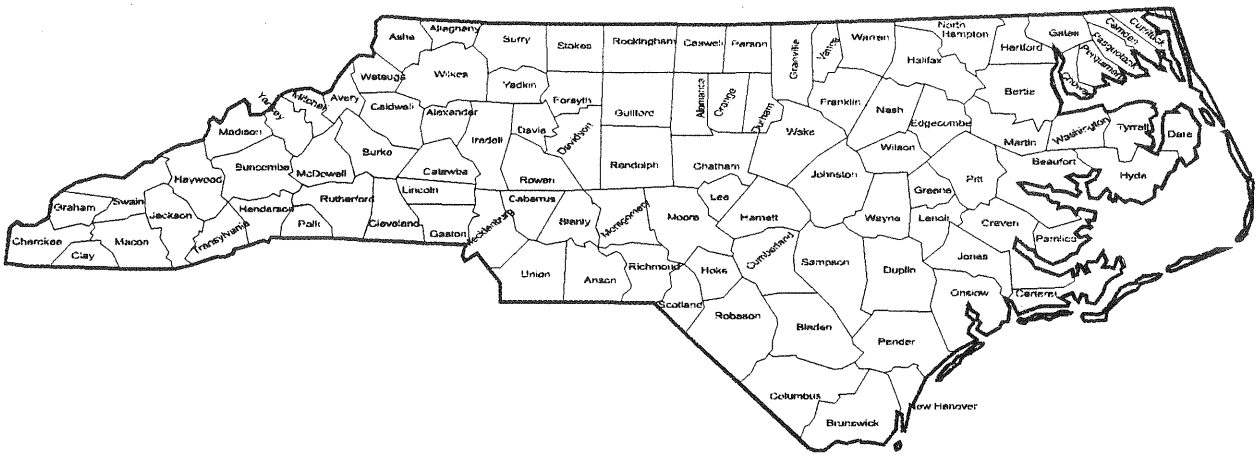
1994 Ambient Air Quality Report



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Foreword

This report is issued by the Division of Air Quality of the Department of Environment and Natural Resources to inform the public of air pollution levels throughout the state of North Carolina. It describes the sources and effects of the following pollutants for which the U.S. Environmental Protection Agency and the State of North Carolina have established ambient air quality standards:

Particulate Matter	Nitrogen Dioxide
Carbon Monoxide	Ozone
Sulfur Dioxide	Lead

A brief discussion of the ambient air monitoring program, including a description of the monitoring network, is provided. Detailed results are presented of monitoring that was conducted in 1994 to measure the outdoor concentrations. The data are presented graphically and as statistical summaries, including comparisons to the ambient air quality standards. The report discusses the recorded data and seasonal variability of some pollutants. Data and areas exceeding the ambient air quality standards are identified. Factors that have contributed to those exceedances also are described.

Acid rain data from the National Atmospheric Deposition Program/National Trends Network for North Carolina also are included for 1994. Data collected after 1994 will be discussed in later reports.

Current air pollution information is available to the public 24 hours a day through the use of the air quality index telephone numbers listed below for the following locations:

Statewide toll-free 1-888-AIR-WISE
(for Asheville, Durham, Fayetteville, Greensboro, Greenville, Raleigh, Wilmington, and Winston-Salem areas)

Charlotte area 1-703-333-SMOG

Additional copies of this report and previous annual reports are available from:

Division of Air Quality
Department of Environment and Natural Resources
P O Box 29580
Raleigh, North Carolina 27626-0580

Comments regarding this report or suggestions for improving future reports are welcomed. Comments may be sent to Mr. Charles O. Davis III at the above address.

Alan W. Klimek, P.E., Director

Executive Summary

In 1994, the North Carolina Division of Environmental Management (DEM) and three local program agencies (listed in Appendix A) collected 380,122 air quality samples. These samples included measurements of the U.S. Environmental Protection Agency's (EPA) criteria air pollutants: particulate matter, carbon monoxide, ozone, sulfur dioxide, and nitrogen dioxide. This report discusses each pollutant and presents summary tables, maps, charts and explanations of the data.

This report also includes data from weekly acid rain samples collected by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) at seven North Carolina sites and one Tennessee site very close to the North Carolina border. It discusses acid rain and presents summary tables, maps, charts and explanations of the data.

Two different types of **particulate matter** were sampled in North Carolina during 1994. Total Suspended Particulate (TSP), generally considered to be particles having an aerodynamic diameter of 45 micrometers or less, is regulated by North Carolina standards. Particulate matter (PM-10) with an aerodynamic diameter less than or equal to a nominal 10 micrometers (0.00004 inches) is regulated by both EPA and N.C. standards.

TSP was sampled at 18 sites, yielding 969 daily samples. Two exceedances of the state TSP ambient air quality standard for daily samples (150 $\mu g/m^3$) were observed in 1994. One on November 16 at East Trade Street in Mecklenburg County, was attributed to blasting at a construction site adjacent to the sampling site. A second, in Robeson County on March 21, was determined to be the result on a high percentage of pollen being collected.

PM-10 was sampled at 47 sites, yielding 3,433 24-hour samples. There were no exceedances of the National Ambient Air Quality Standards for PM-10 (150 $\mu g/m^3$ for 24-hour samples or the 50 $\mu g/m^3$ for the annual arithmetic mean).

Carbon monoxide (CO), the most commonly occurring air pollutant in North Carolina, largely results from the incomplete combustion of fossil fuels. The most likely areas to have excessive CO concentrations are larger cities where there are more cars and congested streets. On January 6, 1992, Wake, Durham and Forsyth Counties were designated as nonattainment areas for the national CO standard.[1] Charlotte, NC has been designated nonattainment since the adoption of the Clean Air Act of 1978.

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(1) Federal Register Vol. 56 (No. 215)

On September 21, 1994, Winston-Salem was redesignated as meeting the National CO Standard effective November 7, 1994.

CO was sampled at 16 sites, yielding 121,717 valid hourly averages. The National Ambient Air Quality Standards for CO are 35 ppm for the maximum one-hour average and 9 ppm for the maximum eight-hour average. There were no exceedances of the one-hour average standard or the eight-hour standard during 1994. The combined effects of newer cars replacing older cars in the vehicle fleet, traffic control strategies, the use of oxygenated fuels, and the Inspection and Maintenance program in Mecklenburg, Forsyth and Wake Counties have helped eliminate CO exceedances during 1994.

Ozone (O_3) forms in the lower atmosphere when hydrocarbons (volatile organic compounds) and nitrogen oxides chemically react in the presence of sunlight and increased temperatures. The main emphasis in the control strategy of ozone has been to reduce and limit hydrocarbon emissions. As of the writing of this report the control emphasis has changed to control of nitrogen oxides

Ozone was sampled at 37 sites, yielding 167,989 valid hourly averages. The National Ambient Air Quality Standard for O_3 is 0.12 ppm for the maximum one-hour average. In 1994, there were no exceedances of the ozone standard (See Table 5.6).

As of January 1, 1994, the following areas were designated as nonattainment for the national ozone standard:

Charlotte-Gastonia Area	(Gaston and Mecklenburg Counties)
Raleigh-Durham Area	(Durham and Wake Counties and Dutchville Township in Granville County)

On April 18, 1994 the Raleigh-Durham Area was redesignated as being in attainment for ozone effective June 17, 1994. As of the printing of this annual report the Charlotte-Gastonia Area also has achieved attainment status and no new areas have been designated as not being in attainment of the 0.12 ppm standard for ozone.

Sulfur dioxide (SO_2) is mainly produced by combustion of fossil fuels containing sulfur compounds and the manufacture of sulfuric acid.

SO_2 was sampled at 11 sites, yielding 69,770 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standards (0.14 ppm for a 24-hour average, 0.50 ppm for a three-hour average, 0.03 ppm for the annual arithmetic mean) in 1994.

Nitrogen oxides (NO_x) are produced primarily from of the burning of fossil fuels such as coal, oil and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is nitric oxide (NO), which reacts to form nitrogen dioxide (NO_2). NO_x compounds play an important role in the formation of ozone. NO_x was monitored in Charlotte, Raleigh, and Winston-Salem to gather data for the development of control strategies for ozone nonattainment areas.

The criteria pollutant NO_2 was sampled at two sites, yielding 16,244 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standard (0.053 ppm for the annual arithmetic mean).

Lead (Pb) emissions result from coal combustion and the sandblasting of highway bridges and water tanks. In the past, the combustion of gasoline containing tetraethyl lead as an additive was a major source.

Although no lead samples were taken in 1994, there have been no recent exceedances of the ambient air quality standard for lead (1.5 $\mu g/m^3$ for a quarterly arithmetic mean). Mean lead concentrations have been decreasing by 17 to 40 percent annually in recent years. The elimination of the use of leaded gasoline is primarily responsible for this trend.

Acid Rain is produced when nitrate and sulfate ions from motor vehicles and industrial sources reach the upper atmosphere, react with water vapor, and are deposited as acid precipitation. Monitoring of pH and other ion concentrations in precipitation will help to identify trends and demonstrate the results of efforts to reduce emissions from mobile and industrial sources.

The annual mean pH in 1994 ranged from 4.69 at the Mount Mitchell site in Yancey County to 4.42 at the Piedmont Research Station in Rowan County.

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1. Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 1994 by the North Carolina Division of Environmental Management (DEM) and three local air pollution agencies, which are more fully described in Appendix A. (The DEM was superseded in 1996 by the Division of Air Quality [DAQ].)

There were 476,592 air quality samples of the U.S. Environmental Protection Agency's (EPA) criteria pollutants -- particulate matter, carbon monoxide, ozone, sulfur dioxide, and nitrogen dioxide-- which are discussed and presented in this report. No samples of another criteria pollutant, lead, were taken in 1994.

This report is broken down into six chapters. Chapter 2 describes the criteria pollutants and discusses their sources and effects on human health, plants and animals. Chapter 3 outlines the standards applied to criteria pollutant concentrations established by the EPA and the state of North Carolina to protect human health (primary standards) and plants, animals, and property (secondary standards). Chapter 4 describes the ambient monitoring program conducted by DEM and three local program agencies. Chapter 5 gives detailed monitoring results for each pollutant, with a map of the monitor sites, a table of the monitor summary statistics relevant to the standards, one or more maps summarizing the important statistics for each county with monitors, and additional summaries as appropriate to each individual pollutant. Chapter 6 describes the EPA Air Quality Index for the criteria pollutants and graphs index measurements for five Metropolitan Statistical Areas of North Carolina. Chapter 7 presents sources, effects and monitoring of acid rain data conducted in North Carolina by the National Atmospheric Deposition Program and National Trends Network (NADP/NTN). It also includes a map of average pH levels and site statistics for the calendar year in two tables.

2. Description of Criteria Pollutants

2.1. Particulate Matter

Atmospheric particulate matter is defined as any airborne material, except uncombined water (mist, steam, etc.) that exists in a finely divided form as a liquid or solid at standard temperature (25°C) and pressure (760 mm mercury) and has an aerodynamic diameter of less than 100 micrometers. Currently, two sizes of particulate matter are monitored, total suspended particulate (TSP) and PM-10. TSP is any particulate matter measured by the method described in EPA regulations 40 CFR 50 App. B (Office of the Federal Register 1993, p. 715-728) and is generally considered to be particles having an aerodynamic diameter of 45 micrometers or less. PM-10 is particulate matter with an aerodynamic diameter less than or equal to 10 micrometers as measured according to EPA regulations 40 CFR 50 App. J (Office of the Federal Register 1993, p. 769-773). TSP measurements have been made in North Carolina since the early 1960s and PM-10 has been sampled locally in Charlotte since 1985 and statewide since 1986 (North Carolina Department of Environment, Health, and Natural Resources 1994).

2.1.1. Sources

Particulates are emitted by activities, such as fuel combustion, motor vehicle operation, industrial processes, grass mowing, agricultural tilling and open burning. Natural sources include windblown dust, forest fires, volcanic eruptions and plant pollen.

Particles emitted directly from a source may be either fine (less than 2.5 micrometers) or coarse (2.5 - 60 micrometers), but particles formed in the atmosphere usually will be fine. Generally, fine particles have very slow settling velocities and are characterized as suspended particulate matter. Typically, fine particles originate by condensation of materials produced during combustion or atmospheric transformation.

2.1.2. Effects

Particulate matter can cause health problems affecting the respiratory system, including aggravation of existing lung and heart disease, limitation of lung clearance, changes in form and structure of organs, and development of cancer. Individuals most sensitive to the effects of particulate matter include those with chronic obstructive lung or heart disease, those suffering from the flu, asthmatics, the elderly, children, and individuals with dysfunctional nasal passages.

Health effects from particulates are influenced by the amount of particles inhaled, the depth of penetration into the respiratory system, and the biological reaction to these particles. The risk of adverse health effects is greater when particles enter the tracheobronchial and alveolar portions

of the respiratory system. Small particles can penetrate into these deeper regions of the respiratory system. Healthy respiratory systems can trap particles larger than 10 micrometers more efficiently, before they move deeply into the system, and can more effectively remove the particles that are not trapped before deep movement.

Particulate matter can interfere with plant photosynthesis, by forming a film on leaves that reduces exposure to sunlight. Particles also can cause soiling and degradation of property, which can be costly to clean and maintain.

Suspended particles can absorb and scatter light, reducing visibility. This is a national concern, especially in areas such as national parks, historic sites and scenic attractions visited by sightseers.

2.2. Carbon Monoxide

Carbon monoxide (CO) is the most commonly occurring air pollutant in North Carolina. CO is a colorless and poisonous gas produced by incomplete burning of carbon-containing fuel.

2.2.1 Sources

Most atmospheric CO is produced by incomplete combustion of fuels used for vehicles, space heating, industrial processes and solid waste incineration. Transportation accounts for the majority of CO emissions. Boilers and other fuel burning heating systems are also significant sources.

2.2.2. Effects

Breathing carbon monoxide affects the oxygen-carrying capacity of the blood. Hemoglobin in the blood binds with CO more readily than with oxygen, starving the body of vital oxygen.

Individuals with anemia, heart and lung diseases are particularly sensitive to CO effects. Low concentrations affect mental function, vision and alertness. High concentrations can cause fatigue and reduced work capacity and may adversely affect fetal development. Chronic exposure to CO at concentrations as low as 70 ppm (80 mg/m^3) can cause cardiac damage. Other health effects associated with exposure to CO include central nervous system effects and pulmonary function difficulties.

Ambient CO apparently does not harm affect vegetation or materials.

2.3. Ozone

Ozone (O_3) is a clear gas that forms in the troposphere (lower atmosphere) by chemical reactions involving hydrocarbons (or volatile organic compounds) and nitrogen oxides in the presence of sunlight and high temperatures. Even low concentrations of tropospheric ozone are harmful to people, animals, vegetation and other materials. Ozone is the most widespread and serious criteria air pollutant in North Carolina.

Ozone in the upper atmosphere (stratosphere) shields the earth from harmful effects of ultraviolet solar radiation. Stratospheric ozone can be damaged by the emission of chlorofluoro-hydrocarbons (CFCs) such as Freon.

2.3.1. Sources

Ozone is not usually emitted directly into the atmosphere, but is formed by a series of complex chemical reactions involving hydrocarbons, nitrogen oxides and sunlight. Ozone concentrations are higher during the daytime in late spring, summer and early autumn when the temperature is above 60°F and the sunlight is more intense. High levels typically occur under low wind speeds often associated with high pressure weather systems.

Two natural sources of upper atmosphere ozone are solar radiation and electrical discharge during thunderstorms. These are not significant sources of tropospheric ozone.

2.3.2. Effects

Ozone is a pulmonary irritant, affecting the respiratory mucous membranes as well as other lung tissues and respiratory functions. Ozone has been shown to impair normal function of the lung–causing shallow, rapid breathing and a decrease in pulmonary function. Other symptoms of exposure include chest tightness, coughing and wheezing. People with asthma, bronchitis or emphysema probably will experience breathing difficulty when exposed to short-term concentrations between 0.15 and 0.25 ppm. Continued or repeated long-term exposure may result in permanent lung structure damage.

Ozone damages vegetation by injuring leaves. Ozone also accelerates material aging–cracking rubber, fading dyes and eroding paint.

2.4. Sulfur Dioxide

Sulfur dioxide (SO_2) is a colorless, corrosive, harmful gas with a pungent odor. Small concentrations of sulfur trioxide and other sulfate compounds also are found in SO_2 emissions. Sulfur oxides contribute to the formation of acid rain and regional haze.

2.4.1. Sources

The main sources of SO_2 are combustion of fossil fuels containing sulfur compounds and the manufacture of sulfuric acid. Other sources include paper mills, petroleum refineries and the smelting of ores that contain sulfur.

2.4.2. Effects

The most obvious health effect of sulfur dioxide is irritation and inflammation of body tissues exposed to the gas. Sulfur dioxide can increase the severity of existing respiratory diseases such as asthma, bronchitis, and emphysema. Sulfuric acid and fine particulate sulfates that are formed from sulfur dioxide, also may cause significant health problems.

2.5. Nitrogen Oxides

Several gaseous oxides of nitrogen are normally found in the atmosphere, including nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2). Nitrous oxide is a stable gas with anesthetic characteristics; typical ambient concentrations are well below the threshold concentration for a biological effect. Nitric oxide is a colorless gas with ambient concentrations generally low enough to have no significant biological effect. Nitrogen dioxide is a reddish-brown gas that is not usually visible at typical ambient concentrations.

2.5.1. Sources

The most significant nitrogen oxide emissions result from of the burning of fossil fuels such as coal, oil and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is NO, which reacts with hydrocarbons, ozone and other atmospheric compounds to form NO_2.

2.5.2. Effects

At concentrations near the ambient air standards, nitrogen dioxide has significant health effects as a pulmonary irritant, especially upon asthmatics and children. In North Carolina a much greater health concern is the formation of ozone, which is promoted by the presence of NO_2 and other nitrogen oxides.

Some types of vegetation are very sensitive to NO_2, including oats, alfalfa, tobacco, peas and carrots. Chronic exposure causes chlorosis (yellowing) and acute exposure usually causes irregularly shaped lesions on the leaves.

