Wear	40,399	0	0	898	0
Category total:	**144,795**	**146,402**	**1,349,001**	**891,780**	**8,108,248**
INCINERATION					
Wood Waste Incineration	12,681	175	1,757	19,323	228,371
Other Incineration	693	2,584	3,190	2,832	11,520
Category total:	**13,373**	**2,759**	**4,946**	**22,155**	**239,891**
MISCELLANEOUS					
Dry Cleaning	4	0	1	13,212	0
Application of Surface Coatings	1	0	4	189,576	0
General Solvent Use	842	1	11	463,326	2
Fuel Marketing	0	0	0	106,541	0
Structural Fires	51	0	19	65	787
Pesticides and Fertilizer Application	22,860	0	822	46,421	0
Cigarette Smoking	493	0	0	0	197
Marine Cargo Handling Industry	4,397	0	0	1	0
Category total:	**28,649**	**1**	**858**	**819,141**	**988**
TOTAL FOR CANADA	***1,397,997***	***3,565,799***	***2,233,366***	***2,882,189***	***11,029,960***

Note(s): The sums may not equal total due to rounding.
* Total particulate.
** The Carbon Black Sector was grouped under the Other Industries Sector to protect the confidentiality of the information.

Source: Marc Deslauriers of Environment Canada, Pollution Data Branch, Hull, Quebec.

Table 7-5. CORINAIR 1985: Nitrogen Oxide Emissions
(thousand short tons)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc	Total	Percent of Total
Belgium	72	7	41	30	0	201	0	0	349	3
Denmark	164	2	14	6	0	114	0	0	300	3
Germany	919	31	250	157	0	1,637	0	0	2,994	26
Greece	163	4	9	31	0	132	0	0	340	3
Spain	293	14	44	75	0	500	0	0	927	8
France	284	20	137	121	0	1,207	0	0	1,769	15
Ireland	40	0	9	6	0	39	0	0	93	1
Italy	487	30	128	139	0	951	0	0	1,735	15
Luxembourg	2	0	3	10	0	10	0	0	25	0
Netherlands	149	22	31	19	0	299	0	0	519	5
Portugal	15	2	12	13	0	63	0	0	106	1
United Kingdom	942	45	331	14	0	1,010	0	0	2,342	20
Total Europe-12	3,532	177	1,009	619	0	6,162	0	0	11,499	
Percent of Total	31	0	9	5	0	54	0	0		

Note(s): The sums may not equal total due to rounding.

Source: Commission of the European Communities, European Environment Agency Task Force.

Table 7-6. CORINAIR 1985: Volatile Organic Compound Emissions
(thousand short tons)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc.	Total	Percent of Total
Belgium	20	12	3	32	90	213	31	78	479	2
Denmark	15	3	2	2	64	106	8	28	228	1
Germany	110	32	23	100	1,235	1,286	280	3,383	6,450	30
Greece	2	7	1	4	31	127	216	290	678	3
Spain	40	24	2	23	360	539	966	406	2,360	11
France	208	34	8	73	483	1,311	467	476	3,060	14
Ireland	19	1	1	1	23	26	23	26	121	1
Italy	52	42	6	50	438	1,090	244	1,326	3,246	15
Luxembourg	0	0	0	0	3	7	3	2	15	0
Netherlands	8	13	11	12	181	239	15	0	479	2
Portugal	1	4	1	19	57	58	72	8	220	1
United Kingdom	99	34	62	267	736	872	88	2,165	4,323	20
Total Europe-12	574	207	120	583	3,701	5,874	2,413	8,188	21,661	
Percent of Total	3	1	1	3	17	27	11	38		

Note(s): The sums may not equal total due to rounding.

Source: Commission of the European Communities, European Environment Agency Task Force.

Table 7-7. CORINAIR 1985: Sulfur Dioxide Emissions
(thousand short tons)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc.	Total	Percent of Total
Belgium	208	39	109	60	0	18	0	0	433	3
Denmark	266	4	67	18	0	12	0	0	367	2
Germany	1,705	160	459	164	0	65	0	0	2,553	17
Greece	411	31	89	20	0	0	0	0	551	4
Spain	1,873	107	290	69	0	74	0	0	2,413	16
France	672	247	489	116	0	109	0	0	1,634	11
Ireland	87	1	61	2	0	4	0	0	155	1
Italy	1,307	163	606	143	0	84	0	0	2,304	15
Luxembourg	3	0	6	9	0	0	0	0	18	0
Netherlands	78	90	17	23	0	12	0	0	220	1
Portugal	95	14	76	25	0	8	0	0	218	1
United Kingdom	3,250	133	615	106	0	47	0	0	4,151	28
Total Europe-12	9,956	990	2,884	755	0	433	0	0	15,018	
Percent of Total	66	7	19	5	0	3	0	0		

Note(s): The sums may not equal total due to rounding.

Source: Commission of the European Communities, European Environment Agency Task Force.

Table 7-8. CORINAIR90 Emissions for Austria and Bulgaria
(thousand short tons)

AUSTRIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	17	11	0	0	6	10,646	1	0
2 Commercial, institutional, and residential combustion	19	12	100	11	776	12,473	0	0
3 Industrial combustion	39	37	11	1	27	15,772	0	0
4 Production processes	11	12	8	NE	241	0	1	5
5 Extraction and distribution of fossil fuels	NE	NE	16	119	0	0	0	0
6 Solvent use	0	0	130	0	0	0	0	0
7 Road transport	7	154	114	3	582	13,859	0	1
8 Other mobile sources and machinery	IE	IE	IE	IE	IE	0	0	0
9 Waste treatment and disposal	0	1	26	161	0	48	0	5
10 Agriculture	0	NE	15	356	60	0	3	75
11 Nature	NE	NE	237	204	NE	0	3	7
TOTAL	93	227	656	855	1,692	52,798	8	94

BULGARIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	1,453	86	1	1	13	31,822	7	0
2 Commercial, institutional, and residential combustion	121	6	17	18	273	7,103	0	0
3 Industrial combustion	326	72	9	4	105	22,529	3	0
4 Production processes	81	29	30	3	48	5,142	3	10
5 Extraction and distribution of fossil fuels	1	0	4	261	0	10,736	0	0
6 Solvent use	0	0	41	0	0	0	0	0
7 Road transport	10	137	74	2	372	7,597	0	0
8 Other mobile sources and machinery	16	29	6	0	15	2,118	0	0
9 Waste treatment and disposal	0	1	7	62	64	2,673	0	26
10 Agriculture	0	1	30	236	1	1,154	21	288
11 Nature	0	0	176	2	10	180	13	0
TOTAL	2,008	361	394	589	901	91,054	48	324

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-9. CORINAIR90 Emissions for Belgium
(thousand short tons)

BELGIUM (FLEMISH REGION)	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	79	51	0	0	2	18,528	2	0
2 Commercial, institutional, and residential combustion	26	7	4	1	52	14,054	2	0
3 Industrial combustion	80	20	2	0	18	12,223	1	0
4 Production processes	41	4	46	3	11	74	2	0
5 Extraction and distribution of fossil fuels	0	0	11	25	0	0	0	0
6 Solvent use	0	0	59	0	0	0	0	0
7 Road transport	9	116	117	9	783	12,251	1	0
8 Other mobile sources and machinery	NE	NE	NE	NE	NE	NE	NE	NE
9 Waste treatment and disposal	1	1	0	1	1	1,028	0	0
10 Agriculture	0	0	0	140	0	0	4	54
11 Nature	0	0	12	17	0	0	2	0
TOTAL	**236**	**200**	**251**	**194**	**867**	**58,159**	**14**	**54**

BELGIUM (WALLONIE REGION)	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	25	14	0	0	1	6,005	0	0
2 Commercial, institutional, and residential combustion	14	9	5	4	50	12,422	1	0
3 Industrial combustion	56	53	5	6	8	22,192	1	0
4 Production processes	8	2	14	13	107	5,804	3	2
5 Extraction and distribution of fossil fuels	0	0	4	27	0	0	0	0
6 Solvent use	0	0	40	0	0	0	0	0
7 Road transport	7	94	91	2	294	9,156	0	8
8 Other mobile sources and machinery	0	4	4	0	2	227	0	0
9 Waste treatment and disposal	3	2	0	5	17	1	0	0
10 Agriculture	0	0	1	158	0	0	6	593
11 Nature	0	0	21	0	0	0	3	0
TOTAL	**113**	**178**	**183**	**214**	**479**	**55,807**	**15**	**602**

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-10. CORINAIR90 Emissions for Croatia and Czech Republic
(thousand short tons)

CROATIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	69	9	NE	NE	NE	0	0	0
2 Commercial, institutional, and residential combustion	20	5	NE	NE	NE	0	0	0
3 Industrial combustion	75	18	NE	NE	NE	0	0	0
4 Production processes	1	1	NE	NE	NE	0	0	0
5 Extraction and distribution of fossil fuels	0	0	NE	NE	NE	0	0	0
6 Solvent use	0	0	NE	NE	NE	0	0	0
7 Road transport	7	28	NE	NE	NE	0	0	0
8 Other mobile sources and machinery	6	22	NE	NE	NE	0	0	0
9 Waste treatment and disposal	2	0	NE	NE	NE	0	0	0
10 Agriculture	0	0	NE	NE	NE	0	0	0
11 Nature	0	0	NE	NE	NE	0	0	0
TOTAL	180	83	0	0	0	0	0	0

CZECH REPUBLIC	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	1,163	321	4	4	28	64,963	9	0
2 Commercial, institutional, and residential combustion	458	103	58	58	501	51,085	6	0
3 Industrial combustion	173	145	3	4	276	27,127	2	0
4 Production processes	61	8	29	1	83	747	3	2
5 Extraction and distribution of fossil fuels	0	0	6	845	0	0	0	0
6 Solvent use	0	0	93	0	0	0	0	0
7 Road transport	0	143	53	3	143	7,667	1	0
8 Other mobile sources and machinery	6	51	7	0	9	3,121	0	0
9 Waste treatment and disposal	1	1	0	34	5	757	0	0
10 Agriculture	0	0	0	508	0	0	26	88
11 Nature	0	0	40	95	0	2,060	16	0
TOTAL	1,863	773	294	1,552	1,044	157,527	62	91

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere
Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-11. CORINAIR90 Emissions for Denmark and Estonia
(thousand short tons)

DENMARK	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	148	100	1	1	41	29,349	1	0
2 Commercial, institutional, and residential combustion	10	6	9	7	154	8,705	0	0
3 Industrial combustion	31	15	1	1	5	8,461	0	0
4 Production processes	4	1	4	0	0	1,285	0	0
5 Extraction and distribution of fossil fuels	0	4	7	13	38	800	0	0
6 Solvent use	0	0	37	0	0	0	0	0
7 Road transport	7	113	109	2	602	8,925	0	0
8 Other mobile sources and machinery	17	63	15	1	30	4,236	0	0
9 Waste treatment and disposal	1	0	0	134	0	0	0	0
10 Agriculture	0	0	2	290	0	0	9	139
11 Nature	0	0	10	390	0	0	7	0
TOTAL	**218**	**301**	**197**	**839**	**870**	**61,761**	**18**	**139**

ESTONIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	217	21	0	0	10	19,395	0	0
2 Commercial, institutional, and residential combustion	5	1	4	2	64	1,354	0	0
3 Industrial combustion	44	7	0	0	12	4,696	0	0
4 Production processes	2	0	10	0	1	553	0	1
5 Extraction and distribution of fossil fuels	0	0	0	0	0	0	0	0
6 Solvent use	0	0	7	0	0	0	0	0
7 Road transport	7	40	28	1	258	3,413	0	0
8 Other mobile sources and machinery	0	2	1	0	2	305	0	0
9 Waste treatment and disposal	0	0	0	0	1	0	0	0
10 Agriculture	0	0	0	78	0	0	4	28
11 Nature	0	0	0	84	0	0	0	0
TOTAL	275	72	50	165	347	29,716	4	29

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-12. CORINAIR90 Emissions for Finland and France
(thousand short tons)

FINLAND	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	78	59	0	1	6	17,021	1	0
2 Commercial, institutional, and residential combustion	15	5	0	1	2	7,626	0	0
3 Industrial combustion	81	31	0	1	8	11,981	0	0
4 Production processes	43	2	35	AZ	0	1,396	1	1
5 Extraction and distribution of fossil fuels	0	AZ	9	191	AZ	0	0	0
6 Solvent use	NE	NE	35	NE	NE	0	0	0
7 Road transport	4	119	73	2	398	11,824	0	0
8 Other mobile sources and machinery	6	52	12	2	38	4,015	1	0
9 Waste treatment and disposal	0	ND	2	66	0	695	0	0
10 Agriculture	NE	ND	ND	160	AZ	0	10	40
11 Nature	0	AZ	292	566	0	2,475	18	0
TOTAL	227	269	457	990	453	57,033	32	41

FRANCE	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	379	117	1	1	23	49,302	1	AZ
2 Commercial, institutional, and residential combustion	128	98	236	165	2,086	122,973	4	AZ
3 Industrial combustion	567	182	8	7	659	96,330	2	AZ
4 Production processes	122	34	110	7	737	7,508	103	18
5 Extraction and distribution of fossil fuels	26	4	135	342	0	200	0	AZ
6 Solvent use	0	0	701	0	0	0	0	0
7 Road transport	160	1,144	1,290	25	7,509	107,414	4	1
8 Other mobile sources and machinery	27	142	134	1	565	12,877	0	AZ
9 Waste treatment and disposal	21	26	23	815	256	14,526	1	2
10 Agriculture	0	0	12	1,776	NE	NE	67	751
11 Nature	3	6	509	211	214	119,881	61	AZ
TOTAL	**1,433**	**1,753**	**3,159**	**3,349**	**12,048**	**531,011**	**245**	**772**

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-13. CORINAIR90 Emissions for Former East Germany and Former West Germany
(thousand short tons)

FORMER EAST GERMANY	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	2,108	167	1	1	413	80,489	2	0
2 Commercial, institutional, and residential combustion	459	10	80	80	1,362	63,447	2	0
3 Industrial combustion	1,727	174	2	2	450	76,237	2	0
4 Production processes	7	5	14	0	59	7,152	5	2
5 Extraction and distribution of fossil fuels	0	0	33	70	23	78	0	0
6 Solvent use	–	–	140	–	–	–	–	–
7 Road transport	26	137	424	22	981	17,809	1	1
8 Other mobile sources and machinery	18	62	28	1	64	4,916	NE	0
9 Waste treatment and disposal	NE	NE	NE	461	NE	NE	0	0
10 Agriculture	–	NE	NE	545	–	–	23	190
11 Nature	–	NE	116	NE	–	NE	NE	0
TOTAL	4,345	556	839	1,183	3,351	250,128	36	193

FORMER WEST GERMANY	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	220	284	6	6	59	220,076	8	0
2 Commercial, institutional, and residential combustion	147	114	37	36	761	155,466	5	0
3 Industrial combustion	492	367	9	9	799	217,059	6	0
4 Production processes	59	18	117	6	667	23,867	104	2
5 Extraction and distribution of fossil fuels	22	2	189	1,628	0	689	0	0
6 Solvent use	–	–	1,136	–	–	–	–	–
7 Road transport	53	1,646	893	53	5,413	142,172	9	8
8 Other mobile sources and machinery	13	242	53	1	216	21,760	ND	0
9 Waste treatment and disposal	NA	NA	NA	1,971	NA	ND	5	0
10 Agriculture	–	NA	NA	1,674	–	–	60	593
11 Nature	–	NA	298	NA	–	ND	ND	0
TOTAL	**1,006**	**2,673**	**2,739**	**5,383**	**7,916**	**781,089**	**197**	**602**

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-14. CORINAIR90 Emissions for Greece and Hungary
(thousand short tons)

GREECE	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	363	123	1	1	7	55,925	8	0
2 Commercial, institutional, and residential combustion	42	2	0	0	1	2,159	0	0
3 Industrial combustion	30	3	0	0	0	1,534	0	0
4 Production processes	56	37	24	2	27	8,945	3	12
5 Extraction and distribution of fossil fuels	0	0	4	401	0	0	0	0
6 Solvent use	0	0	90	0	0	0	0	0
7 Road transport	15	126	152	4	776	11,418	0	0
8 Other mobile sources and machinery	201	300	51	1	73	1,341	0	0
9 Waste treatment and disposal	0	0	0	223	0	668	0	0
10 Agriculture	0	8	35	400	376	1	14	508
11 Nature	1	1	433	5,039	0	8,180	200	0
TOTAL	**707**	**599**	**791**	**6,071**	**1,260**	**90,172**	**226**	**520**

HUNGARY	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	430	33	1	2	4	17,230	0	0
2 Commercial, institutional, and residential combustion	289	26	19	20	150	16,712	2	0
3 Industrial combustion	119	24	4	3	56	17,889	1	0
4 Production processes	9	14	4	1	79	1,042	1	4
5 Extraction and distribution of fossil fuels	0	0	20	220	0	0	0	0
6 Solvent use	0	0	21	0	0	0	0	0
7 Road transport	58	94	79	2	478	7,024	0	0
8 Other mobile sources and machinery	NE	NE	NE	NE	NE	0	0	0
9 Waste treatment and disposal	0	0	0	0	0	0	0	0
10 Agriculture	0	0	0	324	0	0	17	57
11 Nature	0	0	0	40	1	944	0	0
TOTAL	905	191	148	612	768	60,841	22	62

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-15. CORINAIR90 Emissions for Ireland and Italy
(thousand short tons)

IRELAND	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	114	51	0	0	4	11,973	2	0
2 Commercial, institutional, and residential combustion	33	7	9	4	88	8,661	1	0
3 Industrial combustion	43	12	0	0	1	5,985	0	0
4 Production processes	0	2	1	0	0	1,108	0	0
5 Extraction and distribution of fossil fuels	0	0	3	11	0	0	0	0
6 Solvent use	0	0	24	0	0	0	0	0
7 Road transport	6	49	69	1	336	5,078	0	0
8 Other mobile sources and machinery	1	5	1	0	4	511	0	0
9 Waste treatment and disposal	0	1	5	152	43	1,563	0	7
10 Agriculture	0	0	86	708	0	0	44	132
11 Nature	0	0	18	59	0	0	3	0
TOTAL	**196**	**128**	**217**	**937**	**475**	**34,880**	**50**	**139**

ITALY	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	844	449	4	4	25	117,985	18	0
2 Commercial, institutional, and residential combustion	90	65	23	18	286	77,670	9	0
3 Industrial combustion	633	334	12	10	684	158,765	13	0
4 Production processes	116	14	104	8	419	29,895	16	25
5 Extraction and distribution of fossil fuels	0	0	147	383	0	0	0	0
6 Solvent use	0	0	593	0	0	0	0	0
7 Road transport	114	1,043	1,051	28	6,101	101,274	3	1
8 Other mobile sources and machinery	53	307	144	9	793	23,417	3	0
9 Waste treatment and disposal	5	38	124	1,436	1,879	5,883	2	12
10 Agriculture	0	1	436	1,945	30	0	63	385
11 Nature	628	13	168	321	1,189	56,739	29	0
TOTAL	**2,482**	**2,263**	**2,806**	**4,163**	**11,406**	**571,629**	**156**	**423**

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-16. CORINAIR90 Emissions for Latvia and Lithuania
(thousand short tons)

LATVIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	85	20	1	1	5	9,649	0	0
2 Commercial, institutional, and residential combustion	14	5	6	4	95	2,945	0	0
3 Industrial combustion	4	2	0	0	1	1,502	0	0
4 Production processes	0	0	0	0	0	459	0	1
5 Extraction and distribution of fossil fuels	0	0	0	2	0	0	0	0
6 Solvent use	0	0	1	0	0	0	0	0
7 Road transport	3	25	33	1	257	2,289	0	0
8 Other mobile sources and machinery	8	41	5	0	13	1,603	0	0
9 Waste treatment and disposal	0	0	0	43	0	0	0	0
10 Agriculture	0	0	2	110	0	0	4	37
11 Nature	0	0	52	583	0	0	5	0
TOTAL	115	93	101	743	370	18,447	9	38

LITHUANIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	105	47	1	1	5	18,176	0	0
2 Commercial, institutional, and residential combustion	64	9	1	1	4	4,710	0	0
3 Industrial combustion	38	18	29	0	36	3,266	0	0
4 Production processes	7	3	10	0	12	2,082	0	3
5 Extraction and distribution of fossil fuels	0	0	7	26	0	0	0	0
6 Solvent use	0	0	11	0	0	0	0	0
7 Road transport	6	53	45	1	450	4,374	0	0
8 Other mobile sources and machinery	3	28	5	0	12	1,899	0	0
9 Waste treatment and disposal	1	0	0	0	2	0	0	0
10 Agriculture	0	0	3	199	0	0	11	81
11 Nature	0	0	4	58	0	0	1	0
TOTAL	222	158	116	286	521	34,507	12	84

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-17. CORINAIR90 Emissions for Luxembourg and Malta
(thousand short tons)

LUXEMBOURG	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	0	0	0	0	0	2,076	0	0
2 Commercial, institutional, and residential combustion	1	1	1	0	6	1,316	0	0
3 Industrial combustion	14	12	0	0	108	7,133	0	0
4 Production processes	0	0	1	0	19	645	0	2
5 Extraction and distribution of fossil fuels	0	0	2	2	AZ	0	0	0
6 Solvent use	0	0	4	0	0	0	0	0
7 Road transport	0	10	11	0	52	847	0	0
8 Other mobile sources and machinery	0	1	1	0	3	117	0	0
9 Waste treatment and disposal	0	0	0	4	0	146	0	0
10 Agriculture	0	0	0	19	AZ	0	1	6
11 Nature	0	0	2	1	AZ	116	0	0
TOTAL	16	25	23	27	189	12,394	1	8

MALTA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	2	2	0	0	0	1,411	0	0
2 Commercial, institutional, and residential combustion	0	0	0	0	0	84	0	0
3 Industrial combustion	0	0	0	0	0	91	0	0
4 Production processes	0	0	0	0	0	4	0	0
5 Extraction and distribution of fossil fuels	0	0	0	0	0	0	0	0
6 Solvent use	0	0	2	0	0	0	0	0
7 Road transport	0	4	3	0	21	351	0	0
8 Other mobile sources and machinery	3	6	0	0	2	267	0	0
9 Waste treatment and disposal	0	0	0	7	0	0	13	0
10 Agriculture	0	0	0	1	0	0	0	5
11 Nature	0	0	0	0	0	0	0	0
TOTAL	6	12	4	9	23	2,208	13	5

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-18. CORINAIR90 Emissions for Netherlands and Norway
(thousand short tons)

NETHERLANDS	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	48	84	1	1	6	43,541	0	0
2 Commercial, institutional, and residential combustion	5	35	18	2	111	34,717	0	1
3 Industrial combustion	48	44	1	2	13	30,439	0	0
4 Production processes	81	67	85	9	280	26,467	2	4
5 Extraction and distribution of fossil fuels	0	2	1	1	2	563	0	0
6 Solvent use	0	1	160	0	1	313	0	0
7 Road transport	14	300	202	7	744	26,224	5	0
8 Other mobile sources and machinery	19	54	25	0	23	2,966	0	0
9 Waste treatment and disposal	5	6	3	417	3	2,646	3	0
10 Agriculture	2	26	6	573	9	7,723	10	209
11 Nature	AZ	17	4	135	29	0	8	10
TOTAL	222	635	507	1,147	1,219	175,597	27	225

NORWAY	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	1	1	0	0	0	177	0	0
2 Commercial, institutional, and residential combustion	3	3	9	11	126	2,499	1	0
3 Industrial combustion	8	27	2	3	11	9,682	1	0
4 Production processes	31	9	13	1	60	6,523	7	0
5 Extraction and distribution of fossil fuels	0	0	111	13	0	369	0	0
6 Solvent use	0	0	32	0	0	95	0	0
7 Road transport	4	84	88	2	720	8,059	1	0
8 Other mobile sources and machinery	8	99	15	1	33	5,158	0	0
9 Waste treatment and disposal	0	9	1	160	1	1,688	0	0
10 Agriculture	0	0	0	91	0	176	6	37
11 Nature	0	0	0	0	0	9	0	0
TOTAL	54	232	270	282	950	34,435	16	38

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-19. CORINAIR90 Emissions for Poland and Portugal
(thousand short tons)

POLAND	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	1,589	493	2	2	68	154,452	15	1
2 Commercial, institutional, and residential combustion	444	43	99	94	1,343	62,631	4	0
3 Industrial combustion	1,006	348	11	16	3,389	147,337	6	0
4 Production processes	94	75	88	9	122	3,886	13	35
5 Extraction and distribution of fossil fuels	0	0	51	2,914	0	0	0	0
6 Solvent use	0	0	230	0	0	0	0	0
7 Road transport	75	243	248	4	2,133	19,576	1	0
8 Other mobile sources and machinery	65	159	73	1	90	11,674	0	0
9 Waste treatment and disposal	1	83	169	814	225	2,077	2	43
10 Agriculture	0	0	34	1,861	0	0	94	458
11 Nature	0	1	290	392	18	13,287	21	42
TOTAL	3,273	1,446	1,295	6,107	7,389	414,920	155	581

PORTUGAL	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	192	55	0	0	2	15,624	2	0
2 Commercial, institutional, and residential combustion	5	3	11	8	129	3,873	0	0
3 Industrial combustion	84	30	4	3	364	17,314	2	0
4 Production processes	12	5	28	2	12	3,859	2	7
5 Extraction and distribution of fossil fuels	0	0	8	2	0	0	0	0
6 Solvent use	0	0	74	0	0	0	0	0
7 Road transport	15	118	89	2	677	9,422	0	0
8 Other mobile sources and machinery	3	27	7	0	13	1,641	0	0
9 Waste treatment and disposal	0	0	0	39	0	444	0	0
10 Agriculture	0	0	4	224	0	0	34	96
11 Nature	0	6	483	151	0	11,097	19	0
TOTAL	312	243	710	431	1,198	63,275	60	102

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-20. CORINAIR90 Emissions for Romania and Slovakia
(thousand short tons)

ROMANIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	903	167	2	2	13	58,993	8	0
2 Commercial, institutional, and residential combustion	230	29	29	24	373	35,752	4	0
3 Industrial combustion	109	64	9	5	782	65,709	3	0
4 Production processes	30	17	65	11	129	22	11	8
5 Extraction and distribution of fossil fuels	0	0	108	1,095	0	0	0	0
6 Solvent use	0	0	192	0	0	0	0	0
7 Road transport	6	50	76	1	531	3,893	0	0
8 Other mobile sources and machinery	33	186	15	1	27	6,734	0	0
9 Waste treatment and disposal	0	21	75	133	1,332	7	1	0
10 Agriculture	0	11	48	594	0	0	45	292
11 Nature	0	0	150	91	0	0	35	0
TOTAL	1,311	546	769	1,955	3,188	171,110	108	300

SLOVAKIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	243	67	1	0	9	15,863	1	0
2 Commercial, institutional, and residential combustion	117	12	14	14	171	10,470	1	0
3 Industrial combustion	166	58	10	6	116	14,619	2	0
4 Production processes	11	14	7	AZ	19	3,147	0	3
5 Extraction and distribution of fossil fuels	0	6	11	124	2	1,196	0	0
6 Solvent use	AZ	AZ	55	AZ	AZ	0	0	0
7 Road transport	3	56	40	1	151	4,501	0	0
8 Other mobile sources and machinery	1	12	1	0	5	519	0	0
9 Waste treatment and disposal	1	1	11	53	28	320	0	0
10 Agriculture	AZ	AZ	AZ	125	AZ	0	15	57
11 Nature	AZ	0	88	0	0	4	4	7
TOTAL	542	227	237	323	501	50,639	22	66

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-21. CORINAIR90 Emissions for Slovenia and Spain
(thousand short tons)

SLOVENIA	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	154	17	1	1	1	6,145	1	0
2 Commercial, institutional, and residential combustion	18	1	1	1	9	1,581	0	0
3 Industrial combustion	17	3	0	0	1	1,337	0	0
4 Production processes	4	1	2	0	0	416	0	0
5 Extraction and distribution of fossil fuels	0	0	3	47	0	0	0	0
6 Solvent use	0	0	10	0	0	0	0	0
7 Road transport	3	34	18	0	65	3,141	0	0
8 Other mobile sources and machinery	NE	NE	NE	NE	NE	NE	NE	NE
9 Waste treatment and disposal	0	0	0	32	0	0	0	0
10 Agriculture	0	0	0	42	0	0	4	27
11 Nature	0	0	0	0	0	0	6	0
TOTAL	196	57	35	124	77	12,620	11	27

SPAIN	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	1,613	274	11	10	18	71,529	10	AZ
2 Commercial, institutional, and residential combustion	108	23	65	49	981	31,886	3	AZ
3 Industrial combustion	527	187	12	8	447	72,514	7	AZ
4 Production processes	42	16	87	4	274	38,871	11	17
5 Extraction and distribution of fossil fuels	0	0	64	754	0	NE	NE	AZ
6 Solvent use	0	0	340	0	0	AZ	AZ	AZ
7 Road transport	76	564	495	13	2,877	53,688	2	0
8 Other mobile sources and machinery	19	272	44	2	122	16,093	0	0
9 Waste treatment and disposal	46	38	25	559	580	7,821	0	NE
10 Agriculture	0	1	92	964	157	15,557	69	347
11 Nature	0	11	855	944	29	11,483	119	NE
TOTAL	**2,431**	**1,386**	**2,088**	**3,305**	**5,486**	**319,442**	**223**	**365**

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Table 7-22. CORINAIR90 Emissions for Sweden and United Kingdom
(thousand short tons)

SWEDEN	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	15	14	2	1	6	6,917	1	0
2 Commercial, institutional, and residential combustion	16	12	129	10	72	9,099	1	0
3 Industrial combustion	38	42	9	4	24	16,139	1	0
4 Production processes	17	10	31	0	6	1,998	3	0
5 Extraction and distribution of fossil fuels	0	0	17	0	0	0	0	0
6 Solvent use	NE	NE	74	NE	NE	0	0	0
7 Road transport	7	163	154	13	1,118	16,128	1	0
8 Other mobile sources and machinery	11	101	35	3	107	6,137	0	0
9 Waste treatment and disposal	2	2	0	180	14	29,599	0	28
10 Agriculture	NE	0	0	205	0	0	8	45
11 Nature	0	0	270	1,691	2	84,378	19	0
TOTAL	105	345	722	2,106	1,347	170,395	33	74

UNITED KINGDOM	SO_2	NO_x as NO_2	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
1 Public power, cogeneration, and district heating	3,008	855	14	3	55	219,365	3	0
2 Commercial, institutional, and residential combustion	229	1,239	45	1	325	121,636	0	0
3 Industrial combustion	774	252	3	0	78	134,475	0	0
4 Production processes	20	10	326	0	0	8,179	94	17
5 Extraction and distribution of fossil fuels	0	71	486	1,334	2	13,883	0	0
6 Solvent use	0	0	829	0	0	0	0	0
7 Road transport	70	1,524	1,083	12	6,639	120,435	0	0
8 Other mobile sources and machinery	72	194	29	0	47	12,115	0	0
9 Waste treatment and disposal	0	14	53	1,199	242	9,739	0	4
10 Agriculture	0	0	0	1,186	0	0	90	495
11 Nature	0	0	88	0	0	0	0	53
TOTAL	4,174	4,159	2,956	3,736	7,387	639,828	187	569

Note(s): The sums may not equal total due to rounding.
AZ=assumed to be zero or negligible; NE/ND/NA=not estimated; IE=included elsewhere

Source: These final and preliminary tables are provided by Gordon McInnes of the European Environment Agency, Copenhagen, Denmark.

Chapter 8.0 Air Toxic Emissions

8.1 INTRODUCTION

This chapter presents the available emissions data for toxic air pollutants. The data are much less comprehensive than those for the criteria air pollutants, because an extensive and long-term monitoring and emissions tracking program similar to that for criteria pollutants has not been established for air toxics. EPA is, however, beginning development of a county-wide toxics data base, bringing together elements from different toxics programs. This data base will be available the Spring of 1996.

