1992
Ambient Air Quality Report

Ambient Monitoring Section
George C. Murray, Jr., Chief

Division of Air Quality
Alan W. Klimek P.E., Director

Published
December 1997

State of North Carolina
James B. Hunt, Jr., Governor

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Environment and Natural Resources
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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 1992 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 are also described.

Acid rain data from the National Atmospheric Deposition Program/National Trends Network for North Carolina also is included for 1992. The report concludes with an account of pollutant concentration trends through 1992. Data collected after 1992 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:

Statewide Toll Free - Asheville, Durham, Greensboro, Greenville, Fayetteville Raleigh, Wilmington and Winston-Salem areas.	888-AIR-WISE
Charlotte area	704-333-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 Dr. Wayne L. Cornelius, at the above address.

Alan W. Klimek, P.E., Director
Division of Air Quality

Executive Summary

In 1992, the North Carolina Division of Environmental Management (DEM) and the three local program agencies (listed in Appendix A) collected 347,223 air quality samples. (The DEM was superseded in 1996 by the Division of Air Quality.). 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.

In addition, this report provides information on pollutant trends from 1972 (or the earliest year available) through 1992. The following summary discusses trends only for those pollutants having either increasing or decreasing tendencies.

Two different types of **particulate matter** were sampled in North Carolina during 1992. 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 35 sites, yielding 1,650 24-hour samples. One exceedance of the state TSP ambient air quality standard for 24-hour samples (150 $\mu g/m^3$) was observed in 1992 at the Taylorsville, State Road 1177 site in Alexander County. This exceedance occurred on July 11, 1992, and was attributed to highway construction taking place near this site.

PM_{10} was sampled at 35 sites, yielding 1,449 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 and 50 $\mu g/m^3$ for the annual arithmetic mean). Mean 24-hour concentrations have remained approximately constant since 1985.

Carbon monoxide (CO), the most common air pollutant, largely results from fuel combustion. The most likely areas to have excessive CO concentrations are larger cities where there are more cars and congested streets.

CO was sampled at 17 sites, yielding 125,380 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, but one exceedance of the eight-hour standard occurred at the Person Street, Raleigh site in Wake County. The mean one-hour average has been decreasing by about five percent per year, and the mean eight-hour average has

been decreasing by about 3.7 percent per year. The combined effects of newer cars in the vehicle fleet, traffic control strategies, and the Inspection and Maintenance program in Wake County have helped reduce the number and intensity of CO exceedances from previous years. Another control strategy was the use of oxygenated fuel in Forsyth County and Wake/Durham Counties from November 1991 to February 1992.

Ozone (O_3) forms in the lower atmosphere when hydrocarbons (or volatile organic compounds) and nitrogen oxides chemically react in the presence of sunlight and high temperatures. The main emphasis in control of ozone has been to limit hydrocarbon emissions.

Ozone (O_3) was sampled at 28 sites, yielding 134,239 valid hourly averages. The National Ambient Air Quality Standard for O_3 is 0.12 ppm for the maximum one-hour average. Three exceedances occurred in North Carolina in 1990 and one occurred in 1991.

In 1992, there was only one exceedance of the standard, at the Camden site in Camden County. Mecklenburg County, Forsyth (Triad) and Wake/Durham (Triangle) continue to be designated as ozone non-attainment areas. These three areas have more recently been redesignated as attainment areas. Hydrocarbon control strategies continue to be used to help reduce 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 8 sites, yielding 59,724 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standards (365 $\mu g/m^3$ for a 24-hour average, 1300 $\mu g/m^3$ for a three-hour average, 80 $\mu g/m^3$ for the annual arithmetic mean).

Nitrogen oxides (NO_x) are produced primarily from 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. 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 non-attainment areas.

The criteria pollutant NO_2 was sampled at three sites, yielding 24,781 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standard (0.053 ppm for the annual arithmetic mean). The mean one-hour average concentration has been decreasing by about 2.8 percent per year.

Lead (Pb) emissions result from coal combustion and the sandblasting of highway bridges, overpasses 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 1992, there have been no recent exceedences 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 steady decline in 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 1992 ranged from 4.52 (Great Smoky Mountains National Park in Elkmont, Tennessee) to 4.81 (Clinton Crops Research Station, Sampson County).

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1. Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 1992 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 347,223 air quality samples of the U.S. Environmental Protection Agency's (EPA) criteria pollutants-particulate matter, carbon monoxide, ozone, sulfur dioxide, and nitrogen dioxide - discussed on this report. No samples of another criteria pollutant, lead, were taken in 1992.

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 human1 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 charts index 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 calendar year mean pH level 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 a nominal 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 1991).

2.1.1 Sources

Particulates are emitted by many human 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 will usually be fine. Generally, coarse 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 breathing system, including aggravation of existing lung and heart disease, limitation of lung clearance, changes in form and structure of organs, and 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 mouth breathers.

Health effects from inhaled particles are influenced by the depth of penetration of the particles into the respiratory system, the amount of particles deposited in the respiratory system, and by the biological reaction to the deposited particles. The risks of adverse health effects are 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 also can interfere with plant photosynthesis, by forming a film on leaves reducing 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 (smog and haze). This is a national concern, especially in areas such as national parks, historic sites and scenic attractions visited by tourists.

2.2 Carbon Monoxide

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

2.2.1 Source

Most atmospheric CO is produced by incomplete combustion of fuels used for vehicles, space heating, industrial processes and incineration. Transportation accounts for the majority of CO emissions in large urban areas. 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, lung and heart diseases are particularly sensitive to CO effects. Low concentrations affect mental function, vision and alertness. High concentrations can cause fatigue, dizziness, headaches, 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 adversely affect vegetation or materials but is a major precursor of the greenhouse gases.

2.3 Ozone

Ozone 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 materials. It is the major reactive constituent of a complex mixture of compounds known as photochemical oxidants.

Ozone is the most widespread and serious criteria air pollutant in North Carolina. Of the six criteria air pollutants for which national Ambient Air Quality Standards have been established, ozone is the most difficult to control.

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 chlorofluor-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 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

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. Exposure to lower levels of ozone can cause respiratory problems, aggravate asthma, cause temporary decreases in lung capacity, and cause inflammation of lung tissue. It also has been found that exposure to ozone impairs the body's immune system, causing an increased incidence of respiratory infections such as pneumonia and bronchitis.

Ozone affects plant growth and reproduction by interfering with their ability to produce and store food. This reduces overall plant health making them more susceptible to disease, pests, and the effects of environmental stresses such as high temperatures, drought, and other pollutants. 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. Smaller concentrations of sulfur trioxide and other sulfate compounds are also found in SO_2 emissions. Sulfur oxides contribute to the formation of acid rain and the formation of particles that reduce visibility.

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 brought in contact with the gas. Sulfur dioxide can increase the severity of existing respiratory diseases such as asthma, bronchitis, emphysema and aggravate of existing cardiovascular disease. Sulfuric acid and fine particulate sulfates also may cause significant health problems.

Sulfur dioxide causes injury to many plants. A bleached appearance between the veins and margins on leaves indicate damage from SO_2 exposure. Commercially important plants sensitive to SO_2 include cotton, sweet potatoes, cucumber, alfalfa, tulips, apple trees, and several species of pine trees.

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 and typical ambient concentrations 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 reddish-brown but is not usually visible at typical ambient concentrations.

2.5.1 Sources

The most significant nitrogen oxide emissions result from 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 to form NO_2.

2.5.2 Effects

At typical concentrations, 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 visibilty. 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 is a 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 the leaded fuel has been phased out and the concentration of lead in such fuel has decreased, minimizing 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 batteries and some 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.

The major toxic effects of lead include: the reduction in the production of hemoglobin (the oxygen carrying component of the blood) and subsequently anemia; central nervous system damage; kidney and liver damage; and high blood pressure in older adults.

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 the 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 pollution effects on soils, water, crops, vegetation, manmade 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 its 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	Standard Level Concentration		
		Primary (Health Related)	Secondary (Welfare Related)	North Carolina
TSP	Annual Geom. Mean	NA[a]	NA[a]	75 µg/m^3
	24-hour[b]	NA[a]	NA[a]	150 µg/m^3
PM-10	Expected Annual Arith. Mean	50 µg/m^3	50 µg/m^3	50 µg/m^3
	24-hour[c]	150 µg/m^3	150 µg/m^3	150 µg/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 µg/m^3)	0.12 ppm (235 µg/m^3)	0.12 ppm (235 µg/m^3)
SO_2	Annual Arith. Mean	80 µg/m^3 (0.03 ppm)	NA	80 µg/m^3 (0.03 ppm)
	24-hour[b]	365 µg/m^3 (0.14 ppm)	NA	365 µg/m^3 (0.14 ppm)
	3-hour[b]	NA	1,300 µg/m^3 (0.50 ppm)	1,300 µg/m^3 (0.50 ppm)
NO_2	Annual Arith. Mean	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
Pb	Maximum Quarterly Arith. Mean	1.5 µg/m^3	1.5 µg/m^3	1.5 µg/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]The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations (following 40 CFR 50 App. H [Office of the Federal Register 1993, p. 767-769]) above the standard concentration is equal to or less than 1.0.

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). (The Air Quality Section became the Division of Air Quality [DAQ] in 1996.) The air monitoring data are used to determine whether air quality standards are being met, to assist in enforcement actions, to determine the improvement or decline of air quality, and to determine the extent of allowable industrial expansion. A list of monitoring sites active in 1992 is presented in Table 4.1. The locations of sites are shown in Figures 5.1, 5.4, 5.7, 5.12, 5.16, and 5.19.

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 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, 1992.

SITE COUNTY	STREET	POLLUTANTS	
37-001-0001 ALAMANCE	1136 E.WEBB AVE.BURLINGTON	TSP	
37-003-0003 ALEXANDER	STATE ROAD 1177	TSP	PM10
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	
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST	TSP	PM10
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD	O3	
37-023-0004 BURKE	126 AND 1254	O3	
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	TSP	PM10
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	O3	SO2
37-031-0003 CARTERET	ARENDELL & 4TH MOREHEAD CITY	TSP	
37-035-0004 CATAWBA	1650 1ST. ST.	TSP	PM10
37-037-0098 CHATHAM	MONCURE PLANT - SOUTH SITE	O3	SO2
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 87	TSP	SO2

SITE COUNTY	STREET	POLLUTANTS	
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	TSP	PM10
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705 OWEN DRIVE	CO	
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857	O3	
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT, ROCKFISH RD.	O3	
37-057-0002 DAVIDSON	S.SALISBURY ST.LEXINGTON	TSP	
37-057-1001 DAVIDSON	CITY HALL 7 WEST GUILFORD ST	TSP	
37-057-1002 DAVIDSON	400 SALEM STREET	TSP	PM10
37-059-0099 DAVIE	FORK RECREATION CENTER	O3	PM10
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	O3	
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	PM10	
37-063-0008 DURHAM	302 EAST MAIN ST DURHAM	CO	
37-063-0010 DURHAM	CITY PARK ON UNIVERSITY DRIVE	CO	
37-063-0011 DURHAM	201 NORTH ROXBORO ST	CO	
37-065-0002 EDGECOMBE	LEGETT RD., WASTE TREATMENT PLANT	TSP	PM10
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	PM10	

SITE COUNTY	STREET	POLLUTANTS		
37-067-0006 FORSYTH	GOODWILL CHURCH RD AT VOL FIRE DEPT.	O3		
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD	O3		
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY PK	PM10		
37-067-0013 FORSYTH	720 RIDGE AVENUE	PM10		
37-067-0018 FORSYTH	201 N. MAIN ST.	CO		
37-067-0019 FORSYTH	QUEEN STREET AT MILLER PARK	CO		
37-067-0020 FORSYTH	SILAS CREEK PKWY AT HAWTHORNE RD	TSP	PM10	
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	SO2	NO2	
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	CO	TSP	PM10
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL	TSP	PM10	
37-067-0025 FORSYTH	100 SW STRATFORD RD	CO		
37-067-1001 FORSYTH	BODENHEIMER ST	PM10		
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE	O3		
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 HOSP	O3		

SITE COUNTY	STREET	POLLUTANTS	
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	PM10	
37-081-0011 GUILFORD	KEELY PARK, KEELY RD	O3	
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST	TSP	
37-081-1011 GUILFORD	401 WEST WENDOVER	CO	
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST.	TSP	PM10
37-085-0001 HARNETT	MUNICIPAL BUILDING	TSP	PM10
37-087-0002 HAYWOOD	ROOF, CANTON FIRE DEPT.	PM10	
37-089-1005 HENDERSON	US 25 & US 64 HENDERSONVILLE	TSP	
37-109-0002 LINCOLN	JAIL	TSP	
37-109-0003 LINCOLN	EAST CONGRESS ST	PM10	
37-109-0099 LINCOLN	SR 1315 & SR 1313	O3	
37-111-0002 MCDOWELL	COURTHOUSE	PM10	
37-113-8001 MACON	COWEETA HYDROLOGIC LABRATORY	O3	
37-117-0099 MARTIN	SR 1538 NC 171	O3	SO2
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	TSP	
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET	TSP	PM10

SITE COUNTY	STREET	POLLUTANTS		
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	TSP	PM10	
37-119-0032 MECKLENBURG	5137 CENTRAL AVE.	CO		
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	O3	[aa]HSCO	NO2
37-119-0035 MECKLENBURG	1330 SPRING ST GRNVILLE NEIGHBORHOOD CNT	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	TSP	PM10	
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	O3	PM10	
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO	O3		
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	TSP	PM10	
37-123-0099 MONTGOMERY	SANDHILLS RESEARCH STATION	O3		
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	PM10	
37-133-0004 ONSLOW	2553 ONSLOW DRIVE, JACKSONVILLE	PM10		

[aa]High Sensitivity Carbon Monoxide

SITE COUNTY	STREET	POLLUTANTS	
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	TSP	PM10
37-145-0099 PERSON	SR 1102 & NC 49	O3	SO2
37-147-0003 PITT	1500 BEATTY ST GREENVILLE	TSP	PM10
37-147-0099 PITT	US 264 NEAR FARMVILLE WATER TOWER	O3	
37-155-0003 ROBESON	SO. WATER ST.	TSP	
37-159-1005 ROWAN	CHURCH ST	TSP	
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	PM10	
37-175-0002 TRANSYLVANIA	HWY 64	TSP	
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS	TSP	PM10
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 HI 3801 SPRING FOREST RD	O3	
37-183-0015 WAKE	808 NORTH STATE STREET	NO2	
37-183-2001 WAKE	HWY 98 WAKE FOREST WATER TREATMENT PLAN	O3	
37-187-0002 WASHINGTON	OLD ACRE RD.	TSP	
37-191-0004 WAYNE	HWY 70 WEST PATROL STA.GOLDSBORO	PM10	

SITE COUNTY	STREET	POLLUTANTS	
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARBORO ST.	TSP	PM10
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	O3	
Sites Operated In 1992		**94**	

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 cause exceedances of the 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 variables such as whether an area is urban or rural, and whether the area has mountains, valleys or plains.