Nitric oxide and nitrogen dioxide do not directly damage materials. However, NO_2 can react with moisture in the air to produce nitric acid, which corrodes metal surfaces and contributes to acid rain.

High concentrations of NO_2 may reduce visibility. A significant portion of the brownish coloration sometimes observed in polluted air in winter months may be due to NO_2.

2.6. Lead

Lead (Pb) is a ubiquitous, toxic heavy metal element occurring in the atmosphere as small particles.

2.6.1. Sources

The major source of atmospheric lead used to be the combustion of gasoline containing the additive tetraethyl lead as an antiknock agent. But leaded fuel has been phased out, eliminating gasoline as a source. Significant remaining sources include coal combustion (lead exists in very small quantities as an impurity in coal) and sandblasting of highway structures and water tanks. Lead also is used in some batteries, paints, insecticides and newspaper inks.

2.6.2. Effects

Lead (Pb) persists and accumulates in the environment and the human body. It may be inhaled, ingested, and eventually absorbed into the bloodstream and distributed to all body tissues. Exposure to low concentrations interferes with blood production and specific enzyme systems. It is believed to cause kidney and nerve cell damage, and severe lead poisoning is known to cause brain damage in children.

3. Standards

Ambient air quality status is determined by measuring pollutant concentrations in outdoor air and comparing the measured concentrations to corresponding standards. The US EPA (Environmental Protection Agency) defines ambient air as "that portion of the atmosphere, external to buildings, to which the general public has access."

Ambient air quality standards are classified as primary and secondary. Primary standards are those established to protect public health. Secondary standards are those established to protect the public welfare from adverse effects. Secondary standards take into account pollution effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, climate, property, transportation, economy, personal comfort, and well-being. The scientific criteria upon which the standards are based are periodically reviewed by EPA, which may reestablish or change the standards according to their findings.

A pollutant measurement that is greater than the ambient air quality standard for a specific averaging time is called an "exceedance." The national primary, secondary and North Carolina ambient air quality standards are summarized in Table 3.1.

Table 3.1 National and North Carolina Ambient Air Quality Standards

Pollutant	Type of Average	National Standard		North Carolina Standard
		Primary Health Related	Secondary Welfare Related	
TSP	Annual Geom. Mean	Na[a]	NA[a]	75 ug/m^3
	24-Hour	NA[a]	NA[a]	150 ug/m^3([b])
PM-10	Expected Annual Arith. Mean	50 ug/m^3	50 ug/m^3	50 ug/m^3
	24-Hour[c]	150 ug/m^3	150 ug/m^3	150 ug/m^3
CO	8-Hour[b]	9 ppm (10 mg/m^3)[d]	NA	9 ppm (10 mg/m^3)
	1-Hour[b]	35 ppm (40 mg/m^3)	NA	35 ppm (40 mg/m^3)
O_3	Maximum Daily 1-Hour Average[e]	0.12 ppm (235 ug/m^3)	0.12 ppm (235 ug/m^3)	0.12 ppm (235 ug/m^3)
SO_2	Annual Arith. Mean	80 ug/m^3 (0.03 ppm)	NA	80 ug/m^3 (0.03 ppm)
	24-Hour[b]	365 ug/m^3 (0.14 ppm)	NA	365 ug/m^3 (0.14 ppm)
	3-Hour[b]	NA	1,300 ug/m^3 (0.50 ppm)	1,300 ug/m^3 (0.50 ppm)
NO_2	Annual Arith. Mean	0.053 ppm (100 ug/m^3)	0.053 ppm (100 ug/m^3)	0.053 ppm (100 ug/m^3)
Pb	Maximum Quarterly Arith. Mean	1.5 ug/m^3	1.5 ug/m^3	1.5 ug/m^3

a. National TSP standards were discontinued in 1987 and superseded by standards for PM-10.
b. Not to be exceeded more than once per year.
c. The standard is attained when the expected number of days per calendar year (following 40 CFR 50 App. K [Office of the Federal Register 1993, p. 773-777]) above the standard concentration is less than or equal to 1.0.
d. Concentrations in parentheses are approximately equivalent to the adjacent specified standard.
e. Same as note c. above (following 40 CFR 50 App. H [Office of the Federal Register 1993, p.767-769]).

4. Ambient Air Quality Monitoring Program

Ambient monitoring and analyses of samples were conducted by the North Carolina Air Quality Section and three local air pollution control programs (Appendix A, pp.65-67). The air monitoring data are used to: determine whether air quality standards are being met; assist in enforcement actions; gauge the improvement or decline of air quality; and determine the extent of allowable industrial expansion. A list of monitoring sites active in 1994 is shown in Table 4.1.

Siting of monitors involves several considerations, including size of the area represented, distance from roadways and nearby sources, unrestricted air flow, safety, availability of electricity and security.

Each site has a defined monitoring objective, and annual evaluations are conducted to ensure that the objectives are met. The four basic monitoring objectives are to determine:

- the highest concentration expected in an area;
- representative concentrations in areas of high population density;
- the impact of significant sources or source categories on ambient air quality;
- general background concentration levels.

All monitors have known precision, accuracy, interferences, and operational parameters. The monitors as well as all measurement devices are carefully calibrated at predetermined frequencies, varying from daily to quarterly. Measurements are traceable to National Institute of Standards and Technology (NIST), when standards are available.

Monitoring and analyses are performed according to a set of standard operating procedures. Field personnel visit manual sampling sites once every six days to replace sample media and check the operation and calibration of monitors. Personnel check continuous monitors at least twice weekly for correct instrument operation.

Quality assurance activities are carried out to determine and improve the quality of the collected ambient data, improve the quality of the data and evaluate how well the monitoring system operates. The objective of the quality assurance activities is to produce high quality air pollution data with defined completeness, precision, accuracy, representativeness and comparability.

Microprocessors are used at most sites to collect the data. A computerized telemetry system aids in assembly of the data for submission to the US EPA. This enhances data validity, minimizes travel costs, and allows real-time data to be available by computer polling when needed. Numerous checks are performed to ensure that only valid data are reported.

Table 4.1. Ambient Air Monitoring Sites Operated in North Carolina, 1994

Site County	Address	Monitored Pollutants		
37-001-0002 ALAMANCE	827 S GRAHAM & HOPEDALE RD	PM-10		
37-003-0003 ALEXANDER	STATE ROAD 1177	O3	SO2	PM-10
37-011-8001 AVERY	ROARING CREEK RD. PISGAH N.F.	O3		
37-013-0003 BEAUFORT	NC HIGHWAY 306	SO2		
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	SO2		
37-013-0005 BEAUFORT	SLATESTONE ROAD (NEAR WATER TOWER)	PM-10		
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BUILDING WOODFIN ST	TSP	PM-10	
37-021-0030 BUNCOMBE	ROUTE 191 SOUTH BREVARD RD	O3		
37-021-0032 BUNCOMBE	LONDON RD ASHEVILLE	PM-10		
37-021-0033 BUNCOMBE	US70 WEST SWANNANOA	PM-10		
37-023-0004 BURKE	126 AND 1254	O3		
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	PM-10		
37-029-0099 CAMDEN	COUNTY ROADS 1136 & 1134	O3	SO2	
37-031-0003 CARTERET	ARENDELL & 4TH MOREHEAD CITY	TSP		
37-031-8001 CARTERET	MERRIMON ROAD BEAUFORT	O3		
37-033-0001 CASWELL	CHERRY GROVE RECREATION CENTER	O3	HSCO*	NO2

Site County	Address	Monitored Pollutants			
37-035-0004 CATAWBA	1650 1ST. ST.	TSP	PM-10		
37-037-0004 CHATHAM	RT 4 BOX 62 PITTSBORO	O3	HSCO*	NO2	PM-10
37-047-0001 COLUMBUS	ACME-DELCO HWY 87	TSP	SO2		
37-051-0004 CUMBERLAND	FIRE STATION. # 5 3296 VILLAGE DR.	TSP	PM-10		
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD 1705 OWEN DRIVE	CO			
37-051-0008 CUMBERLAND	1/4MI SR1857 AND US301 AND 1857	O3			
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT ROCKFISH RD.	O3	SO2		
37-057-0002 DAVIDSON	S.SALISBURY ST. LEXINGTON	PM-10			
37-057-1002 DAVIDSON	400 SALEM STREET	TSP	PM-10		
37-059-0099 DAVIE	FORK RECREATION CENTER	O3	SO2	PM-10	
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	O3	SO2		
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	PM-10			
37-063-0011 DURHAM	201 NORTH ROXBORO ST	CO			
37-063-0012 DURHAM	4001 CHAPEL HILL BLVD	CO			
37-063-0013 DURHAM	2700 NORTH DUKE STREET	O3	HSCO*	NO2	
37-065-0002 EDGECOMBE	LEGETT RD. WASTE TREATMENT PLANT	PM-10			

Site County	Address	Monitored Pollutants			
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	PM-10			
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD	O3			
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY PLANT	PM-10			
37-067-0013 FORSYTH	720 RIDGE AVENUE	PM-10			
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	O3	HSCO*	SO2	NO2
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	CO	PM-10		
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL	PM-10			
37-067-0025 FORSYTH	100 SW STRATFORD RD	CO			
37-067-0026 FORSYTH	1590 BOLTON STREET	CO			
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE	O3			
37-067-1001 FORSYTH	BODENHEIMER ST	PM-10			
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE	O3	HSCO*	NO2	
37-069-0001 FRANKLIN	431 S HILLSBOROUGH ST FRANKLINTON	O3	HSCO*	NO2	
37-071-0014 GASTON	RANKIN LAKE RD GASTONIA	TSP			
37-071-0015 GASTON	1555 EAST GARRISON BLVD	CO			
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL	O3	HSCO*	NO2	

Site County	Address	Monitored Pollutants				
37-077-0002 GRANVILLE	3200 WEBB SCHOOL RD OXFORD	PM-10				
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	PM-10				
37-081-0011 GUILFORD	KEELY PARK, KEELY RD,	O3				
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST	PM-10				
37-081-1011 GUILFORD	401 WEST WENDOVER	CO				
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST.	PM-10				
37-085-0001 HARNETT	MUNICIPAL BUILDING	TSP	PM-10			
37-087-0002 HAYWOOD	ROOF, CANTON FIRE DEPT.	PM-10				
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PKWY MILE MARKER 410	O3				
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STREETS	PM-10				
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	O3				
37-109-0003 LINCOLN	EAST CONGRESS ST	PM-10				
37-109-0004 LINCOLN	RIVERVIEW ROAD	O3	HSCO*	SO2	NO2	PM-10
37-111-0002 MC DOWELL	COURTHOUSE	PM-10				
37-113-8001 MACON	COWEETA HYDROLOGIC LABORATORY	O3				
37-117-0001 MARTIN	HAYES STREET (#2 WELL SITE)	SO2				

Site County	Address	Monitored Pollutants			
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	TSP			
37-119-0003 MECKLENBURG	FIRE STATION #11 620 MORETZ STREET	PM-10			
37-119-0010 MECKLENBURG	FIRE STATION #10 2136 REMOUNT ROAD	TSP	PM-10		
37-119-0032 MECKLENBURG	5137 CENTRAL AVE.	CO			
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	O3	HSCO*	SO2	NO2
37-119-0035 MECKLENBURG	1330 SPRING ST GREENVILLE NEIGHBORHOOD CENTER	CO			
37-119-0037 MECKLENBURG	415 EAST WOODLAWN RD	CO			
37-119-0038 MECKLENBURG	301 N TRYON ST	CO			
37-119-1001 MECKLENBURG	FILTER PLANT	PM-10			
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	O3	PM-10		
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO	O3	HSCO*	NO2	
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	TSP	PM-10		
37-123-8001 MONTGOMERY	112 PERRY DRIVE	O3			
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	O3			
37-129-0005 NEW HANOVER	NINTH AND ORANGE STREETS	TSP	PM-10		
37-129-0007 NEW HANOVER	WAREHOUSE & RECEIVING ST UNCW, WILMINGTON	TSP	PM-10		

Site County	Address	Monitored Pollutants		
37-133-0004 ONSLOW	2553 ONSLOW DRIVE, JACKSONVILLE	PM-10		
37-135-0005 ORANGE	109 ½ EAST FRANKLIN STREET	CO		
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	TSP	PM-10	
37-145-0099 PERSON	SR 1102 & NC 49	SO2		
37-147-0003 PITT	1500 BEATTY ST GREENVILLE	PM-10		
37-147-0099 PITT	US 264 NEAR FARMVILLE WATER TOWER	O3	SO2	
37-155-0003 ROBESON	SO. WATER ST.	TSP		
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL	O3	NO2	
37-159-0021 ROWAN	WEST ST & GOLD HILL AVENUE	O3	HSCO*	NO2
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	PM-10		
37-175-0002 TRANSYLVANIA	HWY 64	TSP		
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS	TSP	PM-10	
37-183-0011 WAKE	420 S PERSON ST	CO		
37-183-0013 WAKE	EF HUTTON, HWY 70 WEST	CO		
37-183-0014 WAKE	E MILLBROOK JR HIGH 3801 SPRING FOREST RD	O3		
37-183-0015 WAKE	808 NORTH STATE STREET	O3	HSCO*	NO2

Site County	Address	Monitored Pollutants		
37-183-0016 WAKE	201 NORTH BROAD STREET	O3	HSCO*	NO2
37-183-0017 WAKE	5033 TV TOWER RD GARNER	O3		
37-187-0002 WASHINGTON	OLD ACRE RD.	TSP		
37-189-0003 WATAUGA	HARDIN PRK ELEMENTARY SCHL HWY 194 BOONE	PM-10		
37-191-0004 WAYNE	HWY 70 WEST PATROL STATION, GOLDSBORO	PM-10		
37-195-0002 WILSON	N.W. CORNER OF KENAN ST. & TARBORO ST.	PM-10		
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	O3		
Sites operated in 1994		**103**		

*HSCO: High Sensitivity CO monitoring only during the ozone season in support of special purpose monitoring for ozone precursors rather than criteria pollutant monitoring

5. Pollutant Monitoring Results

Air quality in a given area is affected by many factors, including meteorological conditions, the location of pollutant sources and amount of pollutants emitted from them.

The speed and direction of air movement determine whether pollutant emissions exceed ambient air quality standards and where those exceedances will occur. Atmospheric stability, precipitation, solar radiation and temperature also affect pollutant concentrations.

Geographic factors that affect concentrations include whether an area is urban or rural, and whether it has mountains, valleys or plains.

Important economic factors affecting air quality include concentration of industries, conditions of the economy, and the day of the week.

Air quality also may be influenced by "exceptional events" in the short term. Exceptional events may be either natural (e.g., forest fire) or manmade (e.g., construction or demolition). Unusual data that can be attributed to an exceptional event are considered biased and may be omitted from data summaries when they are not representative of normal conditions. Data affected by exceptional events are included but flagged, and they are omitted from summaries in charts. A list of typical exceptional events is given in Appendix B.

Data for the 1994 ambient air quality report were collected at 155 air pollutant monitors operated by state and local agencies in North Carolina (listed in Appendix A, pp. 65-67). To save operating costs, some ozone and sulfur dioxide monitors are operated only every third year. Lead concentration data are collected annually by the state and local agencies, but they are analyzed by EPA. Thus, the availability of lead data may be more delayed than that for other pollutants. The most recent lead data available are from 1990.

5.1. Total Suspended Particulate

Total Suspended Particulate (TSP) matter is collected on filters using a "high volume" sampler (an EPA Reference Method). The sampler motor is set and calibrated to an air flow rate of 40 ±4 $feet^3$/min. Gravimetric analysis is performed by comparing the exposed filter weight to the unexposed filter weight. Weights are measured to the nearest 0.1 milligram. The difference between the exposed and unexposed weights is the amount of particulate collected from a known volume of air.

In 1994, 18 sites were used to monitor TSP and 969 samples were collected. A map of the TSP sampling sites is shown in Figure 5.1, and a detailed summary of the data from each site is given in Table 5.1.

Two samples exceeded the N.C. TSP ambient air quality 24-hour standard of 150 ug/m^3, as did two in 1993 and zero exceedances in 1992. A description of the 1994 exceedances is given in Table 5.2. Attainment status is based on the second highest 24-hour concentration

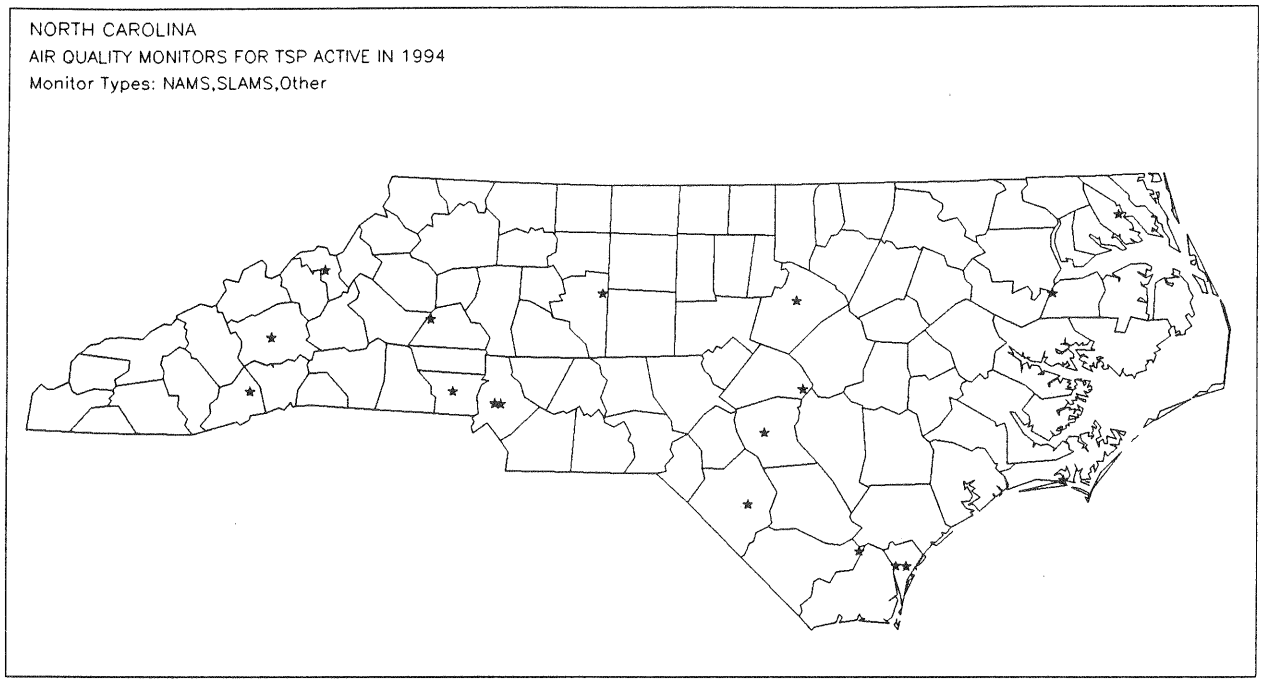

Fig 5.1. TSP Monitoring Sites, 1994

and on the geometric mean of all the 24-hour concentrations at a given site. Two sites produced one maximum 24-hour sample each with a concentration exceeding the standard. Neither of these two exceedances were violations because the second maximums at these sites were below the standard. The largest geometric mean TSP average was 50.0 ug/m^3, which is 66 percent of the level of the air quality standard of 75 ug/m^3.