This chapter therefore presents emissions culled from two different program areas. The scope of the inventories developed for these programs varies because each program was designed to meet a particular need. Because the emissions data were not collected in the same manner for each program, the estimates may differ among programs. The two types of toxic emission inventories cited in this chapter are:

- Toxic Release Inventory (TRI) estimates (currently for over 300 chemicals) submitted annually since 1987 to EPA by certain manufacturing facilities; and
- national inventories for specific pollutants prepared by EPA to support special studies called for by the CAAA.

The term "toxic" was used by legislators drawing up the TRI list, which covers all media — air, land, and water. In this section, all TRI data presented correspond to the release of specific chemicals to air only. "Hazardous" refers to the list of air pollutants targeted for regulation under section 112(b)(1) of the CAA.

Because it is the only one of the three inventory types which is regularly updated, the TRI data discussed in section 8.2 may be used as an indication of toxic emission trends. However, the TRI does not present a complete picture of toxic air emissions because only manufacturing facilities with 10 or more employees must report emissions. The national inventories for specific pollutants presented in section 8.3 provide a more comprehensive picture for a limited number of air toxics because they attempt to identify and include estimates for all source categories emitting those pollutants. For some toxic air pollutants, the mobile, commercial, residential, and consumer sectors can be much more significant sources of emissions than the manufacturing sector. It should be noted that these estimates have been prepared for only a single year, 1990.

The development of comprehensive toxics data is complicated by several factors, including the number of chemical compounds involved, the number and variety of sources emitting the compounds, the low concentrations sometimes involved, and the potential for secondary formation of one hazardous compound from other, often nonhazardous, compounds. The limitations inherent in current data sources limit EPA's ability to identify trends in air toxic emissions and concentrations. Therefore, preliminary assessments of baseline emissions are somewhat tentative. As more information is collected on air toxic emissions, EPA will attempt to modify the baseline estimates to accurately reflect the effectiveness of Title III regulations in reducing toxic air emissions.

8.2 TOXIC RELEASE INVENTORY SUMMARIES

Manufacturing facilities meeting specified activity thresholds are required to report their estimated releases and transfers of listed toxic chemicals to EPA each year. The reports are compiled by EPA into a publicly available data base called the TRI. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). Although 1987 was the first year for TRI reporting, 1988 has been chosen as the baseline year for comparisons because of concerns about the data quality of industry's submissions in the first year. The list of chemicals for which releases and transfers must be reported has seen additions and deletions each year, and now includes over 300 chemicals in 20 chemical categories.

While the TRI is the only data base available for assessing air toxic emission trends, this data base does have some limitations. Facilities with SIC codes outside the range of 20 to 39 (the manufacturing SIC range) are not required to report. Under this exemption, facilities such as mining operations, electric utilities, and oil and gas production operations are not required to report to the TRI. Emissions from small manufacturing facilities (those with fewer than 10 employees) as well as commercial, residential, and mobile sources are also not included in the TRI. The TRI data are self-reported by the emitting facilities, and the TRI does not require facilities to perform any actual monitoring or testing to develop their estimates. The accuracy of the reported data may vary from facility to facility and year to year. Despite these limitations, the TRI estimates are being used here as indicators of the trend in toxic air emissions, at least in the manufacturing sector. Efforts are underway to enhance the TRI data base by expanding both the types of facilities which must report their releases and the list of chemicals which must be reported.

Figure 8-1 shows the trend in toxic air emissions as reported by manufacturing facilities to EPA's TRI data base.[1] In order to

reduce the effects of changing reporting requirements on the underlying trend in toxic emissions, the 1988-1993 totals shown are for a set of 278 chemicals that have been on the TRI list since its inception in 1987. The original TRI list included 173 of the 189 chemicals subsequently defined by the CAAA as HAPs, and these are graphed as a subset in figure 8-1. These HAPs have shown the same trend in reductions as the larger TRI set, representing more than 60 percent of the declining TRI total for each year.

The 10 HAPs ranked highest in emissions (based on 1988 reported air releases) have accounted for approximately 56 percent of total TRI air emissions and approximately 79 percent of the total HAP air emissions in each reporting year. The sums of the emissions for these 10 HAPs are shown for 1988 through 1993 in figure 8-1; the 6-year trend for each individual HAP is shown in figure 8-2. A generally declining trend is evident for 9 of the 10 HAPs; hydrochloric acid shows slight increases for 1989 and 1990, decreases for 1991 and 1992, and a slight increase for 1993.

Sixteen of the 189 HAPs defined by the CAAA were not included in the original TRI list. Two of the 16, acetophenone and ethylidene dichloride, have been added to the TRI list, with the first reports to be submitted by July 1, 1995 for the 1994 reporting year. Nine other HAPs were proposed for addition to the TRI on January 12, 1994. The nine HAPs are:

- hexane
- caprolactam
- triethylamine
- mineral fibers
- polycyclic organic matter (polycyclic aromatic compounds)
- phosphine
- isophorone
- dimethyl formamide
- hexamethylene-1,6-diisocyanate

The five remaining HAPs were not proposed for addition to the TRI list for various reasons, such as being produced in quantities too low to meet the TRI thresholds or being emitted by sources which do not have to report to the TRI. These HAPs include:

- coke oven emissions;
- 2,2,4-trimethylpentane;
- radionuclides (including radon);
- 2,3,7,8-tetrachlorodibenzo-p-dioxin; and
- p,p'-dichlorodiphenyldichloroethylene (DDE).

Table 8-1 shows total TRI-reported air emissions for each State for 1988 through 1993.[1] Only two States (Nevada and North Dakota) reported greater emissions in 1993 than in 1988. Most States show a steady downward trend through all years. Figure 8-3 shows the trend in TRI emissions for each of the 20 SIC groups required to report to TRI.[1] Only three SIC groups (Food, Tobacco, and Apparel) reported greater emissions in 1993 than in 1988.

8.3 NATIONAL INVENTORIES FOR SPECIFIC POLLUTANTS

The EPA's OAQPS has developed a number of nationwide toxic emissions inventories for individual chemicals to help address specific requirements of the CAAA. For the pollutants addressed, these inventories are more comprehensive than the TRI in that they attempt to identify and quantify all source categories and air emissions of these pollutants, whether from manufacturing facilities, commercial facilities, mobile sources, or residential and consumer sources. These inventories also include emissions from facilities with fewer than 10 employees and emissions from sources with very low concentrations of toxics, which are exempted from the TRI reporting requirements. These considerations can be extremely important for estimating the total emissions of some pollutants.

These inventories have been compiled by using existing national estimates for a specific chemical from a specific source category (e.g., for development of a National Emission Standard for Hazardous Air Pollutants [NESHAP]) wherever possible. Other EPA inventories such as the TRI were used as well. If no suitable inventory was available, an average emission factor and national activity data were used to estimate emissions. In general, the emissions estimates are based on national activity data for an entire source category, rather than data for individual facilities. Details on how the estimates for each source category were derived can be found in the references cited.

Inventories are available for only 13 HAPs at this time, and most of these inventories are still in draft form. Since these inventories have been prepared for a single year, no evaluation of a trend is possible. However, they are valuable as an initial assessment of the potential magnitude of risks posed by certain pollutants and source categories. They also provide an initial baseline for evaluating potential methods for reducing identified risks. A projected trend can be estimated by examining the major sources of the emissions, assessing whether these source categories are growing or shrinking, and whether or not they are regulated or scheduled to be regulated.

8.3.1 Section 112(k) Inventories (Urban Area Source Program)

Section 112(k) of the CAA requires the EPA to identify source categories and subcategories of HAPs in urban areas that pose a threat to human health. Area sources accounting for at least 90 percent of total emissions of at least 30 HAPs that present the greatest threat to urban populations must be identified. Emission standards for these HAP species are to be developed by the year 2000. The work being performed in support of section 112(k) is referred to as the Urban Area Source Program.

In order to meet the requirements of section 112(k), national inventories of toxic pollutants are needed. This information, in

conjunction with risk factors for the specific toxics, can be used to determine the specific pollutants and source categories that need to be controlled. Thus far, national inventories have been developed for seven HAPs under the Urban Area Source Program. These HAPs are thought to be ubiquitous in most urban areas, regardless of the type of industries present in the local area.

Tables 8-2 through 8-4 present the 1990 national estimates for three HAPs emitted primarily from combustion source categories.[2] Tables 8-5 through 8-8 present the 1990 national totals for four HAPs used primarily as solvents.[2]

8.3.2 Section 112(c)(6) Inventories

Section 112(c)(6) of the CAA requires EPA to identify and characterize all source categories and subcategories that emit any of seven specified pollutants by November 15, 1995. Section 112(c)(6) also requires the subsequent development of emission standards for the largest-emitting source categories of each pollutant. The categories to be regulated must account for at least 90 percent of the national emissions of that pollutant. The seven pollutants specified in section 112(c)(6) are:

- polycyclic organic matter (POM);
- hexachlorobenzene (HCB);
- alkylated lead compounds (TEL and TML);
- polychlorinated biphenyl compounds (PCBs);
- 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD);
- 2,3,7,8-tetrachlorodibenzofuran (TCDF); and
- mercury.

All of these pollutants are included in the list of 189 HAPs defined in section 112 (b)(1) of the CAA.

In addition to the source category emissions estimates called for by section 112(c)(6), national emissions were estimated for major point and area source contributors and were allocated to urban and rural areas, in order to support the section 112(k) Urban Area Source Program. Regional emissions estimates were also developed to support work required by section 112(m) of the CAA, which mandates the quantification of atmospheric deposition to the Great Lakes, Chesapeake Bay, Lake Champlain, and coastal waters.

1990 base year national emissions are summarized below for five of the seven pollutants listed in section 112(c)(6). The inventories for TCDD and TCDF are still under development. It should be noted that the inventory for mercury, although presented below, is considered draft.

In table 8-9, 1990 estimates of extractable organic matter (EOM) are presented as a surrogate for POM emissions.[3] Extractable organic matter is a gravimetric-based measurement which correlates with the POM class of compounds in terms of compound carcinogenicity and mutagenicity.

The only known commercial use of alkylated lead compounds is in the manufacture of leaded gasoline anti-knock compounds, which raise the octane levels in leaded motor vehicle gasoline and aviation gasoline. The phase-down of lead in on-road motor vehicle gasoline began in 1973. Section 211(n) of the CAA prohibits the manufacture of engines requiring leaded gasoline after 1992. The final deadline for the abolishment of all lead-containing on-road vehicle fuels is December 31, 1995.

The two most common lead anti-knock compounds are tetraethyl lead (TEL) and tetramethyl lead (TML). The potential for TEL and TML emissions is limited to evaporative losses from the distribution, marketing, and use of leaded motor vehicle gasoline and aviation gasoline. National evaporative loss emissions are presented in table 8-10 for pipelines, bulk terminals, bulk plants, service stations, and non-road engines and vehicles.[4]

The source category emissions listed in table 8-11 are those for which reliable PCB emissions could be developed.[5] The following categories were identified as potential sources of PCB emissions for which sufficient data were not available to develop national emissions estimates:

- Treatment, Storage, and Disposal Facilities (TSDFs) and Landfills;
- Superfund Sites;
- Steel and Iron Reclamation (auto scrap burning);
- Accidental Releases (spills, leaks and transformer fires); and
- Environmental Sinks of Past PCB Contamination.

Tables 8-12 and 8-13 present emissions for two key metallic HAPs, mercury and cadmium. Mercury is one of the seven pollutants specified in section 112(c)(6) of the CAA (see above). The estimates for cadmium are taken from an EPA document that is part of the Locating and Estimating (L&E) document series.[6] Over the last 10 years, L&E documents have been published by EPA to assist state and local air pollution control agencies in their efforts to prepare inventories of toxic air pollutants. The documents provide a compilation of available information, including emission factors, on the sources and emissions of specific toxic air pollutants. The series now includes 33 documents. Only those completed in the last year have had national emission estimates included. Several L&E documents expected to be published in the next year will also include national emissions. The estimates for mercury are from an internal EPA draft report to Congress.[7]

8.4 STATE-LEVEL INVENTORIES FOR SPECIFIC POLLUTANTS

Table 8-14 presents the state-level toxic air pollutant estimates that are available.[2,8,9,10] These estimates are not comprehensive because state-level emissions data are not available for some toxic pollutants and source categories. Although state emissions are available for PCB, TEL, and TML, data are not presented for these pollutants because of the relative small amounts emitted (national emissions are less than 1 tpy for each of these pollutants).

8.5 REFERENCES

1. Toxic Release Inventory System files, Technology Transfer Network Bulletin Board, U.S. Environmental Protection Agency, Research Triangle Park, NC. Various years.
2. *National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Benzene, 1,3-Butadiene, Perchloroethylene, Trichloroethylene, Methylene Chloride, Carbon Tetrachloride, and Formaldehyde*, (tables 4-1 through 4-7), Review Draft Report and background data, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1995.
3. *Emissions Inventory of Section 112(c)(6) Pollutants, Extractable Organic Matter (EOM)*, Draft Report, U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1993.
4. *Estimation of Alkylated Lead Emissions*, (table I), Final Report. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1993.
5. *Emissions Inventory of Section 112(c)(6) Pollutants, Polychlorinated Biphenyl Compounds (PCBs)*, Draft Report and background data. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1993.
6. *Locating and Estimating Air Emissions from Sources of Cadmium and Cadmium Compounds*, (table 3-3), EPA-454/R-93-040. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1993.
7. *Draft Mercury Study Report to Congress, Volume II: Inventory of Anthropogenic Mercury Emissions in the United States*, U.S. EPA, Office of Air Quality Planning and Standards, Internal Review Draft, 1995.
8. Telefax entitled "POTW Numbers," from Gary Brooks, Radian Corporation, to Sharon Nizich, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 13, 1995.
9. *Emissions Inventory of Section 112(c)(6) Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), and Polychlorinated Biphenyl Compounds (PCBs), Final Report* and background data, Radian Corporation, Research Triangle Park, NC. March 1995.
10. *Estimation of National Hexachlorobenzene Emissions for 1990*, (table I), Final Report. U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1993.

Table 8-1. State Total Air Emissions from TRI, 1988 to 1993
(short tons/year)

State	1988	1989	1990	1991	1992	1993	Reduction (88-93) Tons	Reduction (88-93) Percent
Texas	105,793	98,252	89,337	83,395	77,540	70,935	34,858	33
Tennessee	73,865	80,035	74,454	71,932	63,501	58,367	15,497	21
Ohio	71,423	70,281	58,080	49,856	44,718	42,299	29,124	41
Louisiana	68,580	67,422	55,722	49,116	43,808	38,833	29,747	43
Virginia	62,833	40,977	39,133	33,600	31,674	30,499	32,335	51
Utah	60,809	65,201	53,159	37,244	34,457	40,075	20,733	34
Indiana	56,732	57,204	54,461	46,193	42,337	38,438	18,294	32
Illinois	55,021	51,486	44,896	40,590	36,039	31,506	23,515	43
Alabama	53,003	52,933	51,954	49,661	47,109	47,580	5,423	10
New York	50,662	43,399	37,883	32,034	27,370	22,427	28,235	56
North Carolina	49,813	47,605	45,099	41,431	40,016	37,091	12,722	26
Michigan	49,657	53,412	41,988	35,186	32,910	33,931	15,726	32
California	46,391	41,721	41,346	33,560	27,131	23,269	23,121	50
Pennsylvania	45,960	40,904	38,378	33,062	30,319	26,036	19,924	43
Georgia	42,528	38,227	37,347	29,116	25,038	22,697	19,831	47
South Carolina	34,207	36,207	34,644	30,883	30,856	28,491	5,716	17
Mississippi	30,783	30,271	30,156	28,212	26,663	24,107	6,676	22
Minnesota	27,461	31,243	25,446	19,528	14,608	11,170	16,291	59
Florida	25,861	30,637	23,648	19,123	16,630	15,294	10,566	41
Missouri	25,276	24,320	22,955	17,479	18,095	16,344	8,932	35
Arkansas	24,380	21,893	17,136	15,978	13,839	14,713	9,667	40
Kentucky	24,264	22,626	20,905	18,918	18,493	17,508	6,756	28
Wisconsin	23,815	21,763	22,080	18,568	18,345	16,610	7,205	30
Iowa	22,410	22,608	19,786	17,237	16,234	14,080	8,331	37
New Jersey	19,829	15,596	12,824	10,637	9,945	7,719	12,109	61
West Virginia	18,923	17,224	15,690	13,578	11,219	11,550	7,373	39
Oklahoma	17,889	14,829	15,336	12,993	12,081	8,614	9,275	52
Kansas	16,344	16,458	15,227	14,402	12,411	10,698	5,645	35
Washington	14,849	14,306	14,239	12,933	10,936	10,245	4,604	31
Massachusetts	13,967	12,468	10,644	8,260	7,091	5,770	8,197	59
Connecticut	13,124	10,784	8,803	7,979	6,618	5,239	7,886	60
Alaska	11,523	10,475	7,984	6,613	5,473	3,114	8,409	73
Oregon	10,595	9,983	9,410	8,934	8,155	8,452	2,143	20
Nebraska	9,345	8,336	8,460	7,396	6,282	5,406	3,939	42
Maryland	9,191	9,236	6,778	5,845	5,274	5,227	3,964	43
Maine	8,718	7,778	6,991	6,901	6,472	5,310	3,408	39
Arizona	8,155	6,385	6,414	4,773	4,161	2,741	5,415	66
Puerto Rico	7,150	6,903	8,716	7,923	6,755	6,694	457	6
New Hampshire	6,157	5,495	4,060	2,645	2,968	1,963	4,193	68
Colorado	6,017	5,412	3,362	2,876	2,456	2,218	3,799	63
Rhode Island	3,890	3,150	2,610	2,178	1,659	1,763	2,128	55
Delaware	3,782	4,320	3,010	2,920	2,484	2,251	1,531	40
Idaho	2,683	2,678	2,870	3,152	2,604	2,135	548	20
Wyoming	1,446	1,830	2,365	1,439	1,146	949	497	34
South Dakota	1,286	1,615	1,406	1,369	1,447	900	386	30
Montana	1,194	1,253	1,226	1,180	1,394	1,198	3	0
New Mexico	1,067	1,411	1,284	1,077	932	918	149	14
Virgin Islands	853	580	606	555	777	780	72	8
North Dakota	636	671	741	903	878	734	(98)	-15
Hawaii	437	343	340	290	298	264	173	40
Nevada	352	343	373	425	416	526	(174)	-49
American Samoa	15	14	10	11	6	9	5	37
Total	**1,341,726**	**1,281,097**	**1,152,240**	**1,002,544**	**910,483**	**836,064**	**505,662**	**38**

Source(s): U.S. EPA, OAQPS, Technology Transfer Network Bulletin Board, Toxic Release Inventory System files, various years.

Table 8-2. 1990 Total Benzene Emissions by Source Category

Source Category	Emissions (tons/yr)
On-road mobile*	217,765
Non-road mobile**	95,994
Oil and gas production, glycol dehydrators	52,900
Residential wood combustion	44,190
Forest fires	29,932
Prescribed burning	23,719
Gasoline distribution, bulk plants and terminals	10,160
Gasoline distribution, local gas stations and underground tank filling	6,826
Petroleum refining	3,086
Chemicals and allied products (SIC 28)***	2,026
Coke oven emissions	806
Industrial wood combustion	326
Landfills	278
Secondary lead smelting	193
Non-road mobile, aircraft****	120
Portland cement kilns	104
POTWs*****	55
Industrial Coal Consumption	40
Internal combustion engines	31
Utility coal combustion	21
Commercial wood combustion	6.1
Medical waste incineration	4.4
Iron and steel foundries	3.0
Utility natural gas combustion	1.8
Hazardous waste incineration	1.7
Industrial residual oil combustion	1.5
Commercial coal combustion	1.4
Commercial residual oil combustion	1.4
Utility residual oil combustion	0.88
Sewage sludge incineration	0.16
Total	**488,591**

Note(s): * On-road mobile includes gasoline and diesel passenger cars and trucks.
** Non-road mobile includes lawn and garden equipment, recreational vehicles and vessels, commercial and industrial engines, and agncultural and construction equipment.
*** Total of SICs 28, 2812, 2819, 2821, 2822, 2865, 2869, and 2879,
**** Non-road mobile, aircraft includes air taxis and general aviation.
***** Publically Owned Treatment Works.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-3. 1990 Total 1,3-Butadiene Emissions by Source Category

Source Category	Emissions (tons/yr)
Non-road mobile*	41,883
On-road mobile**	38,516
Forest fires	10,733
Prescribed burning	8,505
Chemicals and allied products (SIC 28)***	1,577
Secondary lead smelting	374
Petroleum refining	219
Non-road mobile, aircraft****	107
Total	**101,914**

Note(s): * Non-road mobile includes lawn and garden equipment, recreational vehicles and vessels, commercial and industrial engines, and agricultural and construction equipment.
** On-road mobile includes gasoline and diesel passenger cars and trucks.
*** Total of SICs 28, 2812, 2819, 2821, 2822, 2869, 2879, and 2899.
**** Non-road mobile, aircraft includes air taxis and general aviation.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-4. 1990 Total Formaldehyde Emissions by Source Category

Source Category	Emissions (tons/yr)
On-road mobile*	101,722
Forest fires	68,238
Prescribed burning	54,075
Non-road mobile**	45,719
Structure fires	2,217
Wood products (SIC 24 and 25)***	1,504
Chemicals and allied products (SIC 28)****	1,299
Non-road mobile, aircraft*****	942
Industrial natural gas combustion	858
Coating related products (usage)	389
Industrial wood combustion	299
Antimicrobial agents (usage)	103
Commercial distillate oil combustion	78
Industrial residual oil combustion	59
Utility residual oil combustion	59
Utility natural gas combustion	55
Commercial residual oil combustion	53
POTWs******	40
Industrial distillate oil combustion	37
Municipal waste incineration	34
Utility coal combustion	28
Commercial wood combustion	5.6
Adhesives (usage)	2.8
Medical waste incineration	1.4
Air fresheners (usage)	0.83
Sewage sludge incineration	0.46
Hard surface cleaners (usage)	0.08
Fabric, carpet, and upholstery products (usage)	0.02
Total	**277,819**

Note(s): * On-road mobile includes gasoline and diesel passenger cars and trucks.*
** Non-road mobile includes lawn and garden equipment, recreational vehicles and vessels, commercial and industrial engines, and agricultural and construction equipment.
*** Total of SICs 2434, 2435, 2436, 2439, 2493, 2499, 2511, 2517, and 2521.
**** Total of SICs 28, 2812, 2313, 2819, 2821, 2822, 2861, 2869, 2873, 2879, and 2899.
***** Non-road mobile, aircraft includes air taxis and general aviation.
****** Publically Owned Treatment Works.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-5. 1990 Total Carbon Tetrachloride Emissions by Source Category

Source Category	Emissions (tons/yr)
Chemicals and allied products (SIC 28)*	548
POTWs**	345
Utility coal combustion	28
Petroleum refining	24
Portland cement kilns	2.6
Hazardous waste incineration	0.06
Medical waste incineration	0.06
Sewage sludge incineration	0.02
Total	**948**

Note(s): * Total of SICs 28, 2812, 2816, 2819, 2821, 2822, 2865, and 2899.
** Publically Owned Treatment Works.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-6. 1990 Total Perchloroethylene Emissions by Source Category

Source Category	Emissions (tons/yr)
Dry cleaning industry	95,700
Halogenated solvent cleaning	11,847
Maintenance and repair products (usage)	3,368
Fabric, carpet, and upholstery products (usage)	2,430
Landfills	904
Chemicals and allied products (SIC 28)*	215
POTWs**	127
Arts and crafts supplies (usage)	92
Sealants (usage)	89
Coke oven emissions	85
Coating related products (usage)	53
Hard surface cleaners (usage)	43
Miscellaneous household products (usage)	42
Utility coal combustion	27
Automobile detailing products (usage)	3.9
Portland cement kilns	2.1
Petroleum refining	2.0
Utility residual oil combustion	0.34
Sewage sludge incineration	0.05
Medical waste incineration	0.04
Total	**115,031**

Note(s): * Total of SICs 28, 2812, 2819, 2865, 2869, 2979, 2899, and 5169.
** Publically Owned Treatment Works.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-7. 1990 Total Methylene Chloride Emissions by Source Category

Source Category	Emissions (tons/yr)
Halogenated solvent cleaning	9,570
Chemicals and allied products (SIC 28)*	9,243
Landfills	362
POTWs**	168
Wood products (SIC 24 and 25)***	132
Utility coal combustion	110
Coke oven emissions	54
Portland cement kilns	26
Utility residual oil	20
Spray paints and coatings (usage)	14
Petroleum refining	8.1
Medical waste incineration	0.61
Sewage sludge incineration	0.08
Hard surface cleaners (usage)	0.05
Total	**19,708**

Note(s): * Total of SICs 28, 2812, 2819, 2821, 2833, 2834, 2865, 2879, 2899, and 5169.
** Publically Owned Treatment Works.
*** Total of SICs 2434, 2499, 2511, 2517, and 2541.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-8. 1990 Total Trichloroethylene Emissions by Source Category

Source Category	Emissions (tons/yr)
Halogenated solvent cleaning	40,623
Landfills	433
Coke oven emissions	233
Spray paints and coatings (usage)	106
Chemicals and allied products (SIC 28)*	101
POTWs**	90
Coating related products (usage)	76
Maintenance and repair products (usage)	35
Utility coal combustion	27
Fabric, carpet, and upholstery products (usage)	5.9
Adhesives (usage)	4.8
Petroleum refining	0.85
Portland cement kilns	0.29
Sewage sludge incineration	0.24
Medical waste incineration	0.04
Total	**41,735**

Note(s): * Total of SICs 28, 2812, 2819, 2869, 2879, 2899, and 5169.
** Publically Owned Treatment Works.

Source(s): National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft, April 1995, and background data.

Table 8-9. 1990 National Extractable Organic Matter Emissions
(short tons/year)

Source Category	EOM
Residential Wood Combustion	425,448
Industrial Wood Combustion	97,848
On-Road Vehicles	56,157
Utility Coal Combustion	38,628
Non-Road Vehicles	25,116
Residential Natural Gas Combustion	4,143
Diesel IC Engines & Turbines	3,660
Commercial Coal Combustion	2,746
Industrial Coal Combustion	2,411
15 Other Categories Estimated*	11,830
TOTAL	**667,989**

Note(s): *Includes additional combustion sectors, municipal and medical waste incineration, coke ovens, and primary aluminum production.

No estimates available for the following potential sources of EOM emissions:

- Iron and Steel Foundries
- Carbon Black Manufacturing
- Hazardous Waste Incineration
- Wood Treatment and Preserving
- Asphalt Roofing Manufacturing
- Locomotives, Aircraft, and additional Nonroad Vehicles
- Petroleum Refining
- Charcoal Manufacturing
- Secondary Lead Smelting
- Pulp and Paper Production
- Asphalt Hot-Mix Production

Of the above listed categories, iron and steel foundries and petroleum refineries are likely to be major sources of EOM emissions based on the air emissions for individual POM compounds reported in the TRI data base.

Source(s): Emissions Inventory of Section 112(c)(6) Pollutants, Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), and Polychlorinated Biphenyl Compounds (PCBs), Final Report, March 1995 (table 2-2).

Table 8-10. 1990 National Tetraethyl Lead and Tetramethyl Lead Emissions (pounds/year)

Source Category	TEL	TML
Bulk Plants - Aviation Gas	750	N/A
Nonroad Vehicles	38	293
Service Stations	13	102
Bulk Plants - Motor Vehicle Gas	5	40
Bulk Terminals	4	30
Pipelines	2	16
TOTAL	**811**	**481**

Source(s): Estimation of Alkylated Lead Emissions, Final Report, September 1993 (table 1).

Table 8-11. 1990 National Polychlorinated Biphenyl Emissions (pounds/year)

Source Category	PCB Emissions
Municipal Waste Combustion	161
Medical Waste Incineration	76
Hazardous Waste Incineration	28
Sewage Sludge Incineration	10
Other Biological Incineration	5
Waste Tire Incineration	2
TOTAL	**282**

Note(s): The following categories were identified as potential sources of PCB emissions for which sufficient data were not available to develop national emissions estimates:

- Treatment, Storage, and Disposal Facilities (TSDFs) and Landfills;
- Superfund Sites;
- Steel and Iron Reclamation (auto scrap burning);
- Accidental Releases (spills, leaks and transformer fires); and
- Environmental Sinks of Past PCB Contamination.

Source(s): Background data for Emissions Inventory of Section 112(c)(6) Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), and Polychlorinated Biphenyl Compounds (PCBs), Final Report, March 1995.

Table 8-12. 1990 National Cadmium Emissions
(short tons/year)

Source Category	Cadmium
Coal Combustion	240.4
Oil Combustion	26.0
Municipal Waste Incineration	7.7
Sewage Sludge Incineration	6.9
Medical Waste Incineration	3.9
Wood Combustion	0.4
Metal & Metal Compound Production	10.1
Major Uses of Metal	3.6
Primary Lead Smelting	15.8
Primary Copper Smelting	6.2
Primary Zinc Smelting	6.3
Secondary Copper Smelting	4.8
Secondary Zinc Smelting	1.7
Iron and Steel	1.5
Portland Cement Production	3.3
Miscellaneous Sources	0.1
Mobile Sources	NA
TOTAL	**338.7**

Source(s): Locating and Estimating Air Emissions from Sources of Cadmium and Cadmium Compounds, EPA-454/R-93-040, September 1993 (table 3-3).

Table 8-13. National Anthropogenic Mercury Emissions
(short tons/year)

Source Category	Mercury	Activity Year
Area Sources		
Electric Lamp Breakage	1.5	1989
Laboratory Use	0.8	1992
Dental Preparations	0.8	1992
Subtotal	3.1	
Combustion Point Sources		
Utility Boilers	54.5	1990
Commercial/Industrial Boilers	29	1992
Residential Boilers	3.5	1991
Municipal Waste Combustors	55	1991
Medical Waste Incinerators	64.7	1991
Sewage Sludge Incinerators	1.8	1990
Crematories	0.4	1991
Wood-fired Boilers	0.3	1980
Subtotal	209.2	
Manufacturing Sources		
Chlor-alkali Production	6.5	1991
Cement Manufacturing	6.5	1990
Battery Production	0.02	1992
Electrical Apparatus Manufacturing	0.46	1992
Instrument Manufacturing	0.5	1992
Secondary Mercury Production	7.4	1991
Carbon Black Production	0.25	1991
Primary Lead Smelting	9	1990
Primary Copper Smelting*	0.7	1992
Lime Manufacturing	0.7	1992
Fluorescent Lamp Recycling*	0.006	1993
Subtotal	32	
TOTAL	**244.3**	

Note(s): Mercury was phased out of paint use in 1991.
Insufficient information was available to estimate emissions for the following source categories:

- Mobile sources;
- Agricultural burning (one study estimates 0.04 tons/year from preharvest burning of sugarcane in Florida everglades area);
- Landfills;
- Hazardous waste incinerators;
- Mercury compounds production;
- Byproduct coke production; and
- Petroleum refining.

*Emissions are estimated for only one source, which is scheduled to cease operations by March 31, 1995; nationwide estimates are expected to be higher.

Source(s): *Draft Mercury Study Report to Congress, Volume II: Inventory of Anthropogenic Mercury Emissions in the United States*, U.S. EPA, Office of Air Quality Planning and Standards, Internal Review Draft, 1995.