Important economic factors affecting air quality include concentration of industries, economic growth or decline, 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 is considered biased and may be omitted from data summaries when it is not representative of normal conditions. Data for the 1992 ambient air quality report were collected at 126 air pollutant monitors operated by state and local agencies in North Carolina (listed in Appendix A). To save operating costs, some ozone and sulfur dioxide monitors are operated only every third year. Twelve of the 126 monitors used for this report operated most recently in 1990 or 1991. Lead concentration data are collected annually by the state and local agencies, but they are analyzed by EPA. Thus, the availability of the lead data may be more delayed than that for other pollutants. The most recent lead data available are from 1990 and involve 5 of the 126 monitors.

5.1 Total Suspended Particulates

Total Suspended Particulate matter (TSP) 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 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 1992, 35 sites were used to monitor TSP and 1,650 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. Only one sample exceeded the N.C. TSP ambient air quality standards, compared to three in 1991 and two in 1990. A description of the 1992 exceedance is given in Table 5.2. Attainment status is based on the second highest 24-hour concentration and on the geometric mean of all the 24-hour concentrations at a given site. One site produced one maximum 24-hour sample with a concentration exceeding the standard. However, this was associated with an "exceptional event," highway construction. The largest geometric mean TSP average was 51 $\mu g/m^3$, which is 68% of the level of the air quality standard. 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.)

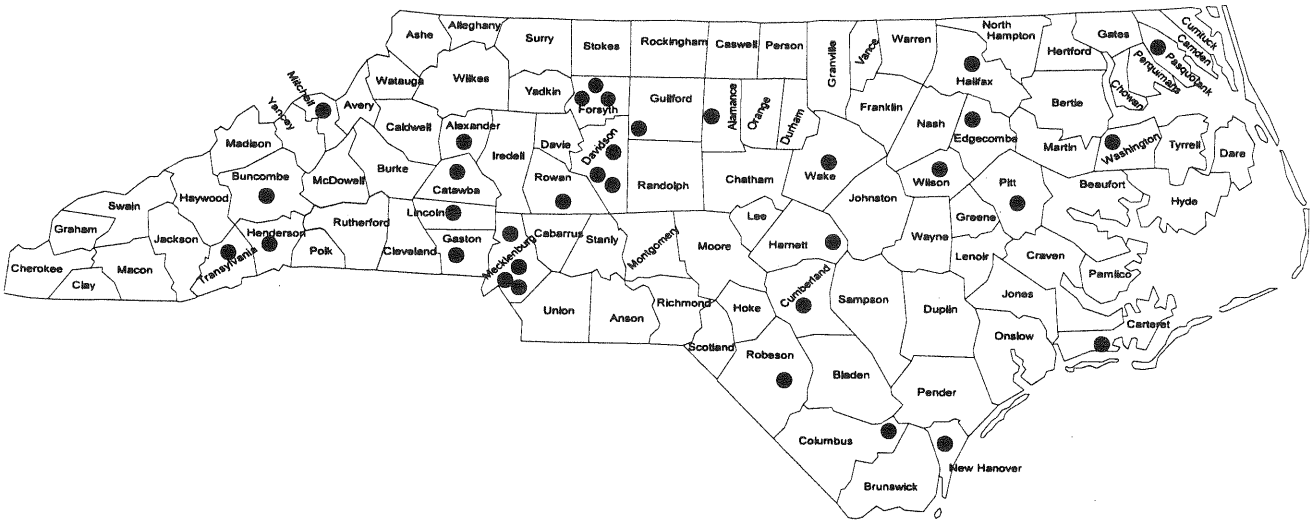


Figure 5.1 Location of TSP Monitoring Sites

Table 5.1 Total Suspended Particulate in Micrograms Per Cubic Meter for 1992.

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA				ARITH	GEOM. MEAN	GEOM. SD
			1ST	2ND	3RD	4TH			
37-001-0001 ALAMANCE	1136 E.WEBB AVE.BURLINGTON	52	82	71	69	60	36.5	33.4	1.53
37-003-0003 ALEXANDER	STATE ROAD 1177	51	197[bb]	61	61	59	37.6	32.6	1.65
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG	58	63	56	55	55	30.0	26.9	1.62
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	39	88	73	73	71	44.9	42.2	1.43
37-031-0003 CARTERRET	ARENDELL & 4TH MOREHEAD CITY	58	139	112	85	85	47.2	43.2	1.52
37-035-0004 CATAWBA	1650 1ST. ST.	51	93	83	82	80	48.3	44.5	1.53
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 8	61	88	67	60	50	32.5	29.8	1.52
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	57	81	75	73	71	42.6	39.1	1.55
37-057-1002 DAVIDSON	S. SALISBURY ST. LEXINGTON	52	85	79	78	77	46.1	42.6	1.50
37-057-1001 DAVIDSON	CITY HALL 7 WEST GUILFORD ST	12	67	65	44	42	38.7	36.4	1.43
37-057-1002 DAVIDSON	400 SALEM STREET	12	53	53	43	36	32.1	30.2	1.43
37-065-0002 EDGECOMBE	LEGETT RD.,WASTE TREATMENT PLA	38	84	84	60	57	38.2	35.1	1.52
37-067-0020 FORSYTH	SILAS CREEK PKWY AT HAWTHORNE	59	70	66	60	58	36.9	34.4	1.47
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	59	126	92	88	88	54.7	51.0	1.47
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL	19	71	56	48	39	31.1	28.4	1.52
37-071-0014 GASTON	RANKIN LAKE RD GASTONIA	61	63	60	58	57	34.3	31.7	1.51
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST	48	76	75	71	67	43.6	40.5	1.48

[bb]Exceeds secondary standard of 150 $\mu g/m^3$. The exceedance sample occurred on 11 July 1992 and was attributed to a highway construction taking place near the site. The fourth maximum excluding the exceedance was 57 $\mu g/m^3$.

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA				ARITH	GEOM. MEAN	GEOM. SD
			1ST	2ND	3RD	4TH			
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST	41	103	73	65	63	37.2	33.7	1.58
37-085-0001 HARNETT	MUNICIPAL BUILDING	61	94	86	81	77	45.5	42.0	1.53
37-089-1005 HENDERSON	US 25 & US 64 HENDERSONVILLE	41	79	66	66	63	41.2	38.0	1.52
37-109-0002 LINCOLN	JAIL	8	66	57	45	40	43.0	41.5	1.33
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	59	78	78	76	68	42.8	39.8	1.49
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET	44	88	86	84	81	52.9	49.8	1.44
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	60	76	72	68	68	40.5	37.7	1.47
37-119-1001 MECKLENBURG	FILTER PLANT	15	46	40	31	30	26.2	25.0	1.37
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	54	126	80	74	72	41.3	37.6	1.55
37-129-0005 NEW HANOVER	NINTH AND ORANGE STREETS	60	85	63	63	60	36.8	34.8	1.41
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	57	134	117	94	88	36.4	31.7	1.64
37-147-0003 PITT	1500 BEATTY ST GREENVILLE NC 2	32	62	61	61	61	40.1	37.7	1.45
37-155-0003 ROBESON	SO. WATER ST.	61	88	78	74	73	41.5	37.5	1.61
37-159-1005 ROWAN	CHURCH ST	53	76	73	71	69	44.5	41.6	1.46
37-175-0002 TRANSYLVANIA	HWY 64	58	75	68	67	66	36.8	33.1	1.63
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD N	61	75	65	64	62	36.3	33.9	1.46
37-187-0002 WASHINGTON	OLD ACRE RD.	60	68	65	62	59	31.9	28.9	1.62
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARB	38	85	59	55	54	39.2	37.1	1.42

Total Samples	**1,650**
Total Sites Sampled	**35**

Table 5.2 TSP Exceedance in 1992

COUNTY SITE NUMBER CITY	Date	TSP VALUE ($\mu g/m^3$)	EXCEPTIONAL EVENT
ALEXANDER 37-003-0003 TAYLORSVILLE	July 1992	197	Highway Construction

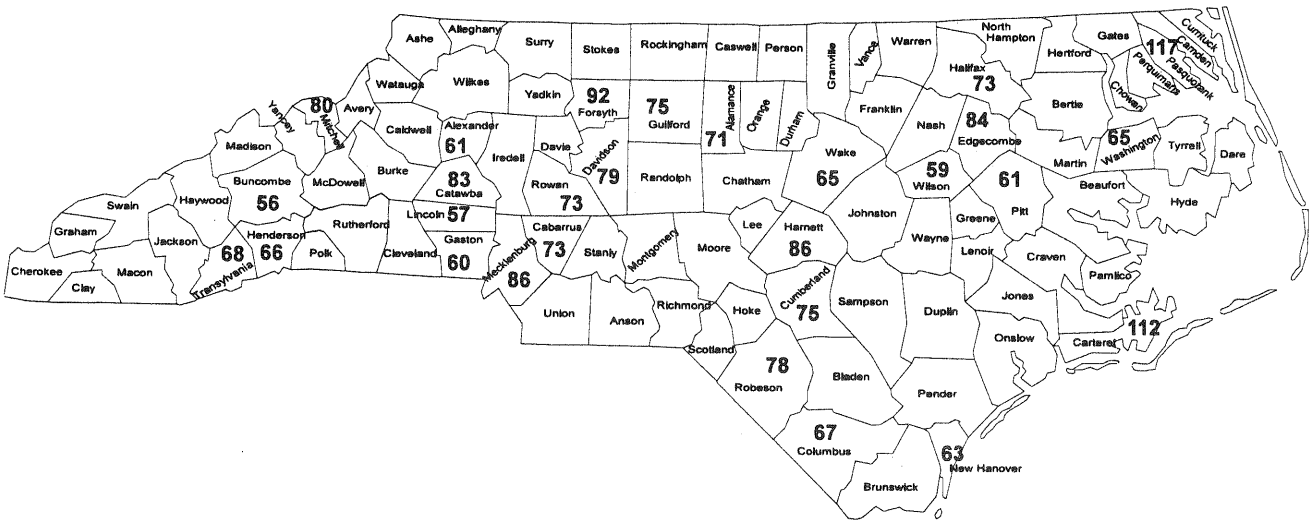


Figure 5.2 Total Suspended Particulate: Second Highest 24-Hour Averages, 1992

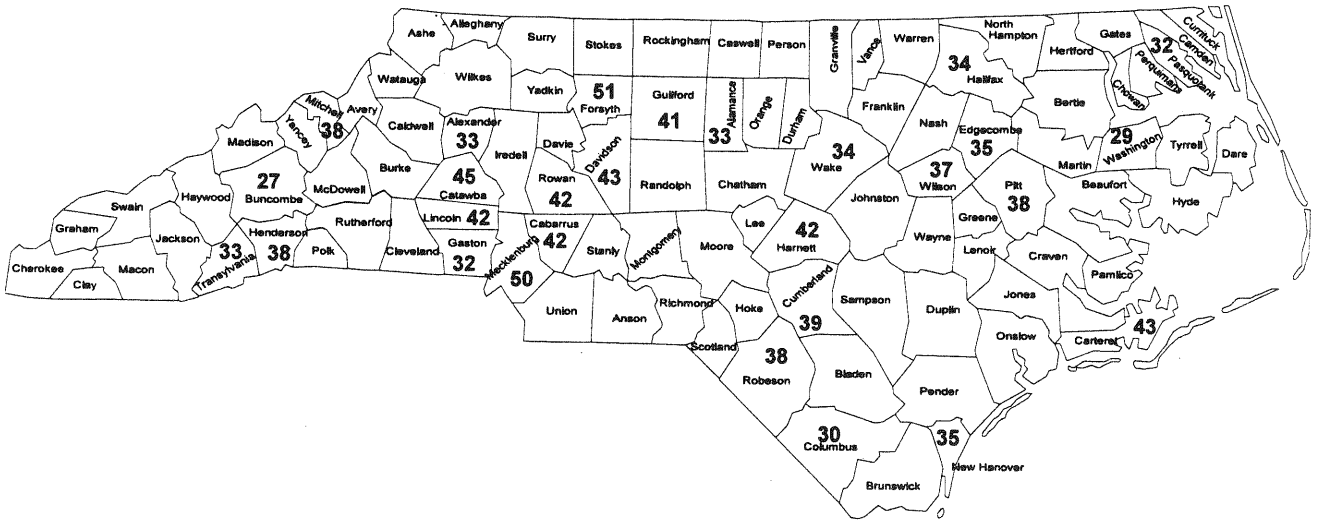


Figure 5.3 Total Suspended Particulate: Maximum Annual Geometric Means, 1992

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 analysis procedure (EPA Reference Method) is used to analyze the samples.