The second highest 24-hour concentrations are charted by county in Figure 5.2 and the annual geometric means are similarly charted in Figure 5.3. (In counties with more than one TSP monitoring site, the concentration reported in Figure 5.2 is the county-wide second largest concentration, and the geometric mean reported in Figure 5.3 is the maximum geometric mean for the county.)

Table 5.1. Total Suspended Particulates in Micrograms Per Cubic Meter for 1994

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	2nd	3rd	4th	Arith. Mean	Geom. Mean	Geom. sd
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG	57	67	64	57	56	33.4	29.7	1.73
37-031-0003 CARTERET	ARENDELL & 4TH MOREHEAD CITY	60	135	91	74	69	45.6	41.8	1.54
37-035-0004 CATAWBA	1650 1ST. ST.	60	124	94	89	87	52.9	50.0	1.41
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 8	58	71	60	58	56	31.1	28.4	1.58
37-051-0004 CUMBERLAND	FIRE STATION . # 5 3296 VILLAGE DR.	56	132	93	88	87	46.8	42.6	1.53
37-057-1002 DAVIDSON	400 SALEM STREET	50	72	66	64	60	38.6	36.2	1.46
37-071-0014 GASTON	RANKIN LAKE RD GASTONIA	60	63	58	56	55	34.5	32.1	1.51
37-085-0001 HARNETT	MUNICIPAL BUILDING	60	101	85	78	77	46.6	43.3	1.49
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	59	**169**[1]	100	95	80	50.1	46.5	1.45
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	56	82	82	62	61	40.3	38.0	1.42
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	56	101	100	87	86	49.0	44.6	1.59
37-129-0005 NEW HANOVER	NINTH AND ORANGE STREETS	15	88	64	58	54	42.6	38.9	1.56
37-129-0007 NEW HANOVER	WAREHOUSE & RECEIVING ST UNCW	32	56	46	44	43	28.4	26.5	1.48
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	57	97	79	74	64	34.5	30.6	1.63

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	 2nd	 3rd	 4th	Arith. Mean	Geom. Mean	Geom. sd
37-155-0003 ROBESON	SO. WATER ST.	58	355[2]	107	73	71	41.2	33.6	1.74
37-175-0002 TRANSYLVANIA	HWY 64	59	75	60	60	58	36.4	34.4	1.42
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD N	59	85	81	80	77	42.2	38.5	1.56
37-187-0002 WASHINGTON	OLD ACRE RD.	57	91	80	72	69	38.4	35.5	1.48
Total Samples		**969**							
Total Sites Sampled		**18**							

(1) Exceeds secondary standard of 150 ug/m^3. The exceedance sample occurred on 16 November 1994 and was attributed to construction adjacent to sampling site. The fourth maximum excluding the exceedance was 77 ug/m^3.

(2) Exceeds secondary standard of 150 µg/m^3. The exceedance sample occurred on 21 March 1994 and was attributed to a high pollen count (40 percent of total). The fourth maximum excluding the exceedance was 66 µg/m^3.

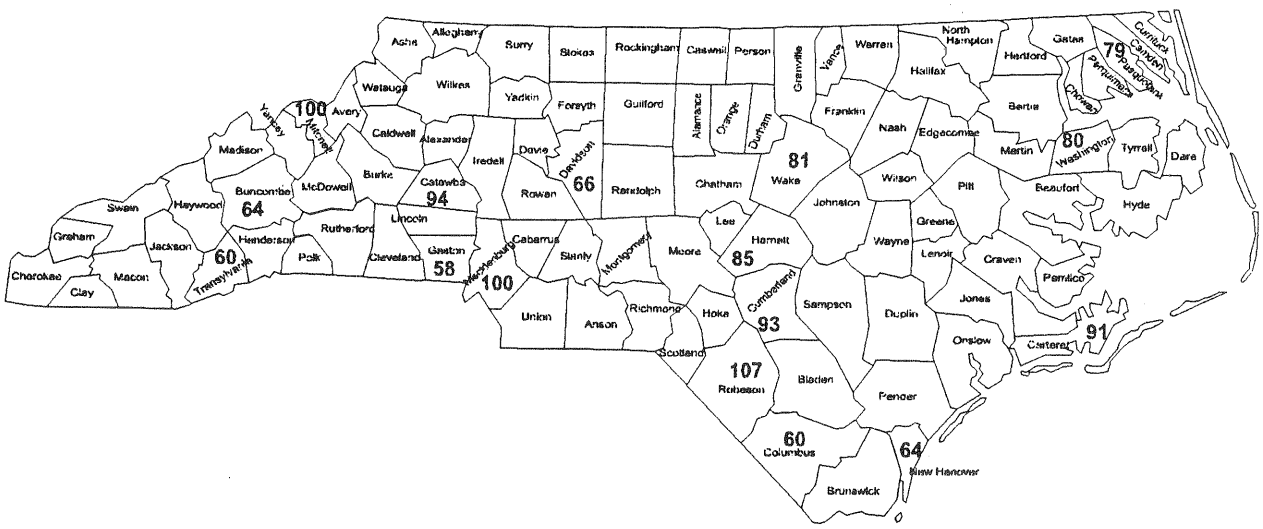

Figure 5.2. Total Suspended Particulates: Second Highest 24-Hour Averages in 1994

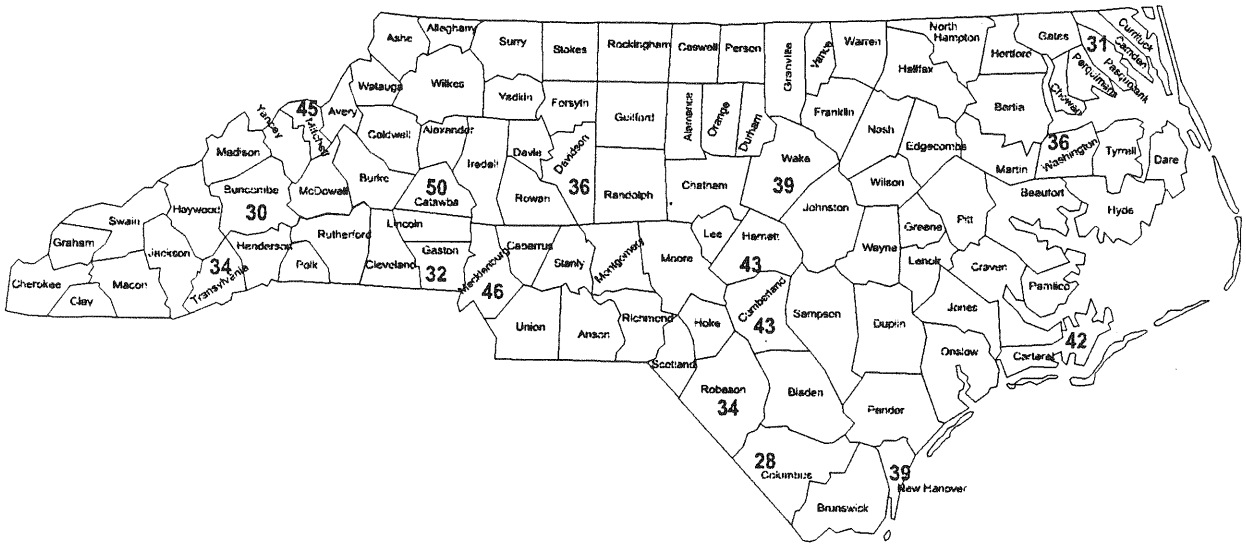

Figure 5.3. Total Suspended Particulates: Maximum Annual Geometric Means, 1994

5.2. PM-10

State and local program agencies in North Carolina use high volume samplers and size selective inlets to collect PM-10 samples. A gravimetric determination procedure (EPA Reference Method) is used to analyze the samples. Two local program agencies also use continuous monitors to collect PM-10 data at a total of three sites

In 1994, 47 sites were used to monitor PM-10 and 3,433 samples were collected. A map of the PM-10 sampling sites is presented in Figure 5.4, and a detailed summary of the data from each site is given in Table 5.2.

There were no exceedances of the PM-10 ambient air quality standards in 1994. The greatest 24-hour maximum concentration was 82 ug/m^3, or about 55 percent of the standard (150 ug/m^3). The greatest annual arithmetic mean was 30 ug/m^3, which is 60 percent of the standard (50 ug/m^3).

The second highest 24-hour concentrations are charted by county in Figure 5.5 and the annual arithmetic means are shown in Figure 5.6. In counties with more than one PM-10 monitoring site, the concentration reported is the county-wide second maximum 24-hour concentration, and the mean reported in Figure 5.6 is the maximum arithmetic mean for the county.

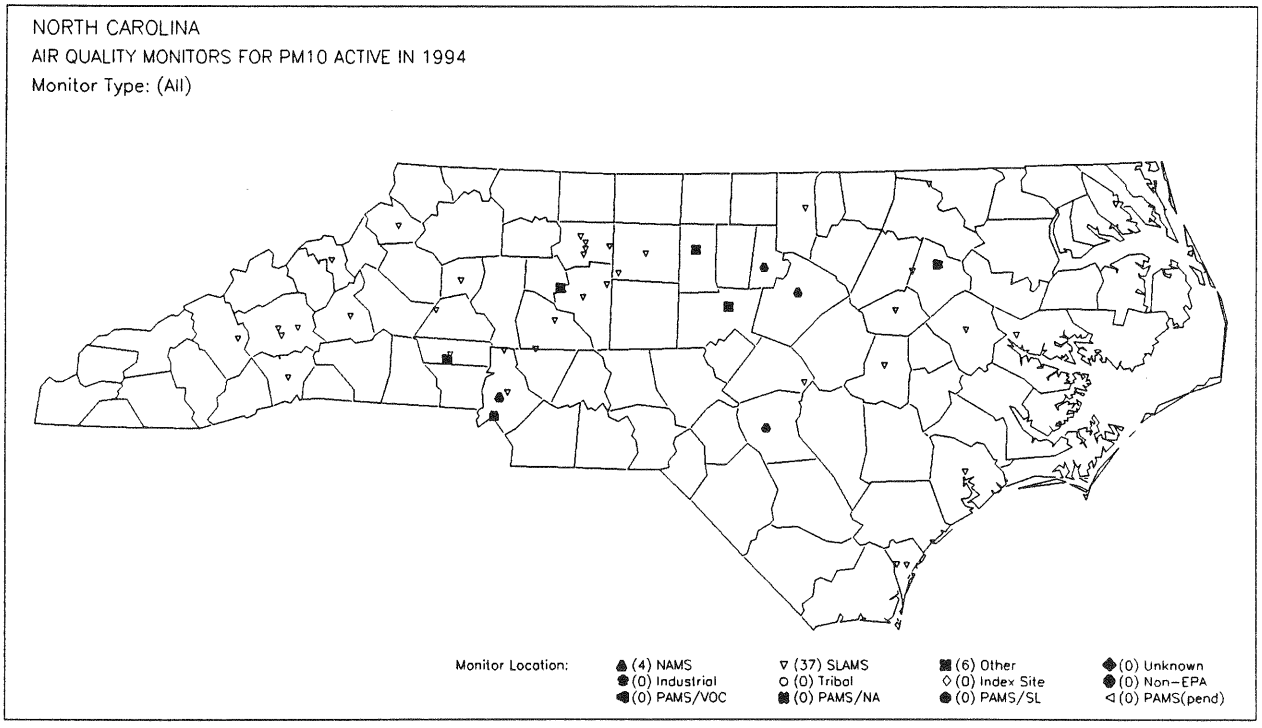

Fig 5.4 PM-10 Monitoring Sites, 1994

Table 5.2. PM-10 in Micrograms Per Cubic Meter for 1994

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	2nd	3rd	4th	Arith. Mean
37-001-0002 ALAMANCE	827 S. GRAHAM & HOPEDALE RD	58	62	51	45	43	23.8
37-003-0003 ALEXANDER	STATE ROAD 1177	59	59	46	42	41	21.9
37-013-0005 BEAUFORT	SLATESTONE ROAD (WATER TOWER)	59	35	32	32	27	16.7
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG	60	34	33	32	31	19.0
37-021-0032 BUNCOMBE	LONDON RD ASHEVILLE	355	66	58	51	50	25.1
37-021-0033 BUNCOMBE	US70 W SWANNANOA	347	53	49	45	44	22.2
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	54	60	41	38	36	22.3
37-035-0004 CATAWBA	1650 1ST. ST.	55	60	45	41	41	26.3
37-037-0004 CHATHAM	RT 4 BOX 62 PITTSBORO	39	45	34	34	33	20.6
37-051-0004 CUMBERLAND	FIRE STATION. # 5 3296 VILLAGE DR.	53	58	44	41	41	25.1
37-057-0002 DAVIDSON	S.SALISBURY ST. LEXINGTON	58	82	48	43	39	25.9
37-057-1002 DAVIDSON	400 SALEM STREET	54	41	39	37	36	23.5
37-059-0099 DAVIE	FORK RECREATION CENTER	59	37	35	32	31	18.8
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	57	47	35	35	33	21.7
37-065-0002 EDGECOMBE	LEGETT RD. WASTE TREATMENT PLANT	58	53	41	38	37	21.4

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	2nd	3rd	4th	Arith. Mean
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	61	47	35	34	32	18.7
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY	61	49	43	40	39	24.9
37-067-0013 FORSYTH	720 RIDGE AVENUE	50	47	43	42	40	26.7
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	59	55	45	44	44	28.1
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	365	66	61	57	57	25.6
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL	60	39	39	37	36	22.8
37-067-1001 FORSYTH	BODENHEIMER ST	57	48	42	41	38	24.8
37-077-0002 GRANVILLE	3200 WEBB SCHOOL RD OXFORD N	46	45	36	33	33	19.3
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	61	42	41	40	36	22.8
37-081-1005 GUILFORD	E GREEN & SOUTH CENTENNIAL ST	54	44	43	43	34	23.8
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST	56	47	36	34	33	21.7
37-085-0001 HARNETT	MUNICIPAL BUILDING	58	52	45	42	41	25.2
37-087-0002 HAYWOOD	ROOF CANTON FIRE DEPT.	53	40	37	33	33	22.2
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON S.	54	42	42	36	34	22.1
37-109-0003 LINCOLN	EAST CONGRESS ST	61	45	44	43	37	24.4

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	2nd	3rd	4th	Arith. Mean
37-109-0004 LINCOLN	RIVERVIEW ROAD	25	39	34	34	30	22.5
37-111-0002 MC DOWELL	COURTHOUSE	60	54	43	42	41	26.7
37-119-0003 MECKLENBURG	FIRE STA #11, 620 MORETZ STREET	61	59	56	47	46	30.0
37-119-0010 MECKLENBURG	FIRE STA #10, 2136 REMOUNT ROAD	60	56	47	47	46	29.0
37-119-1001 MECKLENBURG	FILTER PLANT	61	47	46	40	39	24.2
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	57	61	54	51	51	30.3
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	57	53	53	51	50	29.6
37-129-0005 NEW HANOVER	NINTH AND ORANGE STREETS	14	45	30	27	25	21.6
37-129-0007 NEW HANOVER	WAREHOUSE & RECEIVING, UNCW	29	34	28	27	27	20.4
37-133-0004 ONSLOW	2553 ONSLOW DRIVE JACKSONVILLE	54	67	37	37	30	20.4
37-139-0001 PASQUOTANK	WATER PLANT N. WILSON ST	46	81	35	28	27	17.4
37-147-0003 PITT	1500 BEATTY ST GREENVILLE NC 2	56	43	37	32	32	19.1
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	57	46	44	39	35	22.6
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD N	58	48	38	37	36	21.9
37-189-0003 WATAUGA	HARDIN PRK ELEM SCHL HWY	36	38	36	35	34	21.3

Site Number County	Address	Num. Obs.	24-Hour Maxima 1st	2nd	3rd	4th	Arith. Mean
37-191-0004 WAYNE	HWY 70W PATROL STA. GOLDSBORO	61	50	39	39	38	21.0
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARB	60	52	49	39	39	21.6