Table 8-14. Selected Toxic Emission Estimates by State
(short tons/year)

STATE	BEN	BUT	CTET	EOM	FORM	HCB	METH	PERC	TRI	TOTAL
AK	17,702	6,221	1	1,582	39,309	NA	19	488	62	65,384
AL	12,159	2,594	17	11,493	13,364	2	304	1,483	636	42,051
AR	5,001	610	7	7,074	2,372	1	140	1,185	343	16,732
AZ	5,831	1,140	5	7,845	5,055	0	173	1,133	536	21,719
CA	37,804	5,505	62	65,234	18,138	33	1,820	8,137	4,997	141,730
CO	6,198	577	6	7,306	1,860	2	191	1,856	549	18,544
CT	3,322	487	9	5,529	1,309	0	307	1,104	666	12,733
DC	451	61	4	882	172	NA	50	214	200	2,032
DE	861	132	7	1,063	349	1	146	168	130	2,858
FL	19,536	3,985	16	22,630	18,097	36	628	4,454	2,029	71,412
GA	13,990	3,159	20	22,359	14,984	2	479	3,169	1,093	59,256
HI	1,173	179	2	2,108	628	1	51	357	185	4,684
IA	3,303	430	7	7,706	1,200	11	181	1,667	468	14,973
ID	2,830	718	8	3,200	3,833	0	87	722	134	11,533
IL	12,310	1,600	54	29,086	4,358	13	1,161	4,783	2,092	55,456
IN	7,587	1,077	19	16,963	2,861	8	661	2,888	1,011	33,075
KS	9,633	625	6	6,697	2,386	8	153	3,212	398	23,118
KY	4,878	769	20	9,740	2,237	3	280	2,107	531	20,565
LA	11,613	952	29	8,436	3,087	3	358	1,424	533	26,435
MA	5,946	844	19	10,348	2,343	0	446	2,656	1,259	23,862
MD	5,133	771	10	7,382	2,257	4	260	1,997	777	18,591
ME	1,518	212	2	2,495	614	0	62	787	199	5,889
MI	13,798	1,534	38	24,202	4,211	5	719	4,070	1,550	50,127
MN	6,444	1,077	9	11,859	4,152	4	267	1,907	813	26,533
MO	7,178	1,090	12	13,836	3,227	4	417	8,256	893	34,913
MS	8,436	1,268	10	8,360	6,390	0	138	1,240	333	26,175
MT	4,262	543	2	2,787	2,890	0	36	1,207	97	11,824
NC	6,647	1,359	19	19,424	4,536	4	611	2,796	1,188	38,585
ND	2,254	213	1	2,820	977	0	32	3,119	89	9,506
NE	3,324	339	2	4,213	1,236	10	89	1,356	271	10,842
NH	1,240	177	2	1,969	492	0	59	532	200	4,670
NJ	7,772	1,149	40	13,016	3,106	1	1,200	2,314	1,379	29,977
NM	3,950	661	4	3,770	2,995	1	73	1,665	161	13,300
NV	1,712	267	3	2,694	1,013	0	71	578	230	6,569
NY	14,602	1,963	52	32,575	5,385	3	1,337	5,639	3,220	64,777
OH	12,838	1,749	61	29,275	4,669	6	1,008	3,829	1,956	55,391
OK	8,938	686	6	5,665	2,105	1	151	1,552	404	19,507
OR	5,454	1,152	6	10,696	5,654	2	148	1,022	456	24,589
PA	11,951	1,660	42	26,161	4,561	3	1,078	4,764	2,097	52,316
RI	980	135	4	1,643	372	0	77	456	184	3,851
SC	5,919	1,270	53	6,859	5,332	1	594	1,292	565	21,885
SD	1,381	168	1	1,795	618	1	34	853	98	4,948
TN	6,357	1,099	47	12,033	3,001	2	624	2,248	851	26,262
TX	37,084	3,538	98	36,191	10,285	16	1,393	7,014	2,524	98,143
UT	3,087	410	5	4,275	1,569	0	100	663	263	10,372
VA	7,831	1,187	18	16,552	3,513	3	420	3,851	1,007	34,381
VT	727	106	1	1,015	309	0	29	418	99	2,705
WA	6,571	1,025	26	13,226	3,235	4	386	1,966	771	27,190
WI	6,300	868	12	13,385	2,519	4	304	1,792	896	26,080
WV	2,204	371	18	5,055	1,018	0	226	2,312	214	11,418
WY	2,454	215	1	2,262	960	0	24	315	50	6,281
TOTAL	**392,476**	**59,926**	**920**	**584,770**	**231,149**	**203**	**19,579**	**115,017**	**41,709**	**1,445,749**

BEN - Benzene; BUT - 1,3 -Butadiene; CTET - Carbon Tetrachloride; EOM - Extractable Organic Matter; FORM - Formaldehyde; HCB - Hexachlorobenzene; METH - Methylene Chloride; PERC - Perchloroethylene; TRI - Trichloroethylene.

Note(s). Ninety-nine percent of hexachlorobenzene (HCB) emissions are from pesticides.

Totals in this table may not equal those shown in the national tables because state data were not available for the following source categories:
- Benzene - aircraft, non-road mobile, and utility residual oil sources
- 1,3-Butadiene - aircraft & non-road mobile sources
- Carbon Tetrachloride - hazardous waste incinerators and utility coal sources
- EOM - commercial/wood/wood residue, on-road mobile, and non-road mobile sources
- Formaldehyde - aircraft and non-road mobile sources
- Methylene Chloride - utility coal sources
- Perchloroethylene - utility coal and utility residual oil sources
- Trichloroethylene - utility coal sources

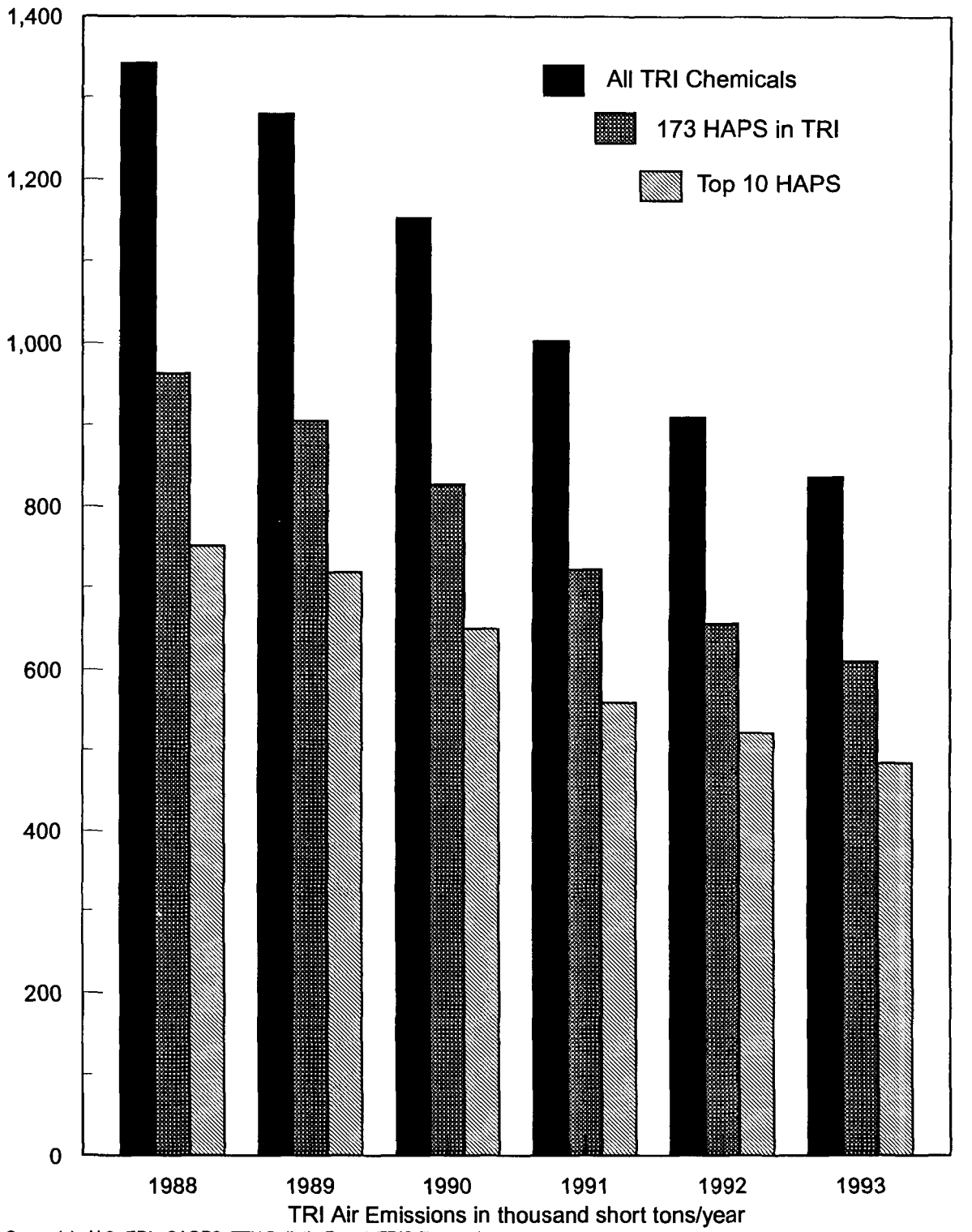
Source(s): *National Screening Inventory of Sources and Emissions of Candidate 112(k) Pollutants to Support the Urban Area Source Program, Review Draft* and background data, U.S. Environmental Protection Agency, April 1995.

Telefax entitled "POTW Number," from G. Brooks, Radian Corporation, to S. Nizich, U.S. Environmental Protection Agency, June 13, 1995.

Emissions Inventory of Section 112(c)(6) Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), and Polychlorinated Biphenyl Compounds (PCBs), Final Report and data, Radian Corporation, March 1995.

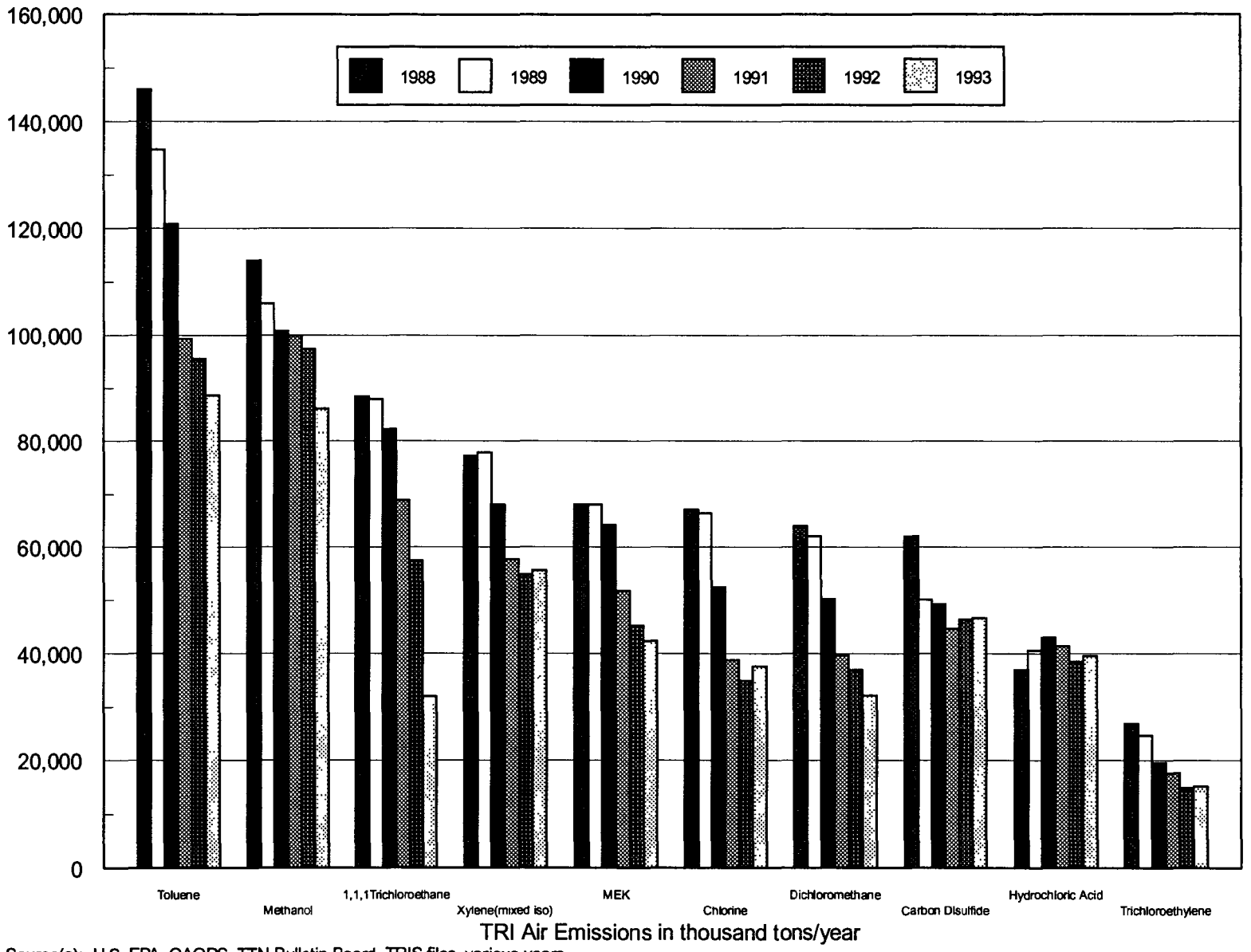
Estimation of National Hexachlorobenzene Emissions for 1990, Final Report, (table 1), U.S. Environmental Protection Agency, October 1993.

Figure 8-1. Toxic Release Inventory
Air Emissions Inventory



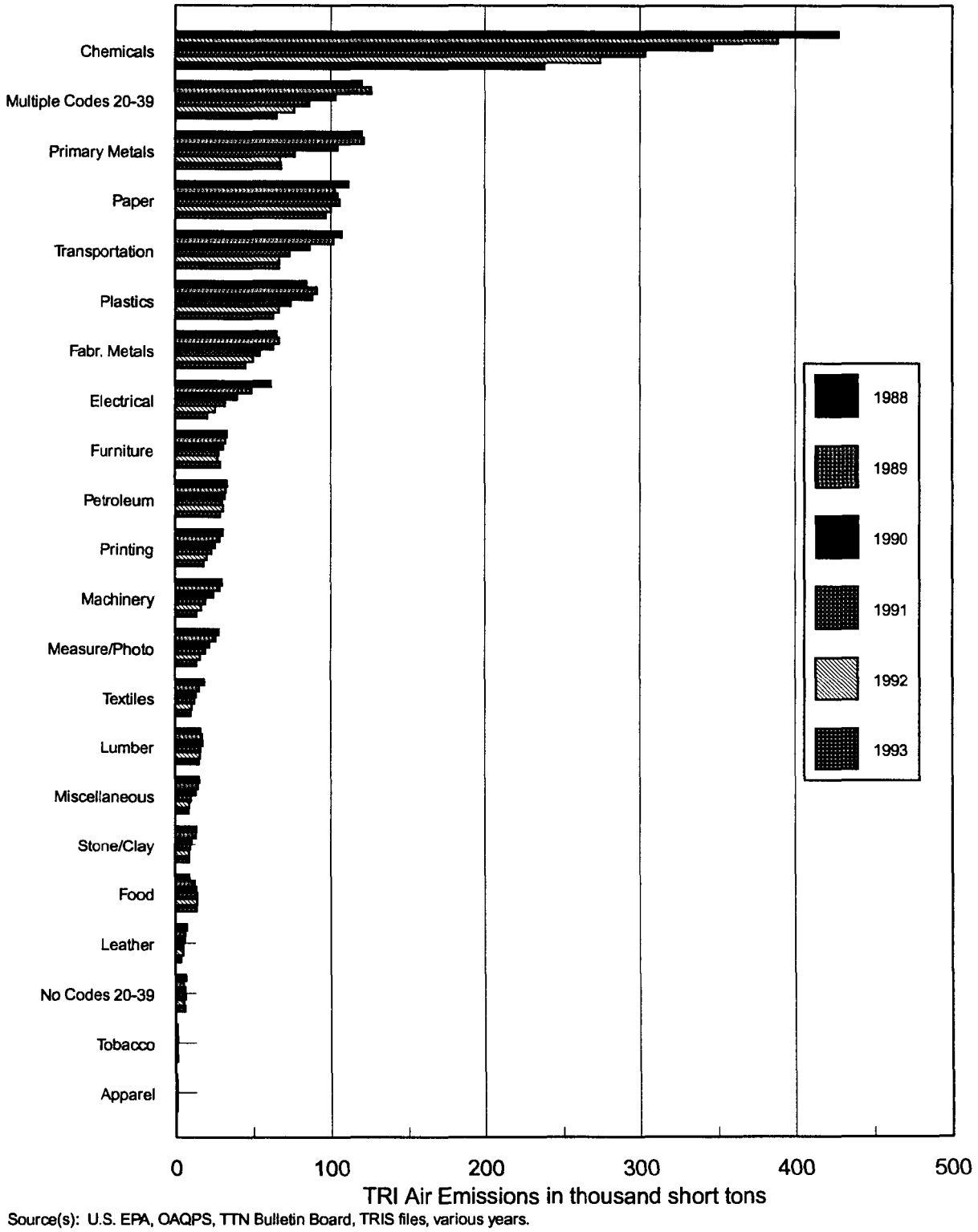
Source(s): U.S. EPA, OAQPS, TTN Bulletin Board, TRIS files, various years.

Figure 8-2. Top 10 Hazardous Air Pollutants - 1988 Basis



Source(s): U.S. EPA, OAQPS, TTN Bulletin Board, TRIS files, various years.

Figure 8-3. Toxic Release Inventory Releases by Industry, 1988 - 1993



Source(s): U.S. EPA, OAQPS, TTN Bulletin Board, TRIS files, various years.

Chapter 9.0 Biogenic Emissions

This chapter presents a preliminary estimate of biogenic VOC and NO emissions for 1990. The methodology for computing these estimates is based on the Biogenic Emissions Inventory System — Version 2 (BEIS2)[1,2]. Because of the availability of more recent field measurements, this newer version of BEIS tends to produce higher annual fluxes of isoprene and NO than the earlier version of BEIS[3,4]. The 1990 annual VOC emissions of 33.61 and NO emissions of 1.69 million short tons are considered preliminary because they are based on interim version of processed land use data and rely on a simple interpolation of meteorological data. The land use data are being adapted from a variety of federal agencies in an effort to provide a realistic depiction of national vegetation coverage for the explicit purpose of computing biogenic emissions. The sources of land use data include (in order of priority): tree coverage by genus (eastern United States, U.S. Forest Service), crop areas (USDA), urbanized areas (U.S. Census Bureau), other areas including water, scrub, and barren (primarily western United States, U.S. Geological Survey's 1990 land use/land cover). The meteorological data used in the calculation are based on spatial interpolations of 1990 mean monthly diurnal profiles of ambient air temperature and cloud cover from National Weather Service surface observing stations.

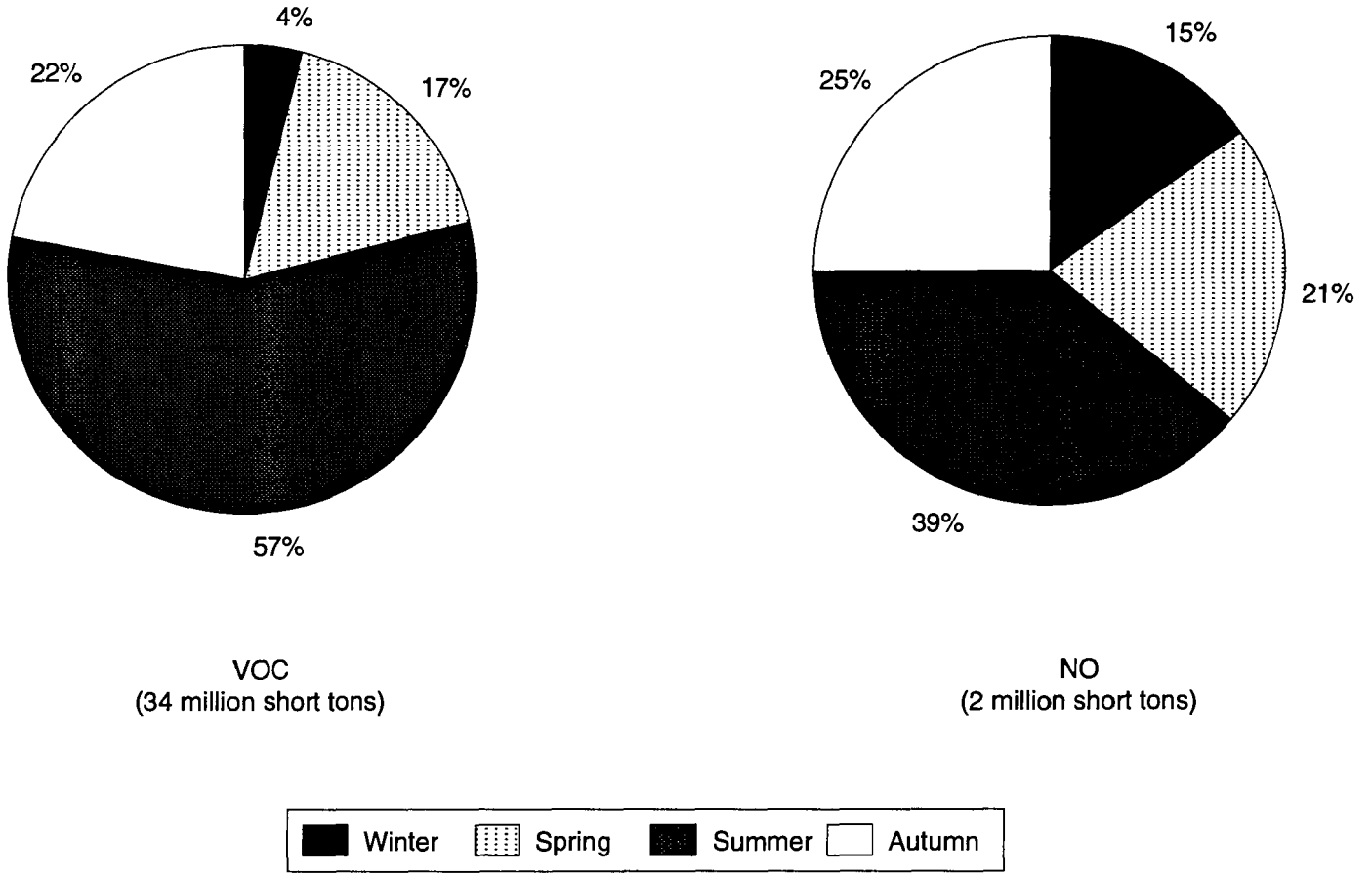
Biogenic emission estimates are strongly affected by differences in climatology and land use. Figure 9-1 shows that highest emissions occur in the summer, when temperatures are highest. Variations in biogenic emissions are influenced by fluctuations in temperature. For example an increase of 10°C can result in over a two-fold increase in both VOC and NO. It is expected, therefore, that future annual emission estimates will correlate very strongly to changes in annual temperature patterns. Figure 9-2 shows the spatial variation in biogenic emission densities estimated for counties across the United States. While some of this variability is attributable to differences in temperature and solar radiation, much of the spatial difference can be attributed to variations in land use. Higher VOC densities in the southern United States and in Missouri are strongly linked to the large areas of high-emitting oak trees. The relatively high densities of NO in the midwestern United States are associated with areas of fertilized crop land.

Research in the area of biogenic emissions continues to be highly volatile, and changes in emission estimates methodology are to be expected in the next few years. Several EPA-sponsored research programs will hopefully begin to yield more accurate estimates of these emissions. However, in the next few years, these estimates should be viewed with a degree of uncertainty.

9.1 REFERENCES

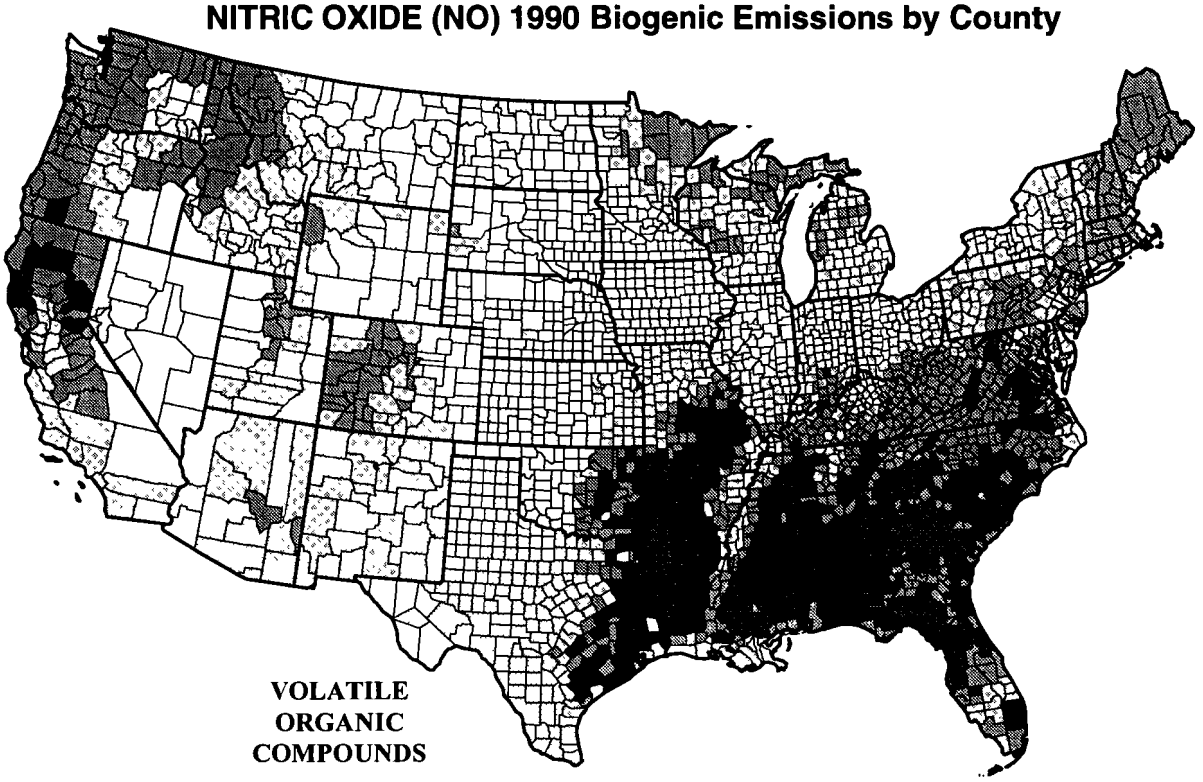
1. Birth, T. User's Guide to the Personal Computer Version of the Biogenic Emissions Inventory System (PC-BEIS2), EPA-600/R-95-091, Environmental Protection Agency, Research Triangle Park, NC. 1995.
2. Geron, C., A. Guenther, and T. Pierce. An improved model for estimating emissions of volatile organic compounds from forests in the eastern United States. Journal of Geophysical Research, vol. 99, pp. 12773-12791. 1994.
3. Guenther, A., et al. A global model of natural organic compound emissions. Journal of Geophysical Research, vol. 100, pp. 8873-8892. 1995.
4. Williams, E., A. Guenther, and F. Fehsenfeld. An inventory of nitric oxide emissions from soils in the United States. Journal of Geophysical Research, vol. 97, pp. 7511-7519. 1992.

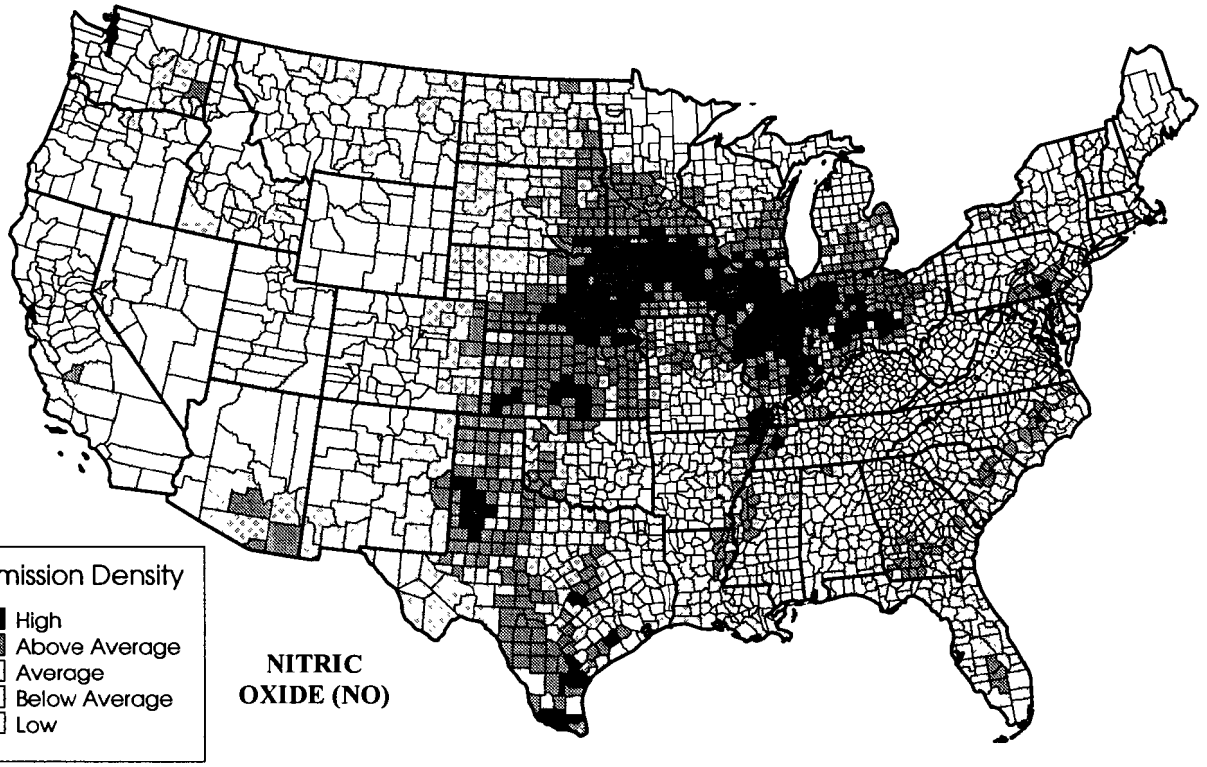
Figure 9-1. Seasonal Breakdown of Total 1990 Biogenic VOLATILE ORGANIC COMPOUND and NITRIC OXIDE (NO) Emissions



Note(s): Winter is defined as December, January, and February.

Figure 9-2. Density Maps of VOLATILE ORGANIC COMPOUND and NITRIC OXIDE (NO) 1990 Biogenic Emissions by County





Chapter 10.0 National and International Greenhouse Gas Emissions

Naturally occurring greenhouse gases include water vapor, CO_2, CH_4, nitrous oxide (N_2O), and O_3. Chlorofluorocarbons (CFCs [a family of human-made compounds]), its substitute hydrofluorocarbons (HFCs), and other compounds such as perfluorinated carbons (PFCs), are also greenhouse gases. Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, their recent atmospheric buildup appears to be largely the result of anthropogenic activities. This growth has altered the composition of the Earth's atmosphere, and may affect future global climate. Since 1800, atmospheric concentrations of carbon dioxide have increased by more than 25 percent, CH_4 concentrations have more than doubled, and nitrous oxide concentrations have risen approximately 8 percent.[1] From the 1950s until the mid-1980s, the use of CFCs increased by nearly 10 percent per year. Now that CFCs are being phased out under the *Montreal Protocol on Substances that Deplete the Ozone Layer* (*Montreal Protocol*), the use of CFC substitutes is expected to grow significantly.

10.1 NATIONAL

10.1.1 Methodology and Data

The U.S. greenhouse gas emissions presented in this report are taken from an EPA report, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994*, Draft Report, September 1995.[2] Emissions of greenhouse gases for various source categories were developed using methods that are similar to those recommended by Volumes 1-3 of the *Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*.[3] The IPCC guidelines were followed whenever possible to ensure that the U.S. emissions inventory is comparable to other countries' inventories submitted under the Framework Convention on Climate Change (FCCC). It should be noted that the IPCC guidelines represent baseline methodologies. The methodologies are currently evolving, and efforts continue to refine the recommended procedures. For U.S. emission sources relating to energy consumption, forest sinks, and some CH_4 sources, the IPCC default methodologies were expanded, resulting in a more comprehensive estimation procedure for the U.S. Details on the methods utilized to develop the U.S. emissions are available in the aforementioned September 1995, EPA report.