In 1992, 35 sites were used to monitor PM_{10} and 1,449 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 1992.

The greatest 24-hour maximum concentration was 88 $\mu g/m^3$, or about 59% of the standard (150 $\mu g/m^3$). The greatest annual arithmetic mean was 31 $\mu g/m^3$, which is 62% of the standard (50 $\mu g/m^3$).

The second highest 24-hour concentrations are charted by county in Figure 5.5 and the annual arithmetic means are shown charted in Figure 5.6. (In counties with more than one PM_{10} monitoring site, the concentration reported in Figure 5.5 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.)

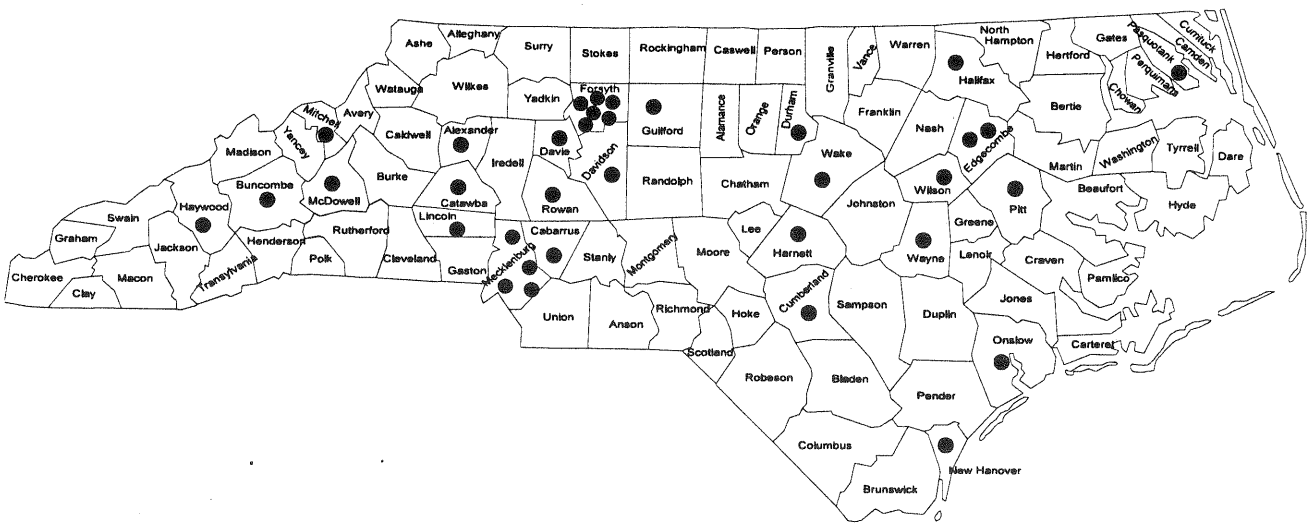


Figure 5.4 Location of PM_{10} Monitoring Sites

Table 5.3 PM-10 in Micrograms Per Cubic Meter for 1992.

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH MEAN
37-003-0003 ALEXANDER	STATE ROAD 1177	7	25	21	19	18	17.7
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG	59	41	41	41	41	22.8
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	18	38	36	34	33	22.1
37-035-0004 CATAWBA	1650 1ST. ST.	12	51	41	39	34	22.0
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	55	56	44	43	42	26.2
37-057-1002 DAVIDSON	400 SALEM STREET	19	51	37	35	35	25.0
37-059-0099 DAVIE	FORK RECREATION CENTER	4	22	15	14	13	16.0
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	52	52	47	45	38	24.2
37-065-0002 EDGECOMBE	LEGETT RD. WASTE TREATMENT PLA	18	38	35	31	30	20.8
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	8	24	18	17	17	15.9
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HO	58	54	54	47	44	27.2
37-067-0013 FORSYTH	720 RIDGE AVENUE	60	55	55	48	46	28.7
37-067-0020 FORSYTH	SILAS CREEK PKWY AT HAWTHORNE	57	50	45	41	40	26.0
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	58	69	53	52	52	30.3
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL	61	50	46	45	39	24.4
37-067-1001 FORSYTH	BODENHEIMER ST	60	51	47	46	43	25.5
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	60	51	45	44	40	24.8
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST	13	38	35	33	32	24.5
37-085-0001 HARNETT	MUNICIPAL BUILDING	58	81	57	52	49	27.5

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH MEAN
37-087-0002 HAYWOOD	ROOF CANTON FIRE DEPT.	59	52	51	49	49	28.0
37-109-0003 LINCOLN	EAST CONGRESS ST	26	53	51	48	44	30.8
37-111-0002 MCDOWELL	COURTHOUSE	58	49	49	48	44	26.3
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET	10	58	45	36	29	28.9
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	61	60	52	50	48	29.6
37-119-1001 MECKLENBURG	FILTER PLANT	45	53	51	42	42	27.1
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	53	60	57	51	51	31.0
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	53	55	45	45	44	26.1
37-129-0005 NEW HANOVER	NINTH AND ORANGE STREETS	60	72	46	36	36	22.5
37-133-0004 ONSLOW	2553 ONSLOW DRIVE, JACKSONVIL	60	70	40	38	38	22.9
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	61	88	74	58	56	24.5
37-147-0003 PITT	1500 BEATTY ST GREENVILLE	23	33	29	28	25	17.3
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	4	20	17	16	14	16.8
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD N	61	54	44	41	40	23.8
37-191-0004 WAYNE	HWY 70 WEST PATROL STA. GOLDSBO	61	55	46	45	43	24.3
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARB	17	43	36	29	27	21.8
Total Samples		**1,449**					
Total Sites Sampled		**35**					

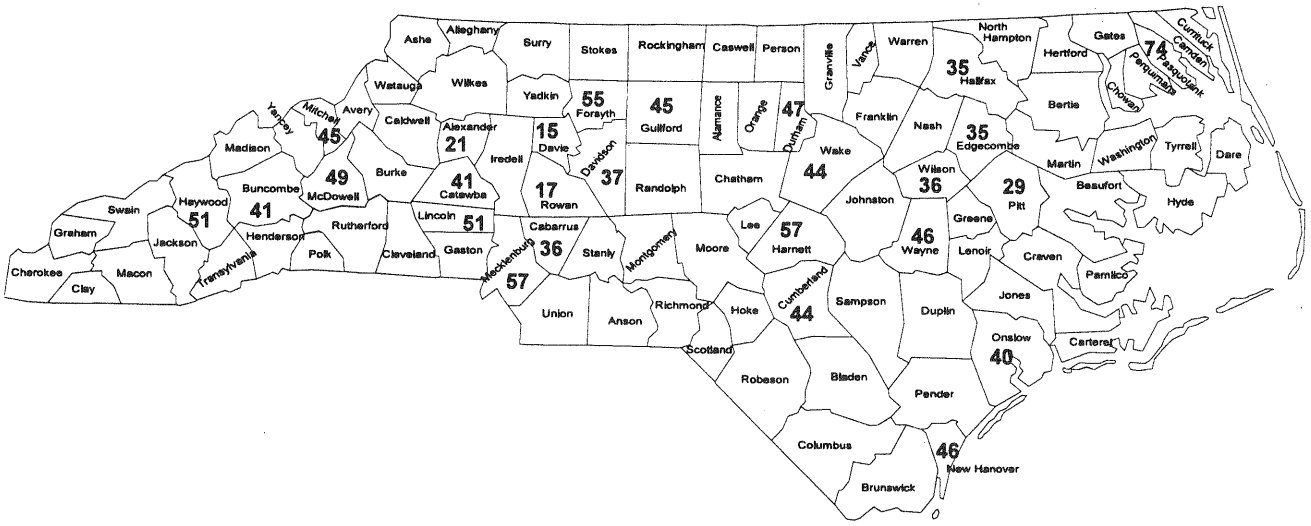


Figure 5.5 PM_{10} - Second Highest 24-hour Averages, 1992

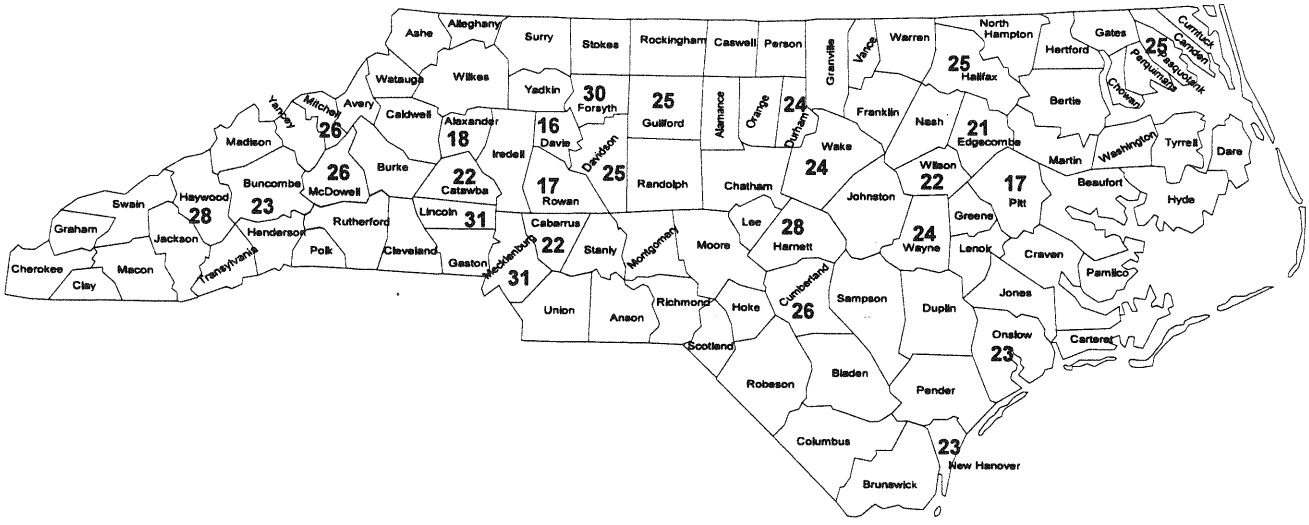


Figure 5.6 PM_{10} - Maximum Annual Arithmetic Means, 1992

5.3 Carbon Monoxide

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

In 1992, 17 sites were used to monitor CO and 125,380 valid hourly averages were collected. A map of the CO sampling sites is presented in Figure 5.7, and a detailed summary of the data from each site is given in Table 5.4.
There were no exceedances of the CO ambient air quality standards in 1992. The greatest 1-hour average was 17.5 parts per million (ppm), or about 50% of the standard (35 ppm). The greatest 8-hour average was 9.1 ppm, which approximately equals the standard of 9 ppm, but is not a violation of the standard. (In order for the national and State 8-hour standard to be exceeded, the two highest reported values for the same monitor must be equal to or greater than 9.5 ppm. However, the second highest average at the same site not overlapping the 9.1 ppm value was 7.3 ppm.)The second highest 1-hour concentrations in each county are charted in Figure 5.8 and the second highest 8-hour concentrations are similarly charted in Figure 5.9. To keep operating costs minimal, some sites are only operated in the colder months when CO levels are generally the highest.

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 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) during colder temperatures, more fuel is burned for comfort heating.

Figure 5.11 identifies areas designated non-attainment under the 1990 Clean Air Act and adjoining areas in which EPA has mandated the wintertime sale of oxygenated gasoline as a control strategy because of the history of exceedances in Forsyth, Durham and Wake Counties. Oxygenated fuel is expected to reduce tailpipe emissions of CO by 25%. However, other factors also have reduced CO concentrations, including increased news media interest and public awareness, and the reporting of the Air Quality Index (see Chapter 6 of this report). As a consequence of increased awareness, more people are keeping their cars in better running condition, thus operating more cleanly; older vehicles are gradually being replaced with newer, more efficient vehicles; and traffic flow improves as new roads are built and better coordinated traffic signals are installed. The motor vehicle Inspection and Maintenance program in effect in Wake County and elsewhere is an intentional control strategy that helps assure cleaner-running cars.