Total Samples	**3,433**
Total Sites Sampled	**47**

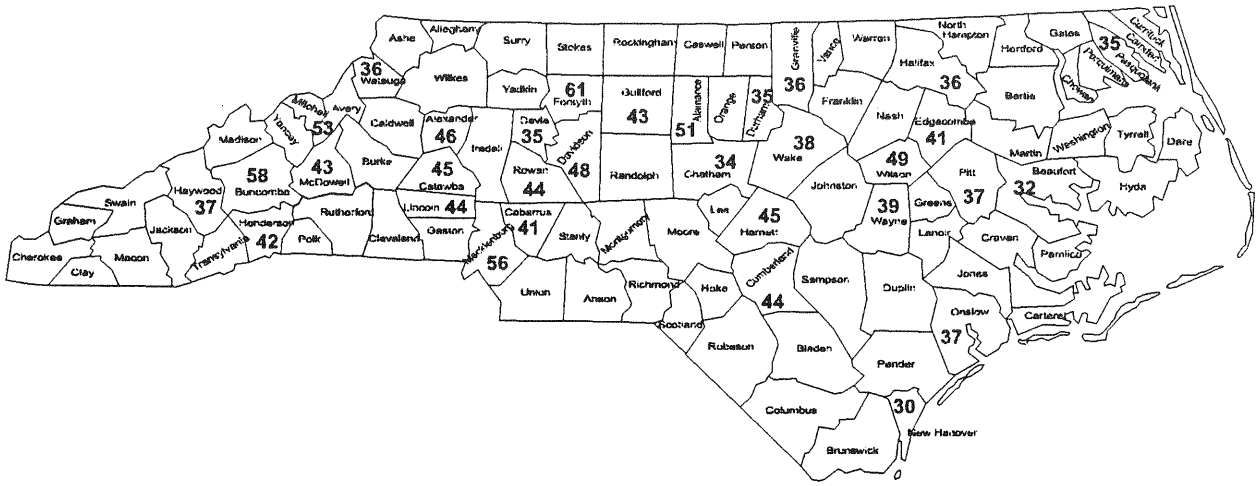

Figure 5.5. PM-10: Second Highest 24-Hour Averages, 1994

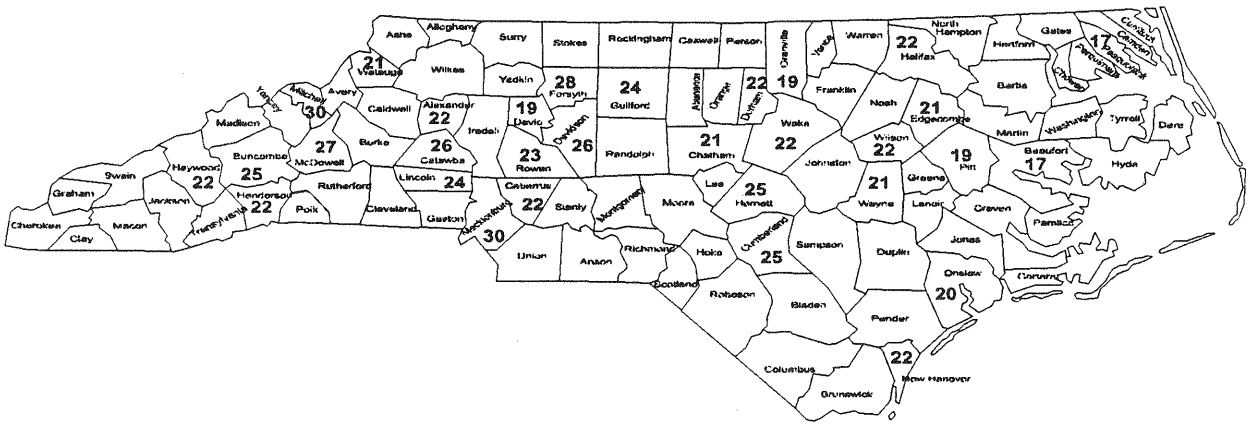

Figure 5.6. PM-10: Maximum Annual Arithmetic Means, 1994

5.3. Carbon Monoxide

The North Carolina State agency collects carbon monoxide (CO) data from eight monitors in Fayetteville, Durham, Greensboro and Raleigh. The local program agencies in Winston-Salem and Charlotte collected CO data from eight monitors. All agencies used EPA Reference or equivalent methods to measure the concentrations.

In 1994, 16 sites were used to monitor CO and 121,717 valid hourly averages were collected. A map of the CO sampling sites is shown in Figure 5.7, and a detailed summary of the data from each site is given in Table 5.3.

There were no exceedances of the CO ambient air quality standards in 1994. The greatest 1-hour average was 11.4 parts per million (ppm), or about 33 percent of the standard (35 ppm). The greatest 8-hour average was 8.0 ppm, which is 89 percent the standard of 9 ppm.

The second highest 1-hour concentrations in each county are charted in Figure 5.9 and the second highest 8-hour concentrations are similarly charted in Figure 5.10.

Monthly distributions of 8-hour CO averages are graphed in Figure 5.11 as box-and-whisker plots. (See Appendix C on page 69 for an explanation of this type of chart.) Historical data have demonstrated that high concentrations of CO occur more frequently in Autumn and Winter than during the warmer months of the year. There are three three main reasons for this seasonal variation:

(1) North Carolina experiences more atmospheric inversions in colder months, trapping air pollutants at low heights; (2) motor vehicles emit more CO due to inefficient combustion during cold starts and warm up; and (3) more fuel is burned for comfort heating during colder temperatures.

Figure 5.8 identifies areas designated nonattainment for carbon monoxide under the 1990 Clean Air Act and adjoining areas in which the EPA later mandated the wintertime sale of oxygenated gasoline (November through February) as a control strategy. This requirement applied in eleven counties in the 1993 - 1994 winter season including: Yadkin, Stokes, Davie, Davidson, Guilford, and Randolph counties surrounding Forsyth County; Orange and Franklin counties adjoining Durham County; and Wake County.

In September 1994, Forsyth was redesignated to be in attainment for carbon monoxide and the surrounding seven counties were released from the requirement to sell oxygenated fuels. In addition to the use of oxygenated fuels that helped reduce CO concentrations a major reason for the continual decline of CO levels is the gradual replacement of older less efficient vehicles with new more efficient ones. In addition increased news media interest and public awareness, and the reporting of the Air Quality Index (see Chapter 6 of this report) has helped to reduce CO concentrations. Due to this increased awareness, more people are keeping their cars in better running condition and

thus operating more cleanly. Plus, traffic flow has improved as new roads have been built and better

coordinated traffic signals have been installed. The motor vehicle Inspection and Maintenance program in Forsyth, Mecklenburg and Wake Counties is an intentional control strategy that helps assure cleaner-running cars.

Four counties (Wake, Orange, Durham, and Franklin) were required to continue selling only oxygenated gasoline for the 1994 - 1995 winter season. As of the publication date of this report these remaining four counties have been redesignated as being in attainment for carbon monoxide and oxygenated fuels no longer are required.

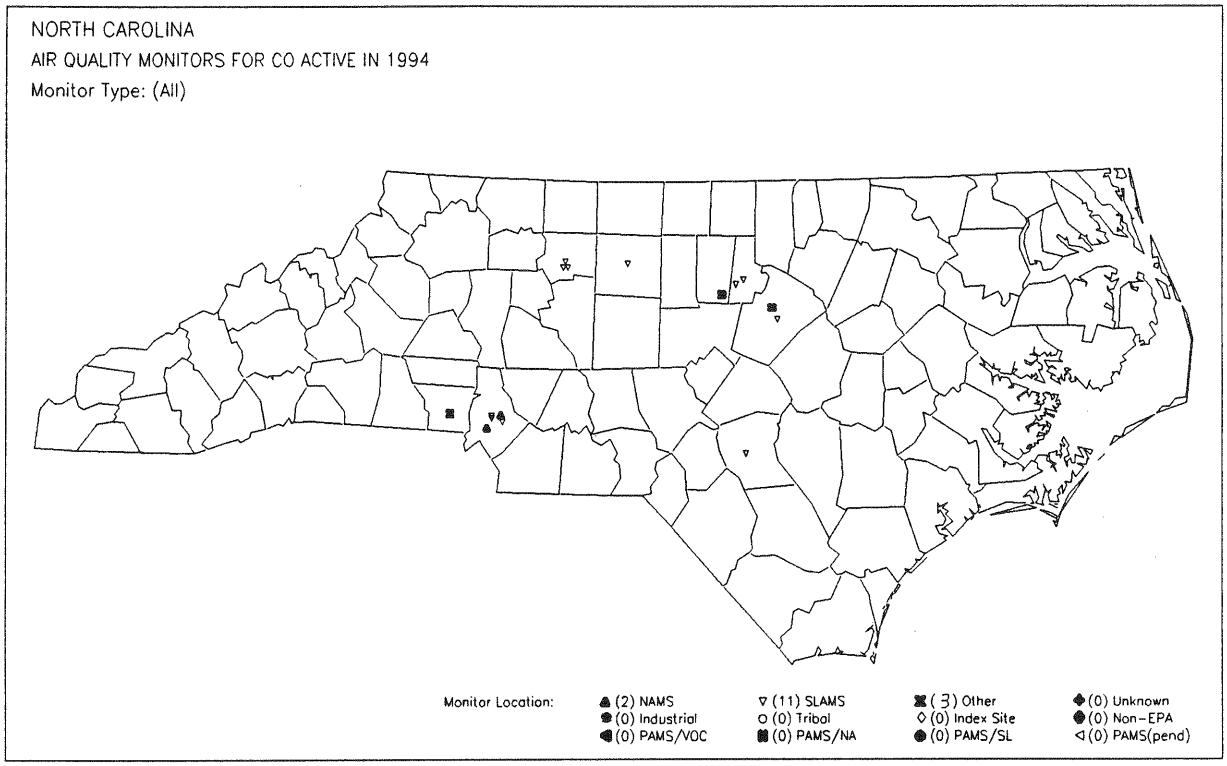

Figure 5.7. Location of Carbon Monoxide Monitoring Sites, 1994

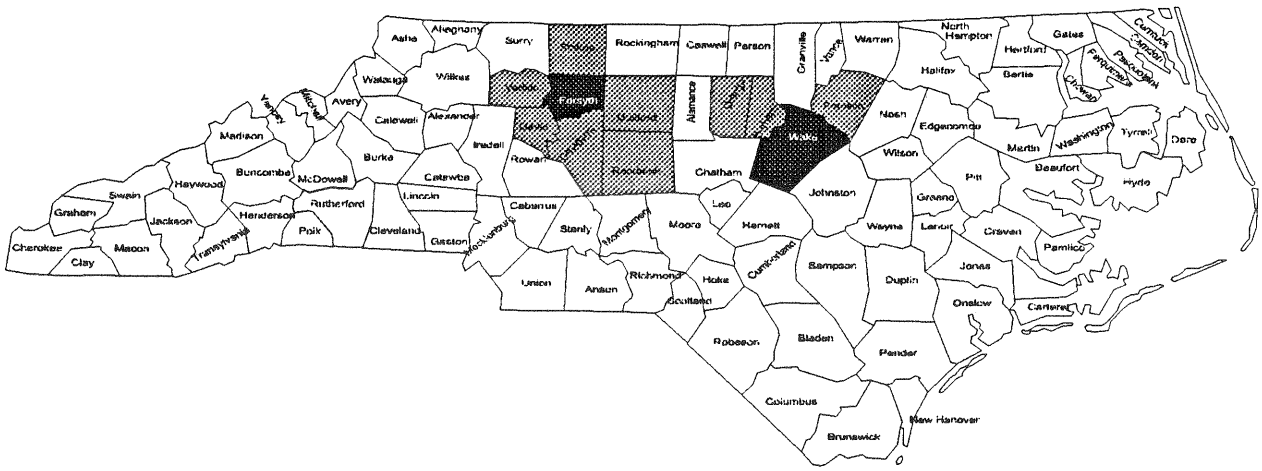

Figure 5.8. Areas with Excessive Carbon Monoxide Subject to Mandatory Oxygenated Fuel Sales in 1994

Table 5.3. Carbon Monoxide in Parts Per Million from All Sites for 1994

Site Number County	Address	Num. Obs.	1-Hour Maxima		8-Hour Maxima	
			1st	2nd	1st	2nd
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705	8,464	9.8	8.8	6.6	6.0
37-063-0011 DURHAM	201 NORTH ROXBORO ST	8,664	8.8	7.9	5.9	5.7
37-063-0012 DURHAM	4001 CHAPEL HILL BLVD	8,666	9.9	9.9	5.2	5.2
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	8,685	8.1	8.0	6.0	6.0
37-067-0025 FORSYTH	100 SW STRATFORD RD	8,623	7.6	6.6	3.7	3.1
37-067-0026 FORSYTH	1590 BOLTON STREET	8,683	5.3	5.0	4.1	3.9
37-071-0015 GASTON	1555 EAST GARRISON BLVD	3,846	7.7	7.6	4.5	4.2

Site Number County	Address	Num. Obs.	1-Hour Maxima		8-Hour Maxima	
			1st	2nd	1st	2nd
37-081-1011 GUILFORD	401 WEST WENDOVER	8,686	6.6	6.0	5.0	4.6
37-119-0032 MECKLENBURG	5137 CENTRAL AVENUE	8,691	11.4	10.8	7.0	6.4
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	8,664	9.2	8.5	6.5	5.8
37-119-0035 MECKLENBURG	1330 SPRING ST GREENVILLE NEIGHBORHOOD	8,614	8.0	7.4	6.2	5.9
37-119-0037 MECKLENBURG	415 EAST WOODLAWN ROAD	8,575	8.7	7.8	5.6	5.0
37-119-0038 MECKLENBURG	301 N TRYON ST	8,644	9.6	8.9	8.0	5.8
37-135-0005 ORANGE	109 ½ EAST FRANKLIN STREET	1,541	9.1	9.0	6.1	6.0
37-183-0011 WAKE	420 S PERSON ST	8,516	9.4	9.1	7.1	6.9
37-183-0013 WAKE	EF HUTTON HWY 70 WEST	4,155	8.2	7.0	5.1	4.7
Total Samples		**121,717**				
Total Sites Sampled		**16**				

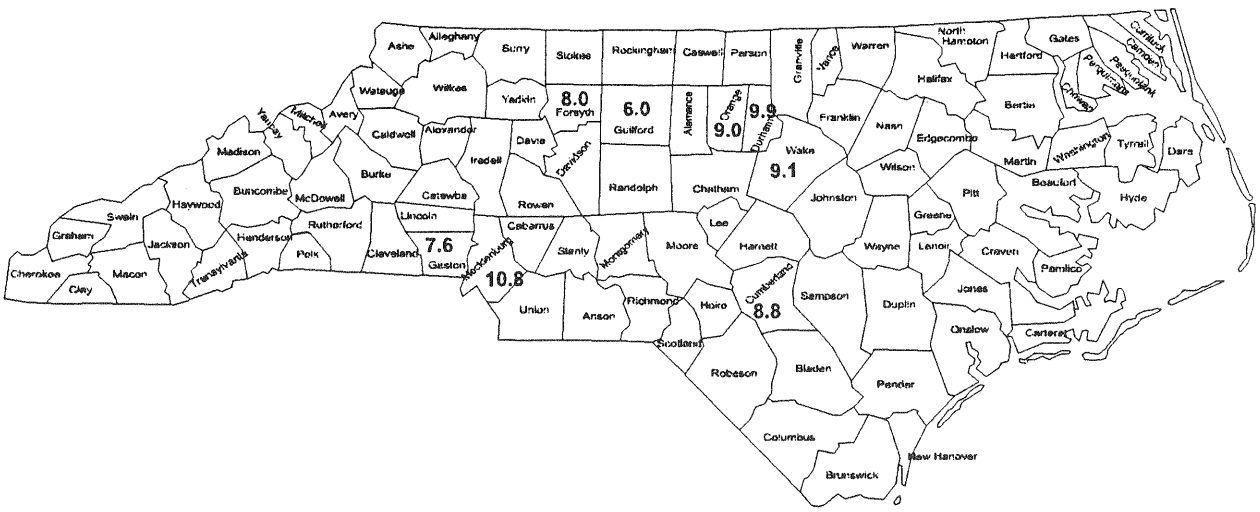

Figure 5.9. Carbon Monoxide: Second Highest Annual One-Hour Average, 1994

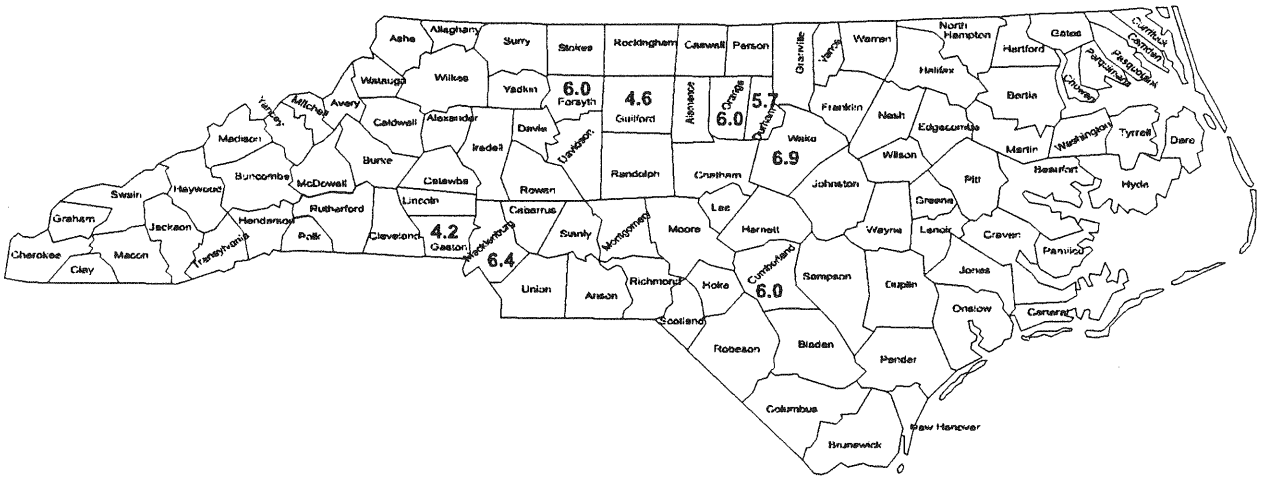

Figure 5.10. Carbon Monoxide: Second Highest Non-Overlapping Eight-Hour Average, 1994