10.1.2 Trends

U.S. emissions and uptake of carbon dioxide for 1990 to 1994 are summarized in table 10-1. Carbon dioxide emissions from fossil fuel consumption comprise the largest category of U.S. emissions, accounting for about 99 percent of total CO_2 emissions and 83 percent of all U.S. greenhouse gas emissions. Changes in CO_2 emissions from fossil fuel consumption had the greatest impact on U.S. emissions during this period. While U.S. emissions of CO_2 in 1991 were approximately 1 percent lower than 1990 emission levels, in 1992 they were about 1 percent over 1991 levels, thus returning emissions to about 1990 levels. In 1993 CO_2 emissions from fossil fuel combustion were approximately 2 percent higher than the previous year, with emissions increasing 1 percent in 1994. Overall, emissions in 1994 were about 4 percent higher than 1990 levels. This trend is largely attributable to changes in total energy consumption resulting from the economic slowdown in the U.S. in the early 1990s and the subsequent recovery. During this period industrial processes accounted for about 1 percent of total U.S. CO_2 emissions. Because certain natural processes remove (sequester) CO_2 from the atmosphere, total net CO_2 emissions are estimated by subtracting the amount of CO_2 sequestered by forest management and land-use activities from the amount produced. Over the 1990 to 1992 period, these activities removed approximately 10 percent of total CO_2 emissions. Forest sink estimates for 1993 and 1994 are not yet available.

Methane emissions from the U.S. from 1990 to 1994 are summarized in table 10-2. Landfills are the largest single anthropogenic source of CH_4 in the United States, accounting for about 36 percent of total U.S. CH_4 emissions. The agricultural sector is also a major source of CH_4, accounting for approximately 33 percent of total U.S. CH_4 emissions in 1994, with enteric fermentation in domestic livestock and manure management together comprising the majority. Methane emissions from coal mining account for about 14 percent of total CH_4 emissions, and have fluctuated significantly in recent years, largely due to decreases in coal production as a result of labor unrest in 1993. As coal production has risen since the end of the strikes, emissions from coal mining have increased commensurately.

Emissions of N_2O from 1990 to 1994 are displayed in table 10-3. These emissions have increased over 10 percent since 1990, primarily for two reasons. First, emissions from fertilizer use,

which account for approximately 45 percent of total U.S. N_2O emissions, increased significantly from 1993 to 1994 as farmers planted more acreage and increased fertilizer use to replace nutrients lost in the flooding of 1993. Second, emissions have also increased slightly from other categories as the U.S. economy has grown since the early 1990s.

Emissions of HFCs and PFCs for 1990 to 1994 are summarized in table 10-4. These compounds are powerful greenhouse gases and have been receiving increased attention under the FCCC. These emissions have begun to grow as the use of these chemicals increases to replace the phaseout of CFCs and other ozone-depleting compounds under the terms of the Montreal Protocol and the CAAA. Their use since 1990 has grown primarily due to an increase in the use of HFC-134a in mobile air conditioners (MACs). Hydrofluorocarbon and PFC emissions are also the result of by-product emissions from other production processes.

10.2 INTERNATIONAL

10.2.1 Carbon Dioxide Emissions

The CO_2 emissions presented in this section were obtained from the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratories.[4] A systematic method for estimating the amount of global CO_2 emissions due to fossil-fuel combustion was first proposed in 1973. The methodology also accounts for CO_2 emissions from cement manufacturing and gas flaring. Since that date, both the data collection and the procedures for estimating CO_2 emissions have been refined and improved.[5] To derive global emissions, energy and population statistics were obtained from the United Nation's Department of International Economic and Social Affairs. The U.S. DOI's Bureau of Mines supplied cement manufacturing data, and gas flaring data were compiled from both the U.S. EIA and the United Nations.

10.2.2 Global Trends

Since 1860, when CO_2 emissions were estimated to be about 375 million short tons per year, global CO_2 emissions have risen dramatically. In 1991, approximately 25 billion short tons of CO_2 were emitted to the atmosphere as a result of fossil-fuel burning, cement manufacturing, and gas flaring.

Table 10-5 presents global CO_2 emissions for 1860 to 1991. Starting in 1950, estimates were developed using the methods of Marland and Rotty.[6] Figure 10-1 depicts the trend in CO_2 emissions over the 1950 to 1991 period. Total global CO_2 emissions continued their upward trend, increasing 2 percent between 1990 and 1991.

Table 10-6 displays regional world CO_2 emissions for 1950 to 1991. The nine regions are based on United Nations conventions and are defined in table 10-6. Between 1990 and 1991, a decline in CO_2 emissions was evident for Eastern Europe and North America. An increase in CO_2 emissions over the same period was seen for regions experiencing much faster population growth (i.e., Africa, Centrally Planned Asia, Other America, Far East, and Oceania). In 1950, North America, and Western and Eastern Europe contributed approximately 89 percent of total CO_2 emissions. Presently, that percentage has dropped to only about 40 percent as economic growth in developing countries has led to substantial increases in emissions.

Figure 10-2 compares estimates of total global CO_2 per capita emissions with CO_2 per capita emissions for Mexico and Canada during 1950 to 1991. Per capita emissions for the United States are presented from 1950 to 1989. 1990 to 1993 CO_2 emissions for the United States are discussed in section 10.1. Per capita CO_2 emissions for Canada peaked in 1979 at 19.8 short tons, well above the global average, while Mexico's per capita emissions are significantly lower, exceeding the global average only once in 1982.

10.2.3 United States

Table 10-7 and figure 10-3 present CO_2 emissions for the United States. The United States continues to be the largest single source of fossil-fuel-related CO_2 emissions, contributing approximately 38 percent more CO_2 emissions than the world's second largest emitter, the former USSR. Carbon dioxide emissions in 1989 were nearly twice those of 1950, although the United States' share of global emissions declined over the same interval due to higher growth rates in other countries. In 1989, CO_2 emissions from the United States reached an all-time high of 6 billion short tons of CO_2 and have since remained near this level. U.S. emissions for 1990 through 1993 are discussed in more detail in section 10.1.

10.2.4 Canada

Table 10-8 and figure 10-4 present CO_2 emissions for Canada for the period 1950 to 1991. Total CO_2 emissions from Canada more than doubled between 1950 and 1974, and continued rising until 1980. In the early 1980s, CO_2 emissions declined, but then began to increase by 1986, peaking in 1989 at 488 million short tons of CO_2. By 1991, CO_2 emissions had decreased 7 percent from 1989 emission levels. Coal burning contributed to 63 percent of the total emissions in 1950, but declined in both absolute and relative terms until 1974. Beginning in 1974, a decline in CO_2 emissions from liquid fuels was accompanied by a steady increase in emissions from coal.[6]

10.2.5 Mexico

Carbon dioxide emissions for Mexico are displayed in table 10-9 and figure 10-5. From 1950 to 1982, total CO_2 emissions

from Mexico increased at a rate of approximately 7 percent per year. Total emissions declined slightly and leveled off near 320 million short tons of CO_2 during the period 1983 to 1988. From 1989 to 1991, total emissions rose approximately 10 percent, peaking at 375 million short tons of CO_2 in 1991. The increase in emissions has been largely attributable to an increase in oil production. In 1991, petroleum products accounted for 74 percent of total CO_2 emissions, the highest fraction of any of the major CO_2-emitting countries. In recent years, natural gas has become increasingly important in Mexico and now accounts for 15 percent of CO_2 emissions.[6]

10.3 REFERENCES

1. *IPCC National Inventory Guidelines: Workbook Module 1.* Document included with CEEM module. Organization for Economic Co-Operation and Development, and International Energy Agency. Paris, France. 1992.
2. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994.* Draft Report. U.S. Environmental Protection Agency. September 1995.
3. *IPCC Guidelines for National Greenhouse Gas Inventories, 3 volumes: Vol. 1, Reporting Instructions; Vol. 2, Workbook; Vol. 3, Reference Manual.* Intergovernmental Panel on Climate Change, Organization for Economic Co-Operation and Development, and International Energy Agency. Paris, France. 1995.
4. Keeling, C.D. Global historical CO_2 emissions. pp. 5-8. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A. 1994.
5. Marland, G. and R.M. Rotty. *Carbon Dioxide Emissions from Fossil Fuels: A Procedure for Estimation and Results for 1950-1982.* Tellus 36b:232-261. 1984.
6. Marland, G., R.J. Andres, and T.A. Boden. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A. 1994.

Table 10-1. Summary of U.S. Carbon Dioxide Emissions and Sinks by Source Category, 1990 to 1994 Preliminary Estimates (thousand short tons)

Source Category	1990	1991	1992	1993	1994
FOSSIL FUEL CONSUMPTION FOR ENERGY					
Electric Utilities	1,920,700	1,909,200	1,905,200	1,976,300	1,993,600
Oil	107,600	101,300	80,600	90,900	83,400
Gas	167,000	196,600	168,000	162,300	180,300
Coal	1,646,000	1,638,300	1,656,700	1,723,100	1,729,900
Industry	1,175,000	1,127,700	1,185,500	1,176,200	1,189,200
Oil	418,400	366,400	411,800	384,200	399,700
Gas	480,600	500,500	520,300	540,800	540,200
Coal	275,900	260,900	253,500	251,100	249,300
Transportation	1,656,400	1,621,400	1,643,600	1,674,300	1,709,100
Oil	1,616,500	1,584,500	1,607,500	1,636,200	1,670,600
Gas	39,800	36,900	36,100	38,000	38,500
Coal	0	0	0	0	0
Commercial	240,100	244,700	245,400	246,400	256,900
Oil	72,900	69,100	65,200	60,300	61,600
Gas	157,600	166,800	171,300	177,200	182,200
Coal	9,700	8,800	8,900	8,900	10,100
Residential	367,300	383,100	392,700	413,600	411,600
Oil	97,000	98,800	100,400	106,200	111,300
Gas	263,900	278,400	286,300	301,500	293,100
Coal	6,500	5,900	5,900	5,900	7,300
U.S. Territories	36,800	43,200	37,800	37,800	37,800
Oil	36,300	42,500	37,100	37,100	37,100
Gas	0	0	0	0	0
Coal	500	800	800	800	800
Total Fossil Fuel Consumption	*5,396,300*	*5,329,400*	*5,410,300*	*5,524,600*	*5,595,300*
FUGITIVE FUEL	***7,200***	***8,200***	***8,000***	***8,000***	***8,000***
INDUSTRIAL PROCESSES					
Cement Production	36,000	35,200	35,400	37,400	40,200
Lime Production	13,100	12,900	13,300	13,800	14,000
Limestone Use	5,600	5,300	4,900	4,500	4,800
Soda Ash Production and Use	4,600	4,400	4,500	4,400	4,400
Carbon Dioxide Manufacture	1,300	1,400	1,500	1,500	1,500
Total Industrial Processes	60,600	59,200	59,600	61,700	64,900
TOTAL EMISSIONS	***5,464,100***	***5,396,800***	***5,477,900***	***5,594,300***	***5,668,200***
FORESTRY/LAND USE*	***(481,000)***	***(477,000)***	***(473,000)***	***NA***	***NA***
TOTAL NET EMISSIONS	**4,983,100**	**4,919,800**	**5,004,900**	**NA**	**NA**

Note(s): * Negative values represent a carbon sink.
Totals presented in this table may not equal the sum of the individual source categories due to rounding.
NA = not available.

Source(s): Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1900-1994. Draft Report, U.S. Environmental Protection Agency. September 1995.

Table 10-2. Summary of U.S. Methane Emissions by Source Category, 1990 to 1994
Preliminary Estimates
(thousand short tons)

Source Category	1990	1991	1992	1993	1994
WASTE					
Landfills	10,900	11,100	10,900	11,000	11,200
Wastewater	200	200	200	200	200
AGRICULTURE					
Cattle	6,000	6,000	6,100	6,200	6,300
Other	300	300	300	300	300
Animal Waste					
Dairy	900	900	900	900	1,000
Beef	200	200	200	200	200
Swine	1,100	1,100	1,200	1,100	1,300
Poultry	300	300	300	300	300
Other	40	40	40	40	40
Agricultural Waste Burning	100	100	100	100	100
Rice Cultivation	500	500	500	500	600
TOTAL AGRICULTURE	*9,400*	*9,500*	*9,700*	*9,700*	*10,200*
FUGITIVE FUEL EMISSIONS					
Coal Mining	4,900	4,700	4,500	4,000	4,400
Oil and Gas Systems	3,600	3,600	3,600	3,600	3,600
MOBILE SOURCE COMBUSTION	300	300	300	300	300
STATIONARY COMBUSTION	700	800	800	700	700
TOTAL EMISSIONS	**29,900**	**30,100**	**30,000**	**29,500**	**30,600**

Note(s): Totals presented in this table may not equal the sum of the individual source categories due to rounding.
Source(s): Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1900-1994. Draft Report, U.S. Environmental Protection Agency. September 1995.

Table 10-3. Summary of U.S. Nitrous Oxide Emissions by Source Category, 1990 to 1994 Preliminary Estimates
(thousand short tons)

Source Category	1990	1991	1992	1993	1994
AGRICULTURE					
Crop Waste Burning	4	4	5	4	5
Fertilizers	204	208	210	209	232
TOTAL AGRICULTURE	*208*	*212*	*215*	*213*	*238*
MOBILE SOURCE COMBUSTION	108	110	113	115	117
STATIONARY COMBUSTION	39	38	39	39	40
INDUSTRIAL PROCESSES					
Adipic Acid Production	62	65	60	64	68
Nitric Acid Production	44	44	44	45	49
TOTAL INDUSTRIAL PROCESSES	*106*	*109*	*104*	*109*	*117*
TOTAL EMISSIONS	**461**	**465**	**471**	**476**	**512**

Note(s): Totals presented in this table may not equal the sum of the individual source categories due to rounding.
Source(s): Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1900-1994. Draft Report, U.S. Environmental Protection Agency. September 1995.

Table 10-4. Emissions of Hydrofluorocarbons and Perfluorinated Carbon, 1990 to 1994 Preliminary Estimates
(thousand short tons; molecular basis)

Compound	GWP	1990	1991	1992	1993	1994
HFCs						
HFC-23	12,100	6.085	6.206	6.327	2.910	3.075
HFC-125	3,200	0.000	0.000	0.000	0.000	4.211
HFC-134a	1,300	0.551	0.992	1.323	6.526	11.475
HFC-125a	140	0.282	0.292	0.296	1.146	1.687
HFC-227	3,300	0.000	0.000	0.000	0.000	3.946
PFCs						
CF_4	6,300	2.701	2.701	2.701	2.695	2.695
C_2F_6	12,500	0.270	0.270	0.270	0.270	0.270
SF_6	24,900	1.102	1.102	1.102	1.102	1.135

Note(s): Totals presented in this table may not equal the sum of the individual source categories due to rounding.
Source(s): Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1900-1994. Draft Report, U.S. Environmental Protection Agency. September 1995.

Table 10-5. Global Carbon Dioxide Emissions
(million short tons)

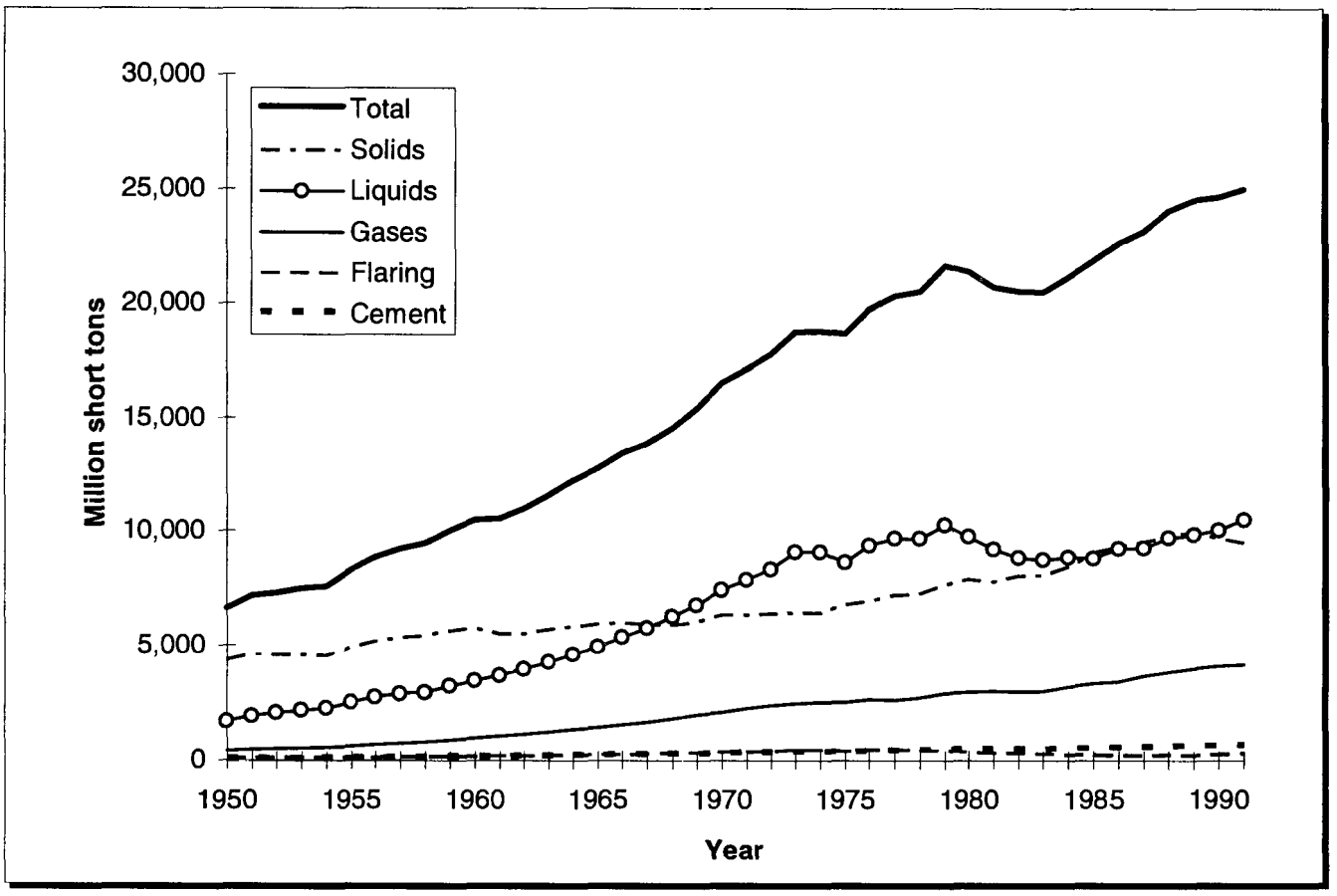
Year	Coal	Lignite	Crude petroleum	Natural gas	Total
1860	370	7	0	0	378
1865	480	11	0	0	491
1870	568	15	4	0	587
1875	741	22	4	0	766
1880	880	26	15	0	917
1885	1,067	33	15	4	1,118
1890	1,331	44	33	7	1,415
1895	1,503	55	44	11	1,610
1900	1,962	81	62	15	2,123
1905	2,402	99	92	22	2,614
1910	2,959	121	139	33	3,252
1915	2,996	139	183	40	3,359
1920	3,340	176	308	51	3,876
1925	3,318	209	462	77	4,066
1930	3,410	220	612	114	4,356
1935	3,113	231	704	121	4,169
1940	3,817	356	909	172	5,254
1945	3,329	209	1,063	264	4,866

Year	Solids	Liquids	Gases	Cement	Flaring	Global per capita	Total
1950	4,353	1,710	392	73	93	3	6,620
1955	4,911	2,526	606	121	125	3	8,286
1960	5,735	3,435	950	174	158	3	10,452
1965	5,933	4,935	1,419	238	222	4	12,748
1970	6,321	7,429	2,086	315	352	4	16,506
1975	6,786	8,613	2,518	384	376	5	18,681
1980	7,881	9,728	2,934	485	360	5	21,389
1985	9,049	8,771	3,306	529	222	5	21,878
1990	9,672	10,032	4,058	635	251	5	24,646
1991	9,466	10,472	4,139	655	283	5	25,010

Note(s): The sums may not equal total due to rounding.

Source(s): Keeling, C.D. 1994. Global historical CO_2 emissions. pp. 5-8. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.
Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Figure 10-1. 1950 to 1991 Global CARBON DIOXIDE Emissions from Fossil Fuel Burning, Cement Production, and Gas Flaring



Source(s): Keeling, C.D. 1994. Global historical CO_2 emissions. pp. 5-8. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

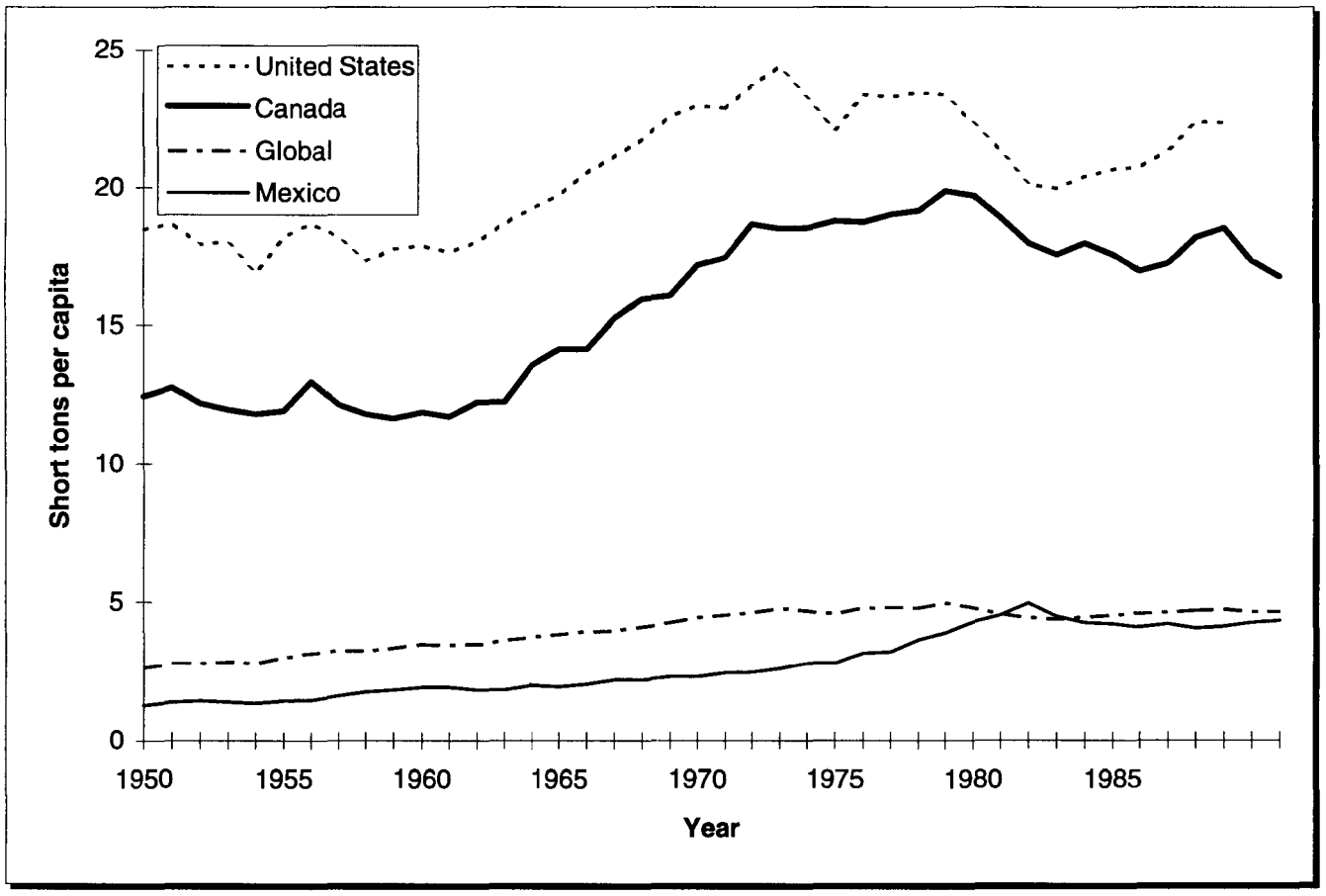
Table 10-6. Regional Carbon Dioxide Emissions
(million short tons)

	Total Emissions								
Year	Region 1 (AMD)	Region 2 (FEA)	Region 3 (AFR)	Region 4 (OCN)	Region 5 (MDE)	Region 6 (WEU)	Region 7 (CPE)	Region 8 (CPA)	Region 9 (NAM)
1950	182	115	105	185	19	1,549	1,185	91	2,984
1955	269	172	144	248	56	1,951	1,772	226	3,203
1960	339	230	174	370	101	2,170	2,390	906	3,445
1965	412	331	237	580	192	2,673	3,086	596	4,111
1970	582	478	331	1,000	299	3,203	3,665	971	5,077
1975	732	640	423	1,156	460	3,267	4,520	1,418	5,193
1980	983	951	571	1,282	564	3,562	5,235	1,807	5,574
1985	979	1,219	646	1,305	712	3,252	5,700	2,378	5,364
1990	1,107	1,719	727	1,519	924	3,353	5,378	2,970	5,905
1991	1,160	1,829	743	1,528	1,446	3,709	4,793	3,107	5,893

1 = Other America (AMD)
2 = Far East (FEA)
3 = Africa (AFR)
4 = Oceania & Japan (OCN)
5 = Middle East (MDE)
6 = Western Europe (WEU)
7 = Eastern Europe (CPE)
8 = Centrally Planned Asia (CPA)
9 = North America (NAM)

Source(s): Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Figure 10-2. Comparison of Per Capita CARBON DIOXIDE Emissions



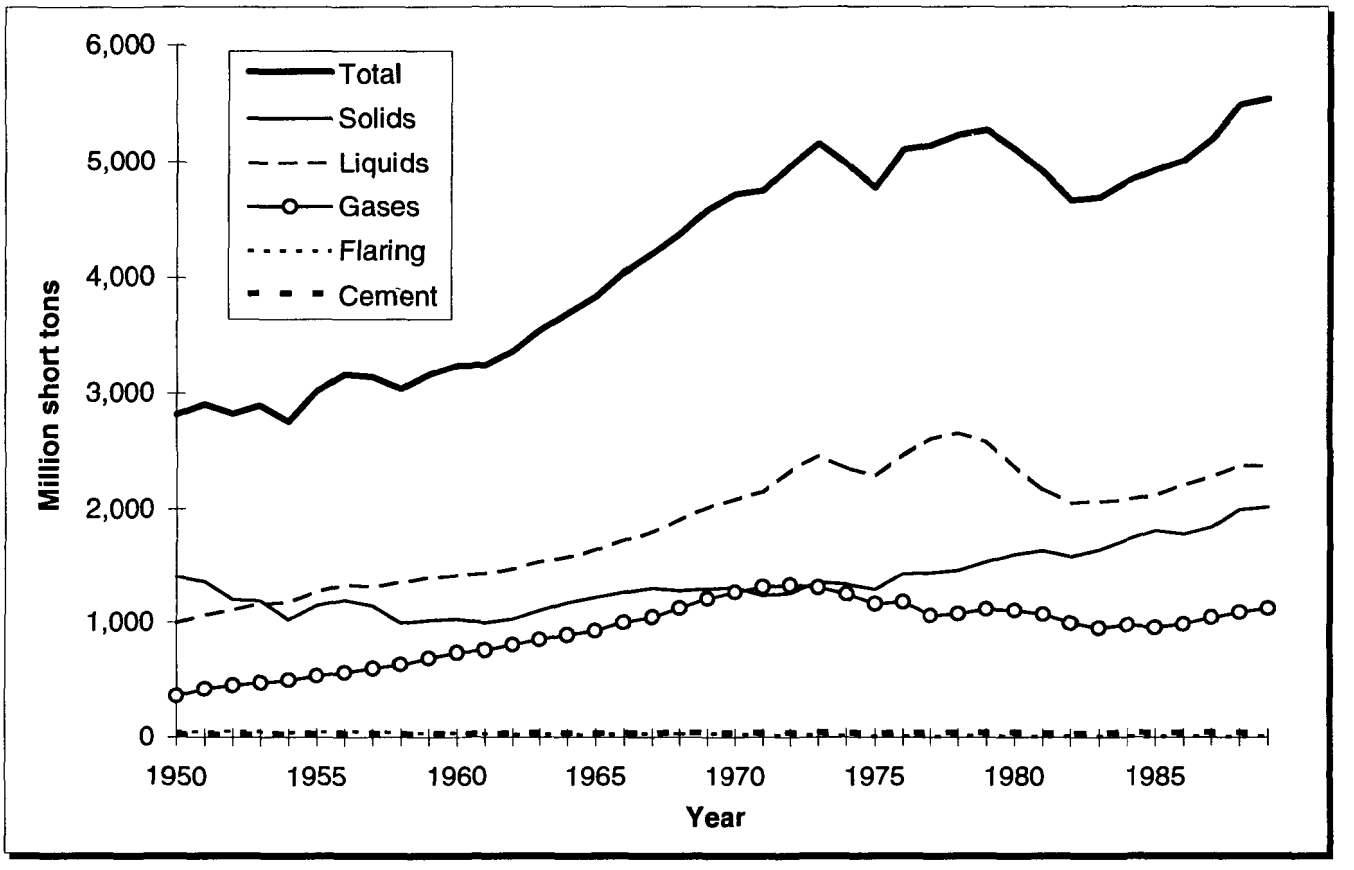
Note(s): U.S. per capita emissions data is not presented for 1990 or 1991. See section 10.1 for a discussion of 1990 to 1994 national CO_2 emission estimates.