Figure 5.7 Location of Carbon Monoxide Monitoring Sites

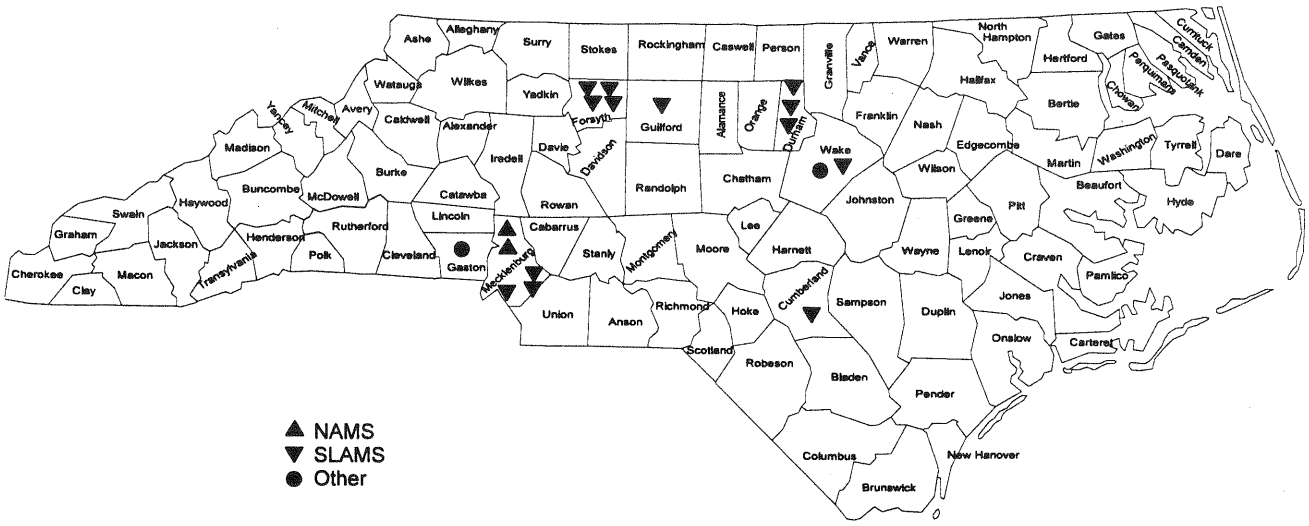
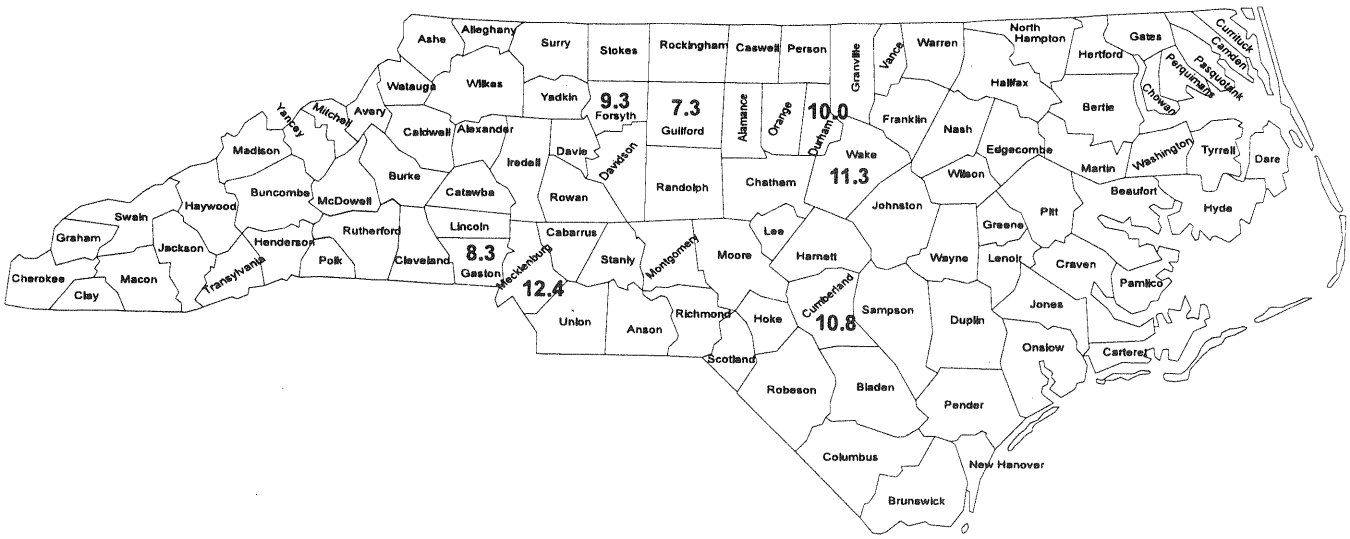


Table 5.4 Carbon Monoxide in Parts Per Million from all sites for 1992.

SITE NUMBER COUNTY	ADDRESS	NUM OBS	1-HOUR MAXIMA		8-HOUR MAXIMA	
			1ST	2ND	1ST	2ND
1992 Data						
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705	8,633	12.4	10.8	8.8	6.7
37-063-0008 DURHAM	302 EAST MAIN ST	2,102	11.1	10.0	6.3	5.5
37-063-0010 DURHAM	CITY PARK ON UNIVERSITY DRIVE	8,653	7.6	6.9	5.5	5.1
37-063-0011 DURHAM	201 NORTH ROXBORO ST	6,535	11.2	9.5	8.5	5.6
37-067-0018 FORSYTH	201 N. MAIN ST.	8,725	11.4	9.3	5.6	4.9
37-067-0019 FORSYTH	QUEEN ST. AT MILLER PARK	7,276	5.6	5.3	3.1	3.0
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	8,717	8.6	8.6	6.2	5.7
37-067-0025 FORSYTH	100 SW STRATFORD RD	1,430	4.7	4.2	2.8	2.7
37-071-0015 GASTON	1555 EAST GARRISON BLVD	8,490	10.9	8.3	6.1	5.6
37-081-1011 GUILFORD	401 WEST WENDOVER	8,719	7.5	7.3	5.3	5.2
37-119-0032 MECKLENBURG	5137 CENTRAL AVE.	8,627	11.4	10.6	6.9	6.8
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	8,626	12.2	12.0	6.8	6.3

SITE NUMBER COUNTY	ADDRESS	NUM OBS	1-HOUR MAXIMA		8-HOUR MAXIMA	
			1ST	2ND	1ST	2ND
37-119-0035 MECKLENBURG	1330 SPRING ST GRNVILLE NEIGHB	8,680	9.1	8.3	6.2	5.6
37-119-0037 MECKLENBURG	415 EAST WOODLAWN RD	8,703	14.6	9.8	6.8	5.0
37-119-0038 MECKLENBURG	301 N TRYON ST	8,532	17.5	12.4	7.9	6.3
37-183-0011 WAKE	420 S PERSON ST	8,459	12.2	11.3	9.1	7.3
37-183-0013 WAKE	EF HUTTON, HWY 70 WEST	4,473	8.6	8.3	5.5	5.3
Total samples		**125,380**				
Total sites sampled		**17**				

Figure 5.8 Carbon Monoxide, Second Highest One-Hour Average, 1992



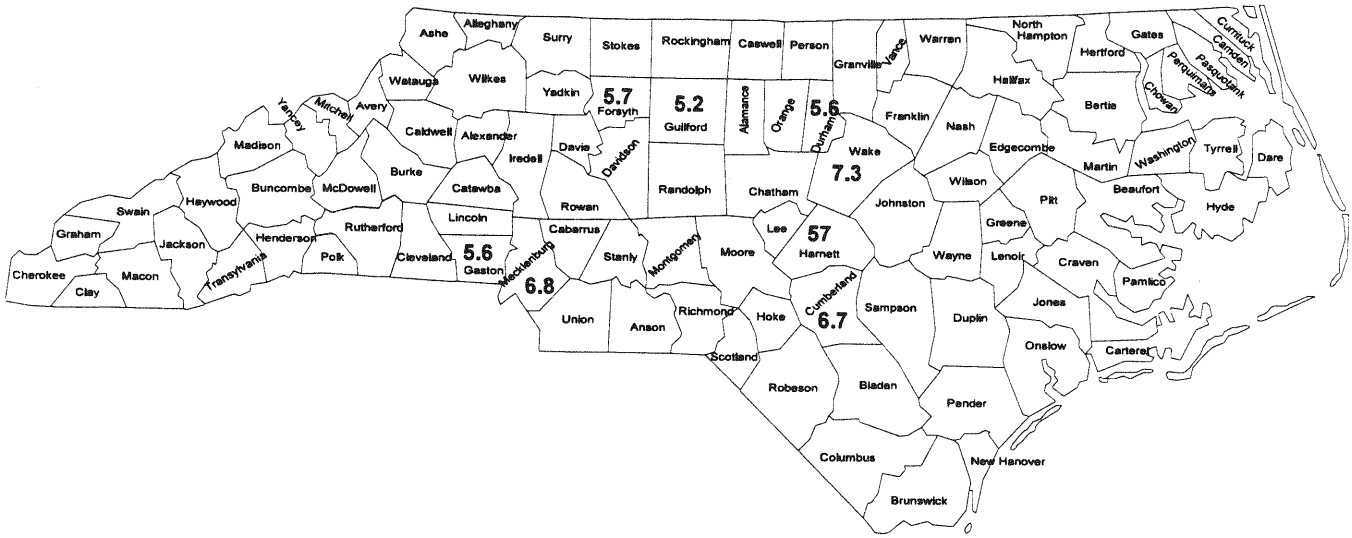


Figure 5.9 Carbon Monoxide, Second Highest Non-overlapping 8-hour Average, 1992

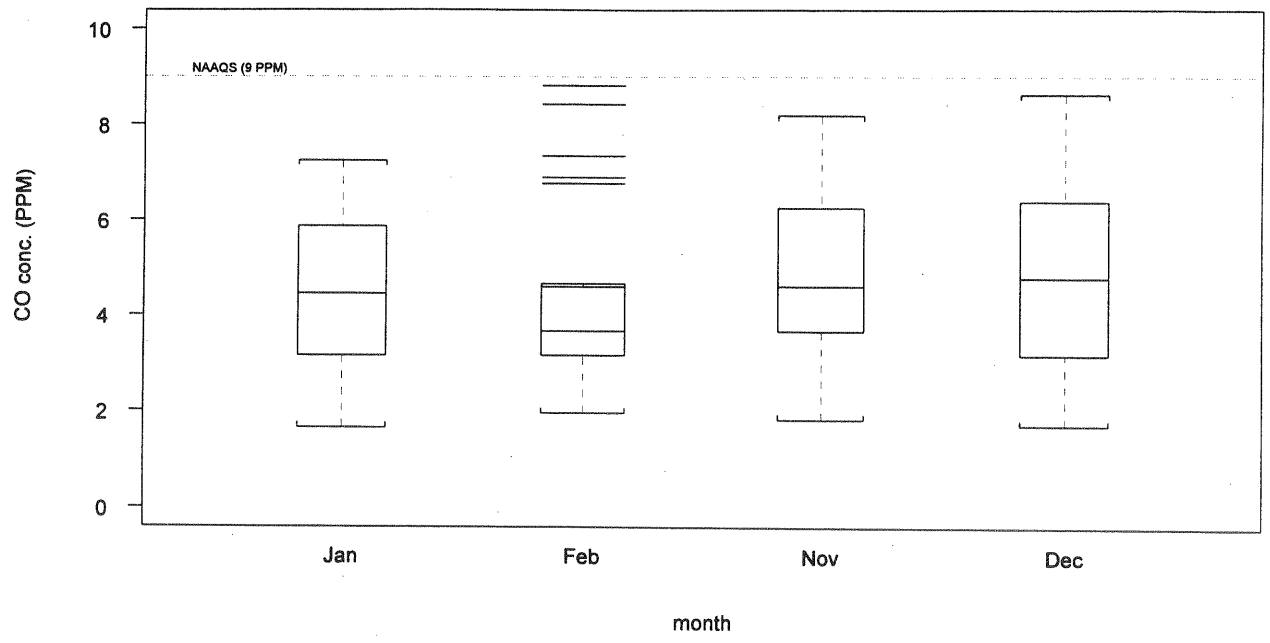


Figure 5.10 Carbon Monoxide Monthly Distribution of Highest Daily Eight-Hour Averages, 1992

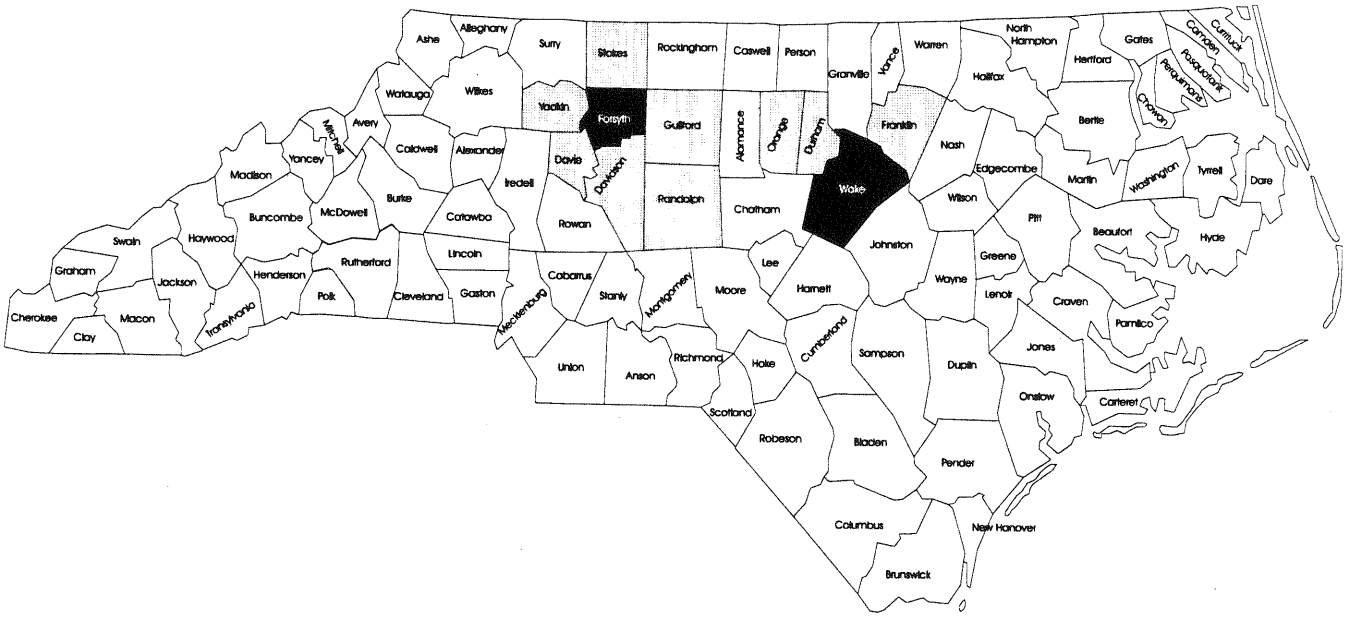


Figure 5.11 Areas With Excessive Carbon Monoxide Subject to Mandatory Oxygenated Fuel Sales by the 1990 Clean Air Act Amendments

5.4 Ozone

Ozone (O_3) concentrations are measured using EPA reference or equivalent continuous monitors. Ozone 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, most ozone monitors only operate from April through October.