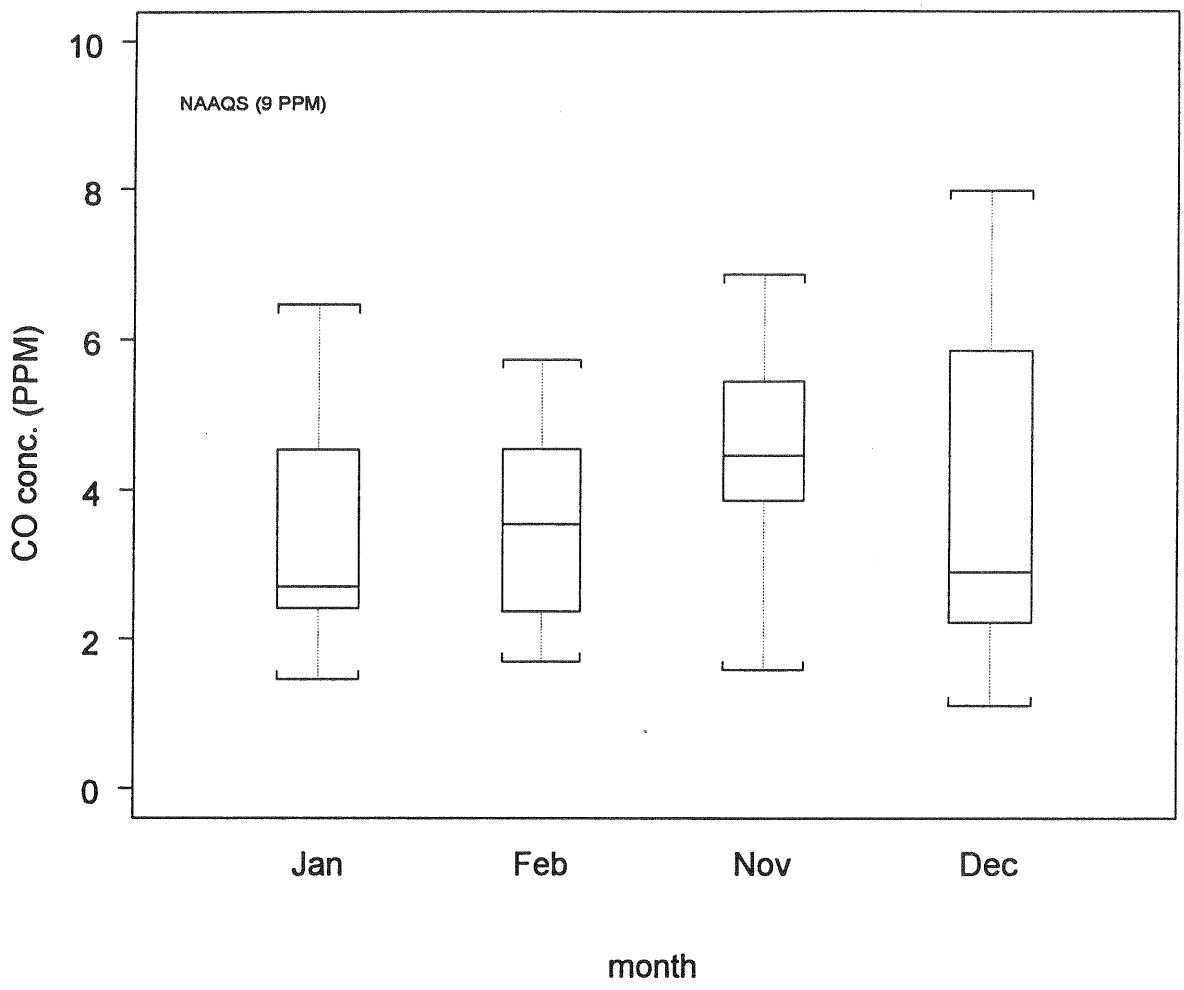

Figure 5.11. Carbon Monoxide: Monthly Distribution of Highest Daily Eight-Hour Averages, 1994

5.4. Ozone

Ozone (O_3) is a seasonal pollutant formed in the atmosphere as a result of many chemical reactions that occur in sunlight, mainly during the warmer months. Thus, ozone monitors only operate from April through October. Ozone (O_3) concentrations are measured using EPA reference or equivalent continuous monitors.

The state and local program agencies operated 37 monitoring sites in 1994 during the ozone season. A map of the O_3 sampling sites is presented in Figure 5.12, and a detailed summary of the data from each site is given in Table 5.4. In North Carolina, some O_3 sites are operated only every third year, so the monitors considered "active" in 1994 included six sites that were last operated in 1993 and three sites that were last operated in 1992. These 46 active (for reporting purposes) monitoring sites provided 207,859 hourly samples.

There were no exceedances of the ambient air quality standard for ozone in 1994. The standard is exceeded when one valid one-hour average exceeds 0.124 ppm at a site and the expected number of exceedances is greater than 1.0. To exceed the standard, the largest one-hour average must be larger than 0.12 ppm when *rounded* to two significant digits. The "expected number" of exceedances is determined from a 3-year average of exceedance day counts for an area.

Moreover, when any ozone sampling day does not have a valid maximum ozone measurement for any reason, the missing day can be counted as an *estimated* exceedance day under certain circumstances [40 CFR 50 App. J, Office of the Federal Register 1993, p. 767-768]. Table 5.5 gives both the actually measured and the estimated number of exceedance days at each site.)

At the beginning of 1994, the Raleigh-Durham Area (Durham County, Wake County, and Dutchville Township in Granville County) and the Charlotte-Gastonia Area (Gaston County and Mecklenburg County) were designated as in nonattainment for the national ozone standard. On April 18, 1994 the Raleigh-Durham Area was redesignated effective June 17, 1994 as being in attainment for ozone having met the national standard for ozone. As of the printing of this annual report the Charlotte-Gastonia Area has also been redesignated as in attainment. Hydrocarbon control strategies are continuing to be used to reduce the ozone problem in Mecklenburg County. An explanation of nonattainment is presented in Appendix D on page 61.

The second highest 1-hour concentrations in each county are shown in Figure 5.13. The seasonal nature of ozone concentrations is shown in figures 5.1.4. and 5.1.5.

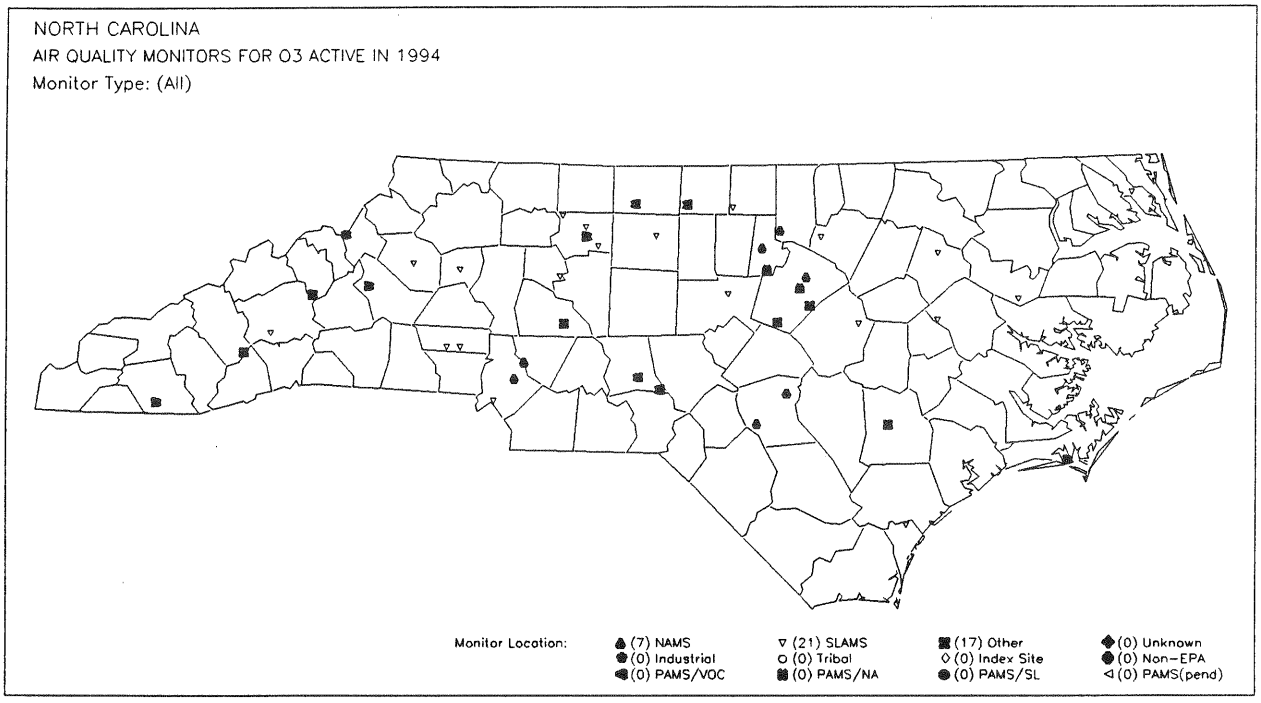

Figure 5.12. Location of Ozone Monitoring Sites, 1994

Table 5.4. Ozone in Parts Per Million for 1994

Site Number County	Address	Num. Obs.	Daily 1-Hour Maxima 1st	2nd	3rd	4th	# Values ≥ 0.125 Meas.	Est.
1994 Data								
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	4,746	0.094	0.092	0.089	0.086	0	0.0
37-011-8001 AVERY	ROARING CREEK RD., PISGAH N.F.	5,079	0.106	0.095	0.087	0.084	0	0.0
37-021-0030 BUNCOMBE	ROUTE 191 S BREVARD RD ASHEVILLE	5,101	0.090	0.084	0.082	0.080	0	0.0

Site Number County	Address	Num. Obs.	Daily 1-Hour Maxima				# Values ≥ 0.125	
			1st	2nd	3rd	4th	Meas.	Est.
37-023-0004 BURKE	126 AND 1254	4,922	0.103	0.101	0.098	0.096	0	0.0
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134 CAMDEN	4,669	0.098	0.095	0.094	0.094	0	0.0
37-031-8001 CARTERET	MERRIMON ROAD BEAUFORT	4,522	0.094	0.089	0.085	0.085	0	0.0
37-033-0001 CASWELL	CHERRY GROVE RECREATION	3,888	0.123	0.113	0.109	0.092	0	0.0
37-037-0004 CHATHAM	RT 4 BOX 62 PITTSBORO	2,873	0.092	0.092	0.087	0.087	0	0.0
37-051-0008 CUMBERLAND	1/4MI SR1857 and US301	4,866	0.101	0.098	0.095	0.094	0	0.0
37-051-1002 CUMBERLAND	HOPE MILLS ROCKFISH RD. FAYETTEVILLE	4,817	0.106	0.096	0.091	0.091	0	0.0
37-059-0099 DAVIE	FORK RECREATION CENTER	4,832	0.086	0.085	0.082	0.079	0	0.0
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	4,832	0.093	0.088	0.084	0.083	0	0.0
37-063-0013 DURHAM	2700 NORTH DUKE STREET	4,852	0.104	0.102	0.097	0.095	0	0.0
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD WINSTON-SALEM	5,021	0.121	0.111	0.106	0.105	0	0.0
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	4,854	0.104	0.098	0.098	0.093	0	0.0
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE	5,045	0.094	0.094	0.084	0.082	0	0.0
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	4,943	0.106	0.105	0.095	0.093	0	0.0
37-069-0001 FRANKLIN	431 SOUTH HILLSBOROUGH ST	4,859	0.115	0.105	0.105	0.101	0	0.0

Site Number County	Address	Num. Obs.	Daily 1-Hour Maxima				# Values ≥ 0.125	
			1st	2nd	3rd	4th	Meas.	Est.
37-077-0001 GRANVILLE	WATER TRTMT PLANT JOHN UMSTEAD HOSP	4,790	0.102	0.101	0.100	0.096	0	0.0
37-081-0011 GUILFORD	KEELY PARK McCLEANSVILLE	4,799	0.114	0.110	0.106	0.105	0	0.0
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PKWY MILE MARKER 410	2,746	0.078	0.077	0.075	0.074	0	0.0
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	4,823	0.107	0.103	0.097	0.097	0	0.0
37-109-0004 LINCOLN	RIVERVIEW ROAD	4,850	0.115	0.108	0.108	0.107	0	0.0
37-113-8001 MACON	COWEETA HYDROLOGIC LABORATORY	5,092	0.089	0.088	0.084	0.083	0	0.0
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	5,077	0.110	0.106	0.106	0.101	0	0.0
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	5,012	0.115	0.114	0.108	0.099	0	0.0
37-119-1009 MECKLENBURG	29 N @ MECKLENBURG CAB CO, CHARLOTTE	5,019	0.115	0.113	0.110	0.105	0	0.0
37-123-8001 MONTGOMERY	112 PERRY DRIVE	4,999	0.108	0.097	0.091	0.090	0	0.0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	4,836	0.106	0.104	0.096	0.095	0	0.0
37-147-0099 PITT	US 264 NEAR WATER TOWER, FARMVILLE	4,799	0.087	0.086	0.085	0.084	0	0.0
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL	4,837	0.111	0.108	0.103	0.103	0	0.0
37-159-0021 ROWAN	WEST ST & GOLD HILL AVENUE ROCKWELL	4,100	0.124	0.116	0.110	0.108	0	0.0

Site Number County	Address	Num. Obs.	Daily 1-Hour Maxima 1st	2nd	3rd	4th	# Values ≥ 0.125 Meas.	Est.
37-183-0014 WAKE	E MILLBROOK JR High SPRING FOREST RD, RALEIGH	4,861	0.122	0.107	0.104	0.102	0	0.0
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	2,796	0.106	0.104	0.102	0.099	0	0.0
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	4,265	0.117	0.111	0.106	0.101	0	0.0
37-183-0017 WAKE	5033 TV TOWER RD GARNER	1,668	0.099	0.097	0.095	0.094	0	0.0
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	3,899	0.093	0.092	0.090	0.089	0	0.0
Total Samples		**167,989**						
Total Sites Sampled		**37**						
1993 Data								
37-027-0003 CALDWELL	HWY 321 N LENOIR	4,769	0.095	0.088	0.087	0.087	0	0.0
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	4,792	0.113	0.110	0.110	0.107	0	0.0
37-067-0006 FORSYTH	GOODWILL CHURCH RD. WINSTON-SALEM	4,979	0.107	0.103	0.093	0.093	0	0.0
37-087-0034 HAYWOOD	MILE POST 408 BLUE RIDGE ROAD	2,125	0.092	0.087	0.082	0.076	0	0.0
37-109-0099 LINCOLN	SR 1315 & SR 1313 IRON STATION	4,877	0.119	0.119	0.115	0.104	0	0.0
37-183-2001 WAKE	HWY 98 WATER TREATMENT PLANT WAKE FOREST	4,854	0.103	0.101	0.101	0.100	0	0.0
Total Samples		**26,396**						
Total Sites Sampled		**6**						

Site Number County	Address	Num. Obs.	Daily 1-Hour Maxima 1st	2nd	3rd	4th	# Values ≥ 0.125 Meas.	Est.
1992 Data								
37-037-0098 CHATHAM	MONCURE PLANT - SOUTH SITE	3,826	0.085	0.082	0.080	0.075	0	0.0
37-117-0099 MARTIN	SR 1538 NC 171	4,812	0.099	0.098	0.085	0.085	0	0.0
37-145-0099 PERSON	SR 1102 & NC 49 GORDONTON	4,836	0.117	0.088	0.086	0.085	0	0.0
Total Samples		13,474						
Total Sites Sampled		3						

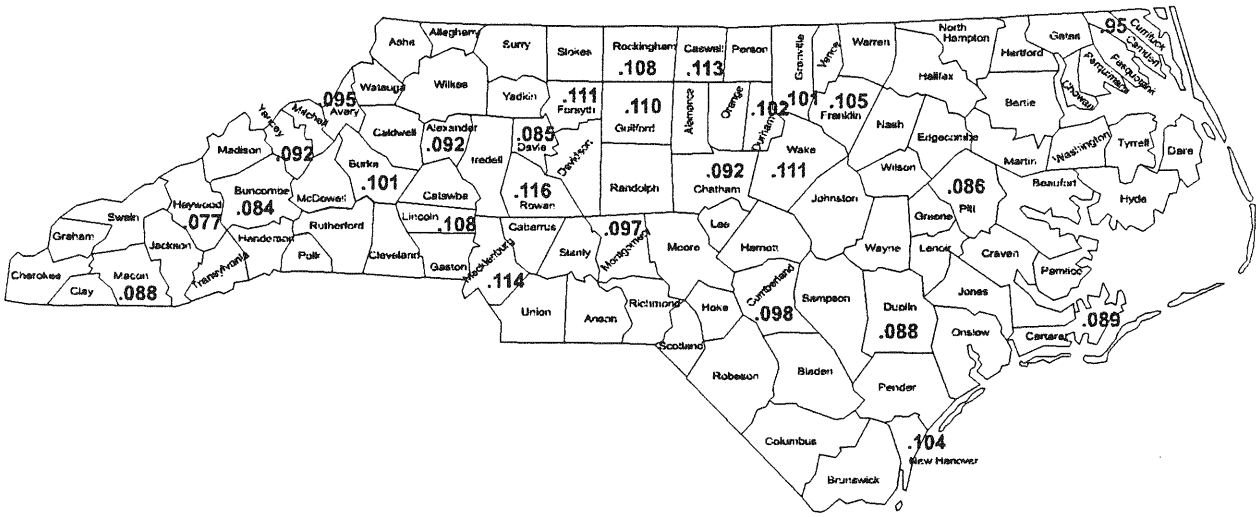

Figure 5.13. Ozone Second Highest One-Hour Average in the Most Recent Year of Data, 1992, 1993, or 1994

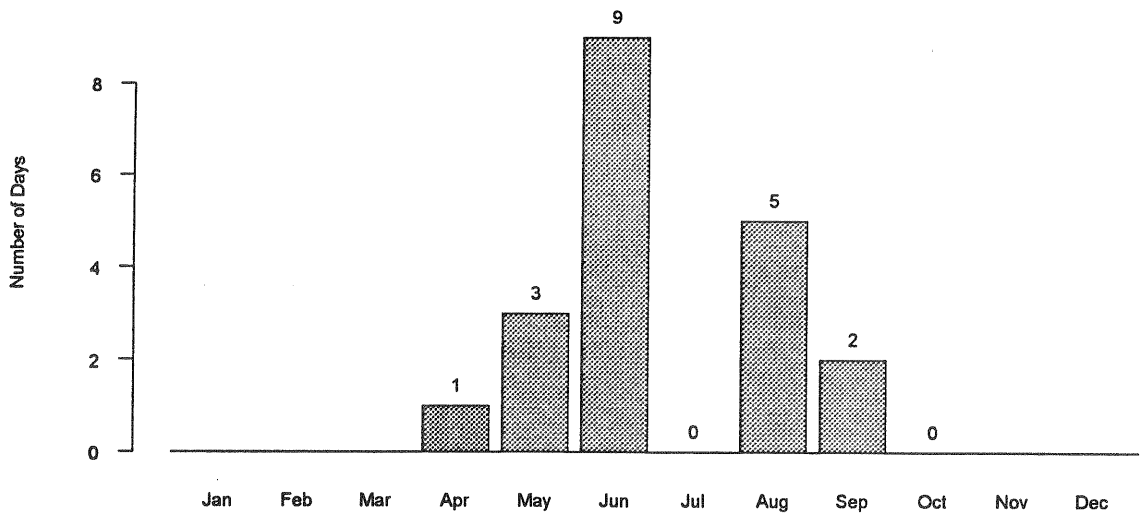

Figure 5.14. Number of Days with 1-Hour Ozone Averages in Excess of 0.10 ppm, 1994