Source(s): Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Table 10-7. Carbon Dioxide Emissions for the United States
(million short tons)

Year	Gas Fuels	Liquid Fuels	Solid Fuels	Gas Flaring	Cement Production	National per capita	Bunker Fuels	Total
1950	352	989	1,403	48	21	18.47	33	2,813
1955	529	1,266	1,145	46	29	18.19	44	3,015
1960	729	1,414	1,024	33	31	17.91	47	3,232
1965	922	1,639	1,217	19	36	19.72	43	3,833
1970	1,261	2,081	1,303	29	36	22.96	54	4,711
1975	1,156	2,284	1,283	8	34	22.07	59	4,765
1980	1,101	2,358	1,595	7	38	22.39	123	5,100
1985	949	2,117	1,811	6	39	20.65	62	4,921
1989	1,116	2,361	2,012	8	38	22.35	68	5,537

Figure 10-3. CARBON DIOXIDE Emissions for the United States

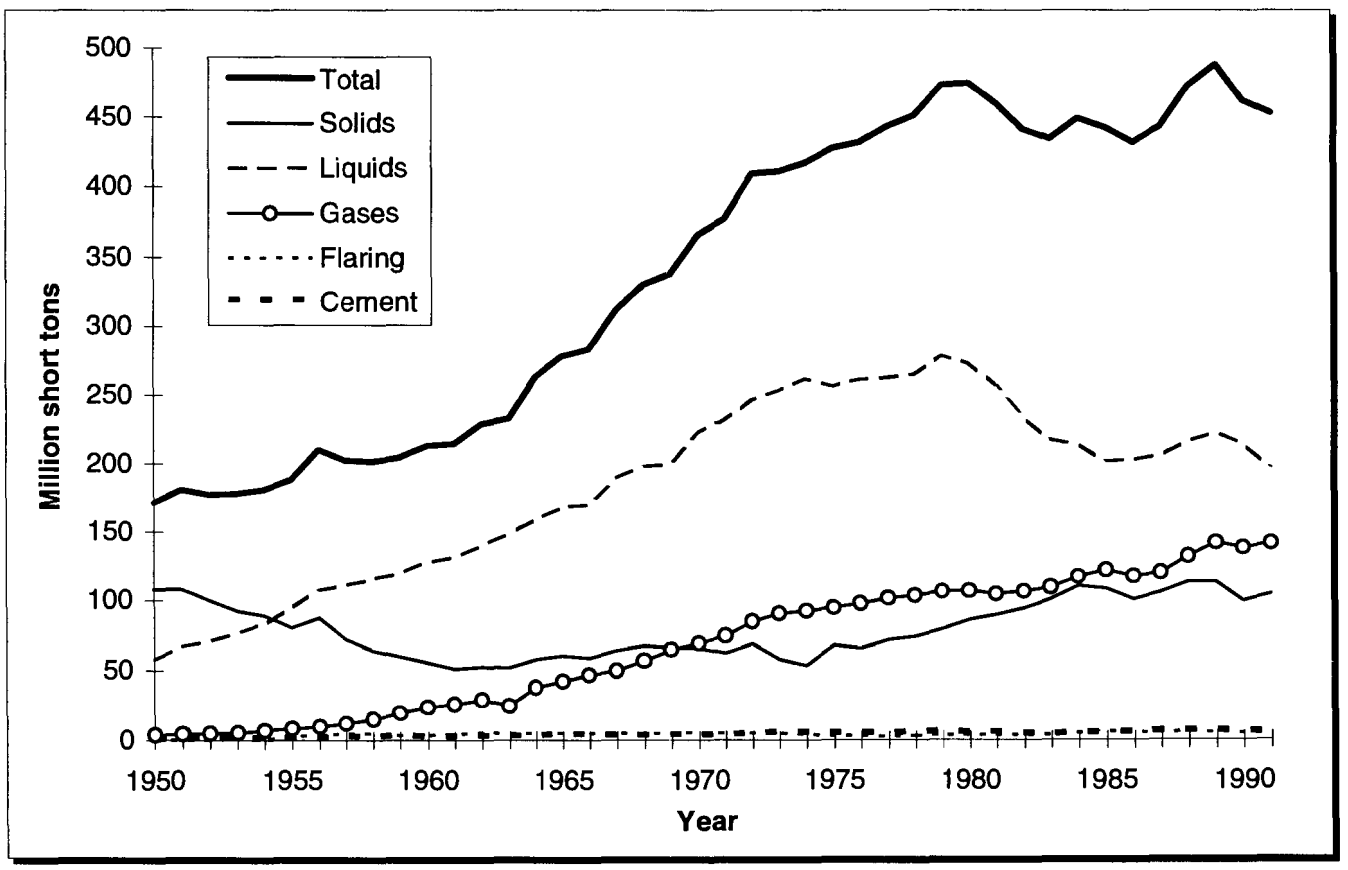


Note(s): U.S. emissions data is not presented for 1990 or 1991. See section 10.1 for a discussion of 1990 to 1994 national CO_2 emission estimates.
Source(s): Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change*. ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Table 10-8. Carbon Dioxide Emissions for Canada
(thousand short tons)

Year	Gas Fuels	Liquid Fuels	Solid Fuels	Gas Flaring	Cement Production	National per capita	Bunker Fuels	Total
1950	3,920	57,853	107,664	0	1,461	12.45	4,987	170,901
1955	8,205	94,597	80,277	2,309	2,197	11.92	5,998	187,585
1960	23,757	127,674	55,149	3,535	2,886	11.88	7,489	212,999
1965	41,957	167,392	60,145	4,644	4,165	14.15	9,931	278,302
1970	69,081	222,764	65,112	5,297	3,962	17.18	11,244	366,221
1975	94,771	256,593	67,663	2,943	5,478	18.79	9,765	427,450
1980	106,613	272,574	86,085	3,455	5,770	19.72	7,663	474,495
1985	121,684	201,299	108,246	5,525	5,602	17.58	3,064	442,360
1990	137,827	213,545	99,394	4,813	6,376	17.34	5,343	461,958
1991	141,048	196,436	104,459	4,972	6,046	16.77	5,000	452,961

Figure 10-4. CARBON DIOXIDE Emissions for Canada

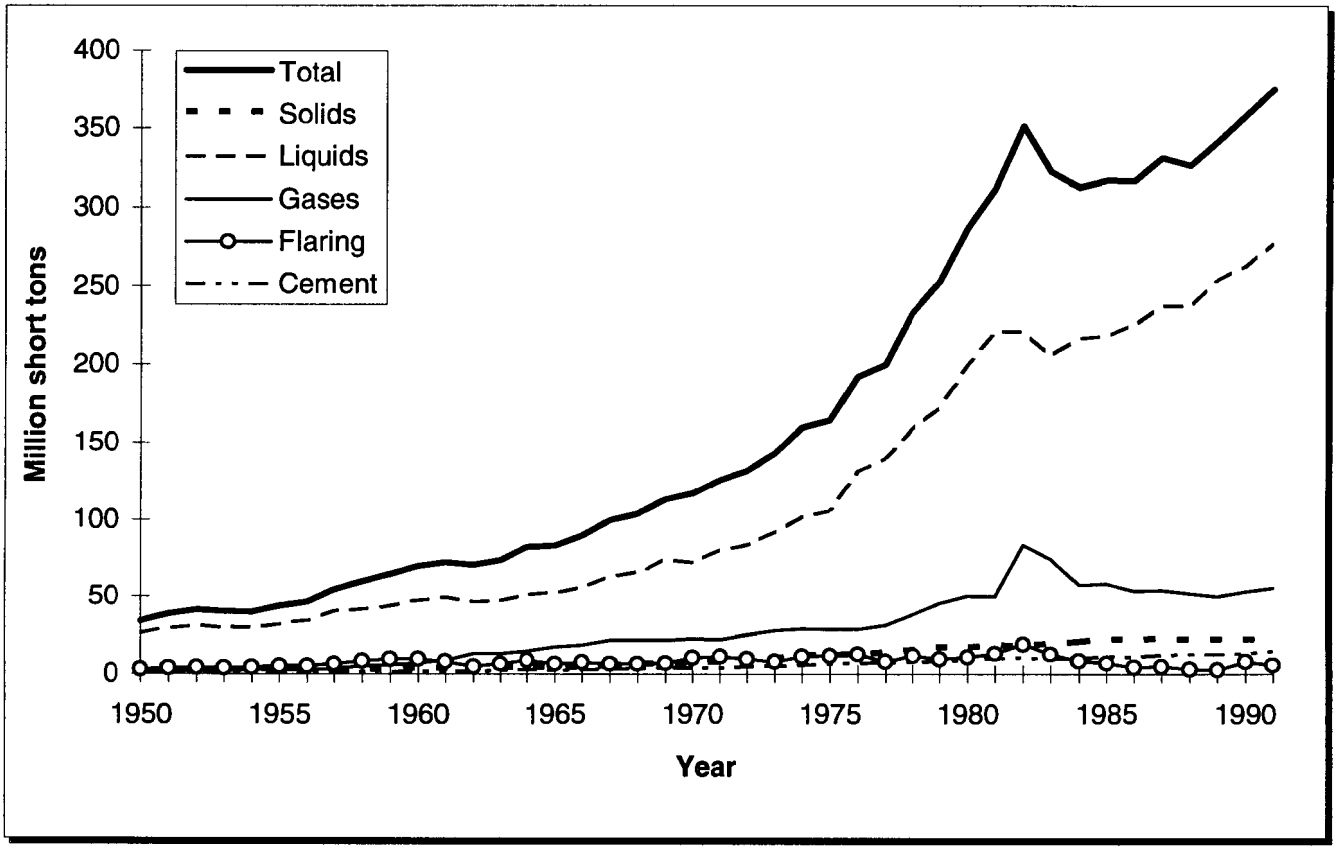


Source(s): Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Table 10-9. Carbon Dioxide Emissions for Mexico
(thousand short tons)

Year	Gas Fuels	Liquid Fuels	Solid Fuels	Gas Flaring	Cement Production	National per capita	Bunker Fuels	Total
1950	1,693	26,122	2,073	2,955	840	1.25	0	33,680
1955	2,571	31,821	2,995	5,302	1,107	1.41	0	43,792
1960	7,037	47,397	3,896	9,585	1,698	1.90	0	69,611
1965	17,392	52,175	4,543	6,518	2,366	1.94	0	82,993
1970	22,735	72,020	7,554	10,606	3,947	2.30	0	116,863
1975	28,757	105,206	12,416	11,537	6,383	2.79	0	164,296
1980	50,283	199,597	17,258	10,905	8,929	4.28	0	286,967
1985	58,043	217,801	22,557	6,906	11,367	4.20	0	316,678
1990	52,801	262,369	22,351	7,754	13,137	4.24	0	358,405
1991	54,911	276,944	22,945	5,438	14,676	4.32	0	374,911

Figure 10-5. CARBON DIOXIDE Emissions for Mexico



Source(s): Marland, G., R.J. Andres, and T.A. Boden. 1994. Global, regional, and national CO_2 emissions. pp. 9-88. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), *Trends '93: A Compendium of Data on Global Change.* ORNL/CDIAC-65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Appendix A National Emissions (1970 to 1994) by Subcategory

Table A-1. Carbon Monoxide Emissions
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***237***	***322***	***292***	***291***	***300***	***313***	***319***	***314***	***315***	***313***	***322***	***325***
Coal	106	188	208	208	217	229	231	233	233	235	245	246
Oil	41	48	18	24	20	25	26	20	19	15	16	14
Gas	90	85	56	48	53	48	51	51	51	51	49	53
Internal Combustion	NA	NA	10	11	10	11	11	11	12	11	12	12
FUEL COMB. INDUSTRIAL	***770***	***750***	***670***	***650***	***649***	***669***	***672***	***677***	***667***	***672***	***670***	***671***
Coal	100	58	86	87	85	87	87	86	72	80	77	80
Oil	44	35	47	46	46	46	46	46	52	47	47	50
Gas	462	418	257	242	252	265	271	276	274	276	276	273
Other	164	239	167	172	171	173	173	171	170	170	170	170
Internal Combustion	NA	NA	113	103	96	98	96	98	99	99	99	98
FUEL COMB. OTHER	***3,625***	***6,230***	***7,525***	***6,607***	***6,011***	***6,390***	***6,450***	***4,072***	***4,373***	***4,616***	***3,961***	***3,888***
Commercial/Institutional Coal	12	13	14	14	14	15	15	15	15	15	15	15
Commercial/Institutional Oil	27	21	18	18	19	18	17	16	16	17	17	17
Commercial/Institutional Gas	24	26	42	42	43	47	49	50	50	50	51	51
Misc. Fuel Comb. (Except Residential)	NA	NA	57	60	59	55	55	52	52	52	52	52
Residential Wood	2,932	5,992	7,232	6,316	5,719	6,086	6,161	3,781	4,090	4,332	3,679	3,607
fireplaces	686	1,402	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
woodstoves	2,246	4,590	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Residential Other	630	178	162	157	157	168	153	158	151	150	149	147
CHEMICAL & ALLIED PRODUCT MFG	***3,397***	***2,151***	***1,845***	***1,853***	***1,798***	***1,917***	***1,925***	***1,940***	***1,944***	***1,964***	***1,998***	***2,048***
Organic Chemical Mfg	340	543	251	261	260	278	285	286	284	288	289	293
ethylene dichloride	11	17	0	0	0	0	0	0	0	0	0	0
maleic anhydride	73	103	16	16	15	16	16	16	16	16	16	16
cyclohexanol	36	37	5	5	5	6	6	6	6	6	6	6
other	220	386	230	240	240	256	264	264	262	266	268	271
Inorganic Chemical Mfg	190	191	89	94	89	95	95	95	95	96	96	98
pigments; TiO2 chloride process: reactor	18	34	77	82	77	83	84	83	83	84	84	85
other	172	157	12	12	11	12	12	12	12	12	12	13
Polymer & Resin Mfg	NA	NA	19	19	18	18	18	19	19	19	19	20
Agricultural Chemical Mfg	NA	NA	16	16	16	17	17	17	18	18	18	19
Pharmaceutical Mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	2,866	1,417	1,471	1,463	1,415	1,509	1,510	1,522	1,529	1,542	1,574	1,619
carbon black mfg	2,866	1,417	1,078	1,068	1,034	1,098	1,112	1,126	1,131	1,142	1,170	1,207
carbon black furnace: fugitives	NA	NA	155	165	161	185	180	179	184	185	190	196
other	NA	NA	238	231	219	226	219	218	214	215	214	216

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
METALS PROCESSING	***3,644***	***2,246***	***2,223***	***2,079***	***1,964***	***2,101***	***2,132***	***2,080***	***1,992***	***2,044***	***2,091***	***2,166***
Nonferrous Metals Processing	652	842	694	650	614	656	677	681	653	665	676	695
aluminum anode baking	326	421	41	40	38	40	41	41	40	41	42	43
prebake aluminum cell	326	421	257	243	232	248	254	255	245	251	256	264
other	NA	NA	396	367	344	368	382	384	368	373	378	389
Ferrous Metals Processing	2,991	1,404	1,523	1,423	1,365	1,439	1,449	1,394	1,333	1,373	1,410	1,465
basic oxygen furnace	440	80	694	640	617	650	662	642	615	634	651	677
carbon steel electric arc furnace	181	280	19	17	17	18	18	17	16	17	17	18
coke oven charging	62	43	9	9	8	9	9	8	8	8	8	9
gray iron cupola	1,203	340	302	294	281	288	280	262	249	254	261	271
iron ore sinter plant windbox	1,025	600	304	280	266	287	293	283	271	280	287	298
other	81	61	194	184	176	188	187	181	174	180	185	192
Metals Processing NEC	NA	NA	6	6	6	6	6	6	5	6	6	6
PETROLEUM & RELATED INDUSTRIES	***2,179***	***1,723***	***462***	***451***	***455***	***441***	***436***	***435***	***412***	***410***	***398***	***390***
Oil & Gas Production	NA	NA	11	9	8	8	8	8	8	8	8	8
Petroleum Refineries & Related Industries	2,168	1,723	449	440	445	431	427	425	403	400	388	380
fcc units	1,820	1,680	403	398	408	393	390	389	367	364	352	344
other	348	44	46	41	37	38	37	36	36	36	36	36
Asphalt Manufacturing	11	0	2	2	2	2	2	2	2	2	2	2
OTHER INDUSTRIAL PROCESSES	***620***	***830***	***694***	***715***	***713***	***711***	***716***	***717***	***710***	***719***	***732***	***751***
Agriculture, Food, & Kindred Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Textiles, Leather, & Apparel Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	610	798	627	647	646	649	655	657	652	661	672	689
sulfate pulping: rec. furnace/evaporator	NA	NA	475	491	489	491	497	498	495	502	510	523
sulfate (kraft) pulping: lime kiln	610	798	140	145	144	145	146	146	145	146	149	152
other	NA	NA	12	12	13	13	13	13	13	13	13	13
Rubber & Miscellaneous Plastic Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Mineral Products	10	32	43	44	44	44	43	43	41	42	44	46
Machinery Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Electronic Equipment	NA	NA	18	18	18	13	12	12	11	11	11	11
Transportation Equipment	NA	NA	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	6	5	5	5	5	5	5	5	5	5
SOLVENT UTILIZATION	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***
Degreasing	NA	NA	1	1	1	1	1	1	1	1	1	1
Graphic Arts	NA	NA	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	0	0	0	1	1	1	1	1	1	1
Other Industrial	NA	NA	0	0	0	0	0	0	0	0	0	0

(continued)

Table A-1. Carbon Monoxide Emissions (continued)

(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
STORAGE & TRANSPORT	***NA***	***NA***	***49***	***51***	***50***	***56***	***55***	***55***	***54***	***55***	***56***	***58***
Bulk Terminals & Plants	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Organic Chemical Storage	NA	NA	42	45	44	51	49	49	48	49	50	52
Inorganic Chemical Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	6	5	5	5	5	5	5	5	5	5
WASTE DISPOSAL & RECYCLING	***7,059***	***2,300***	***1,941***	***1,916***	***1,850***	***1,806***	***1,747***	***1,686***	***1,701***	***1,717***	***1,732***	***1,746***
Incineration	2,979	1,246	958	949	920	903	876	849	857	864	872	879
conical wood burner	1,431	228	17	18	18	19	19	18	18	18	18	18
municipal incinerator	333	13	34	35	34	35	35	35	35	35	35	35
industrial	NA	NA	9	9	9	10	9	9	9	9	9	10
commmercial/institutional	108	60	32	33	35	38	39	40	40	40	41	42
residential	1,107	945	865	852	822	800	773	745	753	759	766	772
other	NA	NA	2	2	2	2	2	2	2	2	2	2
Open Burning	4,080	1,054	982	966	930	903	870	836	844	852	859	867
industrial	1,932	1,007	20	21	21	21	21	21	20	21	22	23
commmercial/institutional	2,148	47	4	4	4	4	5	5	5	5	5	5
residential	NA	NA	958	941	905	877	845	811	819	826	833	839
Landfills	NA	NA	0	0	0	0	0	0	0	0	0	0
Other	NA	NA	0	0	0	0	0	0	0	0	0	0
ON-ROAD VEHICLES	***88,034***	***78,049***	***77,387***	***73,347***	***71,250***	***71,081***	***66,050***	***62,858***	***62,074***	***59,859***	***60,202***	***61,070***
Light-Duty Gas Vehicles & Motorcycles	64,031	53,561	49,451	46,698	45,340	45,553	42,234	40,502	40,267	39,370	39,163	39,303
light-duty gas vehicles	63,846	53,342	49,273	46,522	45,161	45,367	42,047	40,316	40,089	39,190	38,973	39,111
motorcycles	185	219	178	175	179	186	187	187	177	180	190	192
Light-Duty Gas Trucks	16,570	16,137	18,960	17,789	17,274	17,133	15,940	15,084	15,014	14,567	15,196	15,139
light-duty gas trucks 1	10,102	10,395	11,834	10,795	10,187	9,890	9,034	8,511	8,450	8,161	8,430	8,319
light-duty gas trucks 2	6,468	5,742	7,126	6,995	7,087	7,244	6,906	6,573	6,565	6,407	6,766	6,821
Heavy-Duty Gas Vehicles	6,712	7,189	7,716	7,601	7,347	7,072	6,506	5,930	5,459	4,569	4,476	5,244
Diesels	721	1,161	1,261	1,259	1,289	1,322	1,369	1,342	1,334	1,352	1,367	1,383
heavy-duty diesel vehicles	721	1,139	1,235	1,232	1,260	1,290	1,336	1,307	1,298	1,315	1,328	1,343
light-duty diesel trucks	NA	4	4	4	5	5	6	6	6	6	7	7
light-duty diesel vehicles	NA	19	22	23	24	26	28	29	30	31	33	34
NON-ROAD SOURCES	***10,605***	***12,681***	***13,706***	***13,984***	***14,131***	***14,500***	***14,518***	***14,642***	***14,601***	***14,900***	***15,269***	***15,657***
Non-Road Gasoline	9,478	11,004	11,815	12,057	12,286	12,465	12,538	12,655	12,641	12,883	13,162	13,452
recreational	268	299	312	314	316	318	321	324	327	330	333	336
construction	250	368	421	416	402	401	398	395	376	395	423	453
industrial	732	970	1,104	1,137	1,164	1,207	1,227	1,228	1,197	1,234	1,285	1,340
lawn & garden	4,679	5,366	5,685	5,749	5,808	5,866	5,929	6,001	6,075	6,143	6,212	6,276

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
NON-ROAD SOURCES (continued)												
Non-Road Gasoline (continued)												
farm	46	77	84	85	47	92	63	63	66	68	70	73
light commercial	2,437	2,680	2,894	3,028	3,203	3,219	3,223	3,254	3,198	3,295	3,402	3,519
logging	9	25	28	27	33	31	33	33	32	33	34	35
airport service	80	116	129	133	137	144	147	149	148	151	157	163
recreational marine vessels	976	1,102	1,157	1,167	1,175	1,185	1,195	1,207	1,221	1,233	1,245	1,256
other	1	2	2	2	2	2	2	2	2	2	2	2
Non-Road Diesel	543	801	910	912	797	930	845	841	818	853	903	954
recreational	0	0	0	0	0	0	0	0	0	0	0	0
construction	336	479	553	552	538	538	535	528	501	526	564	603
industrial	33	43	49	50	51	53	54	54	53	54	56	59
lawn & garden	3	3	3	3	3	3	3	3	3	4	4	4
farm	127	214	237	237	131	259	175	176	183	189	196	203
light commercial	10	11	12	13	14	14	14	14	14	14	15	15
logging	1	2	2	2	3	3	3	3	3	3	3	3
airport service	33	48	54	55	57	60	61	62	62	63	65	68
Aircraft	506	743	831	858	887	931	955	966	962	980	1,019	1,063
Marine Vessels	14	37	44	47	50	56	59	58	58	60	62	63
coal	2	4	5	5	6	6	7	6	6	7	7	7
diesel	12	32	39	41	44	48	52	51	51	53	54	55
residual oil	0	1	1	1	1	1	1	1	1	1	1	1
Railroads	65	96	106	109	112	118	121	122	122	124	124	124
MISCELLANEOUS	***7,909***	***8,344***	***7,895***	***7,254***	***8,820***	***15,863***	***8,121***	***11,173***	***8,530***	***6,774***	***6,700***	***9,245***
Other Combustion	7,909	8,344	7,895	7,254	8,820	15,863	8,121	11,173	8,530	6,774	6,700	9,245
structural fires	101	217	242	242	242	242	242	242	242	242	242	242
agricultural fires	873	501	396	441	483	612	571	552	549	559	573	589
slash/prescribed burning	1,146	2,226	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300
forest wildfires	5,620	5,396	2,957	2,271	3,795	10,709	3,009	6,079	3,439	1,674	1,586	4,115
other	169	4										
TOTAL ALL SOURCES	**128,079**	**115,625**	**114,690**	**109,199**	**108,012**	**115,849**	**103,144**	**100,650**	**97,376**	**94,043**	**94,133**	**98,017**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-2. Nitrogen Oxide Emissions
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***4,900***	***7,024***	***6,916***	***6,909***	***7,128***	***7,530***	***7,607***	***7,516***	***7,488***	***7,475***	***7,773***	***7,795***
Coal	3,888	6,123	6,051	6,061	6,278	6,668	6,708	6,698	6,662	6,694	7,008	7,007
bituminous	2,112	3,439	4,438	4,427	4,529	4,623	4,665	4,600	4,522	4,564	4,535	4,497
subbituminous	1,041	1,694	1,340	1,290	1,411	1,659	1,650	1,692	1,732	1,707	2,054	2,098
anthracite & lignite	344	542	272	344	337	387	392	406	408	423	418	412
other	391	447	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oil	1,012	901	177	246	204	260	272	210	201	160	169	151
residual	40	39	174	242	200	257	269	207	198	158	166	147
distillate	972	862	4	4	4	4	4	3	3	3	3	3
Gas	NA	NA	640	552	599	551	578	558	569	568	543	582
natural	NA	NA	640	552	599	551	578	558	569	568	543	582
Internal Combustion	NA	NA	48	50	48	50	49	50	56	52	53	55
FUEL COMB. INDUSTRIAL	***4,325***	***3,555***	***3,209***	***3,065***	***3,063***	***3,187***	***3,209***	***3,256***	***3,175***	***3,216***	***3,197***	***3,206***
Coal	771	444	608	613	596	617	615	613	512	571	550	568
bituminous	532	306	430	439	435	447	446	445	371	414	399	412
subbituminous	164	94	14	14	14	15	14	14	12	13	13	13
anthracite & lignite	75	44	33	31	27	29	30	30	25	28	27	28
other	NA	NA	131	129	119	126	124	124	103	115	111	115
Oil	332	286	309	300	292	296	294	297	338	305	306	318
residual	228	179	191	181	172	175	176	177	205	184	185	194
distillate	104	63	89	89	89	91	88	90	104	93	94	99
other	NA	44	29	30	31	31	29	30	28	28	27	26
Gas	3,060	2,619	1,520	1,433	1,505	1,584	1,625	1,656	1,641	1,651	1,650	1,634
natural	3,053	2,469	1,282	1,206	1,285	1,360	1,405	1,436	1,425	1,437	1,440	1,427
process	8	5	227	216	210	214	209	211	206	205	202	199
other	NA	145	11	10	10	10	10	10	9	9	9	9
Other	162	205	118	120	119	121	120	119	117	118	118	118
wood/bark waste	102	138	89	92	92	93	92	91	91	91	91	91
liquid waste	NA	NA	12	12	12	12	12	12	12	12	12	12
other	60	67	17	16	15	16	16	16	15	15	15	15
Internal Combustion	NA	NA	655	599	552	569	556	570	567	571	572	567
FUEL COMB. OTHER	***836***	***741***	***712***	***694***	***706***	***740***	***736***	***712***	***719***	***730***	***726***	***727***
Commercial/Institutional Coal	23	25	37	36	37	39	38	39	39	38	38	38
Commercial/Institutional Oil	210	155	106	110	121	117	106	99	98	101	102	102

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. OTHER (continued)												
Commercial/Institutional Gas	120	131	145	139	144	157	159	164	164	166	167	168
Misc. Fuel Comb. (Except Residential)	NA	NA	11	12	11	11	11	11	11	11	11	11
Residential Wood	44	74	88	77	69	74	75	46	50	53	45	44
Residential Other	439	356	326	320	323	343	347	352	358	361	363	364
distillate oil	118	85	75	76	79	80	78	81	83	85	86	86
natural gas	242	238	248	241	241	259	267	269	272	274	275	276
other	79	33	3	3	3	3	3	3	2	2	2	2
CHEMICAL & ALLIED PRODUCT MFG	***271***	***216***	***262***	***264***	***255***	***274***	***273***	***276***	***278***	***284***	***286***	***291***
Organic Chemical Mfg	70	54	37	38	38	42	42	42	42	43	43	44
Inorganic Chemical Mfg	201	159	22	19	17	18	18	19	19	19	19	19
Polymer & Resin Mfg	NA	NA	22	22	22	23	23	23	23	24	24	25
Agricultural Chemical Mfg	NA	NA	143	145	141	151	152	154	156	161	162	164
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	NA	38	38	37	40	39	38	38	38	39	39
METALS PROCESSING	***77***	***65***	***87***	***80***	***75***	***82***	***83***	***81***	***78***	***80***	***81***	***84***
Nonferrous Metals Processing	NA	NA	16	15	14	15	15	15	14	15	15	15
Ferrous Metals Processing	77	65	58	53	48	53	54	53	51	53	54	56
Metals Processing NEC	NA	NA	13	13	13	13	14	13	12	12	13	13
PETROLEUM & RELATED INDUSTRIES	***240***	***72***	***124***	***109***	***101***	***100***	***97***	***100***	***97***	***96***	***95***	***95***
Oil & Gas Production	NA	NA	69	55	48	48	47	50	49	48	48	49
Petroleum Refineries & Related Industries	240	72	55	53	52	51	49	50	47	47	46	45
Asphalt Manufacturing	NA	NA	1	1	1	1	1	1	1	1	1	1
OTHER INDUSTRIAL PROCESSES	***187***	***205***	***327***	***328***	***320***	***315***	***311***	***306***	***297***	***305***	***315***	***328***
Agriculture, Food, & Kindred Products	NA	NA	5	5	5	5	5	5	5	5	5	5
Textiles, Leather, & Apparel Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Product	18	24	73	76	76	76	77	77	76	78	79	81
Rubber & Miscellaneous Plastic Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Mineral Products	169	181	239	238	230	225	220	216	208	214	222	234
cement mfg	97	98	137	136	130	126	124	121	116	119	124	131
glass mfg	48	60	48	48	47	46	45	44	42	44	46	48
other	24	23	54	54	53	53	51	51	49	50	52	55

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
OTHER INDUSTRIAL PROCESSES (continued)												
Machinery Products	NA	NA	2	2	2	2	2	2	2	2	2	2
Transportation Equipment	NA	NA	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	8	8	7	7	7	7	7	7	7	7
SOLVENT UTILIZATION	***NA***	***NA***	***2***	***3***	***3***	***3***	***3***	***2***	***2***	***3***	***3***	***3***
Degreasing	NA	NA	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	2	2	2	2	2	2	2	2	2	2
Other Industrial	NA	NA	0	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***3***	***3***	***3***
Petroleum & Petroleum Product Storage	NA	NA	1	1	1	1	1	1	1	1	1	1
Petroleum & Petroleum Product Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Organic Chemical Storage	NA	NA	1	1	1	1	1	1	1	1	1	1
Inorganic Chemical Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	0	0	0	1	1	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	***440***	***111***	***87***	***87***	***85***	***85***	***84***	***82***	***83***	***83***	***84***	***85***
Incineration	110	37	27	29	29	31	31	32	32	32	32	32
Open Burning	330	74	59	58	56	54	52	50	51	51	52	52
Landfills	NA	NA	0	0	0	0	0	0	0	0	0	0
Other	NA	NA	0	0	0	0	0	0	0	0	0	0
ON-ROAD VEHICLES	***7,390***	***8,621***	***8,089***	***7,773***	***7,651***	***7,661***	***7,682***	***7,488***	***7,373***	***7,440***	***7,510***	***7,530***
Light-Duty Gas Vehicles & Motorcycles	4,158	4,421	3,806	3,602	3,492	3,500	3,494	3,437	3,464	3,614	3,680	3,750
light-duty gas vehicles	4,156	4,416	3,797	3,592	3,482	3,489	3,483	3,425	3,453	3,602	3,668	3,737
motorcycles	2	5	9	10	10	11	11	12	11	12	12	12
Light-Duty Gas Trucks	1,278	1,408	1,530	1,457	1,436	1,419	1,386	1,341	1,339	1,356	1,420	1,432
light-duty gas trucks 1	725	864	926	867	842	824	803	780	782	792	828	830
light-duty gas trucks 2	553	544	603	590	594	595	584	561	557	564	592	603
Heavy-Duty Gas Vehicles	278	300	330	332	332	336	343	335	326	308	315	333
Diesels	1,676	2,493	2,423	2,383	2,390	2,406	2,458	2,375	2,244	2,163	2,094	2,015
heavy-duty diesel vehicles	1,676	2,463	2,389	2,347	2,352	2,366	2,416	2,332	2,199	2,116	2,047	1,966
light-duty diesel trucks	NA	5	6	6	6	7	7	7	8	8	8	8
light-duty diesel vehicles	NA	25	28	29	31	33	35	36	37	39	39	40

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
NON-ROAD SOURCES	***1,628***	***2,423***	***2,734***	***2,777***	***2,664***	***2,914***	***2,844***	***2,843***	***2,796***	***2,885***	***2,985***	***3,095***
Non-Road Gasoline	81	102	113	116	118	122	123	124	122	125	129	133
recreational	1	1	1	1	1	1	1	1	1	1	1	1
construction	2	3	4	3	3	3	3	3	3	3	4	4
industrial	46	61	70	72	74	76	78	78	76	78	81	85
lawn & garden	5	6	6	6	6	7	7	7	7	7	7	7
farm	0	1	1	1	0	1	1	1	1	1	1	1
light commercial	3	4	4	4	4	4	4	4	4	5	5	5
logging	0	0	0	0	0	0	0	0	0	0	0	0
airport service	2	2	3	3	3	3	3	3	3	3	3	3
recreational marine vessels	16	18	19	19	19	19	19	20	20	20	20	20
other	6	6	7	7	7	7	7	7	7	7	7	7
Non-Road Diesel	941	1,374	1,562	1,569	1,416	1,597	1,485	1,478	1,433	1,494	1,582	1,673
recreational	0	0	0	0	0	0	0	0	0	0	0	0
construction	599	854	986	984	959	961	955	944	894	939	1,007	1,076
industrial	75	99	112	116	119	123	125	125	122	126	131	136
lawn & garden	4	5	5	5	5	5	5	5	6	6	6	6
farm	166	280	309	309	172	340	228	230	239	248	256	265
light commercial	17	18	20	21	22	22	22	22	22	23	23	24
logging	2	5	5	5	6	6	7	7	6	7	7	7
airport service	78	113	125	129	133	140	143	144	144	146	152	159
Aircraft	72	106	119	123	128	134	138	139	139	141	147	153
Marine Vessels	40	110	131	140	149	165	175	173	174	179	183	188
coal	0	0	0	0	0	0	0	0	0	0	0	0
diesel	34	93	110	118	125	138	147	145	146	151	154	158
residual oil	6	17	20	22	24	26	28	27	27	28	29	30
Railroads	495	731	808	829	854	897	923	929	929	946	945	947
MISCELLANEOUS	***330***	***248***	***309***	***257***	***351***	***726***	***292***	***373***	***283***	***249***	***219***	***374***
Other Combustion	330	248	309	257	351	726	292	373	283	249	219	374
TOTAL ALL SOURCES	**20,625**	**23,281**	**22,860**	**22,348**	**22,403**	**23,618**	**23,222**	**23,038**	**22,672**	**22,847**	**23,276**	**23,615**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-3. Volatile Organic Compound Emissions
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***30***	***45***	***32***	***34***	***34***	***37***	***37***	***36***	***36***	***35***	***36***	***36***
Coal	18	31	24	24	25	27	27	27	27	27	29	29
Oil	7	9	5	7	6	7	7	6	5	4	5	4
Gas	5	5	2	2	2	2	2	2	2	2	2	2
Internal Combustion	NA	NA	1	1	1	1	1	1	1	1	1	1
FUEL COMB. INDUSTRIAL	***150***	***157***	***134***	***133***	***131***	***136***	***134***	***135***	***135***	***135***	***134***	***135***
Coal	4	3	7	7	7	7	7	7	6	7	7	7
Oil	4	3	17	16	16	16	16	16	18	16	16	17
Gas	77	62	57	57	57	61	61	61	61	61	61	61
Other	65	89	35	36	36	36	36	35	36	35	35	36
Internal Combustion	NA	NA	18	16	15	15	15	15	15	15	15	15
FUEL COMB. OTHER	***541***	***848***	***1,403***	***1,230***	***1,117***	***1,188***	***1,200***	***749***	***807***	***853***	***729***	***715***
Commercial/Institutional Coal	1	1	1	1	1	1	1	1	1	1	1	1
Commercial/Institutional Oil	4	3	4	4	4	4	4	4	4	4	4	4
Commercial/Institutional Gas	6	7	6	6	6	6	7	7	7	7	7	7
Misc. Fuel Comb. (Except Residential)	NA	NA	4	4	4	4	4	4	4	4	4	4
Residential Wood	460	809	1,372	1,199	1,085	1,155	1,169	718	776	822	698	684
fireplaces	107	189	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
woodstoves	353	620	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Residential Other	70	28	16	16	16	17	15	15	15	15	14	14
CHEMICAL & ALLIED PRODUCT MFG	***1,341***	***1,595***	***1,358***	***1,412***	***1,410***	***1,513***	***1,506***	***1,526***	***1,533***	***1,546***	***1,557***	***1,577***
Organic Chemical Mfg	629	884	492	512	505	552	551	554	557	561	562	567
ethylene oxide mfg	8	10	2	3	2	3	3	3	3	3	3	3
phenol mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
terephthalic acid mfg	29	60	51	54	53	57	57	58	58	58	58	59
ethylene mfg	70	111	41	43	42	48	47	47	48	49	49	50
charcoal mfg	48	40	39	41	42	45	46	46	46	46	47	47
socmi reactor	81	118	100	106	104	116	115	117	116	118	118	120
socmi distillation	NA	NA	10	11	10	11	11	12	11	12	12	12
socmi air oxidation processes	NA	NA	2	2	2	2	2	2	2	2	2	2
socmi fugitives	194	254	203	208	205	221	220	222	223	223	224	224
other	199	291	43	45	44	49	48	48	49	50	50	51
Inorganic Chemical Mfg	65	93	34	36	35	39	38	38	40	40	40	41
Polymer & Resin Mfg	271	384	415	436	449	473	469	477	482	486	492	500
polypropylene mfg	0	1	13	14	13	15	15	15	15	15	16	16
polyethylene mfg	17	22	80	83	81	90	88	89	91	93	95	98
polystyrene resins	10	15	7	8	8	8	8	8	8	8	8	9