The state and local program agencies operated 28 monitoring sites in 1992 during the Ozone season, April through October. 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 5.5. In North Carolina some O_3 sites are operated only every third year, so the monitors considered "active" in 1992 included four sites that were last operated in 1991 and four sites that were last operated in 1990. These 36 active monitoring sites provided 166,585 hourly samples.

There was only one exceedance of the ambient air quality standard for ozone in 1992, at a site in Camden County. The Camden County site also had one exceedance day in 1990. 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. (To exceed the standard, the largest 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.)

As a consequence of older ozone exceedances, Mecklenburg County was designated a moderate ozone non-attainment area in January 1992, and strict hydrocarbon control strategies were implemented, affecting all of the counties in the Charlottte-Gastonia-Rock Hill metropolitan statistical area (Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union Counties, and also York County, South Carolina). The Mecklenburg County area was redesignated as in attainment on July 5, 1995. However, hydrocarbon control strategies continue to be used to help maintain reduced ozone. A discussion of non-attainment is provided in Appendix D.

The second highest 1-hour concentrations in each county are charted in Figure 5.13 for areas with one or more monitors active in 1990, 1991 or 1992 (using only the latest available year of data).

Figure 5.14 shows the number of "high" ozone values on a monthly basis in 1992. Monthly distributions of all the 1-hour O_3 data for 1992 are graphed in Figure 5.15 as box-and-whisker plots.

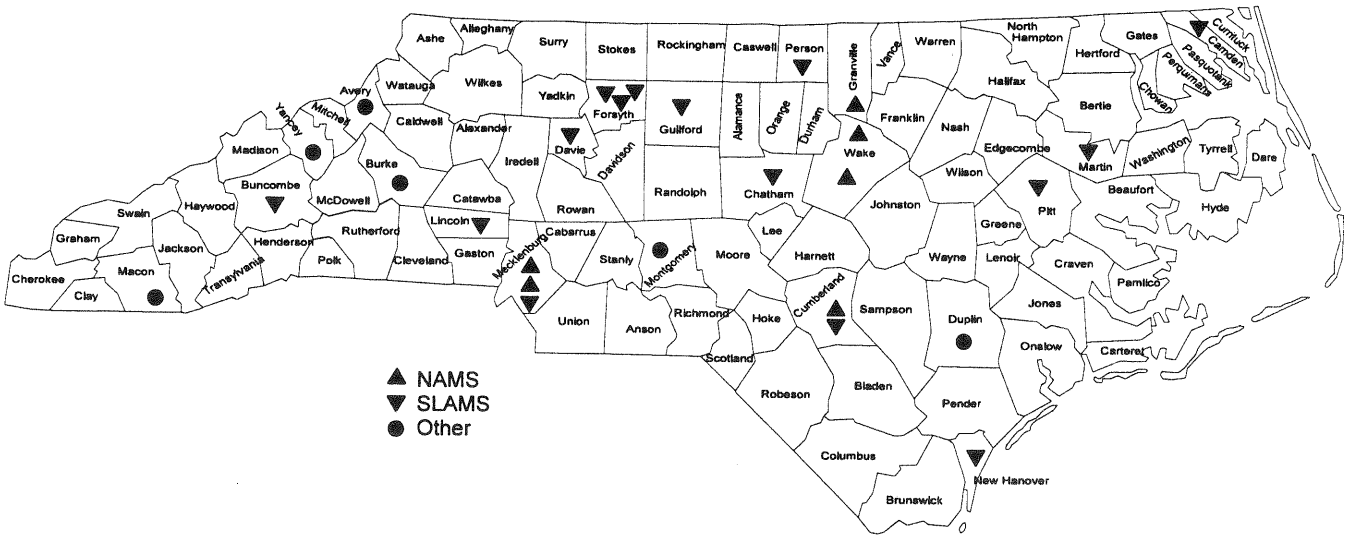


Figure 5.12 Location of Ozone Monitoring Sites

Table 5.5 Ozone In Parts Per Million for 1992

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
1992 Data								
37-011-8001 AVERY	ROARING CREEK RD., PISGAH N.F.	5,032	0.097	0.085	0.084	0.083	0	0.0
37-021-0030 BUNCOMBE	ROUTE 191 S BREVARD RD ASHEVILLE	5,035	0.087	0.083	0.080	0.078	0	0.0
37-023-0004 BURKE	126 AND 1254	4,615	0.078	0.077	0.076	0.076	0	0.0
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134 CAMDEN	4,795	0.125	0.123	0.110	0.088	1	1.0
37-037-0098 CHATHAM	MONCURE PLANT - SOUTH SITE	3,826	0.085	0.082	0.080	0.075	0	0.0
37-051-0008 CUMBERLAND	1/4MI SR1857/US301	4,856	0.111	0.092	0.089	0.087	0	0.0
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT ROCKFISH RD. FAYETTEVILLE	4,823	0.096	0.093	0.089	0.088	0	0.0
37-059-0099 DAVIE	FORK RECREATION CENTER	4,830	0.102	0.102	0.100	0.098	0	0.0
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	4,820	0.105	0.097	0.094	0.092	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-067-0006 FORSYTH	GOODWILL CHURCH RD AT VOL FIRE DEPT. WINSTON-SALEM	4,537	0.097	0.097	0.092	0.092	0	0.0
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD WINSTON-SALEM	4,865	0.097	0.096	0.091	0.089	0	0.0
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	4,872	0.110	0.103	0.102	0.097	0	0.0
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP BUTNER	4,828	0.124	0.107	0.098	0.095	0	0.0
37-081-0011 GUILFORD	KEELY PARK KEELY RD MCCLEANSVILLE	4,820	0.097	0.096	0.093	0.086	0	0.0
37-109-0099 LINCOLN	SR 1315 & SR 1313 IRON STATION	4,627	0.094	0.092	0.088	0.087	0	0.0
37-113-8001 MACON	COWEETA HYDROLOGIC LABORATORY	5,048	0.093	0.085	0.083	0.082	0	0.0
37-117-0099 MARTIN	SR 1538 NC 171	4,812	0.099	0.098	0.085	0.085	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-117-0099 MARTIN	SR 1538 NC 171	4,812	0.099	0.098	0.085	0.085	0	0.0
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	5,014	0.106	0.104	0.102	0.101	0	0.0
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	4,957	0.113	0.104	0.103	0.098	0	0.0
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	4,988	0.105	0.103	0.103	0.102	0	0.0
37-123-0099 MONTGOMERY	SANDHILLS RESEARCH STATION	5,065	0.102	0.102	0.101	0.092	0	0.0
37-123-8001 MONTGOMERY	112 PERRY DRIVE	5,065	0.102	0.102	0.101	0.092	0	0.0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	4,805	0.113	0.103	0.093	0.092	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
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	4,774	0.095	0.095	0.093	0.090	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-183-0014 WAKE	E MILLBROOK JR HI 3801 SPRING FOREST RD RALEIGH	4,880	0.108	0.099	0.097	0.093	0	0.0
37-183-2001 WAKE	HWY 98 WATER TREATMENT PLANT WAKE FOREST	4,843	0.087	0.084	0.083	0.083	0	0.0
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	3,971	0.096	0.090	0.088	0.088	0	0.0
Total Samples		**134,239**						
Total Sites Sampled		**28**						
1991 Data								
37-027-0003 CALDWELL	HWY 321 N LENOIR	4,809	0.096	0.093	0.085	0.084	0	0.0
37-051-0001 CUMBERLAND	OLD US HWY 301 @ ARMSTRONG JR HIGH	3,018	0.101	0.101	0.100	0.099	0	0.0
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	795	0.087	0.085	0.072	0.067	0	0.0
37-183-2001 WAKE	HWY 98 WATER TREATMENT PLANT WAKE FOREST	4,835	0.116	0.108	0.102	0.098	0	0.0
Total Samples		**13,457**						
Total Sites Sampled		**4**						

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
1990 Data								
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	4,869	0.094	0.092	0.091	0.090	0	0.0
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134 CAMDEN	4,680	0.102	0.102	0.096	0.096	0	0.0
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	4,856	0.097	0.097	0.096	0.095	0	0.0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	4,484	0.102	0.093	0.092	0.092	0	0.0
Total Samples		**18,889**						
Total Sites Sampled		**4**						

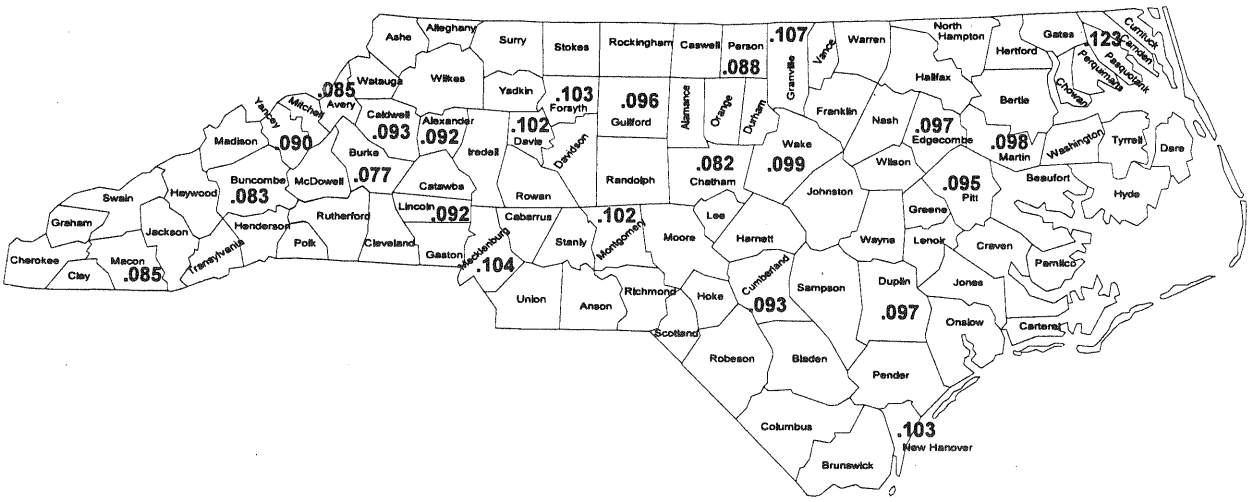


Figure 5.13 Ozone - Second Highest Annual 1-hour Average in the Most Recent Year of Data, 1990, 1991, or 1992.

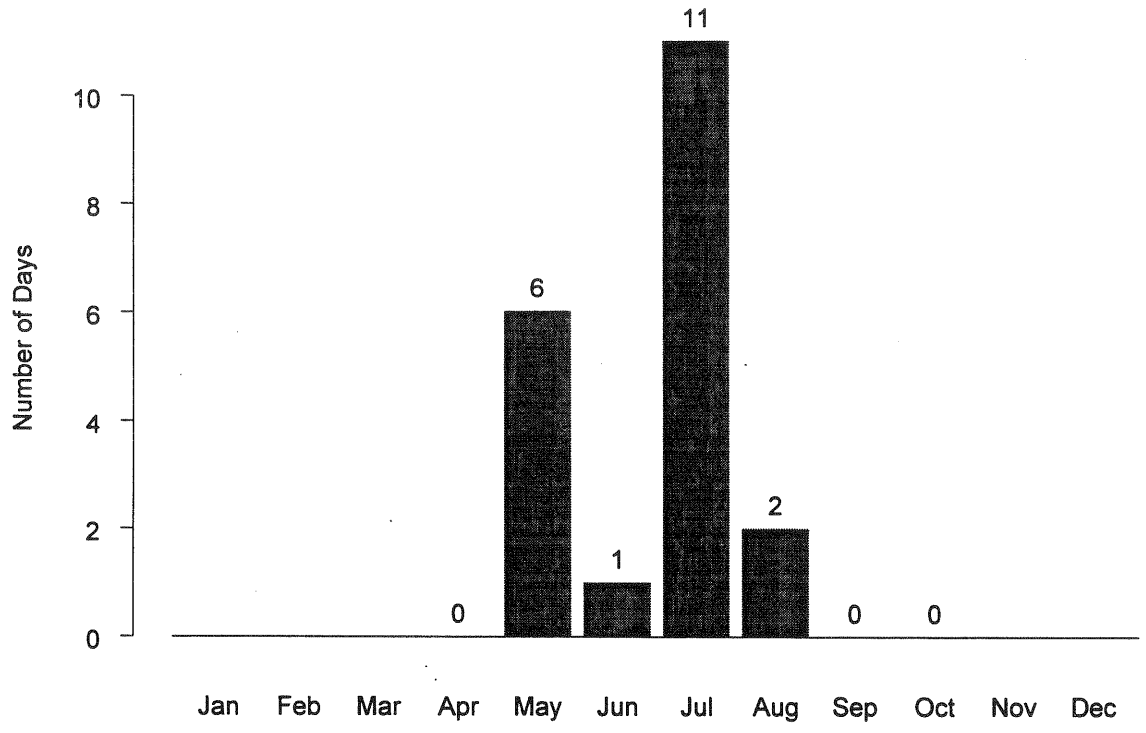


Figure 5.14 Number of Days with 1-Hour Ozone Averages in excess of 0.10 ppm, 1992