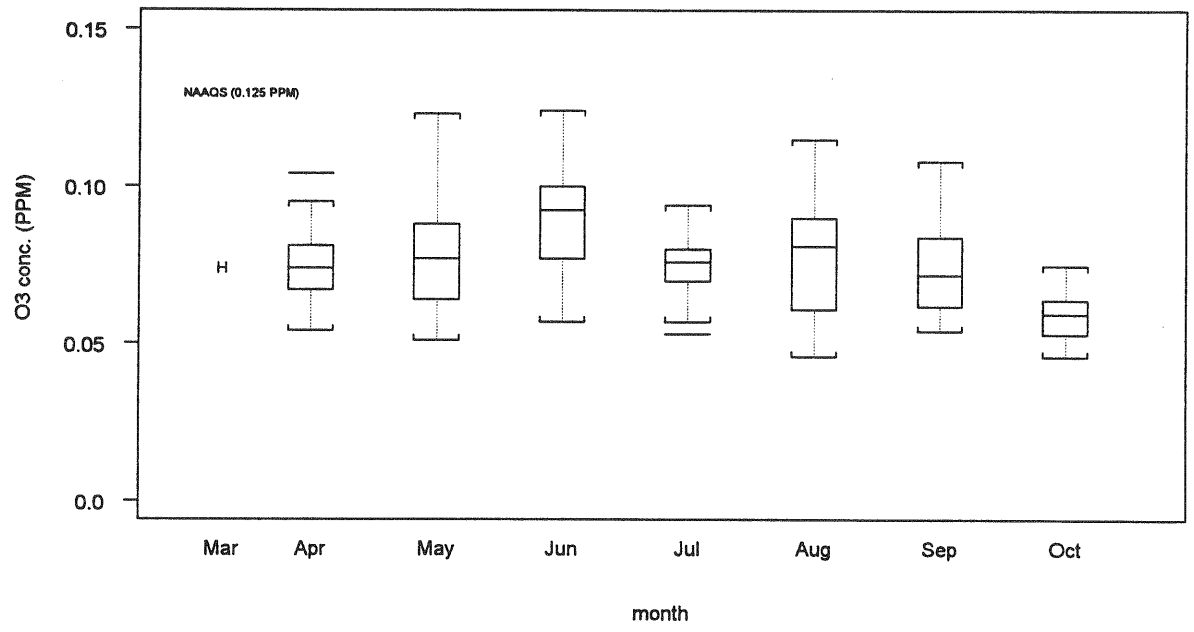

Figure 5.15. Monthly Distributions of Ozone Measurements, 1994

5.5. Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the state and two local program agencies using EPA reference or equivalent methods. Eighteen SO_2 monitors were active in North Carolina in 1994. However, some SO_2 sites are operated only one year of every third year, so eleven (11) sites provided data in 1994, four (4) sites provided data in 1993, and three (3) sites provided data in 1992.

From the 18 sites with SO_2 data obtained between 1992 and 1994, 126,376 valid hourly averages were collected. A map of the SO_2 sampling sites is presented in Figure 5.16, and a detailed summary of the data from each site is given in Table 5.5.

There were no exceedances of the SO_2 ambient air quality standards in 1994. The greatest annual arithmetic mean was 0.0070 ppm, or about 23 percent of the standard (0.0305 ppm). The greatest maximum 24-hour average was 0.024 ppm, or about 17 percent of the standard (0.14 ppm). The greatest maximum 3-hour average was 0.075 ppm, or about 15 percent of the welfare-related (secondary) standard of 0.500 ppm.

Apparently the size of an urban area has little effect on the ambient concentrations of SO_2 in North Carolina. Seasonal variations, such as those with CO and O_3, do not appear to exist for SO_2. Major source characteristics such as type, size, distribution, control devices, operating conditions and dispersion situations significantly affect the amount of SO_2 in ambient air.

The second highest three-hour concentrations in each county are charted in Figure 5.17. The second highest 24-hour concentrations in each county are charted in Figure 5.18.

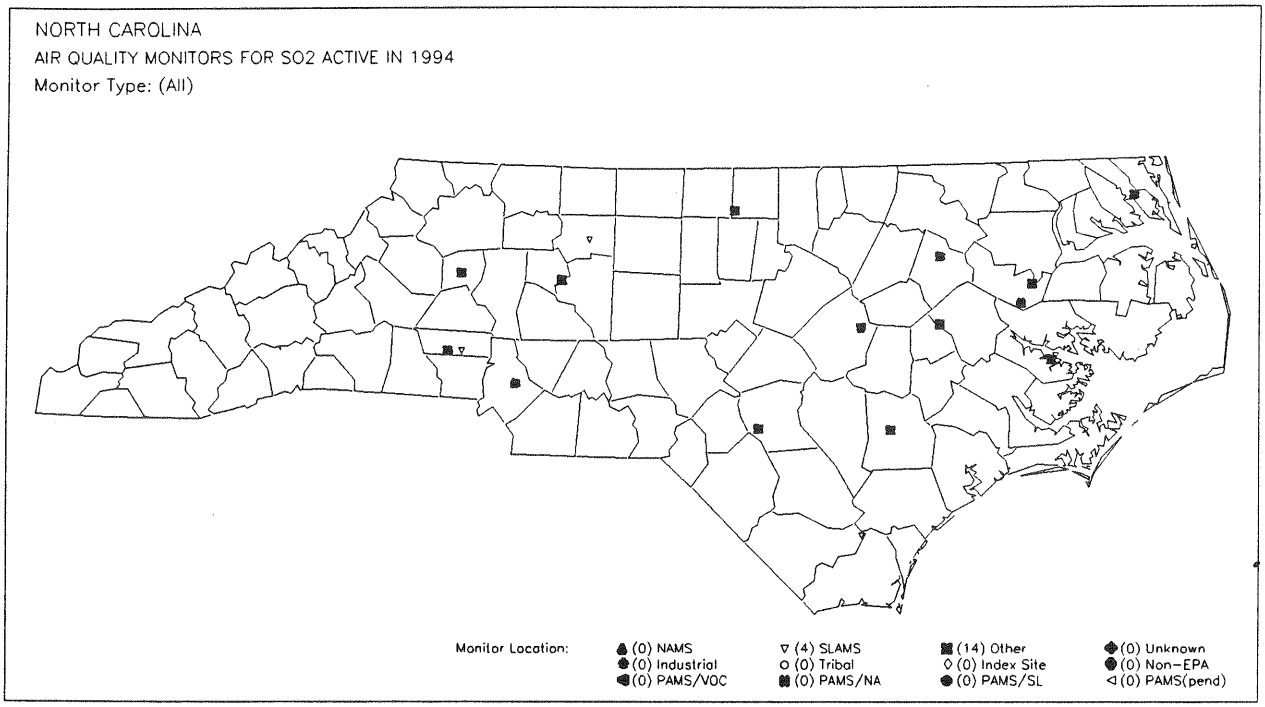

Figure 5.16. Location of Sulfur Dioxide Monitoring Sites, 1994

Table 5.5. Sulfur Dioxide in Parts Per Million from All Sites for 1992-94

Site Number County	Address	Num. Obs.	One-Hour Maxima 1st	One-Hour Maxima 2nd	Three-Hour Maxima 1st	Three-Hour Maxima 2nd	24-Hour Maxima 1st	24-Hour Maxima 2nd	Arith. Mean
1994 Data									
37-003-0003 ALEXANDER	STATE ROAD 1177	8,208	0.091	0.070	0.042	0.033	0.012	0.011	0.0039
37-013-0003 BEAUFORT	NC HWY 306	8,082	0.115	0.089	0.065	0.046	0.022	0.020	0.0035
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	8,198	0.075	0.074	0.052	0.043	0.018	0.013	0.0035
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	2,014	0.031	0.030	0.027	0.025	0.014	0.010	0.0040
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 8	8,189	0.044	0.040	0.026	0.026	0.014	0.009	0.0035
37-059-0099 DAVIE	FORK RECREATION CENTER	8,087	0.060	0.056	0.042	0.040	0.018	0.016	0.0042
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	7,895	0.085	0.080	0.057	0.057	0.023	0.021	0.0070
37-109-0004 LINCOLN	RIVERVIEW ROAD	4,368	0.087	0.086	0.046	0.041	0.020	0.017	0.0050
37-117-0001 MARTIN	HAYES STREET (#2 WELL SITE)	509	0.015	0.013	0.011	0.010	0.006	0.004	0.0031
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	6,022	0.079	0.057	0.040	0.037	0.013	0.012	0.0043
37-147-0099 PITT	US 264 NEAR FARMVILLE WATER TOWER	8,198	0.027	0.023	0.020	0.017	0.011	0.010	0.0031

Total Samples	**69,770**
Total Sites Sampled	**11**

Site Number County	Address	Num. Obs.	One-Hour Maxima 1st	One-Hour Maxima 2nd	Three-Hour Maxima 1st	Three-Hour Maxima 2nd	24-Hour Maxima 1st	24-Hour Maxima 2nd	Arith. Mean
1993 Data									
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT, ROCKFISH	8,277	0.029	0.028	0.026	0.018	0.010	0.010	0.0034
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	8,067	0.021	0.019	0.017	0.016	0.009	0.008	0.0028
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	7,701	0.208	0.204	0.070	0.069	0.010	0.010	0.0028
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	8,145	0.222	0.020	0.075	0.016	0.011	0.010	0.0029
Total Samples		**32,190**							
Total Sites Sampled		**4**							
1992 Data									
37-037-0098 CHATHAM	MONCURE PLANT - SOUTH SITE	8,209	0.111	0.103	0.050	0.049	0.024	0.018	0.0033
37-117-0099 MARTIN	SR 1538 NC 171	7,991	0.026	0.025	0.023	0.019	0.009	0.009	0.0023
37-145-0099 PERSON	SR 1102 & NC 49	8,216	0.074	0.071	0.050	0.041	0.014	0.011	0.0035
Total Samples		**24,416**							
Total Sites Sampled		**3**							

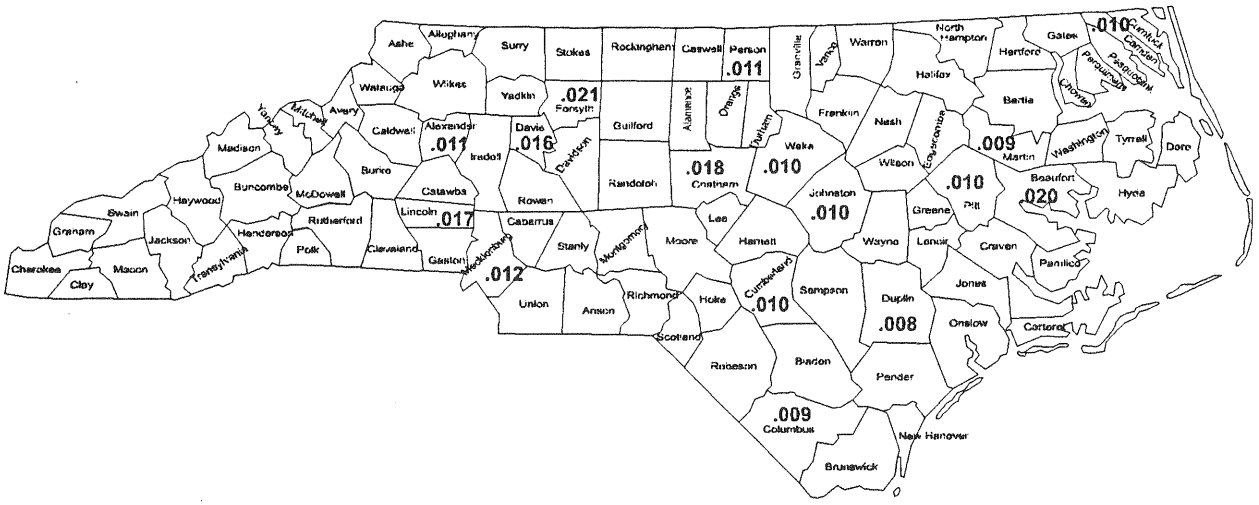

Figure 5.17. Sulfur Dioxide: Second Highest 3-Hour Averages: 1992-1994

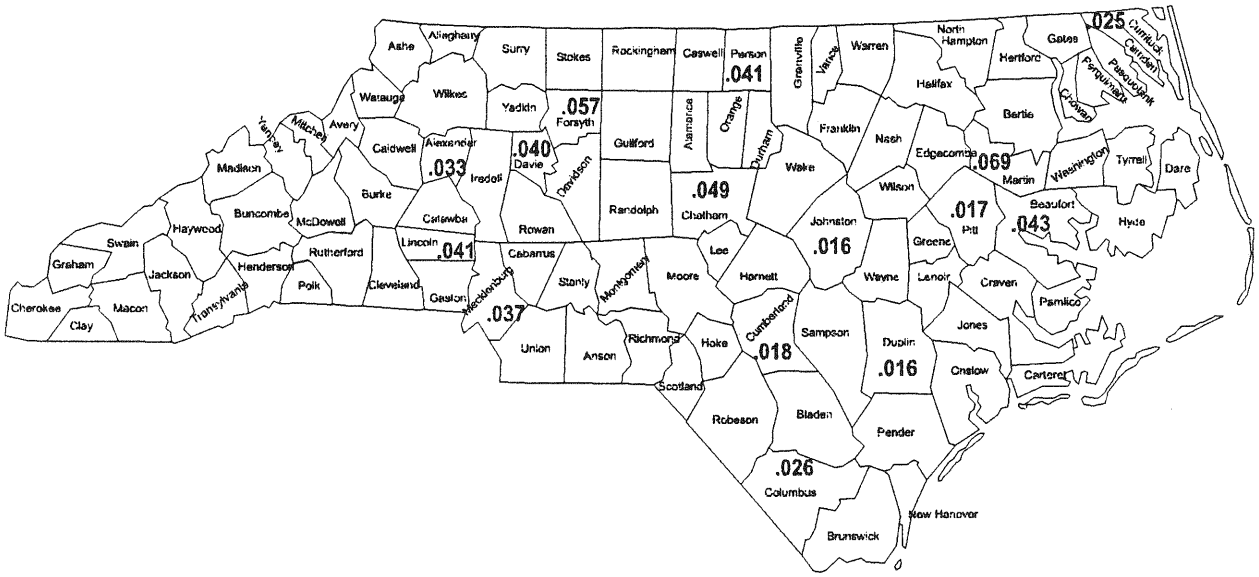

Figure 5.18. Sulfur Dioxide: Second Highest 24-Hour Averages: 1992 - 1994

5.6. Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 1994 at one site each in the local program in Forsyth County and the local program in Mecklenburg County.

From these two sites, 16,244 hourly NO_2 measurements were reported. A map of the two NO_2 sampling sites is presented in Figure 5.19, and a summary of the 1994 data is given in Table 5.6.

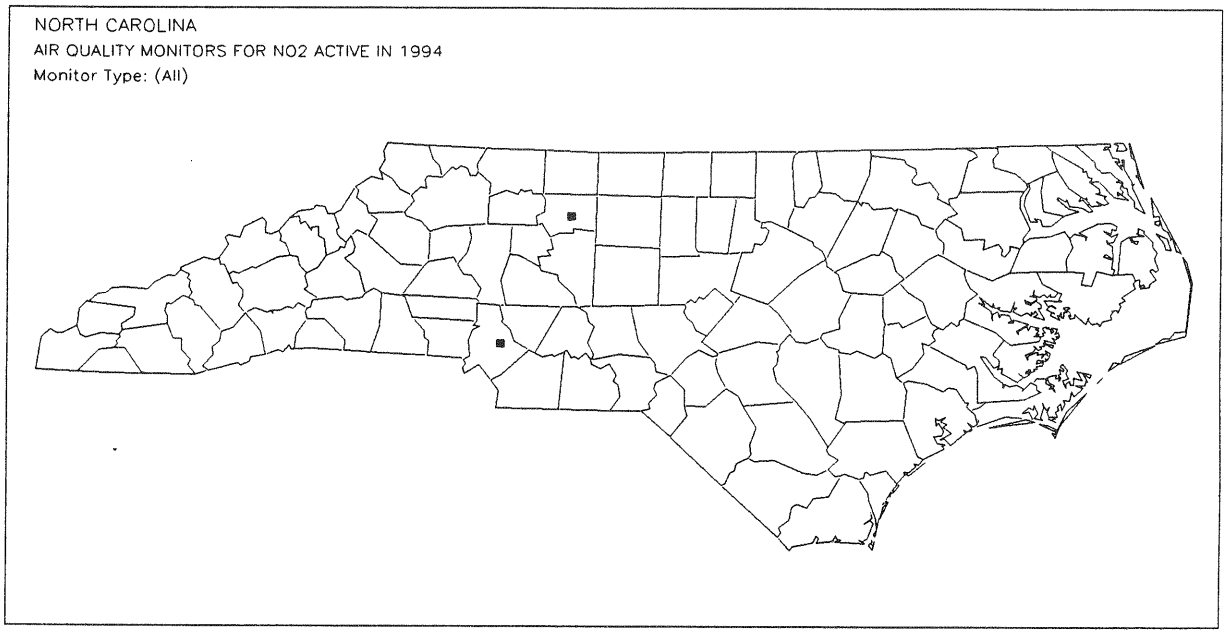

Figure 5.19. Location of Nitrogen Dioxide Monitoring Sites, 1994

Table 5.6. Nitrogen Dioxide in Parts Per Million (PPM) For 1994

Site Number County	Address	Num. Obs.	One-Hour Maxima 1st	One-Hour Maxima 2nd	Arith. Mean
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	7,861	0.072	0.072	0.0167
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	8,383	0.068	0.064	0.0164
Total Samples		16,244			

5.7. Lead

The state and local program agencies have not performed routine analysis of ambient lead (Pb) in North Carolina since 1982. Lead monitoring was discontinued because of the low values measured and a continuing decrease in the lead concentrations being reported. Ambient Pb concentrations in 1982 were approximately one-half the concentrations observed in 1979. The decrease in ambient Pb concentrations is due to the reduction and elimination of leaded gasoline, resulting in greatly reduced lead emissions from automobiles.