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
CHEMICAL & ALLIED PRODUCT MFG (continued)												
Polymer & Resin Mfg (continued)												
synthetic fiber	112	199	217	231	248	250	250	257	257	257	258	259
styrene/butadiene rubber	77	70	59	61	60	66	65	65	66	67	69	71
other	55	77	38	40	39	44	43	43	45	45	46	48
Agricultural Chemical Mfg	NA	NA	22	23	23	25	25	25	26	27	27	28
Paint, Varnish, Lacquer, Enamel Mfg	61	65	10	10	10	11	11	11	11	11	11	11
paint & varnish mfg	61	65	10	10	10	11	11	11	11	11	11	11
other	NA	NA	0	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	40	77	55	57	58	61	61	62	62	62	63	64
Other Chemical Mfg	275	92	330	339	331	352	352	357	356	359	361	366
carbon black mfg	275	92	26	25	24	26	26	27	27	27	28	29
printing ink mfg	NA	NA	13	13	13	13	13	13	13	14	14	14
fugitives unclassified	NA	NA	16	17	16	18	18	18	18	18	18	18
carbon black furnace: fugitives	NA	NA	4	4	4	5	5	5	5	5	5	5
other	NA	NA	271	279	273	290	290	295	293	295	296	300
METALS PROCESSING	***394***	***273***	***76***	***73***	***70***	***74***	***74***	***72***	***69***	***72***	***74***	***77***
Nonferrous Metals Processing	NA	NA	18	18	18	19	19	19	19	19	20	21
Ferrous Metals Processing	394	273	57	54	51	54	54	52	50	51	53	55
coke oven door & topside leaks	216	152	12	12	11	12	12	11	10	11	11	11
coke oven by-product plants	NA	NA	3	3	3	3	3	3	3	3	3	3
other	177	121	41	39	37	39	39	38	37	38	39	40
Metals Processing NEC	NA	NA	1	1	1	1	1	1	1	1	1	1
PETROLEUM & RELATED INDUSTRIES	***1,194***	***1,440***	***703***	***666***	***655***	***645***	***639***	***643***	***634***	***638***	***631***	***630***
Oil & Gas Production	411	379	107	79	70	71	68	72	69	68	69	70
Petroleum Refineries & Related Industries	773	1,045	592	584	582	571	568	568	562	566	560	557
vaccuum distillation	24	32	15	14	14	13	13	13	12	12	11	11
cracking units	27	21	34	33	33	32	31	31	30	29	28	28
process unit turnarounds	NA	NA	15	14	14	13	13	14	13	13	12	12
petroleum refinery fugitives	NA	NA	76	71	69	66	65	66	66	66	65	64
other	721	992	454	452	452	447	446	444	442	447	443	442
Asphalt Manufacturing	11	16	3	3	3	3	3	3	3	3	3	3

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
OTHER INDUSTRIAL PROCESSES	***270***	***237***	***390***	***395***	***394***	***408***	***403***	***401***	***398***	***403***	***406***	***411***
Agriculture, Food, & Kindred Products	208	191	169	171	175	177	175	177	176	179	180	183
vegetable oil mfg	59	81	46	47	49	50	49	50	50	52	52	53
whiskey fermentation: aging	105	64	24	24	24	24	23	23	23	24	24	24
bakeries	45	46	51	52	51	52	51	51	50	50	51	51
other	NA	NA	49	50	51	52	52	52	52	53	54	55
Textiles, Leather, & Apparel Products	NA	NA	10	10	10	10	10	10	10	10	10	10
Wood, Pulp & Paper, & Publishing Products	NA	NA	42	44	44	44	44	44	44	44	45	46
Rubber & Miscellaneous Plastic Products	60	44	41	43	43	46	46	46	45	45	46	46
rubber tire mfg	60	44	10	10	10	11	11	11	11	11	11	11
green tire spray	NA	NA	5	5	5	6	6	6	6	6	6	6
other	NA	NA	26	28	28	29	29	29	29	29	29	30
Mineral Products	2	2	15	15	15	14	14	14	14	14	14	15
Machinery Products	NA	NA	4	4	4	4	4	3	3	3	3	4
Electronic Equipment	NA	NA	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	1	1	1	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	108	108	103	112	109	106	106	106	106	106
SOLVENT UTILIZATION	***7,174***	***6,584***	***5,699***	***5,626***	***5,743***	***5,945***	***5,964***	***5,975***	***5,918***	***6,031***	***6,156***	***6,313***
Degreasing	707	513	756	634	681	754	757	757	728	745	762	785
open top	NA	NA	28	28	28	29	29	28	28	28	28	29
conveyorized	NA	NA	5	5	5	5	4	4	4	4	4	4
cold cleaning	NA	NA	31	33	31	34	35	34	34	34	34	35
other	707	513	691	568	618	687	689	690	662	678	695	717
Graphic Arts	319	373	317	325	340	362	363	363	362	368	381	396
letterpress	NA	NA	2	2	2	2	2	2	2	2	2	2
flexographic	NA	NA	18	19	19	20	20	20	20	21	21	22
lithographic	NA	NA	4	4	4	4	4	4	4	4	5	5
gravure	NA	NA	131	138	140	148	150	151	149	151	156	163
other	319	373	162	163	174	188	187	186	187	191	198	205
Dry Cleaning	263	320	169	217	216	216	212	209	211	216	218	221
perchloroethylene	NA	NA	85	111	110	109	107	105	106	109	110	111
petroleum solvent	NA	NA	84	106	106	106	105	104	105	107	108	109
other	263	320	0	0	0	0	0	0	0	0	0	0

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
SOLVENT UTILIZATION (continued)												
Surface Coating	3,570	3,685	2,549	2,602	2,606	2,646	2,635	2,619	2,568	2,623	2,687	2,773
industrial adhesives	52	55	381	353	353	366	375	383	366	378	392	412
fabrics	161	186	34	34	35	35	35	35	34	35	36	36
paper	652	626	106	109	110	114	114	114	112	114	117	121
large appliances	49	36	22	19	19	19	18	18	17	18	18	19
magnet wire	7	5	0	0	0	0	0	0	0	0	0	0
autos & light trucks	165	165	85	86	88	87	87	86	79	80	80	81
metal cans	49	73	97	96	95	96	95	95	91	93	94	97
metal coil	18	21	50	50	49	50	50	49	47	48	50	52
wood furniture	211	231	132	140	142	143	140	138	133	138	148	159
metal furniture	35	52	41	44	44	44	44	43	42	43	46	50
flatwood products	64	82	4	4	4	4	4	4	4	4	5	5
plastic parts	17	25	11	11	11	11	11	11	10	10	10	11
large ships	21	20	15	16	15	16	15	15	15	15	15	16
aircraft	1	2	27	29	26	31	34	33	33	33	33	34
misc. metal parts	NA	NA	14	14	14	14	14	14	13	13	14	15
architectural	442	477	473	502	503	504	500	495	500	505	510	515
traffic markings	NA	NA	100	106	106	107	106	105	106	107	108	109
maintenance coatings	108	106	79	80	80	80	80	79	76	78	81	85
railroad	5	9	4	3	3	3	3	3	3	3	3	4
auto refinishing	83	186	111	132	132	133	132	130	132	137	140	144
machinery	39	62	37	28	28	29	28	28	26	26	27	27
electronic & other electrical	NA	NA	79	79	79	80	79	78	75	77	80	85
general	79	52	146	147	148	158	154	153	154	157	160	163
miscellaneous	942	799	104	109	108	105	103	98	98	98	98	98
thinning solvents	NA	NA	90	92	94	97	96	95	94	96	98	100
other	372	415	306	317	318	320	317	315	307	315	324	336
Other Industrial	640	690	125	131	132	133	131	126	124	126	126	127
miscellaneous	39	44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
rubber & plastics mfg	309	327	25	29	29	29	29	28	28	28	29	31
other	292	319	100	102	103	104	102	98	96	97	97	97
Nonindustrial	1,674	1,002	1,783	1,717	1,768	1,834	1,867	1,900	1,925	1,952	1,982	2,011
cutback asphalt	1,045	323	191	175	186	199	199	199	202	207	214	221
pesticide application	241	241	212	263	262	262	260	258	264	272	280	289

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
SOLVENT UTILIZATION (continued)												
Nonindustrial (continued)												
adhesives	NA	NA	345	332	332	345	353	361	365	368	372	375
consumer solvents	NA	NA	1,035	947	988	1,030	1,056	1,083	1,095	1,105	1,116	1,126
other	387	437	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
STORAGE & TRANSPORT	***1,954***	***1,975***	***1,747***	***1,673***	***1,801***	***1,842***	***1,753***	***1,759***	***1,720***	***1,745***	***1,757***	***1,773***
Bulk Terminals & Plants	599	517	606	620	632	652	651	658	629	626	614	606
fixed roof	14	12	14	14	14	15	15	15	15	15	16	16
floating roof	45	39	46	47	48	50	50	49	49	49	51	53
variable vapor space	1	1	1	1	1	1	1	1	1	1	1	1
underground tanks	NA	0	0	0	0	0	0	0	0	0	0	0
area source: gasoline	509	440	512	526	537	554	553	560	532	527	512	501
other	30	26	32	32	32	33	33	33	33	33	34	36
Petroleum & Petroleum Product Storage	300	306	223	217	214	215	210	212	213	216	215	216
fixed roof gasoline	47	43	26	25	25	24	23	24	24	24	24	24
fixed roof crude	135	148	26	24	22	21	21	21	21	21	21	21
floating roof gasoline	49	45	27	26	26	25	24	25	25	25	25	25
floating roof crude	32	36	5	5	5	5	5	5	5	5	5	5
efr / seal gasoline	3	3	2	2	2	2	2	2	2	2	2	2
efr / seal crude	1	2	0	0	0	0	0	0	0	0	0	0
ifr / seal gasoline	1	1	1	1	1	1	1	1	1	1	1	1
ifr / seal crude	2	2	0	0	0	0	0	0	0	0	0	0
variable vapor space gasoline	3	3	1	1	1	1	2	2	2	2	2	2
other	25	23	133	132	131	135	132	133	134	136	135	136
Petroleum & Petroleum Product Transport	92	61	126	123	123	125	125	125	126	128	131	134
gasoline loading: normal / splash	3	0	3	3	3	3	3	3	3	3	3	3
gasoline loading: balanced / submerged	20	2	21	20	21	21	22	21	21	21	22	22
gasoline loading: normal / submerged	39	3	41	41	40	41	42	42	42	43	45	46
gasoline loading: clean / submerged	2	0	2	2	2	2	2	2	2	2	2	2
marine vessel loading: gasoline & crude	26	50	24	23	23	23	22	22	23	23	24	24
other	2	6	35	34	34	35	35	35	35	35	36	36
Service Stations: Stage I	416	461	207	213	219	223	223	230	226	233	240	247
Service Stations: Stage II	521	583	485	400	511	522	441	428	420	434	446	458
Service Stations: Breathing & Emptying	NA	NA	49	48	51	52	52	53	53	54	56	57
Organic Chemical Storage	26	46	34	35	34	37	36	36	37	37	38	38
Organic Chemical Transport	NA	NA	17	17	16	16	15	16	16	16	16	16

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
STORAGE & TRANSPORT (continued)												
Inorganic Chemical Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
WASTE DISPOSAL & RECYCLING	***1,984***	***758***	***2,310***	***2,293***	***2,256***	***2,310***	***2,290***	***2,262***	***2,265***	***2,268***	***2,271***	***2,273***
Incineration	548	366	64	63	61	60	59	57	57	58	58	59
Open Burning	1,424	372	309	304	292	284	274	263	265	268	270	272
industrial	NA	NA	6	6	6	6	6	6	6	6	6	6
commmercial/institutional	NA	NA	1	1	1	2	2	2	2	2	2	2
residential	NA	NA	302	297	285	277	266	256	258	260	262	264
other	1,424	372	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
POTW	NA	NA	10	11	11	11	11	11	11	11	11	11
Industrial Waste Water	NA	NA	1	2	1	2	2	2	2	2	2	2
TSDF	NA	NA	1,925	1,913	1,890	1,953	1,945	1,929	1,929	1,929	1,929	1,929
Landfills	NA	NA	0	0	0	0	0	0	0	0	0	0
Other	11	20	0	0	0	0	0	0	0	0	0	0
ON-ROAD VEHICLES	***12,972***	***8,979***	***9,376***	***8,874***	***8,477***	***8,290***	***7,192***	***6,854***	***6,499***	***6,072***	***6,103***	***6,295***
Light-Duty Gas Vehicles & Motorcycles	9,193	5,907	5,864	5,537	5,281	5,189	4,462	4,285	4,069	3,832	3,812	3,921
light-duty gas vehicles	9,133	5,843	5,810	5,483	5,227	5,136	4,412	4,234	4,033	3,799	3,777	3,884
motorcycles	60	64	54	54	53	53	50	51	37	33	34	36
Light-Duty Gas Trucks	2,770	2,059	2,425	2,279	2,185	2,129	1,867	1,769	1,688	1,588	1,647	1,664
light-duty gas trucks 1	1,564	1,229	1,437	1,316	1,227	1,173	1,018	960	906	849	875	874
light-duty gas trucks 2	1,206	830	988	963	958	956	849	809	781	739	772	790
Heavy-Duty Gas Vehicles	743	611	716	700	662	626	517	470	423	334	326	393
Diesels	266	402	370	357	350	345	346	330	319	318	318	317
heavy-duty diesel vehicles	266	392	360	346	338	332	332	316	304	302	301	299
light-duty diesel trucks	NA	2	2	2	2	2	3	3	3	3	3	3
light-duty diesel vehicles	NA	8	8	9	9	10	11	12	12	13	13	14
NON-ROAD SOURCES	***1,542***	***1,869***	***2,008***	***2,039***	***2,038***	***2,106***	***2,103***	***2,120***	***2,122***	***2,159***	***2,206***	***2,255***
Non-Road Gasoline	1,284	1,474	1,561	1,582	1,601	1,620	1,631	1,646	1,654	1,677	1,704	1,730
recreational	138	151	156	157	158	159	160	161	163	164	166	167
construction	22	32	37	37	36	35	35	35	33	35	37	40
industrial	46	61	69	71	73	75	77	77	75	77	80	84
lawn & garden	574	655	691	699	706	713	720	728	737	745	753	761
farm	4	7	8	8	4	9	6	6	6	7	7	7
light commercial	142	158	171	178	188	189	190	191	188	194	200	207

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
NON-ROAD SOURCES (continued)												
Non-Road Gasoline (continued)												
logging	3	7	8	8	10	9	10	10	9	10	10	10
airport service	4	6	6	7	7	7	7	7	7	7	8	8
recreational marine vessels	350	395	413	416	419	422	425	429	434	438	442	446
other	1	1	1	1	1	1	1	1	1	1	1	1
Non-Road Diesel	129	191	216	217	188	223	200	200	195	203	214	226
construction	75	106	123	122	119	120	119	118	111	117	125	134
industrial	9	12	13	14	14	14	15	15	14	15	15	16
lawn & garden	1	1	1	1	1	1	1	1	1	1	1	1
farm	33	56	61	62	34	67	45	46	48	49	51	53
light commercial	3	3	3	3	3	3	3	3	3	4	4	4
logging	0	0	0	0	0	0	1	1	0	1	1	1
airport service	9	13	15	15	15	16	17	17	17	17	18	18
Aircraft	97	146	165	170	176	185	190	192	192	195	203	212
Marine Vessels	9	25	30	32	34	38	40	39	40	41	42	43
coal	0	0	1	1	1	1	1	1	1	1	1	1
diesel	8	23	28	29	31	35	37	36	37	38	38	39
residual oil	1	2	2	2	2	2	3	3	3	3	3	3
Railroads	22	33	37	38	39	41	42	42	42	43	43	43
MISCELLANEOUS	***1,101***	***1,134***	***562***	***544***	***652***	***1,227***	***639***	***1,069***	***741***	***466***	***516***	***685***
Other Combustion	1,101	1,134	562	543	651	1,226	638	1,068	740	465	515	684
structural fires	19	40	44	44	44	44	44	44	44	44	44	44
agricultural fires	131	70	55	61	67	85	79	77	76	78	79	82
slash/prescribed burning	147	285	179	179	179	179	179	179	179	179	179	179
forest wildfires	770	739	283	259	361	918	335	768	440	164	212	379
other	34	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Health Services	NA	NA	0	1	0	1	1	1	1	1	1	1
TOTAL ALL SOURCES	**30,646**	**25,893**	**25,798**	**24,991**	**24,778**	**25,719**	**23,935**	**23,599**	**22,877**	**22,420**	**22,575**	**23,174**

Note(s): NA = not available. For several source categones, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
Zero values represent less than 500 short tons/year.
No data was available after 1984 to weigh the emissions from residential wood burning devices.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-4. Sulfur Dioxide Emissions
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***17,398***	***17,469***	***16,273***	***15,701***	***15,715***	***15,990***	***16,218***	***15,898***	***15,788***	***15,418***	***15,191***	***14,869***
Coal	15,799	16,073	15,630	14,860	15,034	15,224	15,408	15,227	15,101	14,840	14,546	14,312
bituminous	9,574	NA	14,029	13,454	13,513	13,546	13,576	13,365	13,203	12,900	12,199	11,904
subbituminous	4,716	NA	1,292	1,048	1,182	1,311	1,423	1,425	1,381	1,456	1,796	1,854
anthracite & lignite	1,509	NA	309	357	338	368	409	438	517	484	551	555
Oil	1,598	1,395	612	811	651	734	779	639	652	546	612	523
residual	1,578	NA	604	799	640	722	765	629	642	537	602	512
distillate	20	NA	8	12	11	12	14	10	10	9	10	11
Gas	1	1	1	1	1	1	1	1	1	1	1	1
Internal Combustion	NA	NA	30	30	29	31	30	31	35	32	32	34
FUEL COMB. INDUSTRIAL	***4,568***	***2,951***	***3,169***	***3,116***	***3,068***	***3,111***	***3,086***	***3,106***	***2,915***	***3,002***	***2,942***	***3,029***
Coal	3,129	1,527	1,818	1,828	1,817	1,856	1,840	1,843	1,547	1,722	1,661	1,715
bituminous	2,171	1,058	1,347	1,375	1,374	1,395	1,384	1,382	1,162	1,294	1,248	1,289
subbituminous	669	326	28	29	29	29	29	29	24	27	26	26
anthracite & lignite	289	144	90	82	73	79	79	81	67	75	72	75
other	NA	NA	353	341	341	353	348	351	293	327	315	325
Oil	1,229	1,065	862	828	807	806	812	823	935	845	848	882
residual	956	851	671	637	617	614	625	633	733	656	662	692
distillate	98	85	111	109	106	108	107	108	125	112	113	118
other	175	129	80	82	84	84	80	82	77	76	73	71
Gas	140	299	397	370	356	360	346	352	348	348	346	345
Other	70	60	86	84	82	83	82	82	79	81	80	80
Internal Combustion	NA	NA	7	6	6	6	6	6	6	6	6	6
FUEL COMB. OTHER	***1,490***	***971***	***579***	***611***	***662***	***660***	***624***	***595***	***592***	***599***	***599***	***599***
Commercial/Institutional Coal	109	110	158	161	164	172	169	176	175	173	171	169
Commercial/Institutional Oil	883	637	239	267	310	295	274	233	232	238	241	242
Commercial/Institutional Gas	1	1	2	2	2	2	2	2	2	2	2	2
Misc. Fuel Comb. (Except Residential)	NA	NA	1	1	1	1	1	1	1	1	1	1
Residential Wood	6	13	13	11	10	11	11	7	7	8	6	6
Residential Other	492	211	167	169	175	180	167	175	176	177	178	177
distillate oil	212	157	128	129	134	137	132	137	141	144	145	145
bituminous/subbituminous coal	260	43	29	30	32	33	27	30	26	26	25	25
other	20	11	10	10	10	10	8	9	8	8	8	8

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
CHEMICAL & ALLIED PRODUCT MFG	***591***	***280***	***456***	***432***	***425***	***449***	***440***	***440***	***440***	***447***	***450***	***457***
Organic Chemical Mfg	NA	NA	16	16	17	19	17	17	17	18	18	18
Inorganic Chemical Mfg	591	271	354	329	322	341	334	333	333	338	341	345
sulfur compounds	591	271	346	320	314	333	326	325	325	330	332	336
other	NA	NA	8	8	8	8	8	9	8	9	9	9
Polymer & Resin Mfg	NA	NA	7	7	6	7	7	7	7	7	7	7
Agricultural Chemical Mfg	NA	NA	4	4	4	4	4	4	4	4	4	4
Pharmaceutical Mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	10	76	77	75	78	77	79	79	80	81	82
METALS PROCESSING	***4,775***	***1,842***	***1,042***	***888***	***648***	***707***	***695***	***663***	***633***	***650***	***667***	***692***
Nonferrous Metals Processing	4,060	1,279	853	710	479	529	513	486	463	476	488	506
copper	3,507	1,080	655	525	298	343	327	300	285	292	300	312
lead	77	34	121	112	111	113	113	112	108	111	114	119
aluminum	80	95	62	59	57	59	60	60	58	59	60	62
other	396	71	14	13	13	14	13	13	12	13	13	13
Ferrous Metals Processing	715	562	172	161	153	162	165	160	153	158	162	168
Metals Processing NEC	NA	NA	18	17	15	16	17	17	17	17	17	18
PETROLEUM & RELATED INDUSTRIES	***881***	***734***	***505***	***469***	***445***	***443***	***429***	***440***	***422***	***417***	***409***	***406***
Oil & Gas Production	111	157	204	176	155	159	156	164	159	156	155	158
natural gas	111	157	202	175	154	157	155	163	157	154	154	156
other	NA	NA	2	1	1	1	1	1	1	1	1	1
Petroleum Refineries & Related Industries	770	577	300	291	289	283	272	274	262	260	253	248
fluid catalytic cracking units	480	330	212	207	207	202	195	196	185	183	177	172
other	290	247	88	84	82	81	77	78	77	77	76	75
Asphalt Manufacturing	NA	NA	1	1	1	1	1	1	1	1	1	1
OTHER INDUSTRIAL PROCESSES	***846***	***918***	***425***	***427***	***418***	***411***	***405***	***401***	***391***	***401***	***413***	***431***
Agriculture, Food, & Kindred Products	NA	NA	3	3	3	3	3	3	3	3	3	3
Textiles, Leather, & Apparel Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	169	223	131	135	135	135	136	137	137	139	141	145
Rubber & Miscellaneous Plastic Products	NA	NA	1	1	1	1	1	1	1	1	1	1
Mineral Products	677	694	286	285	276	268	261	257	247	254	265	279
cement mfg	618	630	192	190	183	177	172	169	163	169	176	186
other	59	64	95	95	93	91	89	87	84	86	89	93
Machinery Products	NA	NA	0	0	0	0	0	0	0	0	0	0
Electronic Equipment	NA	NA	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	3	3	3	3	3	3	3	3	3	3

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
SOLVENT UTILIZATION	***NA***	***NA***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***
Degreasing	NA	NA	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	1	1	1	1	1	1	1	1	1	1
Other Industrial	NA	NA	0	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***4***	***4***	***4***	***5***	***5***	***5***	***5***	***5***	***5***	***5***
Petroleum & Petroleum Product Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	1	1	1	1	1	1	1	1	1	1
Organic Chemical Storage	NA	NA	1	1	1	1	1	1	1	1	1	1
Inorganic Chemical Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	1	2	2	2	2	2	2	2	2	2
WASTE DISPOSAL & RECYCLING	***8***	***33***	***34***	***35***	***35***	***36***	***36***	***36***	***36***	***37***	***37***	***37***
Incineration	4	21	25	26	26	28	28	29	28	29	29	29
industrial	NA	NA	10	10	10	11	10	10	10	10	10	10
other	4	21	15	16	16	17	18	18	18	18	19	19
Open Burning	4	12	9	8	8	8	8	7	7	7	7	7
industrial	NA	NA	0	0	0	0	0	0	0	0	0	0
other	4	12	8	8	8	8	7	7	7	7	7	7
Landfills	NA	NA	0	0	0	0	0	0	0	0	0	0
industrial	NA	NA	0	0	0	0	0	0	0	0	0	0
other	NA	NA	0	0	0	0	0	0	0	0	0	0
Other	NA	NA	0	0	0	0	0	0	0	0	0	0
ON-ROAD VEHICLES	***411***	***521***	***522***	***527***	***538***	***553***	***570***	***571***	***570***	***578***	***517***	***295***
Light-Duty Gas Vehicles & Motorcycles	132	159	146	143	142	144	145	144	143	146	147	147
light-duty gas vehicles	132	158	145	143	142	144	145	144	142	146	146	147
motorcycles	0	0	0	0	0	0	0	0	0	0	0	0
Light-Duty Gas Trucks	40	50	55	55	56	58	58	58	59	59	61	61
light-duty gas trucks 1	26	33	36	36	36	37	38	38	38	38	39	39
light-duty gas trucks 2	13	16	19	19	20	21	21	21	21	21	22	22
Heavy-Duty Gas Vehicles	8	10	11	11	11	11	11	11	10	10	11	11
Diesels	231	303	311	318	328	340	356	358	358	363	299	76
heavy-duty diesel vehicles	231	291	298	305	314	325	341	342	342	347	286	73
light-duty diesel trucks	0	2	2	2	2	3	3	3	3	3	2	1
light-duty diesel vehicles	0	10	11	11	11	12	12	13	13	13	11	3

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
NON-ROAD SOURCES	***83***	***175***	***208***	***221***	***233***	***253***	***267***	***265***	***266***	***273***	***278***	***283***
Aircraft	4	6	6	6	7	7	7	7	7	7	8	8
Marine Vessels	43	117	143	154	164	181	193	190	191	197	201	206
Railroads	36	53	59	60	62	65	67	68	68	69	69	69
MISCELLANEOUS	***110***	***11***	***11***	***9***	***13***	***27***	***10***	***14***	***10***	***9***	***8***	***14***
Other Combustion	110	11	11	9	13	27	10	14	10	9	8	14
TOTAL ALL SOURCES	**31,161**	**25,905**	**23,230**	**22,442**	**22,204**	**22,647**	**22,785**	**22,433**	**22,068**	**21,836**	**21,517**	**21,118**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
Zero values represent less than 500 short tons/year.
The 1985 fuel combustion, electric utility category is based on the National Allowance Data Base Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. *Allocations at the Tier 3 levels are approximations only and are based on the methodology described in section 6.0, paragraph 6.2.1.1.*
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-5. Particulate Matter (PM-10) Emissions
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***1,775***	***879***	***284***	***288***	***284***	***279***	***273***	***282***	***248***	***247***	***268***	***266***
Coal	1,680	796	272	273	271	264	258	269	234	236	255	254
bituminous	1,041	483	219	219	214	191	194	187	168	167	184	182
subbituminous	513	238	36	34	35	50	40	40	40	44	46	48
anthracite & lignite	126	75	17	20	21	23	24	42	25	24	23	23
other	NA	NA	0	0	0	0	0	0	0	0	0	0
Oil	89	76	8	11	9	10	11	9	10	8	9	8
residual	85	74	8	11	9	10	11	9	10	8	9	8
distillate	3	2	0	0	0	0	0	0	0	0	0	0
Gas	7	7	1	1	1	1	1	1	1	1	1	1
Internal Combustion	NA	NA	3	3	3	3	3	3	3	3	3	3
FUEL COMB. INDUSTRIAL	***641***	***679***	***245***	***243***	***238***	***242***	***241***	***240***	***234***	***236***	***234***	***237***
Coal	83	18	70	71	67	70	70	69	57	64	62	64
bituminous	52	12	48	48	48	49	49	48	40	45	43	45
subbituminous	16	4	1	1	1	1	1	1	1	1	1	1
anthracite & lignite	15	2	7	6	6	6	6	6	5	6	6	6
other	NA	NA	15	15	13	14	14	13	11	12	12	12
Oil	89	67	50	48	46	46	47	47	53	48	48	50
residual	83	63	41	39	37	37	38	38	44	39	40	41
distillate	6	4	5	5	5	5	5	5	6	5	6	6
other	0	0	4	4	4	4	4	4	4	4	3	3
Gas	27	23	47	45	44	45	44	44	44	44	44	43
natural	24	20	24	23	23	24	24	24	24	24	24	24
process	4	3	22	21	20	20	20	20	20	19	19	19
other	NA	NA	1	1	1	1	1	1	1	1	1	0
Other	441	571	75	77	78	79	78	77	77	77	77	77
wood/bark waste	415	566	67	69	70	71	71	69	69	69	69	69
liquid waste	NA	NA	1	1	1	1	1	1	1	1	1	1
other	26	5	6	6	6	6	6	6	6	6	6	6
Internal Combustion	NA	NA	3	3	3	3	3	3	3	3	3	3
FUEL COMB. OTHER	***455***	***887***	***1009***	***888***	***811***	***862***	***869***	***553***	***593***	***626***	***539***	***529***
Commercial/Institutional Coal	13	8	13	13	13	14	13	14	14	14	13	13
Commercial/Institutional Oil	52	30	12	14	16	15	13	11	11	12	12	12
Commercial/Institutional Gas	4	4	4	4	4	5	5	5	5	5	5	5
Misc. Fuel Comb. (Except Residential)	NA	NA	3	3	3	3	3	3	3	3	3	3