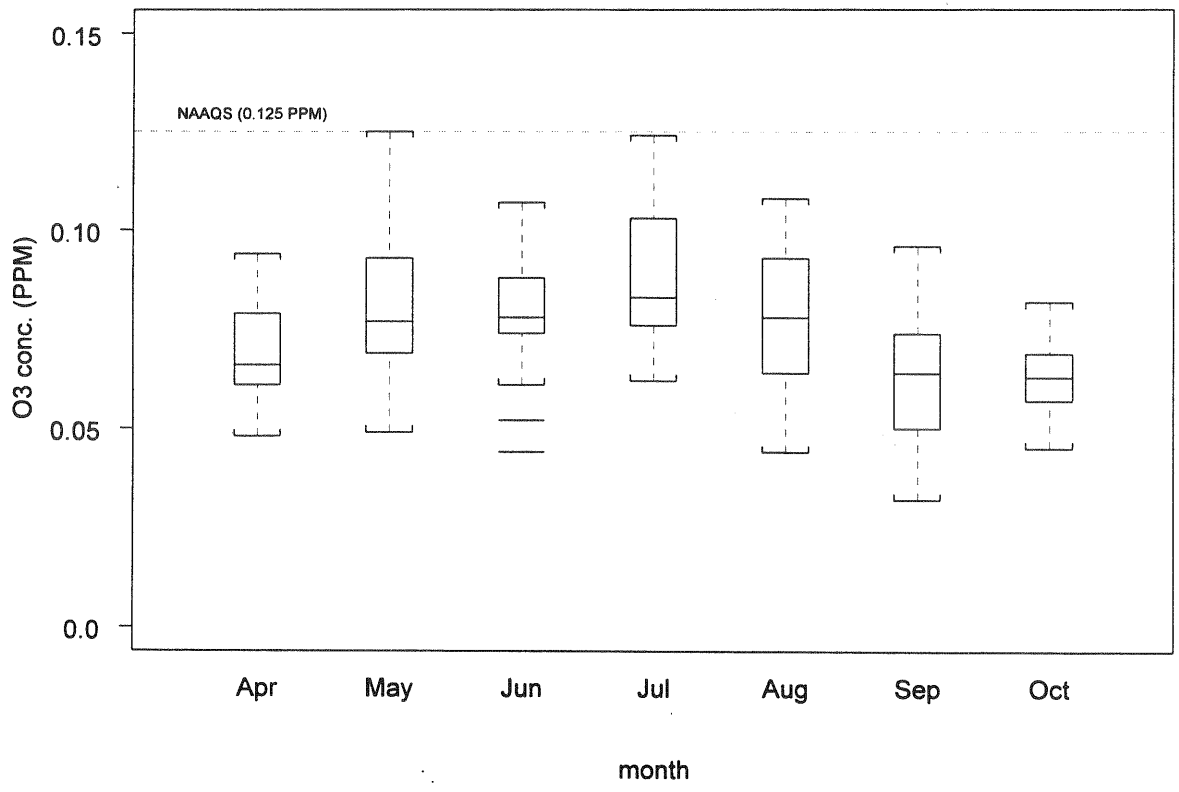


Figure 5.15 Monthly Distribution of Ozone Measurements, 1992

5.5 Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the state and one local program agencies using EPA reference or equivalent methods. Eight SO_2 monitors were active in North Carolina in 1992. However, some SO_2 sites are operated only every third year, so three sites provided data in 1991 and four sites provided data in 1990.

From the 16 sites with SO_2 data obtained between 1990 and 1992, 112,222 valid hourly averages were collected. A map of the (16 "active") SO_2 sampling sites is presented in Figure 5.16, and a detailed summary of the data from each site is given in Table 5.6.

There were no exceedances of the SO_2 ambient air quality standards in 1992. The greatest annual arithmetic mean was 15 $\mu g/m^3$, or about 19% of the standard (80 $\mu g/m^3$), the greatest maximum 24-hour average was 71 $\mu g/m^3$, about 19% of the standard (365 $\mu g/m^3$), and the greatest maximum 3-hour average was 167 $\mu g/m^3$, about 13% of the welfare-related (secondary) standard.

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.

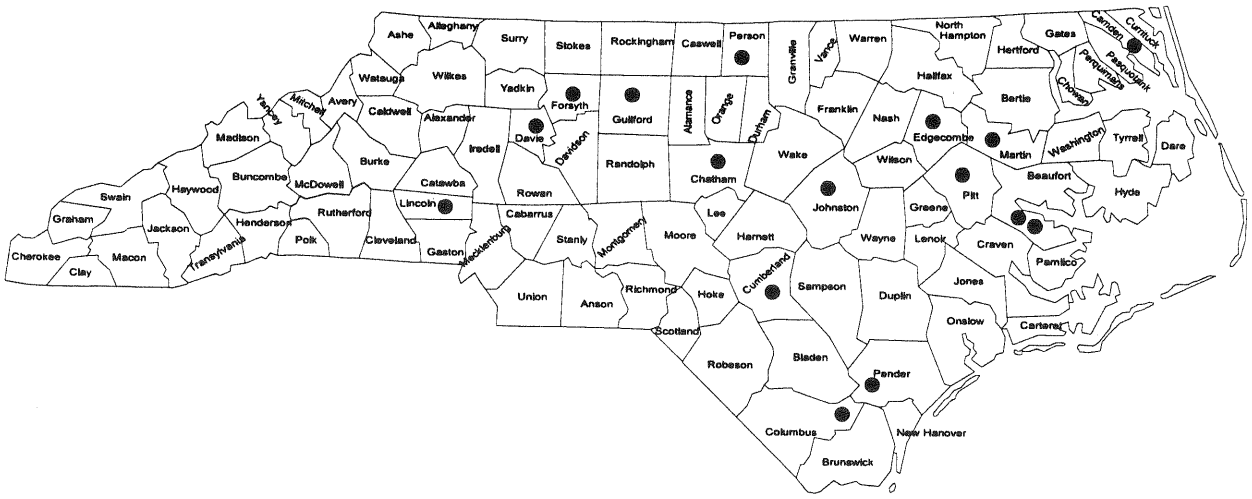


Figure 5.16 Location of Sulfur Dioxide Monitoring Sites.

Table 5.6 Sulfur Dioxide in Parts Per Million from All Sites for 1990-92.

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH MEAN
			1ST	2ND	1ST	2ND	1ST	2ND	
1992 Data									
37-013-0003 BEAUFORT	NC HIGHWAY 306	7,875	0.085	0.078	0.063	0.043	0.019	0.013	0.0027
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RI	8,045	0.084	0.070	0.052	0.049	0.023	0.012	0.0030
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	3,148	0.025	0.025	0.024	0.020	0.014	0.010	0.0031
37-037-0098 CHATHAM	MONCURE PLANT - SOUTH SITE	8,209	0.111	0.103	0.050	0.049	0.024	0.018	0.0033
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 8	8,030	0.056	0.045	0.029	0.029	0.012	0.009	0.0025
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	8,210	0.082	0.071	0.050	0.050	0.027	0.019	0.0058
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		**59,724**							
Total Sites Sampled		**8**							
1991 Data									
37-059-0099 DAVIE	FORK RECREATION CENTER	8,017	0.093	0.065	0.056	0.053	0.028	0.020	0.0037

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH MEAN
			1ST	2ND	1ST	2ND	1ST	2ND	
37-109-0099 LINCOLN	SR 1315 & SR 1313	8,241	0.084	0.082	0.046	0.044	0.016	0.015	0.0033
37-147-0099 PITT	US 264 NEAR FARMVILLE WATER TO	8,211	0.032	0.024	0.018	0.018	0.012	0.011	0.0028
Total Samples		**24,469**							
Total Sites Sampled		**3**							
1990 Data									
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT, ROCKFIS	8,300	0.035	0.033	0.025	0.024	0.012	0.012	0.0031
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	8,175	0.059	0.049	0.053	0.035	0.018	0.010	0.0026
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD	3,061	0.118	0.069	0.055	0.048	0.023	0.021	0.0072
37-081-0010 GUILFORD	1305 MERRITT DR.	341	0.033	0.026	0.022	0.018	0.009	0.009	0.0056
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	8,152	0.022	0.021	0.020	0.020	0.011	0.008	0.0026
Total Samples		**28,029**							
Total Sites Sampled		**5**							

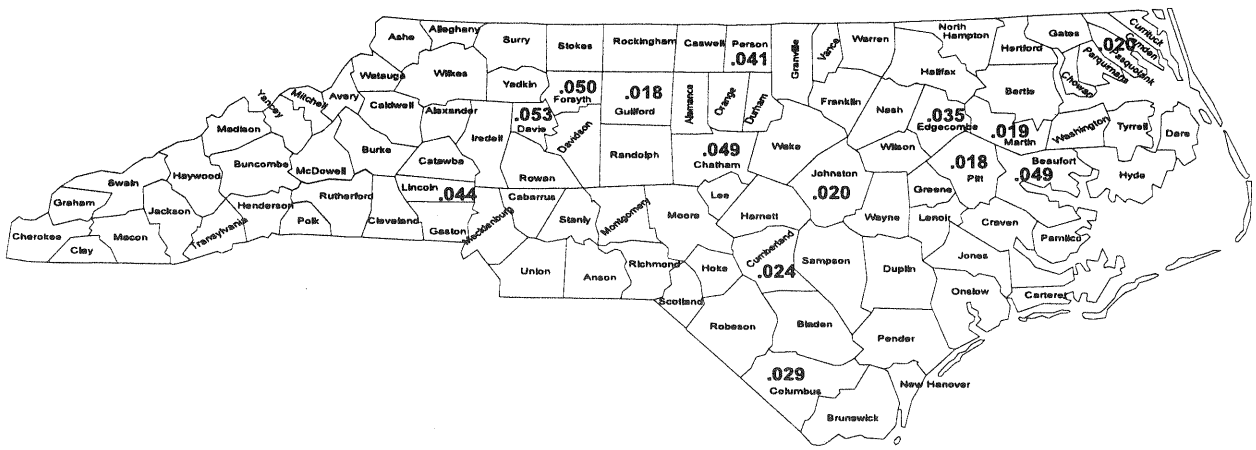


Figure 5.17 SO_2 Second Highest 3-hour Averages in Most Recent Year, 1990, 1991, or 1992.

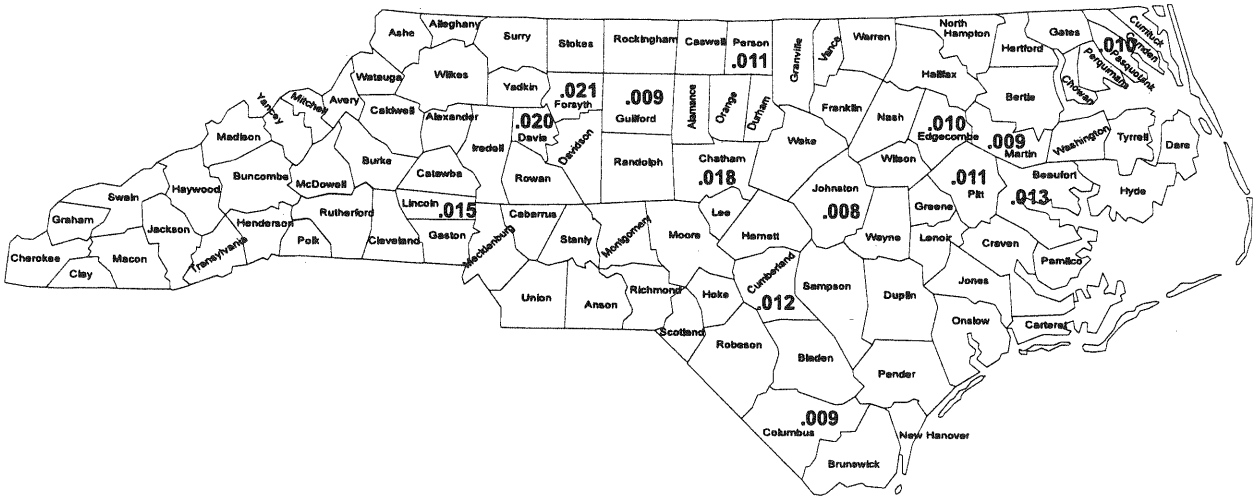


Figure 5.18 SO_2 Second Highest 24-hour Averages in Most Recent Year, 1990, 1991, or 1992.

5.6 Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 1992 at one state program site in Wake County, one local program site in Forsyth County, and one local program site in Mecklenburg County.

From these three sites, 24,781 hourly NO_2 measurements were reported. A map of the three NO_2 sampling sites is presented in Figure 5.19, and a summary of the 1992 NO_2 data is given in Table 5.7.