The state and local agencies provide particulate filter samples from three sites to EPA. EPA performs lead analysis on these filters as part of the National Particulate Analysis Program (formerly the National Filter Analysis Network, NFAN). The most recent year of data available is 1990; no data have been provided for 1994. As part of the National Particulate Analysis program, state and local agencies provided particulate filter samples from five sites to EPA. EPA performs lead analysis on the The greatest quarterly lead concentration in 1990 in North Carolina was 0.08 $\mu g/m^3$, which is about 5 percent of the standard.

6. Air Quality Index

The Air Quality Index (AQI) was developed by the EPA to provide the public with a simple, accessible and uniform assessment of air quality at a specific location, based on the criteria pollutants PM-10, CO, O_3, SO_2 and NO_2. AQI measurements are made and reported in all U.S. metropolitan areas with a population over 200,000. Ambient concentrations of each of these five pollutants are converted to a segmented linear numerical scale ranging from 0 to 500, where 100 corresponds to the EPA primary standard for a 24-hour average (8-hour CO average, 1-hour O_3 average) and 500 corresponds to a concentration associated with "significant harm." The AQI is determined by the pollutant with the highest scaled concentration, and a subjective description of "good", "moderate", "unhealthful, "very unhealthful", or "hazardous" is included with the report, with the descriptions corresponding to AQI values of 0-50, 51-100, 101-200, 201-300, and 301-500, respectively. For AQI values between 101 and 500, an appropriate cautionary statement is included advising people susceptible to deleterious health effects to restrict activities and exposure to the ambient air.

An AQI of 101-200 (unhealthful) can produce mild aggravation of symptoms in susceptible persons and possible irritation in healthy persons. People with existing heart or lung ailments should reduce physical exertion and outdoor activity. The general population should reduce vigorous outdoor activity.

An AQI of 201 to 300 (very unhealthful) can produce significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, and a variety of symptoms in healthy persons. Elderly people and those with existing heart or lung disease should stay indoors and reduce physical activity. The general population should avoid vigorous outdoor activity.

The health effects of an AQI of over 300 (hazardous) include early onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons. The elderly and persons with existing diseases should stay indoors and avoid physical exertion.

At AQI values over 400, premature death of ill and elderly persons may result, and healthy people will experience adverse symptoms that affect normal activity. Outdoor activity should be avoided. All people should remain indoors, keeping windows and doors closed, and should minimize physical exertion.

During winter months in North Carolina, carbon monoxide usually has the highest pollution standard index value, and in summer months the highest index value is usually due to ozone. In 1994, five areas provided an AQI report to the public by telephone *via* computer-

generated recorded voice announcements 24 hours daily. Those areas were Raleigh-Durham, Fayetteville, Greensboro-Winston Salem, Charlotte, and Asheville. The AQI report also may be published by local newspapers or broadcast on radio and television stations.

Air Quality Index values for 1994 at five metropolitan areas in North Carolina are given in Figures 6.1, 6.2, 6.3, 6.4 and 6.5.

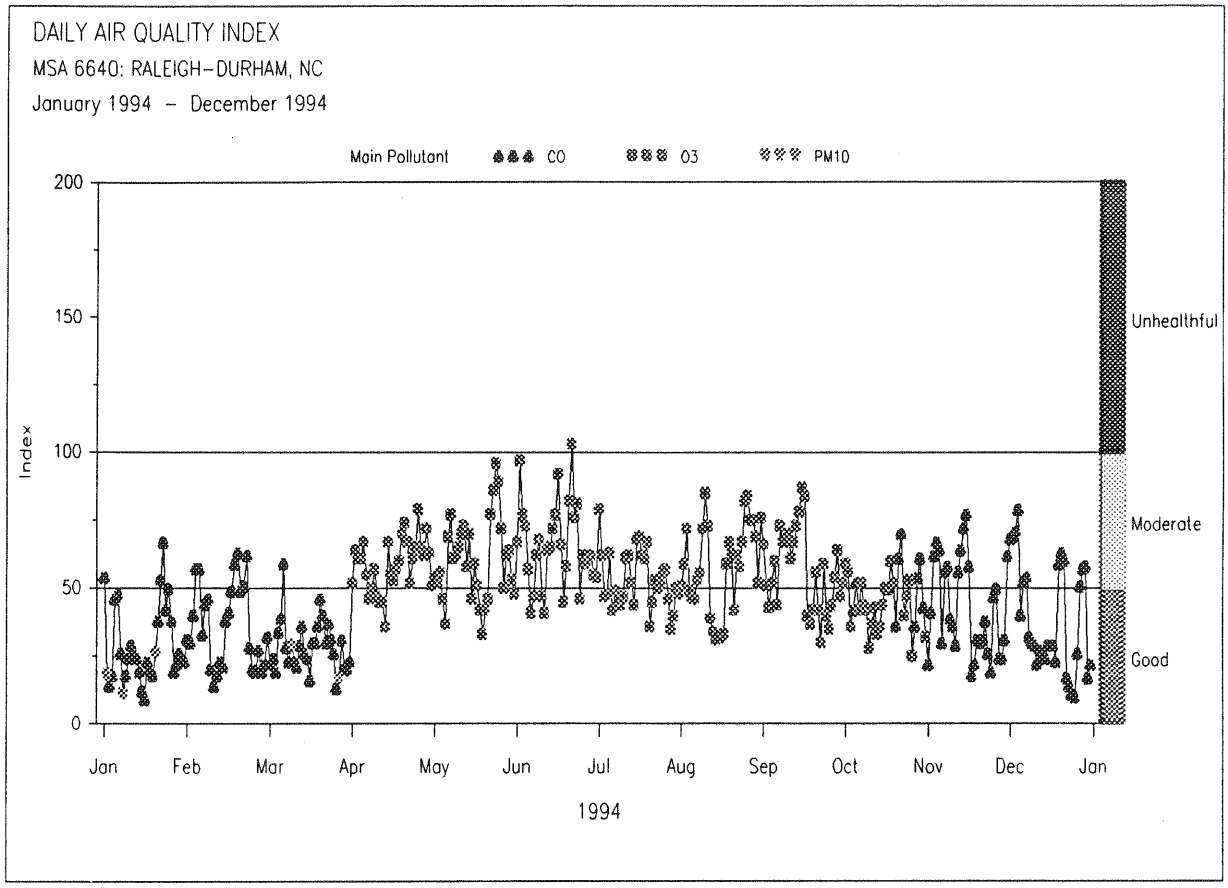

Figure 6.1. Daily Air Quality Index Values for Raleigh-Durham, North Carolina, Metropolitan Statistical Area, 1994

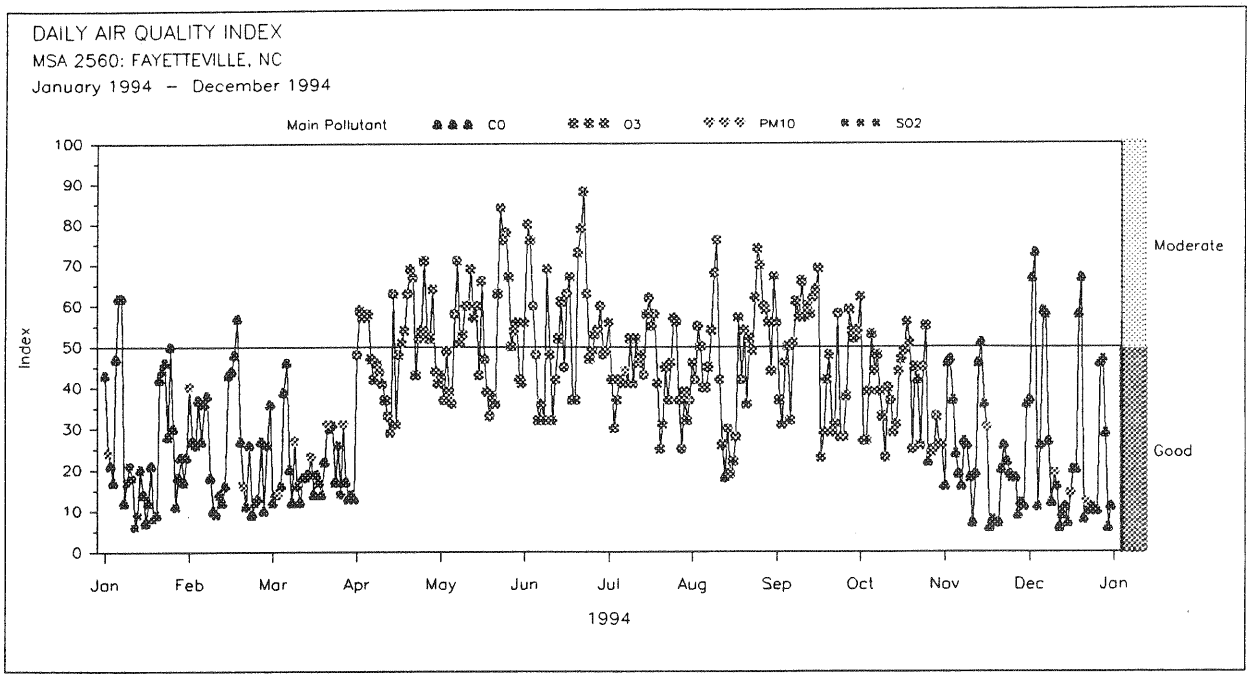

Figure 6.2. Daily Air Quality Index Values for Fayetteville, North Carolina, Metropolitan Statistical Area, 1994

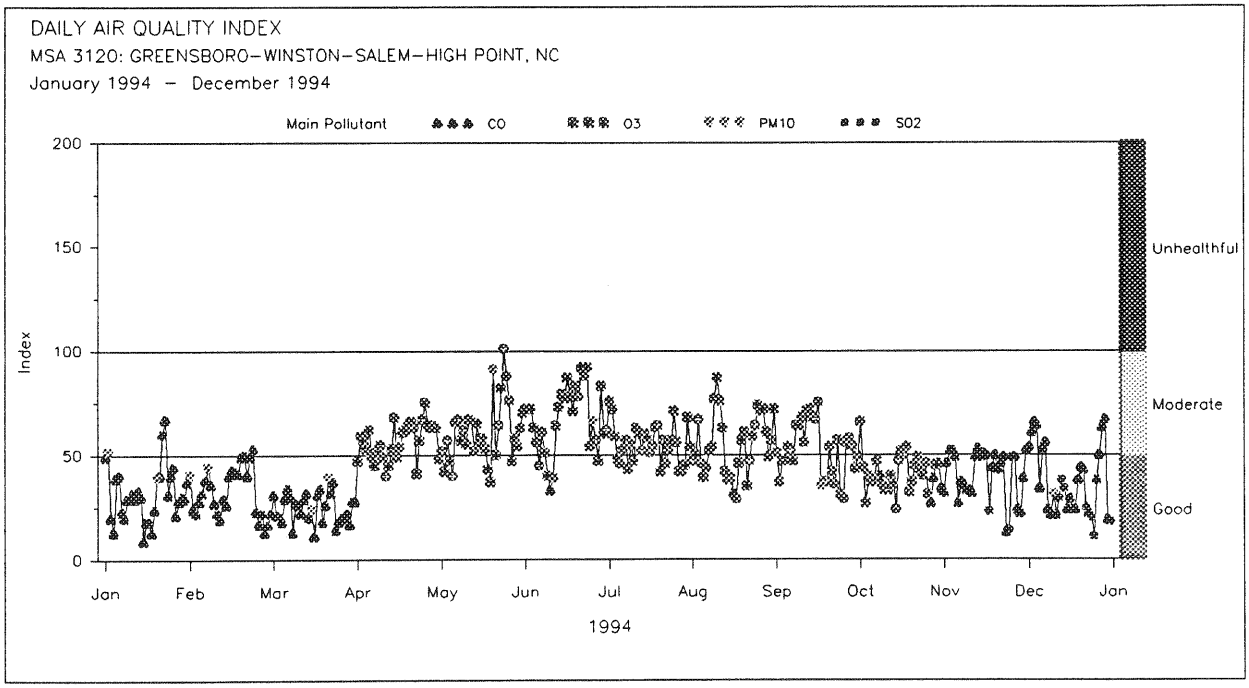

Figure 6.3. Daily Air Quality Index Values for Greensboro-Winston-Salem-High Point, North Carolina, Metropolitan Statistical Area, 1994

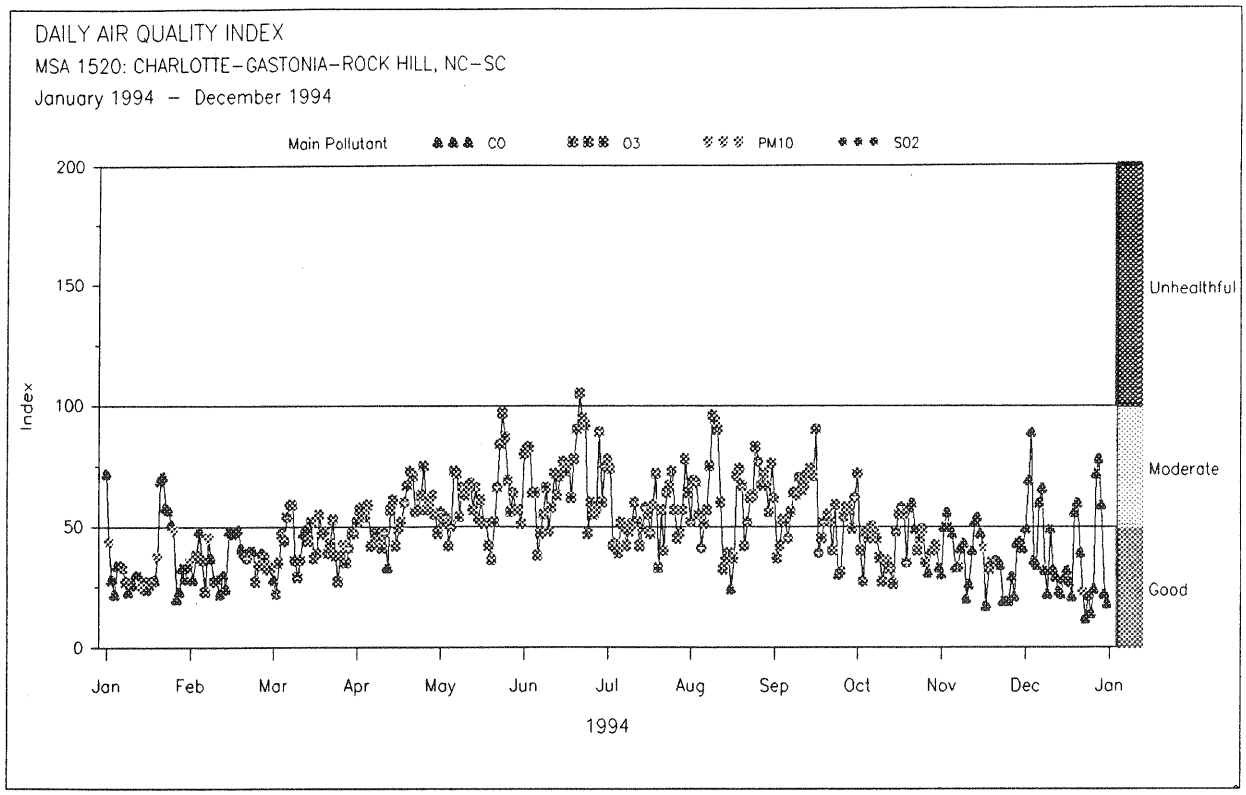

Figure 6.4. Daily Air Quality Index Values for Charlotte, North Carolina-Rock Hill, South Carolina, Metropolitan Statistical Area, 1994

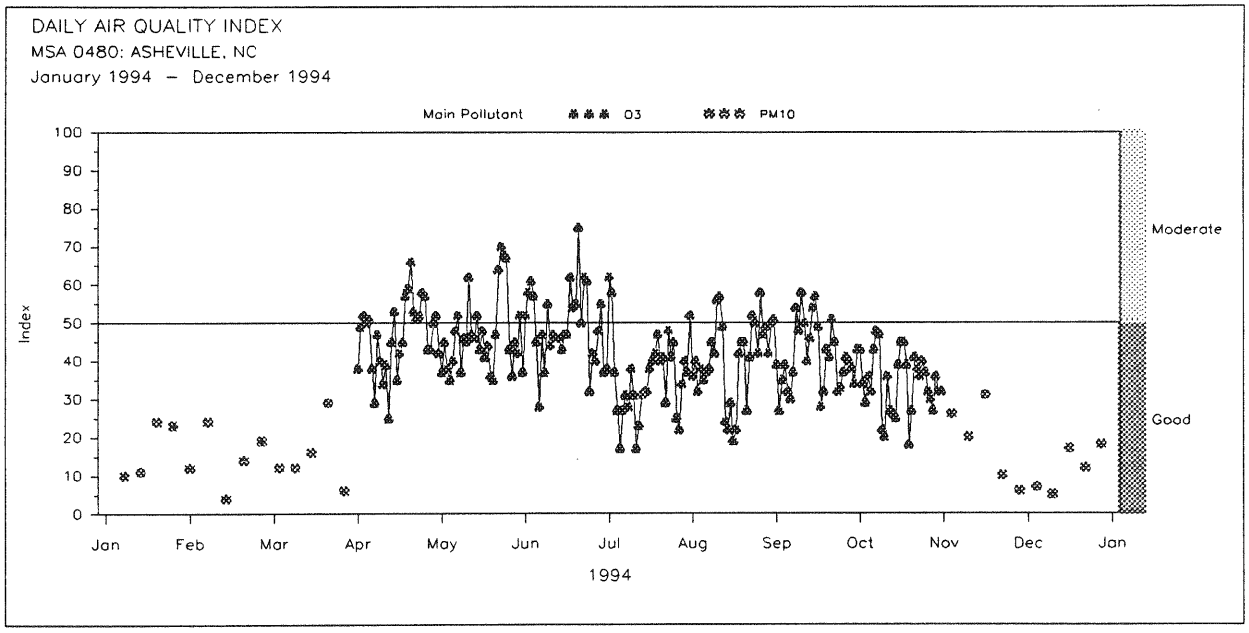

Figure 6.5. Daily Air Quality Index Values for Asheville, North Carolina, Metropolitan Statistical Area, 1994

7. Acid Rain

7.1. Sources

Acid rain is produced when nitrate and sulfate ions from transportation and industrial sources are released into the atmosphere, react with moisture in the air, and are deposited as acid precipitation. Acid ions are produced when sulfur dioxide and nitrogen oxides reach equilibrium with water to form sulfuric acid and nitric acid.