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. OTHER (continued)												
Residential Wood	384	818	959	837	758	807	817	501	542	574	488	478
fireplaces	90	191	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
woodstoves	294	626	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Residential Other	3	27	18	18	18	19	18	18	18	18	18	18
CHEMICAL & ALLIED PRODUCT MFG	***235***	***148***	***57***	***58***	***57***	***61***	***62***	***62***	***62***	***63***	***63***	***64***
Organic Chemical Mfg	43	19	19	20	20	21	22	22	22	22	22	23
Inorganic Chemical Mfg	61	25	7	7	7	8	8	8	7	8	8	8
Polymer & Resin Mfg	NA	NA	4	4	4	5	5	5	5	5	5	5
Agricultural Chemical Mfg	46	61	9	9	9	9	10	10	10	10	10	10
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	0	0	0	0	0	0	0	0	0	1
Pharmaceutical Mfg	NA	NA	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	86	42	17	17	17	17	17	18	17	17	18	18
METALS PROCESSING	***1,316***	***622***	***142***	***132***	***126***	***136***	***137***	***136***	***130***	***133***	***136***	***141***
Nonferrous Metals Processing	593	130	46	44	42	45	45	45	43	43	45	46
copper	343	32	3	3	3	3	3	3	3	3	3	3
lead	53	18	4	3	3	3	3	3	3	3	3	3
zinc	20	3	3	2	2	3	3	3	2	3	3	3
other	177	77	36	35	33	36	36	36	34	34	35	36
Ferrous Metals Processing	198	322	91	83	80	86	88	86	83	85	87	90
primary	31	271	70	63	60	65	67	66	63	65	66	69
secondary	167	51	21	20	20	21	21	20	19	20	20	21
other	NA	NA	0	0	0	0	0	0	0	0	0	0
Metals Processing NEC	525	170	5	5	4	5	5	4	4	4	4	5
PETROLEUM & RELATED INDUSTRIES	***286***	***138***	***32***	***31***	***30***	***29***	***28***	***28***	***27***	***27***	***27***	***26***
Oil & Gas Production	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum Refineries & Related Industries	69	41	28	27	26	25	24	24	23	23	23	22
fluid catalytic cracking units	69	41	24	23	23	22	21	21	20	20	19	19
other	NA	NA	4	4	4	4	3	3	3	3	3	3
Asphalt Manufacturing	217	97	4	4	4	4	4	4	4	4	4	4
OTHER INDUSTRIAL PROCESSES	***5,832***	***1,846***	***382***	***390***	***384***	***385***	***377***	***374***	***362***	***368***	***377***	***390***
Agriculture, Food, & Kindred Products	485	402	28	29	29	30	30	30	30	31	31	32
country elevators	257	258	3	3	3	3	3	3	3	3	3	3
terminal elevators	147	86	1	1	1	1	1	1	1	1	1	1
feed mills	5	3	2	3	3	3	3	3	3	3	3	3
soybean mills	25	22	7	7	7	7	7	7	7	8	8	8

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
OTHER INDUSTRIAL PROCESSES (continued)												
Agriculture, Food, & Kindred Products (continued)												
wheat mills	5	1	0	0	0	0	0	0	0	0	0	0
other grain mills	9	6	6	6	7	7	7	7	7	7	7	7
other	38	26	9	9	9	9	9	9	9	9	9	9
Textiles, Leather, & Apparel Products	NA	NA	0	0	1	1	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	727	183	99	103	104	106	105	104	103	105	107	111
sulfate (kraft) pulping	668	142	67	69	69	69	70	69	69	70	71	73
other	59	41	32	34	35	37	35	35	34	35	36	38
Rubber & Miscellaneous Plastic Products	NA	NA	4	4	4	4	4	4	4	4	4	4
Mineral Products	4,620	1,261	224	228	221	220	215	212	202	205	211	220
cement mfg	1,731	417	36	36	34	33	32	32	30	31	33	35
surface mining	134	127	22	21	18	17	16	17	16	16	17	17
stone quarrying/processing	957	421	80	84	84	87	84	84	78	79	80	83
other	1,798	296	86	87	85	84	82	80	77	79	82	85
Machinery Products	NA	NA	3	3	3	3	4	4	4	4	4	4
Electronic Equipment	NA	NA	1	1	1	1	1	1	1	1	1	1
Transportation Equipment	NA	NA	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	22	22	20	19	19	18	18	18	18	18
SOLVENT UTILIZATION	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***	***2***
Degreasing	NA	NA	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	2	2	2	2	2	2	2	2	2	2
Other Industrial	NA	NA	0	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***59***	***58***	***56***	***56***	***56***	***57***	***55***	***56***	***57***	***59***
Bulk Terminals & Plants	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Organic Chemical Storage	NA	NA	1	1	1	1	1	1	1	1	1	1
Organic Chemical Transport	NA	NA	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	58	56	54	55	54	55	53	54	55	57
storage	NA	NA	20	21	20	20	19	19	18	18	19	20
transfer	NA	NA	37	35	34	34	35	35	34	35	36	37
combined	NA	NA	1	1	1	1	1	1	1	1	1	1
Bulk Materials Transport	NA	NA	0	0	0	0	0	0	0	0	0	0

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
WASTE DISPOSAL & RECYCLING	***999***	***273***	***278***	***274***	***265***	***259***	***251***	***242***	***244***	***246***	***248***	***250***
Incineration	229	75	52	52	51	51	50	49	49	50	51	51
residential	51	42	39	38	37	36	35	34	34	34	35	35
other	178	32	13	14	14	15	15	16	16	16	16	16
Open Burning	770	198	225	222	214	208	200	192	194	196	197	199
residential	770	198	221	217	209	203	195	188	189	191	193	194
other	NA	NA	4	4	4	5	5	5	4	5	5	5
Industrial Waste Water	NA	NA	0	0	0	0	0	0	0	0	0	0
Landfills	NA	NA	0	0	0	0	0	0	0	0	0	0
Other	NA	NA	0	0	0	0	0	0	0	0	0	0
ON-ROAD VEHICLES	***443***	***397***	***363***	***356***	***360***	***369***	***367***	***357***	***349***	***343***	***321***	***311***
Light-Duty Gas Vehicles & Motorcycles	225	120	77	69	66	66	65	64	63	64	65	65
light-duty gas vehicles	224	119	77	69	65	66	64	63	63	63	64	64
motorcycles	1	1	0	0	0	0	0	0	0	0	0	0
Light-Duty Gas Trucks	70	55	43	39	37	37	34	32	32	31	31	31
light-duty gas trucks 1	41	25	19	17	17	16	16	15	15	15	15	15
light-duty gas trucks 2	29	29	24	22	21	20	19	17	17	17	16	16
Heavy-Duty Gas Vehicles	13	15	14	13	12	12	11	11	10	9	10	10
Diesels	136	208	229	236	245	254	257	250	245	239	215	206
heavy-duty diesel vehicles	136	194	219	226	235	244	247	240	234	228	205	197
light-duty diesel trucks	0	2	1	1	2	2	2	2	2	2	2	2
light-duty diesel vehicles	0	12	8	8	8	9	9	9	9	9	8	8
NON-ROAD SOURCES	***223***	***329***	***368***	***372***	***350***	***387***	***372***	***372***	***367***	***379***	***395***	***411***
Non-Road Gasoline	35	41	43	43	44	44	44	45	45	46	46	47
recreational	3	3	3	3	3	3	3	3	3	3	3	3
construction	0	0	0	0	0	0	0	0	0	0	0	1
industrial	0	0	0	0	0	0	0	0	0	0	0	1
lawn & garden	10	11	12	12	12	13	13	13	13	13	13	13
farm	0	0	0	0	0	0	0	0	0	0	0	0
light commercial	1	1	1	1	1	1	1	1	1	1	1	1
logging	0	0	0	0	0	0	0	0	0	0	0	0
airport service	0	0	0	0	0	0	0	0	0	0	0	0
other	21	24	25	25	26	26	26	26	26	27	27	27

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Non-Road Diesel	135	202	227	227	200	231	211	211	205	214	227	240
recreational	0	0	0	0	0	0	0	0	0	0	0	0
construction	85	123	141	139	134	134	134	133	127	133	142	152
industrial	11	14	16	16	17	17	18	18	17	18	18	19
lawn & garden	1	1	1	1	1	1	1	1	1	1	1	1
farm	29	49	53	54	30	59	40	40	42	43	45	46
light commercial	2	2	2	3	3	3	3	3	3	3	3	3
logging	0	1	1	1	1	1	1	1	1	1	1	1
airport service	8	12	13	14	14	15	15	15	15	16	16	17
Aircraft	21	33	37	38	40	42	43	44	44	44	46	48
Marine Vessels	6	17	20	21	23	25	27	26	26	27	28	29
coal	1	2	2	2	3	3	3	3	3	3	3	3
diesel	4	10	12	13	13	15	16	16	16	16	16	17
residual oil	2	5	6	6	7	7	8	8	8	8	8	8
Railroads	25	37	41	42	43	45	47	47	47	48	48	48
NATURAL SOURCES	***NA***	***NA***	***4,047***	***10,324***	***1,577***	***18,110***	***12,101***	***4,362***	***10,095***	***4,626***	***1,978***	***2,593***
Geogenic	NA	NA	4,047	10,324	1,577	18,110	12,101	4,362	10,095	4,626	1,978	2,593
wind erosion	NA	NA	4,047	10,324	1,577	18,110	12,101	4,362	10,095	4,626	1,978	2,593
MISCELLANEOUS	***839***	***852***	***37,715***	***37,056***	***37,432***	***39,423***	***37,440***	***36,267***	***36,136***	***36,367***	***37,905***	***40,150***
Agriculture & Forestry	NA	NA	7,108	7,183	7,326	7,453	7,320	7,364	7,332	7,223	7,231	7,121
agricultural crops	NA	NA	6,833	6,899	6,996	7,077	6,923	6,983	6,952	6,838	6,837	6,716
agricultural livestock	NA	NA	275	285	330	376	396	381	380	386	394	405
Other Combustion	839	852	873	798	967	1,683	891	1,178	921	760	743	1,017
wildfires	385	514	308	226	389	1,086	300	590	333	171	152	424
managed burning	390	315	506	513	519	538	532	529	529	530	532	535
other	64	23	59	59	59	59	59	59	59	59	59	59
Fugitive Dust	NA	NA	29,734	29,075	29,139	30,287	29,229	27,725	27,883	28,384	29,930	32,012
wind erosion	NA	NA	0	0	0	0	0	0	0	0	0	0
unpaved roads	NA	NA	11,644	11,673	11,110	12,379	11,798	11,338	11,873	11,540	12,482	12,883
paved roads	NA	NA	5,080	5,262	5,530	5,900	5,769	5,992	5,969	5,942	6,095	6,358
other	NA	NA	13,009	12,139	12,499	12,008	11,662	10,396	10,042	10,901	11,353	12,771
TOTAL ALL SOURCES	**13,044**	**7,050**	**44,982**	**50,473**	**41,973**	**60,601**	**52,577**	**43,333**	**48,905**	**43,718**	**42,548**	**45,431**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

No data was available after 1984 to weigh the emissions from residential wood burning devices.

See section 6.2.4.1 for explanation of wide variation in Geogenic - wind erosion emissions.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-6. Lead Emissions
(short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
FUEL COMB. ELEC. UTIL.	***327***	***129***	***64***	***69***	***64***	***66***	***67***	***64***	***61***	***59***	***61***	***63***
Coal	300	95	51	50	48	46	46	46	46	47	49	49
bituminous	181	57	31	30	29	28	28	28	28	28	30	30
subbituminous	89	28	15	15	14	14	14	14	14	14	15	15
anthracite & lignite	30	9	5	5	5	4	4	4	4	4	5	5
Oil	28	34	13	19	16	20	21	18	15	12	12	14
residual	27	34	13	19	16	20	21	18	15	12	12	14
distillate	0	0	0	0	0	0	0	0	0	0	0	0
FUEL COMB. INDUSTRIAL	***237***	***60***	***30***	***25***	***22***	***19***	***18***	***18***	***18***	***18***	***15***	***15***
Coal	218	45	22	17	14	14	14	14	15	14	11	11
bituminous	146	31	15	12	10	10	10	10	10	10	7	8
subbituminous	45	10	5	4	3	3	3	3	3	3	2	2
anthracite & lignite	27	4	2	2	1	1	1	1	1	1	1	1
Oil	19	14	8	8	8	5	4	3	3	4	4	4
residual	17	14	7	7	7	5	3	3	2	3	4	3
distillate	1	1	1	1	1	1	1	1	1	1	1	1
FUEL COMB. OTHER	***10,052***	***4,111***	***421***	***422***	***425***	***426***	***420***	***418***	***416***	***414***	***415***	***415***
Commercial/Institutional Coal	1	12	6	6	5	5	4	4	3	4	4	3
bituminous	1	6	4	4	3	3	3	3	2	2	2	2
subbituminous	NA	2	1	1	1	1	1	1	1	1	1	1
anthracite, lignite	NA	4	1	1	1	1	1	0	0	0	1	0
Commercial/Institutional Oil	4	10	4	5	5	5	4	4	4	4	3	4
residual	3	9	3	4	4	4	3	3	3	3	3	3
distillate	NA	1	1	1	1	1	1	1	1	1	1	1
other	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Misc. Fuel Comb. (Except Residential)	10,000	4,080	400	400	400	400	400	400	400	400	400	400
Residential Other	47	9	11	11	14	16	12	10	9	7	8	8
CHEMICAL & ALLIED PRODUCT MFG	***103***	***104***	***118***	***108***	***123***	***136***	***136***	***136***	***132***	***93***	***96***	***93***
Inorganic Chemical Mfg	103	104	118	108	123	136	136	136	132	93	96	93
lead oxide and pigments	103	104	118	108	123	136	136	136	132	93	96	93

(continued)

Table A-6. Lead Emissions (continued)
(short tons)

Source Category	1970	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
METALS PROCESSING	***24,224***	***3,026***	***2,097***	***1,820***	***1,835***	***1,965***	***2,088***	***2,169***	***1,975***	***1,775***	***1,887***	***1,873***
Nonferrous Metals Processing	15,869	1,826	1,376	1,161	1,204	1,248	1,337	1,409	1,258	1,111	1,195	1,171
primary lead production	12,134	1,075	874	660	673	684	715	728	623	550	604	566
primary copper production	242	20	19	16	16	17	19	19	19	20	21	22
primary zinc production	1,019	24	16	11	7	8	9	9	11	11	13	14
secondary lead production	1,894	481	288	296	347	353	433	449	414	336	353	360
secondary copper production	374	116	70	63	31	61	37	75	65	73	70	80
lead battery manufacture	41	50	65	66	73	73	74	78	77	77	86	85
lead cable coating	127	37	43	47	56	50	50	50	48	44	47	44
other	38	24	3	2	1	1	1	1	1	1	1	1
Ferrous Metals Processing	7,395	911	577	553	499	554	582	576	517	462	499	489
coke manufacturing	11	6	3	3	3	4	4	4	3	3	3	3
ferroalloy production	219	13	7	13	14	14	20	18	14	14	12	13
iron production	266	38	21	16	17	18	19	18	16	19	20	19
steel production	3,125	481	209	200	128	157	138	138	145	139	145	150
gray iron production	3,773	373	336	320	337	361	401	397	339	288	319	304
Metals Processing NEC	960	289	144	107	132	164	169	184	199	201	193	213
metal mining	353	207	141	106	131	163	169	184	198	201	193	212
other	606	82	3	1	1	1	1	1	1	1	1	1
OTHER INDUSTRIAL PROCESSES	***2,028***	***808***	***316***	***199***	***202***	***172***	***173***	***169***	***167***	***56***	***54***	***55***
Mineral Products	540	93	43	25	28	23	23	26	24	26	27	26
cement manufacturing	540	93	43	25	28	23	23	26	24	26	27	26
Miscellaneous Industrial Processes	1,488	715	273	174	174	149	150	143	143	30	28	28
WASTE DISPOSAL & RECYCLING	***2,200***	***1,210***	***871***	***844***	***844***	***817***	***765***	***804***	***807***	***847***	***829***	***847***
Incineration	2,200	1,210	871	844	844	817	765	804	807	847	829	847
municipal waste	581	161	79	52	52	49	45	67	69	67	67	74
other	1,619	1,049	792	792	792	768	720	738	738	780	762	774
ON-ROAD VEHICLES	***171,961***	***62,189***	***15,978***	***3,589***	***3,121***	***2,700***	***2,161***	***1,690***	***1,519***	***1,444***	***1,401***	***1,403***
Light-Duty Gas Vehicles & Motorcycles	142,918	48,501	12,070	2,689	2,325	2,018	1,614	1,263	1,134	1,078	1,046	1,048
Light-Duty Gas Trucks	22,683	11,996	3,595	841	748	637	512	400	364	346	336	336
Heavy-Duty Gas Vehicles	6,361	1,692	313	59	48	44	36	28	20	19	19	19
NON-ROAD SOURCES	***8,340***	***3,320***	***229***	***219***	***222***	***211***	***207***	***197***	***186***	***193***	***179***	***193***
Non-Road Gasoline	8,340	3,320	229	219	222	211	207	197	186	193	179	193
TOTAL ALL SOURCES	**219,471**	**74,956**	**20,124**	**7,296**	**6,857**	**6,513**	**6,034**	**5,666**	**5,279**	**4,899**	**4,938**	**4,956**

Note(s): NA = not available.
In order to convert emissions to megagrams (metric tons), multiply the above values by 0.9072.

Table A-7. United States 1990 Ammonia Emissions by Environmental Protection Agency Region
(short tons)

Source Category	Region I	Region II	Region III	Region IV	Region V	Region VI	Region VII	Region VIII	Region IX	Region X	National Total
FUEL COMB. ELEC. UTIL.	***22***	***75***	***22***	***67***	***36***	***4,758***	***4***	***2***	***46***	***1***	***5,033***
Coal	0	0	0	0	0	19	0	0	0	0	19
Oil	19	18	11	26	8	195	1	0	8	0	286
Gas	3	57	11	40	28	4,544	4	2	38	0	4,727
FUEL COMB. INDUSTRIAL	***399***	***845***	***934***	***1,926***	***2,062***	***5,370***	***452***	***407***	***4,045***	***830***	***17,271***
Coal	0	1	2	4	6	2	1	1	0	0	18
Oil	294	574	322	832	385	1,088	54	89	528	127	4,292
Gas	105	270	610	1,091	1,671	4,280	397	317	3,516	703	12,960
FUEL COMB. OTHER	***1,362***	***1,804***	***1,347***	***827***	***1,263***	***405***	***213***	***171***	***388***	***193***	***7,973***
Commercial/Institutional Coal	0	0	0	0	1	0	0	0	0	0	2
Commercial/Institutional Oil	375	637	324	369	184	181	39	50	153	72	2,384
Commercial/Institutional Gas	26	79	61	68	189	78	50	32	79	16	677
Residential Other	961	1,089	962	390	889	145	125	90	156	104	4,910
CHEMICAL & ALLIED PRODUCT MFG											
Agricultural Chemical Mfg	0	0	4,277	48,478	10,193	73,825	41,477	52	3,319	954	182,574
METALS PROCESSING											
Ferrous Metals Processing	0	43	1,154	338	4,060	0	9	288	0	0	5,893
PETROLEUM & RELATED INDUSTRIES											
Petroleum Refineries & Related Industries	0	0	2,176	1,498	8,689	19,195	934	1,739	8,007	607	42,845
OTHER INDUSTRIAL PROCESSES	***0***	***0***	***2***	***17***	***3,113***	***22,929***	***6,899***	***2***	***1,088***	***3,524***	***37,574***
Agriculture, Food, & Kindred Products	0	0	0	0	0	0	0	0	0	2,079	2,079
Miscellaneous Industrial Processes	0	0	2	17	3,113	22,929	6,899	2	1,088	1,445	35,495
WASTE DISPOSAL & RECYCLING											
POTW	5,540	10,176	8,421	11,566	20,675	7,032	3,677	2,501	9,479	2,694	81,761
HIGHWAY VEHICLES	***10,065***	***15,645***	***19,640***	***39,258***	***36,488***	***24,609***	***10,165***	***6,327***	***28,761***	***7,522***	***198,479***
Light-Duty Gas Vehicles & Motorcycles	8,433	13,159	16,352	32,633	30,416	20,513	8,413	5,238	24,203	6,254	165,614
Light-Duty Gas Trucks	1,599	2,438	3,218	6,480	5,942	4,009	1,712	1,065	4,470	1,240	32,173
Heavy-Duty Gas Vehicles	20	29	42	85	76	52	23	15	53	16	411
Diesels	13	19	29	59	53	35	16	10	35	11	281
NONROAD ENGINES and EQUIPMENT	***44***	***119***	***249***	***451***	***348***	***684***	***219***	***152***	***480***	***179***	***2,926***
Marine Vessels	11	69	117	170	31	365	20	0	285	71	1,139
Railroads	33	50	132	281	317	319	199	152	195	108	1,788
AGRICULTURE & FORESTRY	***19,725***	***43,076***	***192,594***	***633,536***	***830,200***	***794,897***	***1,065,173***	***643,068***	***257,394***	***158,807***	***4,638,469***
Fertilizer Application	546	370	9,780	64,346	114,564	63,957	111,811	26,219	25,291	2,860	419,744
Animal Husbandry	19,180	42,705	182,814	569,190	715,635	730,941	953,362	616,848	232,103	155,947	4,218,725
TOTAL ALL SOURCES	***37,157***	***71,783***	***230,816***	***737,961***	***917,128***	***953,703***	***1,129,223***	***654,711***	***307,822***	***175,067***	***5,215,370***

Note(s): NA = not available.

"Residential Other" is residential combustion of all fuels except wood.

Zero values represent less than 0.5 short tons/year.

In order to convert emissions to megagrams (metric tons), multiply the above values by 0.9072.

Appendix B Regional Emissions (1985 to 1994)

Table B-1. Regional Emissions of Carbon Monoxide, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	5.07	4.81	4.68	4.60	4.45	4.08	4.01	4.07	3.90	4.03
II	7.60	7.37	7.17	7.18	6.69	6.18	6.13	6.02	5.72	5.72
III	10.81	10.66	10.61	10.22	9.50	8.80	8.77	8.83	8.69	8.88
IV	23.57	22.75	22.64	23.03	21.92	20.52	22.62	21.06	20.65	20.88
V	20.58	19.69	19.08	19.38	18.47	17.12	17.06	17.07	17.12	17.48
VI	16.10	15.35	14.93	14.97	14.16	13.47	13.12	13.03	13.33	13.67
VII	5.90	5.57	5.35	6.02	6.02	5.21	5.23	4.90	5.01	5.95
VIII	5.51	4.65	4.60	9.69	4.15	3.95	3.81	3.66	3.69	4.25
IX	13.17	11.87	13.01	12.18	11.85	11.78	11.33	9.93	10.09	11.05
X	6.38	6.47	5.94	8.59	5.92	9.54	5.29	5.47	5.94	6.10
National	**114.69**	**109.20**	**108.01**	**115.85**	**103.14**	**100.65**	**97.38**	**94.04**	**94.13**	**98.02**

Table B-2. Regional Emissions of Nitrogen Oxides, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	0.72	0.72	0.73	0.74	0.74	0.70	0.68	0.68	0.65	0.65
II	1.20	1.19	1.19	1.23	1.24	1.19	1.15	1.14	1.11	1.10
III	2.33	2.31	2.31	2.36	2.38	2.28	2.21	2.23	2.27	2.28
IV	4.26	4.27	4.26	4.42	4.41	4.39	4.43	4.49	4.65	4.62
V	4.57	4.53	4.52	4.65	4.69	4.65	4.59	4.60	4.76	4.82
VI	4.46	4.27	4.17	4.31	4.31	4.29	4.25	4.30	4.37	4.40
VII	1.43	1.39	1.40	1.48	1.50	1.49	1.48	1.46	1.51	1.57
VIII	1.15	1.09	1.12	1.56	1.21	1.23	1.23	1.27	1.27	1.34
IX	2.09	1.93	2.04	2.09	2.06	2.04	1.98	1.99	2.01	2.10
X	0.66	0.65	0.66	0.76	0.68	0.78	0.66	0.70	0.69	0.73
National	**22.86**	**22.35**	**22.40**	**23.62**	**23.22**	**23.04**	**22.67**	**22.85**	**23.28**	**23.62**

Table B-3. Regional Emissions of Volatile Organic Compounds, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	1.06	1.01	1.00	1.01	0.95	0.90	0.87	0.88	0.87	0.89
II	1.87	1.81	1.78	1.81	1.68	1.61	1.57	1.56	1.56	1.58
III	2.81	2.77	2.78	2.75	2.60	2.51	2.46	2.46	2.45	2.51
IV	5.39	5.29	5.31	5.43	5.14	4.95	5.13	4.84	4.81	4.89
V	4.57	4.38	4.37	4.40	4.19	4.01	3.97	3.95	3.98	4.09
VI	4.56	4.40	4.27	4.37	4.15	4.07	4.03	4.00	4.05	4.12
VII	1.27	1.22	1.20	1.30	1.27	1.16	1.15	1.10	1.11	1.25
VIII	0.86	0.76	0.77	1.02	0.71	0.69	0.67	0.67	0.68	0.72
IX	2.50	2.42	2.43	2.44	2.38	2.34	2.23	2.16	2.16	2.26
X	0.92	0.94	0.87	1.19	0.86	1.38	0.80	0.80	0.90	0.86
National	**25.80**	**24.99**	**24.78**	**25.72**	**23.93**	**23.60**	**22.88**	**22.42**	**22.58**	**23.17**

Table B-4. Regional Emissions of Sulfur Dioxide, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	0.59	0.61	0.58	0.63	0.63	0.57	0.56	0.51	0.44	0.41
II	0.88	0.83	0.85	0.86	0.88	0.86	0.82	0.77	0.71	0.66
III	3.24	3.32	3.37	3.45	3.45	3.36	3.44	3.46	3.40	3.35
IV	5.25	5.32	5.32	5.43	5.47	5.52	5.40	5.55	5.72	5.40
V	7.17	7.09	6.94	7.02	7.06	6.95	6.75	6.48	6.35	6.34
VI	2.47	2.12	2.11	2.14	2.20	2.17	2.17	2.21	2.27	2.25
VII	1.70	1.52	1.60	1.55	1.54	1.46	1.38	1.30	1.09	1.16
VIII	0.73	0.58	0.57	0.64	0.62	0.64	0.67	0.64	0.64	0.65
IX	0.97	0.83	0.63	0.68	0.69	0.65	0.63	0.64	0.64	0.62
X	0.25	0.21	0.23	0.24	0.25	0.25	0.25	0.27	0.26	0.27
National	**23.23**	**22.44**	**22.20**	**22.65**	**22.79**	**22.43**	**22.07**	**21.84**	**21.52**	**21.12**

Table B-5a. Regional Emissions of Particulate Matter (PM-10) from Point and Fugitive Process Sources, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	0.11	0.11	0.11	0.11	0.11	0.09	0.09	0.09	0.08	0.08
II	0.16	0.16	0.15	0.16	0.16	0.14	0.14	0.14	0.13	0.13
III	0.35	0.36	0.37	0.35	0.34	0.30	0.29	0.31	0.29	0.30
IV	1.07	1.04	1.03	1.05	1.06	0.92	1.11	0.96	0.93	0.93
V	0.60	0.58	0.56	0.59	0.58	0.54	0.52	0.53	0.52	0.53
VI	0.58	0.55	0.55	0.56	0.55	0.53	0.50	0.51	0.51	0.53
VII	0.24	0.23	0.22	0.29	0.30	0.23	0.23	0.21	0.20	0.29
VIII	0.18	0.14	0.15	0.70	0.15	0.15	0.14	0.13	0.12	0.18
IX	0.43	0.31	0.45	0.35	0.34	0.33	0.30	0.30	0.28	0.36
X	0.37	0.39	0.35	0.60	0.35	0.68	0.28	0.31	0.35	0.37
National	**4.09**	**3.89**	**3.93**	**4.75**	**3.93**	**3.88**	**3.59**	**3.49**	**3.41**	**3.70**

Table B-5b. Regional Emissions of Particulate Matter (PM-10) from Fugitive Dust Sources, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	1.36	1.26	1.27	1.28	1.12	1.03	0.99	1.02	0.89	0.98
II	2.30	2.07	2.09	1.82	1.81	1.57	1.60	1.54	1.64	1.62
III	2.29	2.18	2.31	2.25	2.15	2.15	2.24	2.20	1.99	2.03
IV	5.74	5.63	5.94	6.18	6.10	5.39	5.80	5.90	7.05	7.14
V	6.83	6.47	6.56	6.58	6.24	5.87	5.78	5.67	5.78	6.26
VI	8.21	15.17	7.33	20.73	16.96	10.43	11.87	9.38	8.75	8.08
VII	4.68	4.80	3.92	7.22	5.83	4.93	7.91	5.49	4.13	5.08
VIII	3.31	2.88	2.97	4.11	3.12	2.90	3.04	3.68	3.87	5.24
IX	4.22	4.24	3.72	3.84	3.55	3.18	3.38	2.87	2.90	3.04
X	1.96	1.90	1.94	1.84	1.78	1.99	2.71	2.47	2.15	2.26
National	**40.89**	**46.58**	**38.04**	**55.85**	**48.65**	**39.45**	**45.31**	**40.23**	**39.14**	**41.73**

Table B-5c. Regional Emissions of Particulate Matter (PM-10) from All Sources, 1985 to 1994

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	1.47	1.37	1.37	1.39	1.23	1.12	1.08	1.11	0.98	1.07
II	2.46	2.23	2.24	1.98	1.96	1.71	1.73	1.68	1.77	1.75
III	2.64	2.54	2.68	2.60	2.50	2.45	2.53	2.50	2.28	2.33
IV	6.81	6.67	6.97	7.23	7.15	6.30	6.91	6.86	7.98	8.07
V	7.43	7.05	7.12	7.18	6.82	6.41	6.30	6.21	6.29	6.78
VI	8.79	15.73	7.87	21.29	17.51	10.96	12.37	9.89	9.26	8.61
VII	4.92	5.03	4.14	7.51	6.13	5.16	8.14	5.70	4.33	5.36
VIII	3.49	3.02	3.12	4.81	3.27	3.05	3.18	3.81	3.99	5.42
IX	4.65	4.56	4.17	4.18	3.89	3.51	3.68	3.17	3.17	3.40
X	2.32	2.28	2.29	2.44	2.12	2.67	2.98	2.78	2.50	2.63
National	**44.98**	**50.47**	**41.97**	**60.60**	**52.58**	**43.33**	**48.91**	**43.72**	**42.55**	**45.43**

Table B-6. Regional Emissions of Lead, 1985 to 1994

(thousand short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
I	0.93	0.30	0.28	0.24	0.22	0.19	0.18	0.17	0.17	0.17
II	1.54	0.54	0.50	0.44	0.38	0.36	0.34	0.33	0.32	0.32
III	1.83	0.59	0.52	0.47	0.41	0.37	0.35	0.33	0.32	0.33
IV	3.57	1.16	1.11	1.08	1.01	0.95	0.89	0.81	0.81	0.82
V	3.98	1.68	1.56	1.54	1.45	1.41	1.32	1.22	1.24	1.26
VI	2.58	0.87	0.82	0.75	0.70	0.64	0.62	0.58	0.58	0.60
VII	1.88	1.00	0.99	0.99	1.00	0.99	0.88	0.79	0.83	0.80
VIII	0.74	0.27	0.26	0.24	0.23	0.21	0.20	0.18	0.18	0.18
IX	2.39	0.68	0.64	0.57	0.50	0.42	0.39	0.36	0.36	0.36
X	0.68	0.21	0.19	0.17	0.15	0.13	0.12	0.12	0.11	0.12
National	**20.12**	**7.30**	**6.86**	**6.51**	**6.03**	**5.67**	**5.28**	**4.90**	**4.94**	**4.96**