Table 5.7 Nitrogen Dioxide in Parts Per Million (PPM) For 1992

SITE NUMBER COUNTY	STREET	NUM OBS	ONE-HOUR MAXIMA		ARITH. MEAN
			1ST	2ND	
37-067-0022	1300 BLK. HATTIE AVENUE	8,272	0.081	0.065	0.0153
37-119-0034	PLAZA ROAD AND LAKEDELL	8,395	0.075	0.073	0.0164
37-183-0015	808 NORTH STATE STREET	8,114	0.078	0.071	0.0146
Number of Samples		**24,781**			

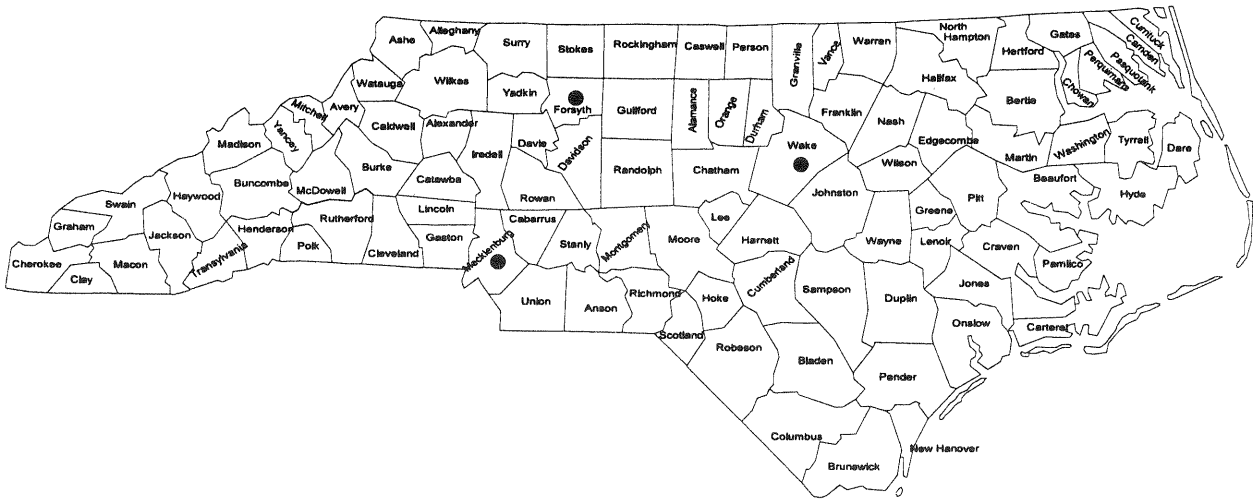


Figure 5.19 Location of Nitrogen Dioxide Monitoring Sites

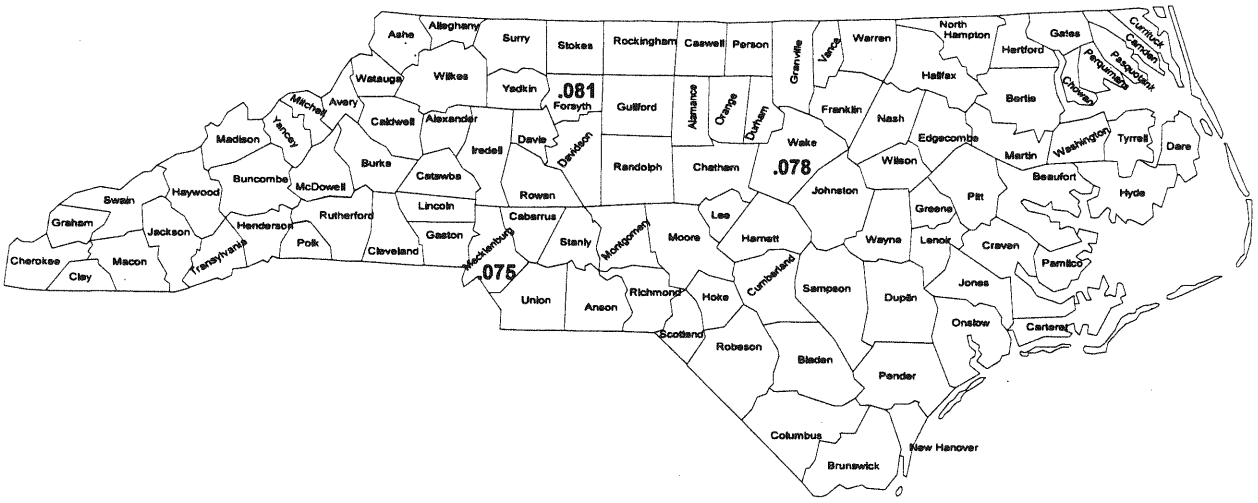


Figure 5.20. Distributions of Nitrogen Dioxide Concentrations 1992

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 as a result 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 five 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 1991 and 1992. Lead concentrations in 1990 average less than half the concentrations measured in 1987 and less than 1/10 of the concentrations measured in 1982. 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.

Summaries of the lead data from 1988 and 1990 are given in Table 5.8 and Table 5.9. The 1988 data have not been published in a previous Annual Report.

Table 5.8 Lead in Micrograms Per Cubic Meter ($\mu g/m^3$) for 1988

COUNTY SITE NUMBER ADDRESS CITY	NUM OBS	QUARTERLY ARITHMETIC MEANS				MEANS >1.5
		1ST	2ND	3RD	4TH	
DURHAM 37-063-0001 300 EAST MAIN ST DURHAM	10		0.03	0.03		0
FORSYTH 37-067-0001 SIXTH AND BROAD ST WINSTON-SALEM	8	0.02	0.01	0.00	0.02	0
GUILFORD 37-081-0009 EDGEWORTH AND BELLEMEADE ST GREENSBORO	9		0.03	0.03		0
MECKLENBURG 37-119-0001 600 EAST TRADE ST CHARLOTTE	13	0.03	0.04			0
WAKE 37-183-0003 FIRE STATION #9 NORTH HILLS PLAZA RALEIGH	10		0.02	0.02		0
Total Samples	**50**					
Total Sites Sampled	**5**					

Table 5.9. Lead in Micrograms Per Cubic Meter (μg/m³) for 1990.

COUNTY SITE NUMBER ADDRESS CITY	NUM OBS	QUARTERLY ARITHMETIC MEANS				MEANS >1.5
		1ST	2ND	3RD	4TH	
DURHAM 37-063-0001 300 EAST MAIN ST DURHAM	4	0.02	0.01	0.00	0.02	0
FORSYTH 37-067-0001 SIXTH AND BROAD ST WINSTON-SALEM	4	0.01	0.01	0.00	0.01	0
GUILFORD 37-081-0009 EDGEWORTH AND BELLEMEADE ST GREENSBORO	3	0.02	0.01	0.01		0
MECKLENBURG 37-119-0001 600 EAST TRADE ST CHARLOTTE	4	0.03	0.08	0.05	0.03	0
WAKE 37-183-0003 FIRE STATION #9 NORTH HILLS PLAZA RALEIGH	2		0.00	0.01		0
Total Samples	**17**					
Total Sites Sampled	**5**					

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 for each of these five pollutants is 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 1992, four areas provided an AQI report to the public by telephone via computer generated recorded voice announcement 24 hours daily. These areas were Raleigh, Durham, Fayetteville and Charlotte. The AQI report may also be published by local newspapers or broadcast on radio and television stations.

The Air Quality Index report is now available by telephone for nine areas as follows:

Asheville	888-AIR-WISE
Charlotte	704-333-SMOG
Durham	888-AIR-WISE
Fayetteville	888-AIR-WISE
Greensboro	888-AIR-WISE
Greenville	888-AIR-WISE
Raleigh	888-AIR-WISE
Wilmington	888-AIR-WISE
Winston-Salem	888-AIR-WISE

Air Quality Index values for 1992 at five metropolitan areas in North Carolina are given in Figures 6.1, 6.2, 6.3, 6.4 and 6.5.

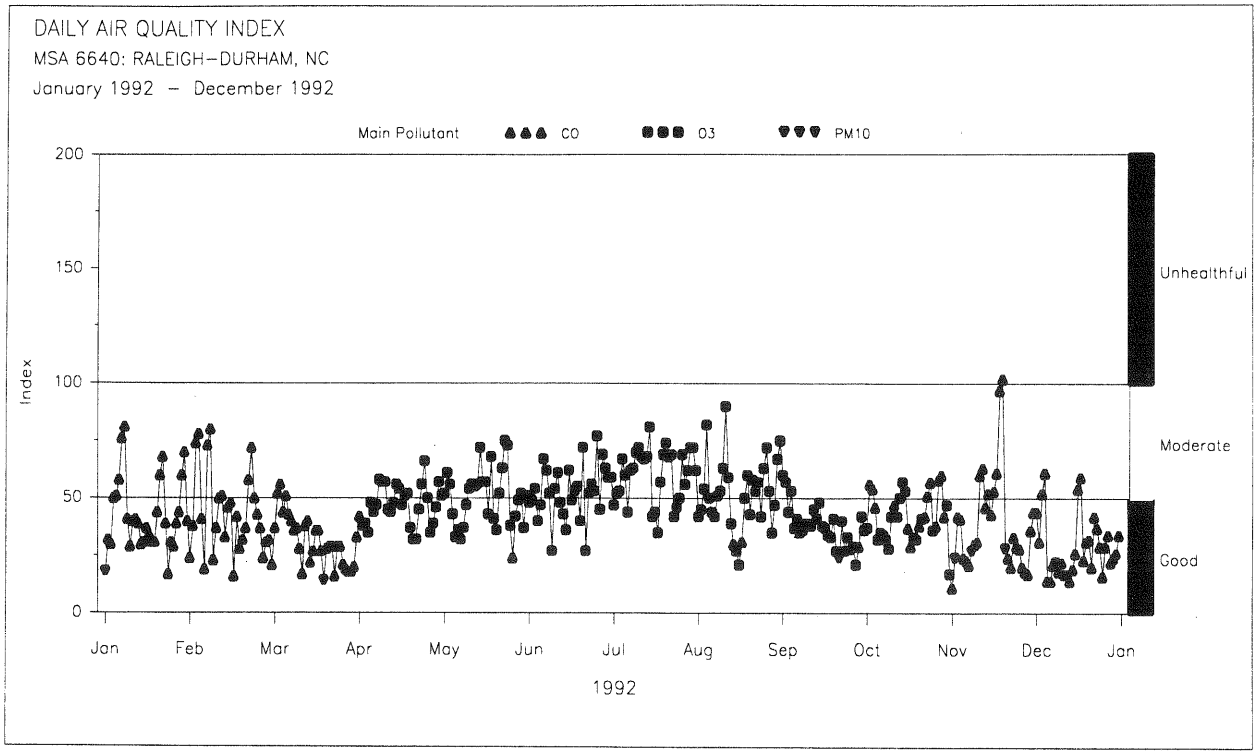


Figure 6.1 Daily Air Quality Index Values for Raleigh-Durham, NC, Metropolitan Statistical Area, 1992.

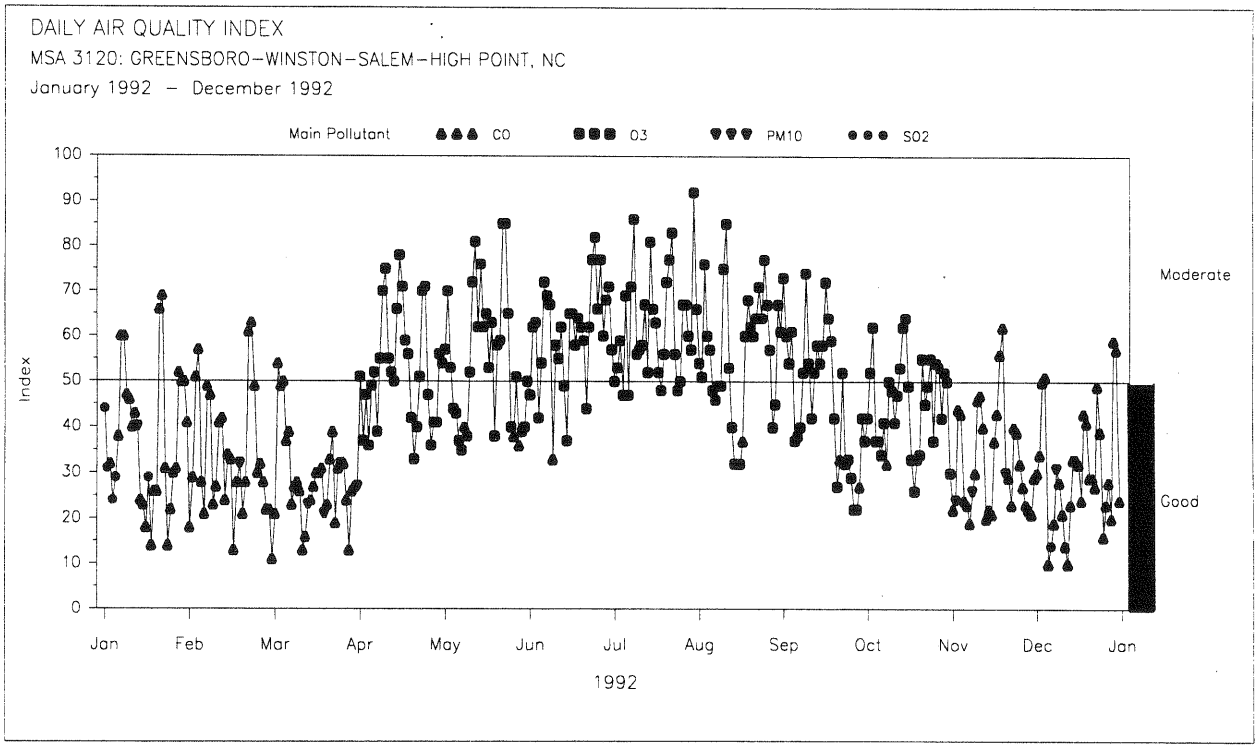


Figure 6.2. Daily Air Quality Index Values for Greensboro, Winston-Salem, High Point, NC, Metropolitan Statistical Areas, 1992