7.2. Effects

Many agricultural crops in North Carolina are sensitive to acid rain. Forests are subject to mineral loss from acid rain exposure and may also suffer root damage. Acid fogs and mists, typical in the mountains of North Carolina, can expose trees and plants to even higher acid concentrations and cause direct damage to foliage. Lakes, rivers and streams that are too acidic impede fish and plant growth.

7.3. Monitoring

Acid rain monitoring has been conducted nationally, including North Carolina, since 1978 by the National Atmospheric Deposition Program (NADP). On January 11, 1994, the sampling protocols changed substantially so direct comparisons to samples collected and analyzed in previous years is not possible. In 1994, acid rain samples were collected at eight sites. Seven sites in North Carolina and one Tennessee site in the Great Smoky Mountains less than 10 miles from the western border of North Carolina.

NADP/NTN conducts acid deposition monitoring using a wet/dry bucket type sampler. When rainfall is detected, a sensor is activated and a metal lid automatically covers and protects the "dry" sample, exposing the "wet" bucket to collect precipitation.

Acidity is measured using a "pH" scale. The pH scale is numbered from 0 to 14, with 0 being extremely acidic, 14 being extremely basic, and 7 being neutral. A substance with a pH of five is ten times more acidic than one with a pH of six, 100 times more acidic than a substance with a pH of seven, etc. The pH of vinegar is approximately 2.8, and lemon juice has a pH of about 2.3. The pH of ammonia is approximately 12.

Pure water in equilibrium with the air is slightly acidic and has a pH of about 5.6. The measurements of pH at the NC and TN monitoring sites in 1994 ranged from 4.42 to 4.69, with an average of 4.59. The 1994 annual average pH values, average conductivity, and precipitation totals for NC from the NADP/NTN database are presented in Figure 7.1 and Table 7.1. In Table 7.2, the measured concentrations of several chemical constituents of precipitation are presented.

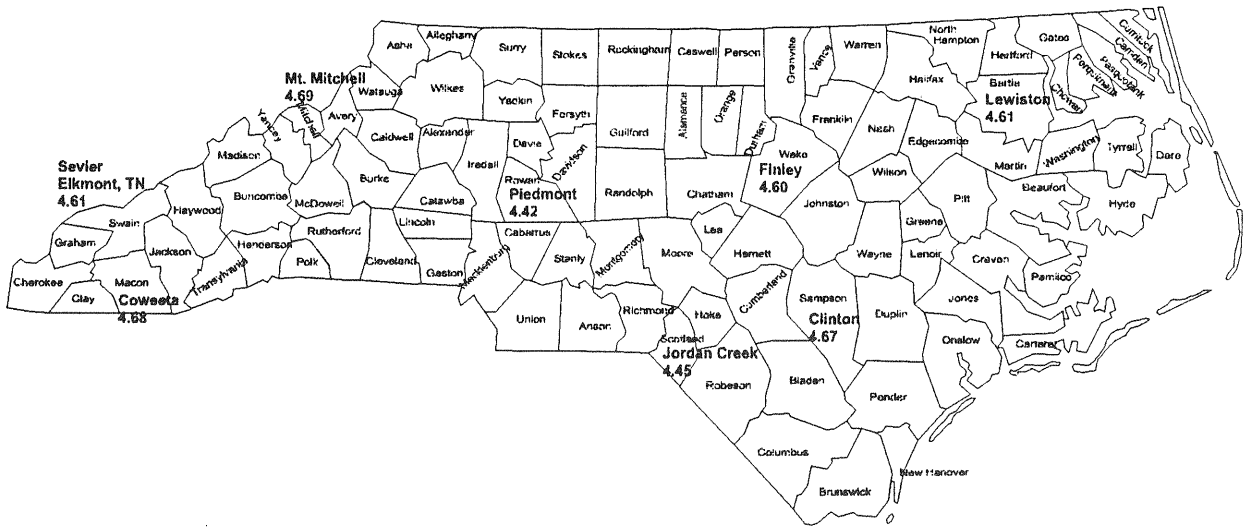

Figure 7.1. Annual Mean pH Values at North Carolina NADP/NTN/NDDN Sites, 1994

Table 7.1. " pH", Conductivity in Microsiemans Per Centimeter, and Precipitation in Inches from the National Atmospheric Deposition Program/National Trends Network and National Dry Deposition Network Data for 1994

County Site # Address	pH	Conductivity	Precipitation
Bertie 340320 Lewiston	4.61	15.2	102.64
Macon 342500 Coweeta	4.68	12.0	202.72
Rowan 343460 Piedmont Research Station	4.42	22.7	104.92
Sampson 343560 Clinton Crops Research Station	4.67	15.3	88.03
Scotland 343600 Jordan Creek	4.45	20.1	119.96
Wake 344160 Finley Farm	4.60	15.9	100.18
Yancey 344500 Mt. Mitchell	4.69	11.5	204.39
Sevier (TN) 441190 Great Smoky Mts Nat'l Park, Elkmont TN	4.61	13.5	191.62

Table 7.2. Ion Concentrations in Milligrams Per Liter (Precipitation-Weighted Annual Means) from the National Atmospheric Deposition Program/National Trends Network and National Dry Deposition Network Data for 1994

County Site # Address	Percent Completeness	Ca	Mg	K	Na	NH_4	NO_3	Cl	SO_4
Bertie 340320 Lewiston	90.4	0.06	0.038	0.034	0.290	0.19	0.81	0.52	1.21
Macon 342500 Coweeta	94.2	0.05	0.014	0.018	0.109	0.14	0.62	0.19	1.03
Rowan 343460 Piedmont Research Station	98.1	0.07	0.030	0.057	0.198	0.33	1.10	0.38	2.08
Sampson 343560 Clinton Crops Research Station	90.4	0.06	0.037	0.033	0.282	0.36	0.92	0.50	1.45
Scotland 343600 Jordan Creek	76.9	0.06	0.028	0.021	0.207	0.17	1.06	0.37	1.59
Wake 344160 Finley Farm	92.3	0.05	0.028	0.032	0.196	0.26	0.86	0.35	1.43
Yancey 344500 Mt. Mitchell	83.0	0.04	0.010	0.013	0.067	0.13	0.50	0.12	1.02
Sevier (TN) 441190 Great Smoky Mts Nat'l Park Elkmont TN	90.4	0.06	0.010	0.026	0.057	0.15	0.75	0.10	1.17

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Office of the Federal Register (National Archives and Records Administration) (1993), "Code of Federal Regulations, Title 40, Parts 1 to 51, Protection of Environment," (July 1 ed.), Washington, DC: Author.

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Appendix A. Air Pollution Monitoring Agencies

North Carolina State Headquarters

Division of Air Quality
Parker Lincoln Building
2728 Capital Boulevard
P O Box 29580
Raleigh, North Carolina 27626-0580
(919) 715-0665

North Carolina Regional Offices

Asheville Regional Office
Interchange Building
59 Woodfin Place
Asheville, North Carolina 28801
(828) 251-6208

Counties of Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Swain, Transylvania, and Yancey.

Fayetteville Regional Office
Suite 714
225 Green Street
Fayetteville, North Carolina 28301
(910) 486-1541

Counties of Anson, Bladen, Cumberland, Harnett, Hoke, Montgomery, Moore, Robeson, Richmond, Sampson, and Scotland.

Mooresville Regional Office
919 North Main Street
P.O. Box 950
Mooresville, North Carolina 28115-0950
(704) 663-1699

Counties of Alexander, Cabarrus, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Stanley and Union.

Raleigh Regional Office
3800 Barrett Drive
P.O. Box 27687
Raleigh, North Carolina 27609
(919) 541-4700

Counties of Chatham, Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Lee, Nash, Northampton, Orange, Person, Vance, Wake, Warren, and Wilson.

Washington Regional Office
943 Washington Square Mall
Washington, North Carolina 27889
(252) 946-6481

Counties of Beaufort, Bertie, Camden, Chowan, Craven, Currituck, Dare, Gates, Greene, Hertford, Hyde, Jones, Lenoir, Martin, Pamlico, Pasquotank, Perquimans, Pitt, Tyrrell, Washington, and Wayne.

Wilmington Regional Office
127 Cardinal Drive Ext.
Wilmington, North Carolina 28405-3845
(910) 395-3900

Counties of Brunswick, Carteret, Columbus, Duplin, New Hanover, Onslow and Pender.

Winston-Salem Regional Office
585 Waughtown Street
Winston-Salem, North Carolina 27107
(336) 771-4600

Counties of Alamance, Alleghany, Ashe, Caswell, Davidson, Davie, Forsyth, Guilford, Rockingham, Randolph, Stokes, Surry, Yadkin, Watauga, and Wilkes.

Local Agencies

Forsyth County Environmental Affairs Department
537 North Spruce Street
Winston-Salem, North Carolina 27101
(336) 727-8064

Mecklenburg County Department of Environmental Protection
1200 Blythe Boulevard
Charlotte, North Carolina 28203
(704) 376-4603

Western North Carolina Regional Air Pollution Control Agency
Buncombe County Courthouse Annex
Asheville, North Carolina 28801-3569
(828) 255-5655

Counties of Buncombe and Haywood.

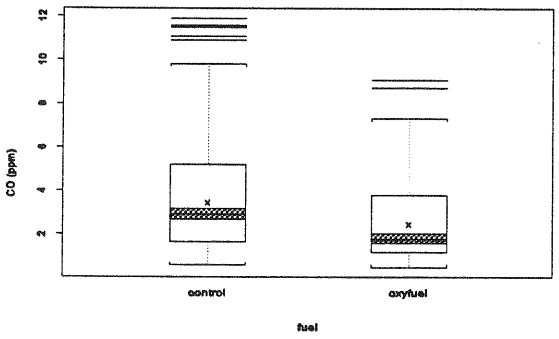
Appendix B. Exceptional Events

Type of Event	Pollutants Affected
Natural Events	
Sustained high wind speeds	particulate matter (PM)
Stagnations, inversions	all pollutants
Unusual lack of precipitation	PM
Stratospheric ozone intrusion	O_3
Volcanic eruption	CO, SO_2, PM
Forest fires	CO, PM
High pollen count	PM
Unintentional Manmade Events	
Large structural fires	CO, PM
Major traffic congestion due to accident or nonrecurring obstruction	CO
Chemical spills	SO_2, NO_2, PM, CO
Industrial accidents	SO_2, NO_2, PM, CO
Intentional Manmade Events	
Short-term construction/demolition	PM
Sandblasting	PM
High-sulfur oil refining	SO_2
Roofing operations	PM, SO_2
Salting or sanding of streets	PM
Infrequent large gatherings	PM, CO
Soot blowing from ships	PM
Agricultural tilling	PM
Prescribed burning	CO, PM
Noncompliance of local sources	CO, SO_2

Appendix C. Box-And-Whisker Plots

A *box-and-whisker plot* (also called *boxplot* or *schematic plot*) is a schematic diagram useful for depicting the location, spread and skewness of a continuous data variable. Box plots are constructed from *order statistics* (data values sorted from smallest to largest). The "box" of the box plot is oriented parallel to a continuous scale and is defined by 3 points, (1) a line or point in the interior of the box at the median of the data (a point that divides the order statistics into two equal parts), and (2) upper and (3) lower *fourths* or *quartiles.* (Fourths divide the upper and lower halves of the data values into two equal parts; quartiles divide the entire range of the data into 4 equal parts. Fourths and quartiles are not necessarily the *same*, because there may be more than one number that appropriately divides a given set of data in the prescribed way, and different computational techniques [or computer programs] may make different choices.)

The distance between the upper and lower fourth in the box plot is called the *interquartile range.* In most box plots, the length of each of the *whiskers* is 1.5 times the interquartile range or to the extreme (maximum or minimum) of the data, whichever is *shorter.* The endpoint of each whisker is called an *inner fence.* (In the box plots pictured below, the end of each whisker is marked by a "staple" for clarity.) There may be data points, called *outliers*, beyond the inner fences; if so, they are usually indicated individually on the box plot by a dot, small circle, or (as below) a short line segment perpendicular to the axis of the box. Box plots of variables with very long-tailed distributions may display two kinds of outliers—small dots for those just beyond the inner fences and larger dots or circles for *extreme outliers* at a distance of more than 3.0 times the interquartile range beyond the fourths. This boundary between outliers and extreme outliers is termed the *outer fence* and usually not explicitly shown in the plot.



The maximum and minimum values are always visible in a box-and-whisker plot as either the outermost outliers or, if there is no outlier, the position of the inner fence.

Box plots may have additional, optional features, such as a point marker at the *arithmetic mean* or a distinctive display of a *confidence interval for the median*, which is calculated from the fourths. In the figure, the arithmetic mean is marked with an "X", and the confidence interval for the median is displayed as a shaded or colored range. It is also common to display the confidence interval by cutting notches in the sides of the box at its endpoints.

Box plots are very useful for comparing two or more variables by placing two comparable variables side-by-side on the same scale (as in the figure). The statistics displayed can be directly compared, and statistical significance of difference between the medians can be assessed by examining overlap or lack of overlap of confidence intervals.

Appendix D. Nonattainment and North Carolina

What is nonattainment and what are the sources of the pollutants?

The United States Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards. North Carolina monitors concentrations of air pollutants in the ambient air. Some of these monitors have measured concentrations of ozone and carbon monoxide exceeding the standards. Areas that have not met the National Ambient Air Quality Standards can be classified by EPA as "nonattainment".

Mobile sources such as cars and trucks are the primary cause of carbon monoxide and ozone precursors. About 90 percent of the carbon monoxide emissions come from motor vehicles. Volatile organic compounds react with nitrogen oxides and sunlight in warm weather to produce ozone. Approximately 50 percent of the nitrogen oxides come from motor vehicles, with the remainder coming from large stationary combustion sources. Thirty percent to 50 percent of the man-made hydrocarbons or volatile organic compound emissions come from motor vehicles; the rest comes from petroleum marketing, factories, businesses and households.

Why is my county nonattainment?

Unless the state can demonstrate a better alternative, EPA has indicated that they will designate nonattainment areas based on Metropolitan Statistical Areas (MSAs). These MSAs were established by the Office of Management and Budget. Monitors showing violations of Standards may not be in every county. Previous emission control programs instituted in single counties across the nation often have failed to produce compliance with standards. Pollution from one county blows into neighboring counties, especially with ozone. EPA concluded that the control plans must cover metropolitan areas, not single counties.

Once we are nonattainment, what is the process for becoming attainment?

North Carolina is required by the federal Clean Air Act and EPA to produce and implement emission reduction plans and show that these plans are strong enough to produce compliance with the standards. The plans could involve resource-intensive monitoring, emissions inventory, modeling, public participation, and strategy formulation efforts. There are deadlines for producing the plans and for achieving compliance with the standards. EPA must approve the plans.

How does the public get involved in the formulation of the emission reduction plans, known as State Implementation Plan (SIP) revisions?

Local agencies and officials, as well as state agencies, will be involved in drawing up the SIP revisions. It is likely that there will be public meetings or special citizen panels. When

draft SIP revisions are done, there will be public hearings on them. The SIP revisions must be approved by the N.C. Environmental Management Commission and possibly by local bodies as well. EPA's approval process includes an opportunity for public comment.

How will it affect citizens?

Emission reduction strategies fall into several categories. Motor vehicle inspection/maintenance may be required for hydrocarbons or carbon monoxide or both. Traffic patterns may be altered by changing roads or traffic signals. Both new and existing factories and business may have to reduce emissions by installing control equipment or changing processes. This might include requirements that gas stations trap vapors that escape when vehicles are refueled or that gasoline contain pollution-reducing additives.

What happens if North Carolina refuses to address these air pollution problems?

Under the Clean Air Act, EPA has the authority to apply sanctions. EPA can ban the construction of major pollutant sources, and may withhold federal highway construction funds in the nonattainment areas.

What is the likelihood of receiving sanctions if we are showing progress in reducing pollution?

North Carolina can avoid sanctions if it produces and carries out SIP revisions that EPA approves by the deadlines. If pollution concentrations do not recede and attain the standards as projected, the EPA could impose construction bans. However, EPA has some discretion about imposing sanctions. Sanctions are a last step to persuade states to take required positive action.

What does inspection/maintenance cost?

The inspection/maintenance (I/M) or motor vehicle tailpipe testing process, costs the motorist $15.40 as of October 1, 1990. If a vehicle fails the test, it must be repaired. A waiver is available if a vehicle still fails after $50.00 worth of repairs have been done. The $50.00 limit does not apply to tampered or misfueled vehicles. The inspection/maintenance program includes tests for hydrocarbon (HC) and carbon monoxide (CO) emissions. Currently Mecklenburg and Wake counties have I/M programs. Testing for HC began in April 1993. Guilford and Forsyth counties started I/M programs in July 1993. Only gasoline powered motor vehicles built after 1974, excluding the current model year and motorcycles, are inspected in these counties. Inspection/maintenance pass-fail levels vary with vehicle age and pollutant.

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