Appendix C National Total Particulate Emissions (1940 to 1992) by Subcategory

Table C-1. Total Particulate (TSP) Emissions
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1985	1990	1991	1992
FUEL COMB. ELEC. UTIL.	*1,431*	*2,179*	*3,122*	*2,603*	*919*	*479*	*456*	*445*	*454*
Coal	1,419	2,142	3,089	2,475	797	432	394	394	407
bituminous	822	1,240	1,847	1,492	483	262	239	239	247
subbituminous	405	611	910	735	238	129	118	118	122
anthracite and lignite	192	291	333	247	75	41	37	37	39
Oil	11	36	30	121	116	42	56	47	42
residual	11	34	29	117	113	40	54	45	41
distillate	0	2	1	4	3	1	2	2	2
Gas	0	1	3	7	7	6	5	5	5
FUEL COMB. INDUSTRIAL	*3,870*	*3,334*	*1,960*	*2,436*	*1,503*	*1,355*	*1,071*	*1,058*	*1,030*
Coal	3,598	2,934	1,659	1,444	272	132	92	98	99
bituminous	2,227	1,756	1,103	982	188	92	64	68	69
subbituminous	686	541	340	303	58	28	20	21	21
anthracite and lignite	685	638	217	159	26	12	8	9	9
Oil	44	82	76	106	80	43	22	20	15
residual	33	62	56	83	63	35	14	13	8
distillate	0	2	2	9	6	5	5	5	5
other	11	17	18	14	11	4	3	3	3
Gas	6	15	25	27	23	20	26	26	27
natural	5	13	22	24	20	17	22	21	22
process	1	2	3	4	4	3	5	5	5
Other	222	302	200	859	1,129	1,159	930	914	889
wood/bark waste	171	252	187	818	1,121	1,156	926	911	885
other	51	50	13	40	7	3	4	3	4
FUEL COMB. OTHER	*2,678*	*2,062*	*1,247*	*509*	*937*	*900*	*538*	*523*	*493*
Commercial/Institutional Coal	415	480	58	47	36	21	14	13	13
Commercial/Institutional Oil	25	45	63	71	44	19	20	20	19
Commercial/Institutional Gas	0	1	2	4	4	4	4	4	4
Residential Wood	1,716	1,128	850	384	818	821	469	457	429
fireplaces	402	264	199	90	191	192	110	107	100
woodstoves	1,315	864	651	294	626	629	359	350	328
Residential Other	522	408	275	4	36	35	30	29	29

(continued)

Table C-1. Total Particulate (TSP) Emissions (continued)
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1985	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	*330*	*456*	*310*	*238*	*150*	*129*	*121*	*118*	*127*
Organic Chemical Mfg	6	9	18	45	21	23	22	22	23
Inorganic Chemical Mfg	68	31	45	62	25	13	12	12	12
Agricultural Chemical Mfg	19	15	16	46	61	48	41	42	43
Other Chemical Mfg	237	401	230	86	42	45	45	43	48
METALS PROCESSING	*4,478*	*4,853*	*3,170*	*2,781*	*782*	*496*	*486*	*461*	*487*
Nonferrous Metals Processing	620	385	443	731	151	112	99	100	105
copper	238	120	146	428	38	34	33	32	33
lead	168	82	46	57	19	13	16	14	15
zinc	188	89	52	24	3	4	4	4	4
other	26	94	199	222	91	61	47	50	52
Ferrous Metals Processing	3,446	4,189	2,247	1,473	430	242	248	217	237
primary	3,287	3,858	2,083	1,304	379	201	198	173	188
secondary	159	331	164	169	51	41	50	43	49
Metals Processing NEC	411	279	481	577	201	142	138	144	146
PETROLEUM & RELATED INDUSTRIES	*389*	*547*	*1,219*	*687*	*166*	*144*	*152*	*147*	*148*
Petroleum Refineries & Related Industries	2	23	50	70	41	16	13	13	13
fluid catalytic cracking units	2	23	50	70	41	16	13	13	13
Asphalt Manufacturing	387	524	1,169	617	125	128	139	133	134
OTHER INDUSTRIAL PROCESSES	*4,366*	*8,152*	*9,042*	*7,949*	*2,542*	*2,196*	*1,994*	*1,878*	*1,919*
Agriculture, Food, & Kindred Products	882	898	1,036	872	629	834	639	574	563
country elevators	371	417	512	426	388	465	404	344	342
terminal elevators	351	313	346	310	152	252	142	121	120
feed mills	24	26	27	20	10	27	18	16	12
soybean mills	48	60	53	30	22	27	16	29	25
wheat mills	12	11	9	10	2	3	1	2	2
other grain mills	17	19	20	20	11	10	6	7	9
other	58	53	69	56	43	52	52	56	53
Wood, Pulp & Paper, & Publishing Products	550	866	1,031	788	229	220	202	202	208
sulfate (kraft) pulping	470	729	886	668	142	124	90	92	95
other	80	137	145	120	87	96	112	110	114

(continued)

Table C-1. Total Particulate (TSP) Emissions (continued)
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1985	1990	1991	1992
OTHER INDUSTRIAL PROCESSES (continued)									
Mineral Products	2,934	6,388	6,975	6,289	1,684	1,142	1,153	1,103	1,148
cement mfg	1,363	1,998	2,014	1,731	417	287	226	212	217
surface mining	175	307	403	388	385	392	444	428	442
stone quarrying/processing	482	764	1,411	1,582	500	206	275	255	276
other	914	3,319	3,147	2,587	382	256	207	209	213
WASTE DISPOSAL & RECYCLING	*550*	*659*	*962*	*1,210*	*365*	*318*	*304*	*288*	*334*
Incineration	330	327	417	440	167	141	127	111	125
residential	98	86	115	134	112	105	101	101	101
other	232	241	302	306	55	35	26	10	24
Open Burning	220	333	544	770	198	177	178	177	209
other	220	333	544	770	198	177	178	177	209
ON-ROAD VEHICLES	*220*	*329*	*582*	*1,004*	*1,161*	*1,233*	*1,412*	*1,451*	*1,451*
Light-Duty Gas Vehicles & Motorcycles	169	232	442	681	637	594	698	726	726
ldgv	169	232	441	677	629	591	694	722	722
motorcycles	0	0	1	4	7	4	4	4	4
Light-Duty Gas Trucks	23	36	56	111	171	189	234	238	238
ldgt1	18	28	45	91	96	112	148	163	163
ldgt2	5	8	11	20	75	76	86	75	75
Heavy-Duty Gas Vehicles	29	51	68	71	61	51	52	43	43
Diesels	0	9	15	141	291	400	427	444	444
hddv	0	9	15	141	279	375	410	427	427
lddt	0	0	0	0	3	4	4	3	3
lddv	0	0	0	0	9	21	13	14	14
NON-ROAD SOURCES	*2,762*	*2,014*	*245*	*317*	*281*	*286*	*285*	*274*	*278*
Non-Road Gasoline	2	16	19	17	14	13	11	10	11
recreational	0	0	0	2	3	3	2	2	2
construction	0	5	5	1	1	1	1	1	1
industrial	0	3	2	3	2	1	2	2	2
farm	0	7	10	9	5	5	3	3	4
other	0	1	2	2	2	3	3	2	3

(continued)

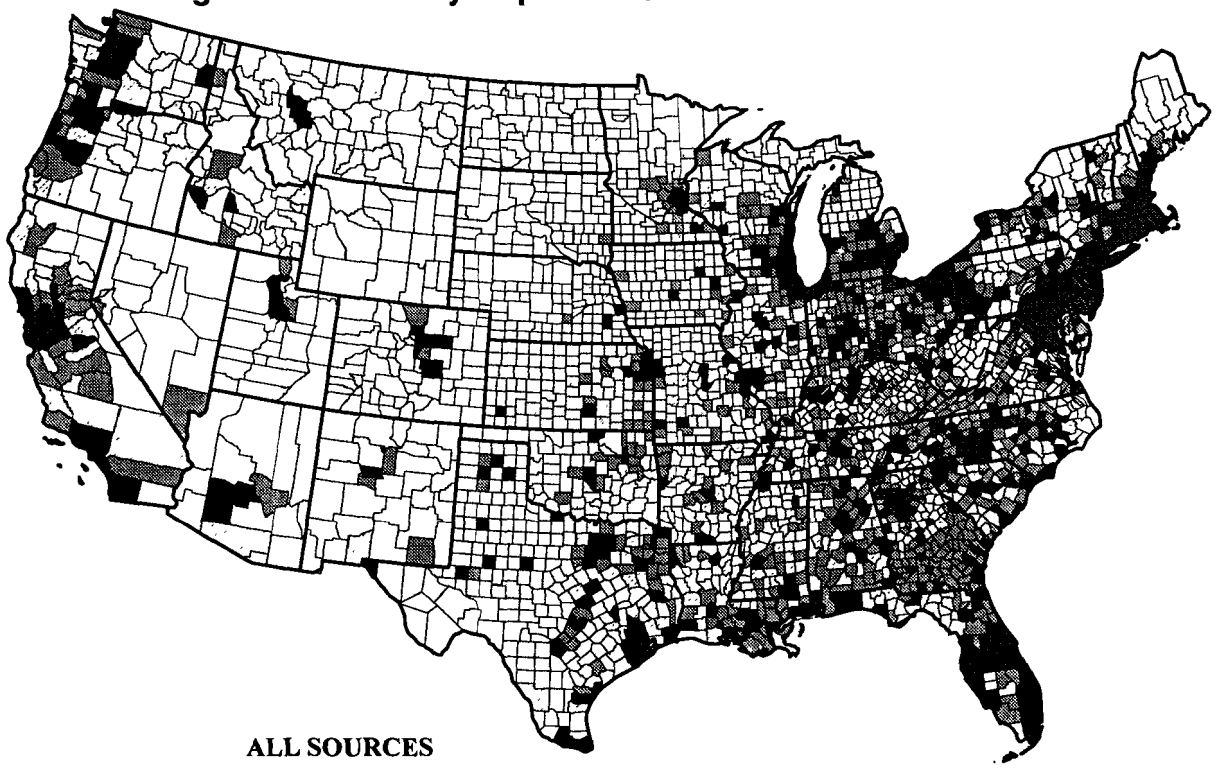
Table C-1. Total Particulate (TSP) Emissions (continued)
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1985	1990	1991	1992
NON-ROAD SOURCES (continued)									
Non-Road Diesel	1	16	22	71	94	107	112	110	112
construction	0	12	12	14	19	20	23	22	23
industrial	0	0	3	19	18	14	16	16	14
farm	0	4	7	38	57	73	73	72	75
Aircraft	0	0	40	110	82	96	86	80	81
Marine Vessels	107	1,982	45	49	32	30	35	36	37
coal	94	87	28	32	0	0	0	0	0
diesel	6	7	7	7	11	17	20	20	21
residual oil	7	13	10	9	22	13	15	16	16
Railroads	2,651	1,874	119	70	60	40	41	38	37
MISCELLANEOUS	***4,081***	***2,791***	***1,903***	***1,210***	***1,186***	***1,114***	***1,312***	***1,087***	***1,116***
Other Combustion	4,081	2,791	1,903	1,210	1,186	1,114	1,312	1,087	1,116
wildfires	2,774	1,353	544	490	654	597	807	581	613
managed burning	881	987	903	581	472	471	471	471	471
other	426	451	456	139	59	47	34	35	32
TOTAL ALL SOURCES	**25,157**	**27,375**	**23,761**	**20,944**	**9,992**	**8,651**	**8,131**	**7,730**	**7,836**

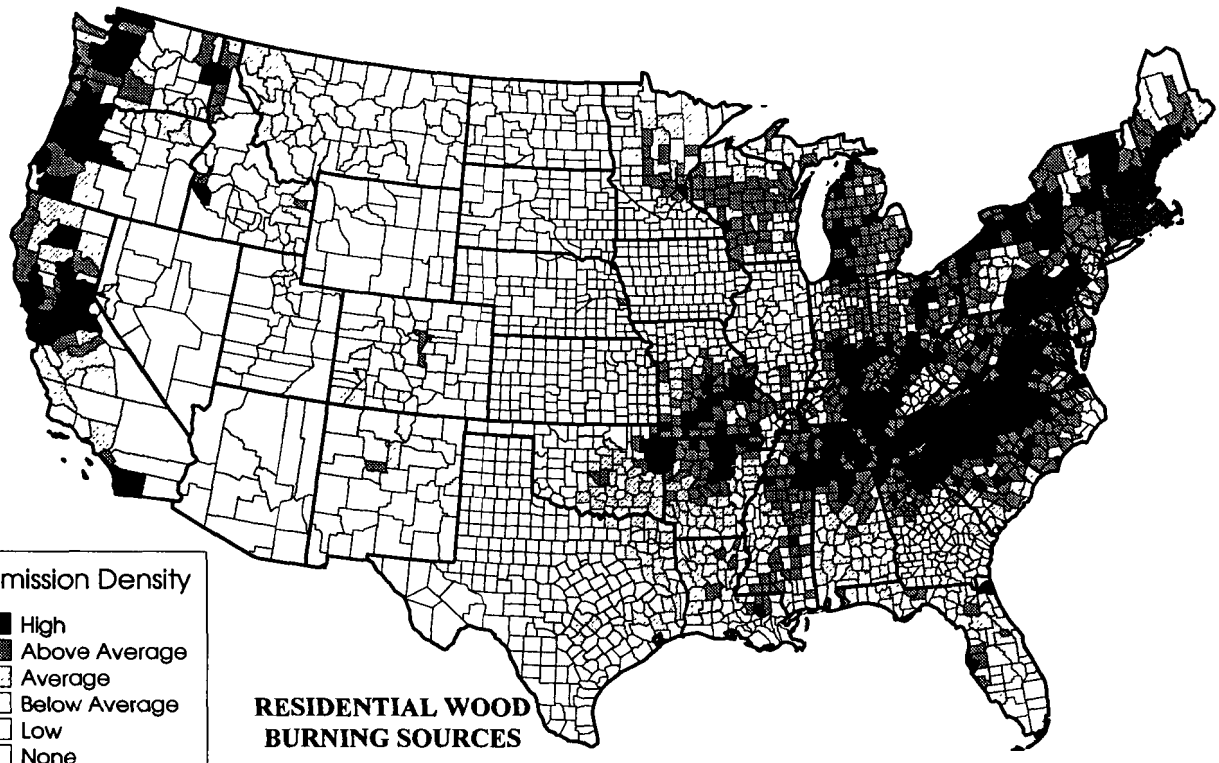
NOTE(S): NA = not available
Zero values represent less than 500 short tons/year.

Appendix D Chapter 2 Color Maps Converted to Black and White

Figure D-1. Density Maps of 1994 CARBON MONOXIDE Emissions

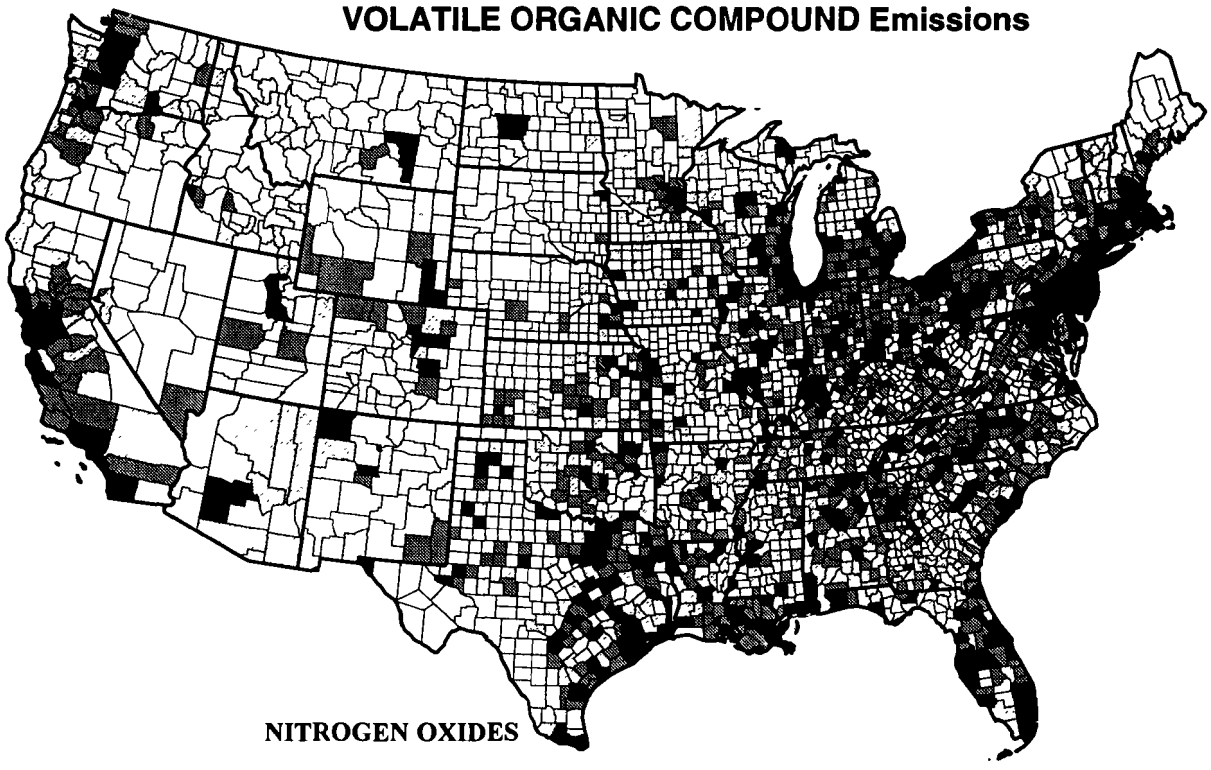


ALL SOURCES



RESIDENTIAL WOOD BURNING SOURCES

Figure D-2. Density Maps of 1994 NITROGEN OXIDE and VOLATILE ORGANIC COMPOUND Emissions



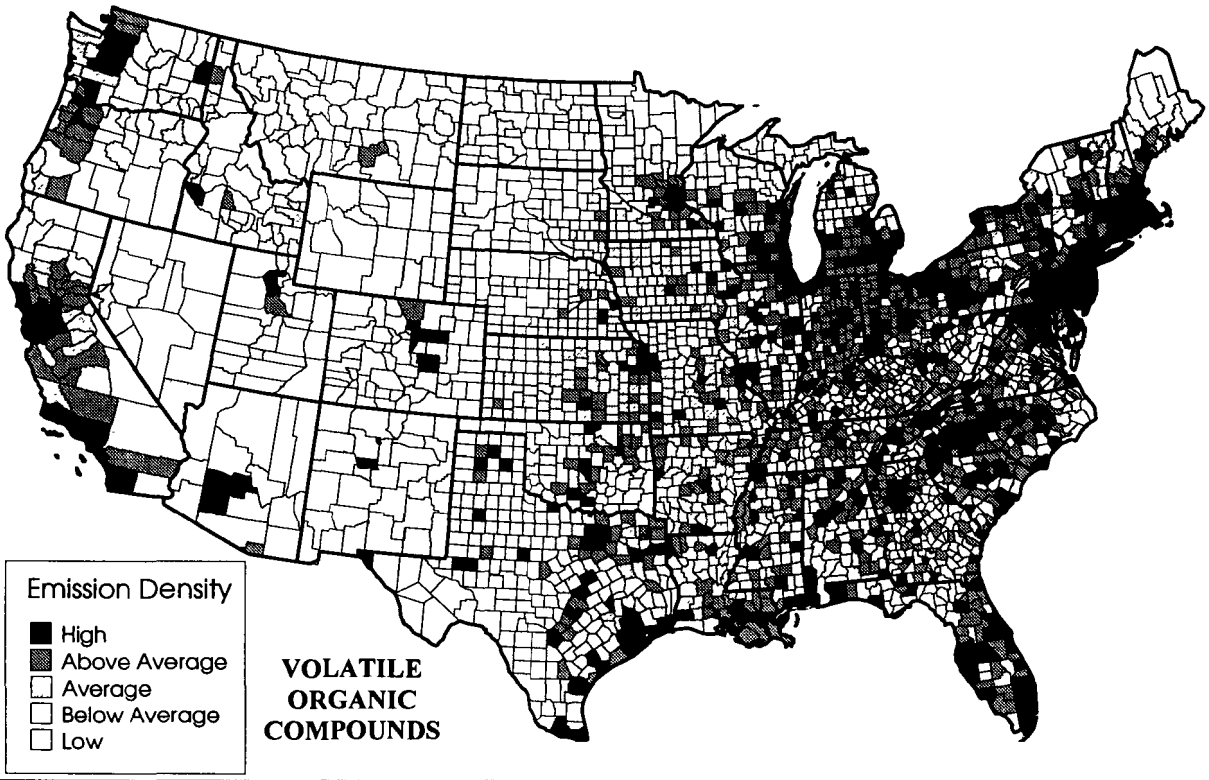
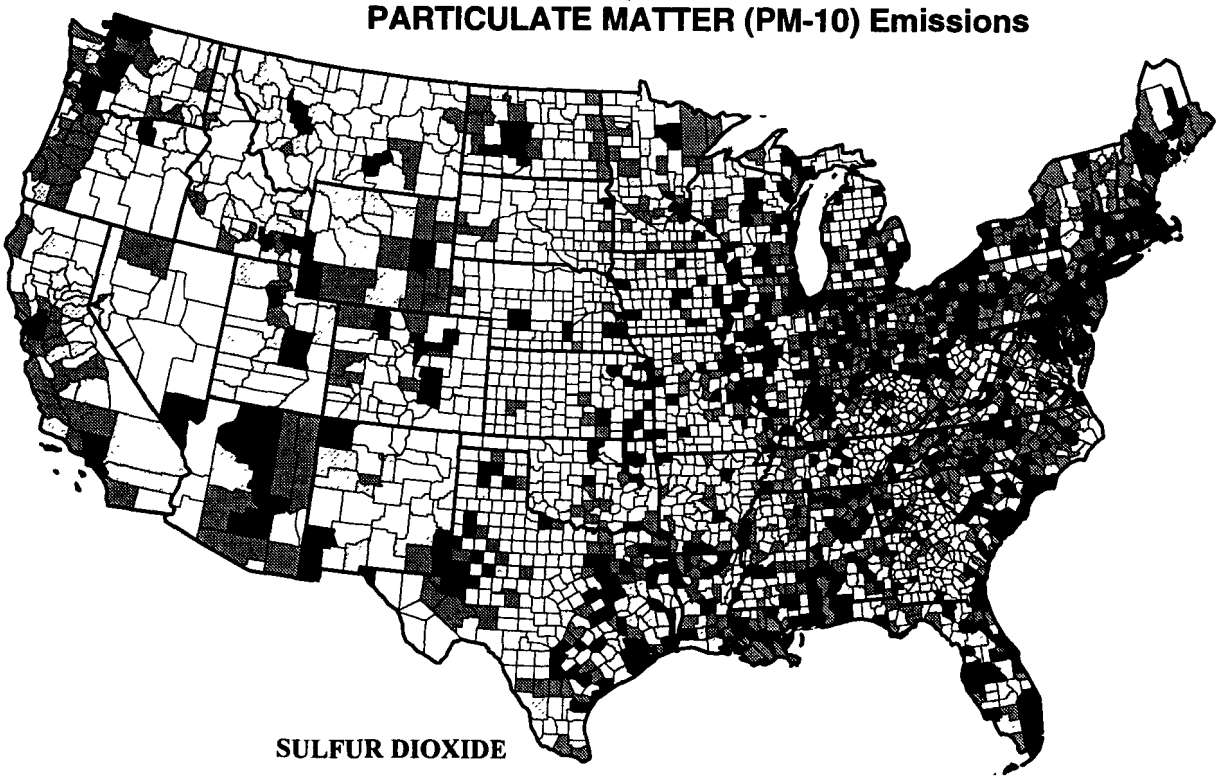
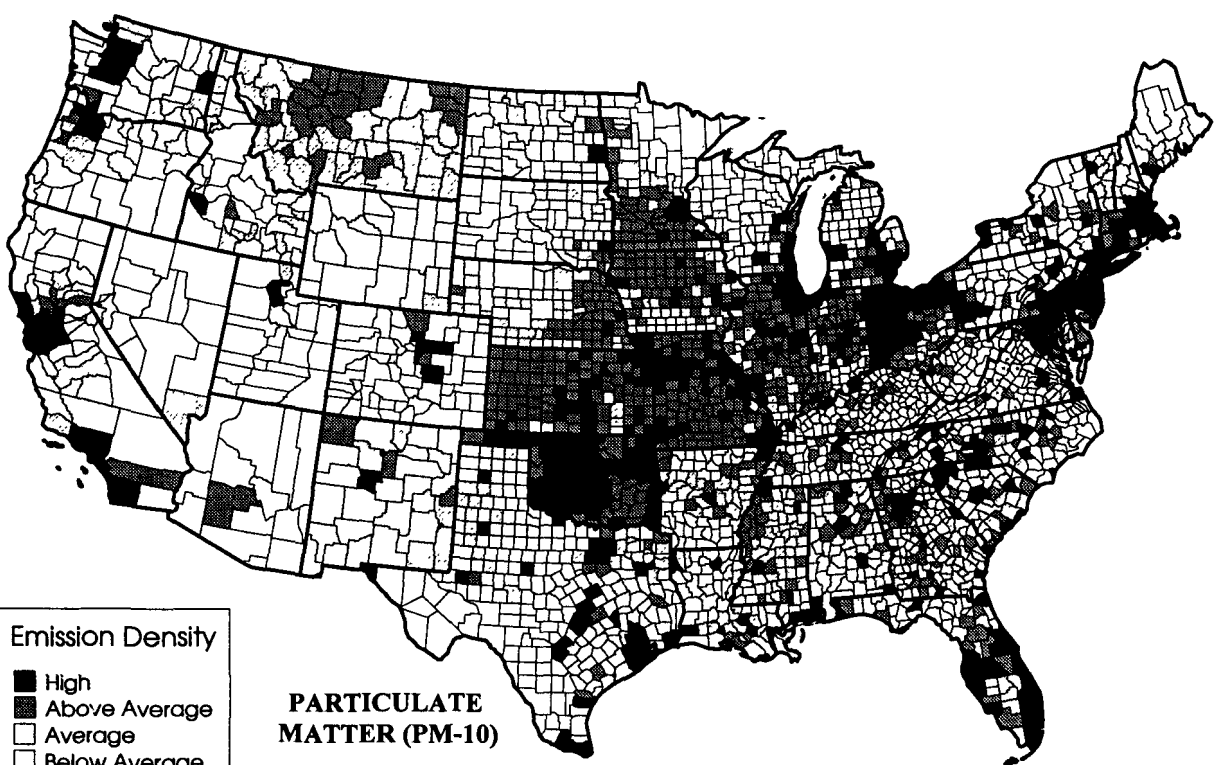


Figure D-3. Density Maps of 1994 SULFUR DIOXIDE and PARTICULATE MATTER (PM-10) Emissions



SULFUR DIOXIDE

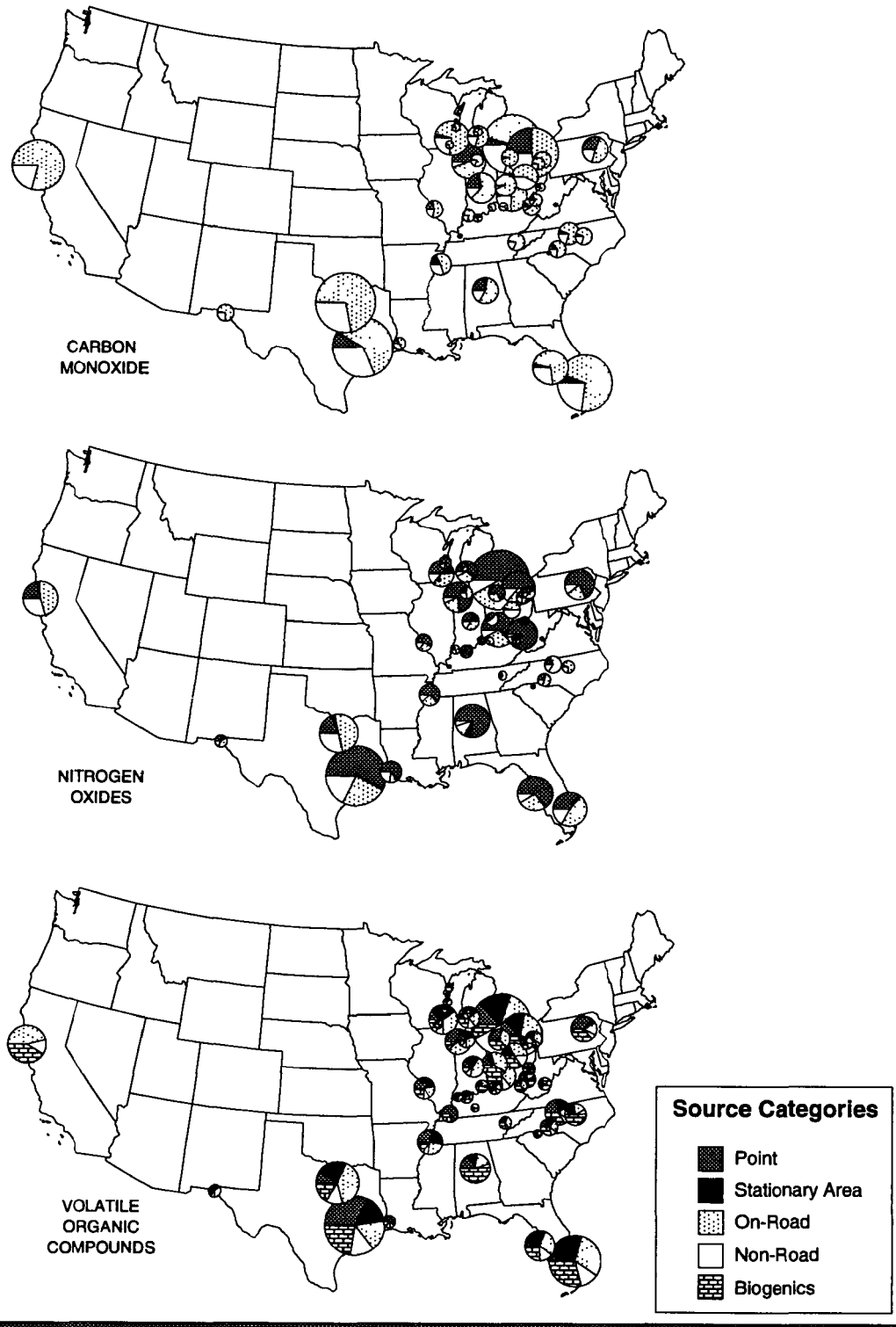


PARTICULATE MATTER (PM-10)

Emission Density
- High
- Above Average
- Average
- Below Average
- Low

Note(s): 1994 emissions except 1990 PM-10 Fugitive Dust-paved and unpaved road emissions for Mississippi
The data used to estimate emissions for Mississippi is currently under review.

Figure D-4. Ozone Nonattainment Areas with Approved 1990 Base Year Emissions by Major Sources and Locations



TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

1. REPORT NO. EPA-454/R-95-011	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE National Air Pollutant Emission Trends, 1900 - 1994		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Sharon V. Nizich, Thomas Pierce, William Hohenstein, E.H. Pechan and Associates		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Mail Drop 14 Research Triangle Park, NC 27711		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-D30035
12. SPONSORING AGENCY NAME AND ADDRESS Director Office of Air Quality Planning and Standards Office of Air and Radiation U.S. Environmental Protection Agency Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Technical - 1900-1994 14. SPONSORING AGENCY CODE EPA/200/04
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This report presents the latest estimates of national and regional emissions for criteria air pollutants: carbon monoxide, lead, nitrogen oxides, fine particulate matter, sulfur dioxide, particulate matter, and volatile organic compounds. Estimates are presented for the years 1900 to 1994, with greater detail in more recent years. This report also includes sections on air toxics, international emissions, greenhouse gases, projections, and biogenics.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Emission Trends	Particulate Matter	Air Pollution Control	
Lead	Carbon Monoxide	Air Pollution Research	
Air Pollution	Sulfur Dioxide	Air Pollution Trends	
Nitrogen Dioxide	Emission Projections		
Ozone	Greenhouse Gases		
Biogenics			
Total Suspended Particulates			
Volatile Organic Compounds			

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS *(Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(Page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

C: horse.wpd

ERRATA SHEET:

National Air Pollutant Emission Trends, 1900-1994
EPA-454/R-95-011
October 1995

NTIS Number = TD96-135678

Page 2-19, Table 2-15: Top 50 AIRS/AFS Plants Emitting Lead - 1994

Horsehead Resource Development Co., Inc., ranked number 3 with 303 tons per year of emissions, was not reported correctly in AIRS. According to the state of Illinois, the correct value for 1994 is less than 1 ton per year.