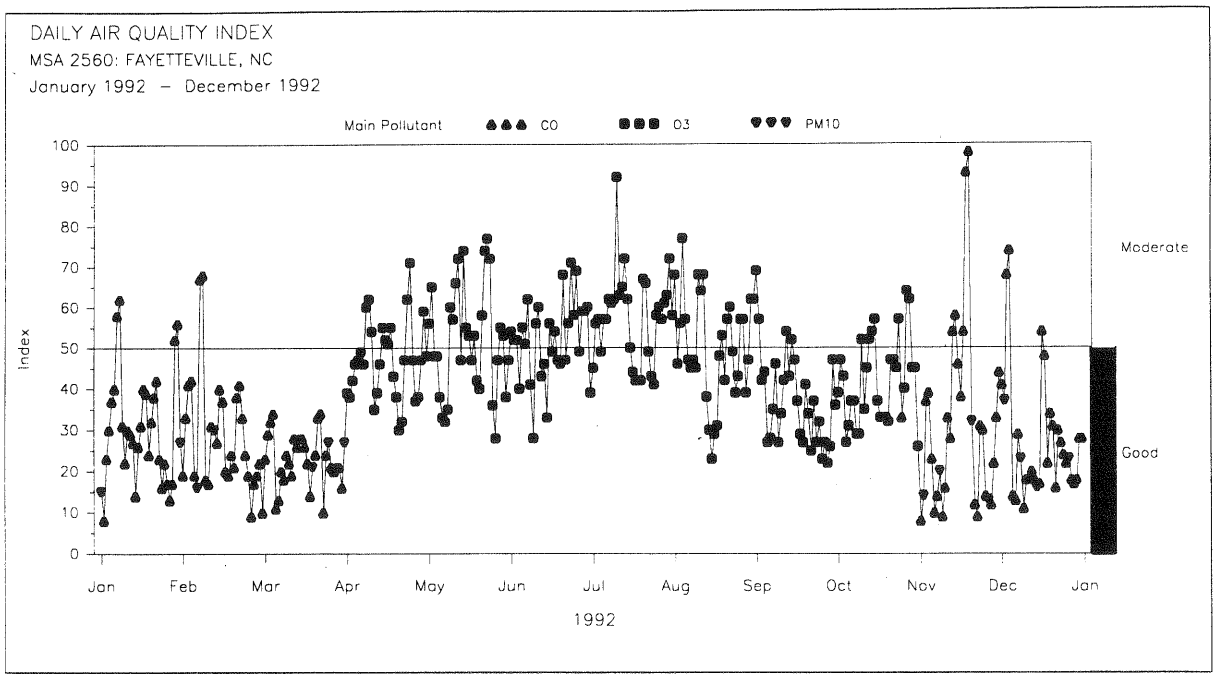


Figure 6.3. Daily Air Quality Index Values for Fayetteville, NC, Metropolitan Statistical Area, 1992

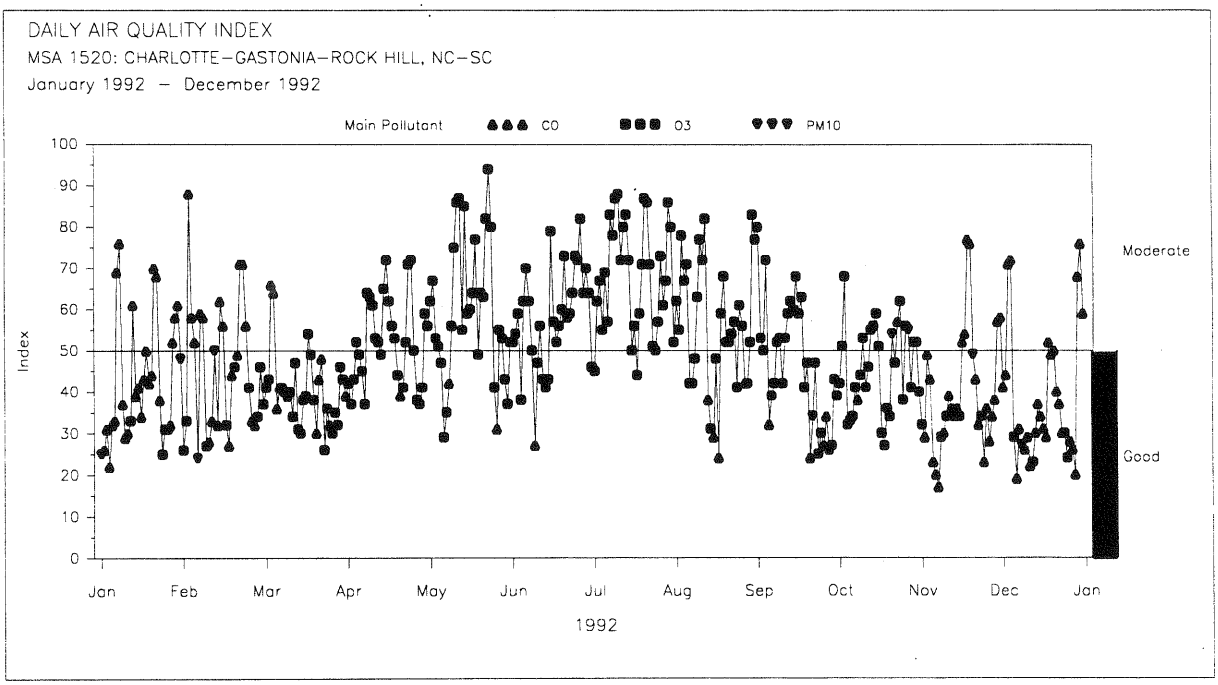


Figure 6.4. Daily Air Quality Index Values for Charlotte, Gastonia, NC, and Rock Hill, SC, Metropolitan Statistical Area, 1992

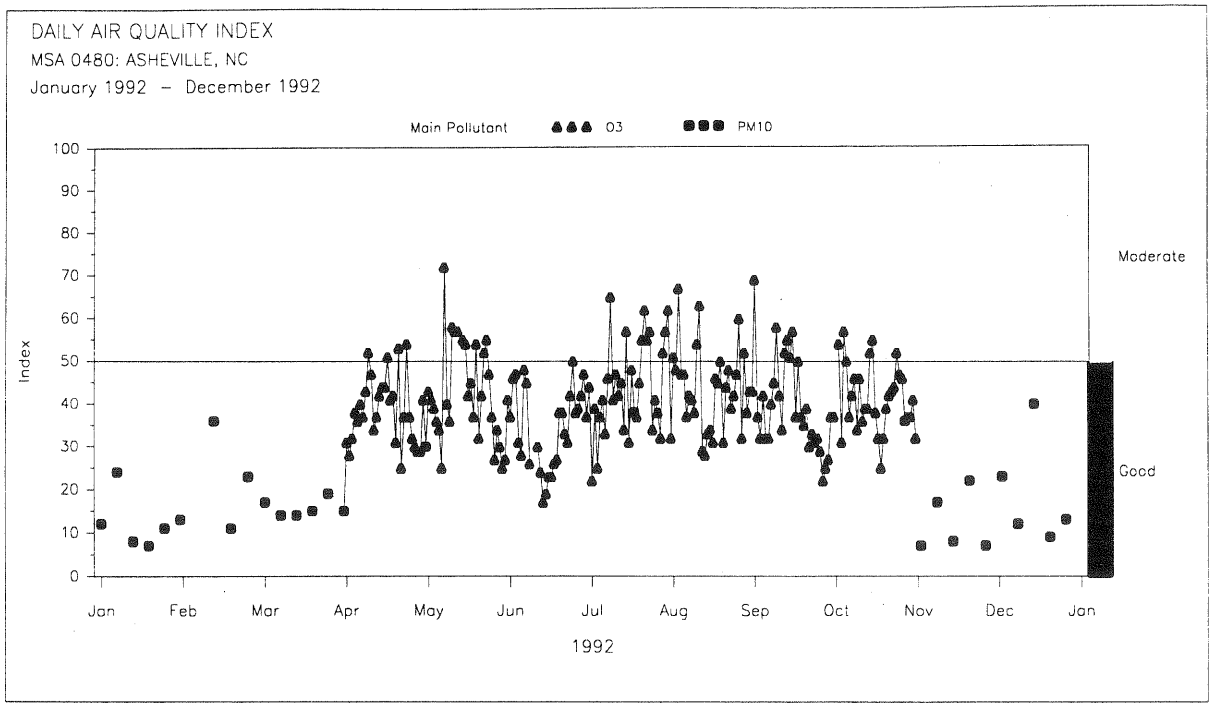


Figure 6.5 Daily Air Quality Index Values for Asheville, NC, Metropolitan Statistical Area, 1992.

7. Acid Rain

7.1 Sources

Acid rain is produced when nitrate and sulfate ions from automobile and industrial sources are released into the upper atmosphere, undergo a reaction 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 72 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 in North Carolina, since 1978 by the National Atmospheric Deposition Program (NADP) and the National Trends Network (NTN) which merged with NADP in 1982. In 1992, acid rain samples were collected at 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 and 14 being extremely basic. A substance with a pH of five is ten times as acidic as one with a pH of six, 100 times as acidic as a substance with a pH of seven, etc. Neutral water with an equal concentration of acid and base ions has a pH of seven. 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 approximately 5.6. The measurements of pH at the North Carolina monitoring sites in 1992 ranged from 4.57 to 4.81 with a mean of 4.65. The 1992 pH annual means for North Carolina from the NADP/NTN database are presented in Figure 7.1 and Table 7.1. Table 7.1 also exhibits conductivity averages and precipitation totals for rainfall. Measured concentrations of several other chemical constituents of precipitation are given in Table 7.2.

Figure 7.1. Annual Mean pH Values at North Carolina NADP/NTN/NDDN Sites, 1992

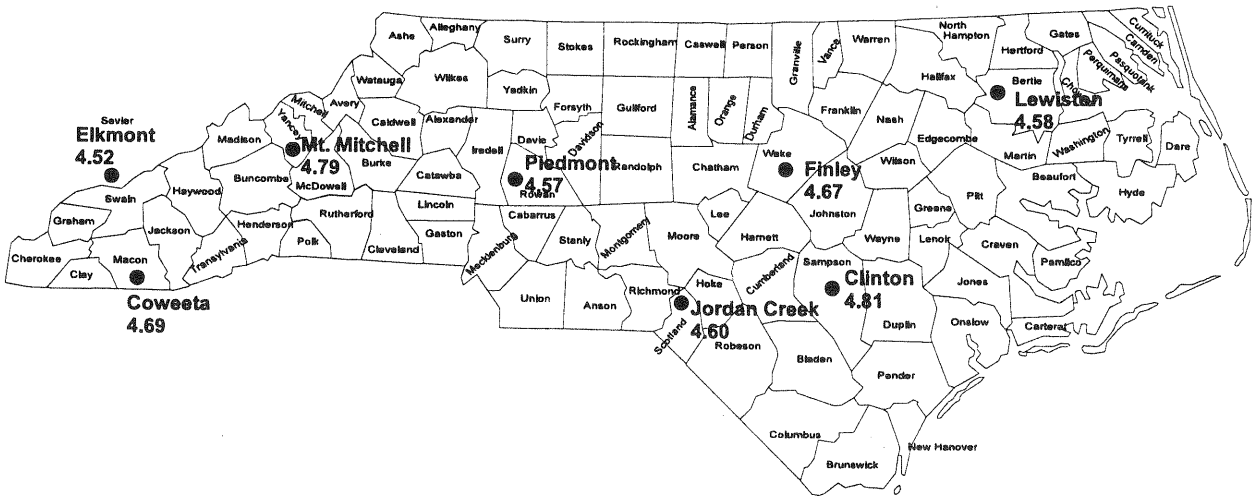


Table 7.1 pH Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program/National Trends Network and National Dry Deposition Network Data for 1992

COUNTY SITE ADDRESS	pH	Conductivity	Precipitation
Bertie 340320 Lewiston	4.58	15.9	51.1
Macon 342500 Coweeta	4.69	11.4	89.8
Rowan 343460 Piedmont Research Station	4.57	16.1	44.1
Sampson 343560 Clinton Crops Res. Station	4.81	11.6	46.8
Scotland 343600 Jordan Creek	4.60	14.6	48.5
Wake 344160 Finley Farm	4.67	13.3	40.7
Yancey 344500 Mt. Mitchell	4.79	9.1	72.0
Sevier (TN) 441190 Great Smoky Mts Nat'l Park Elkmont TN	4.52	16.2	60.4

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 1992.

COUNTY SITE ADDRESS	%com- pleteness	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Bertie 340320 Lewiston	92.3	0.05	0.032	0.020	0.251	0.18	0.84	0.44	1.35
Macon 342500 Coweeta	78.8	0.03	0.007	0.014	0.053	0.11	0.54	0.10	1.04
Rowan 343460 Piedmont Research Station	92.3	0.06	0.021	0.068	0.103	0.23	0.93	0.19	1.53
Sampson 343560 Clinton Crops Res. Station	92.3	0.05	0.036	0.021	0.282	0.19	0.66	0.49	1.08
Scotland 343600 Jordan Creek	88.5	0.05	0.022	0.016	0.158	0.15	0.86	0.27	1.34
Wake 344160 Finley Farm	90.4	0.05	0.023	0.021	0.160	0.25	0.79	0.28	1.22
Yancey 344500 Mt. Mitchell	71.1	0.02	0.005	0.006	0.039	0.08	0.45	0.06	0.87
Sevier (TN) 441190 Great Smoky Mts Nat'l Park Elkmont TN	88.5	0.05	0.009	0.019	0.045	0.13	0.93	0.08	1.45

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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.

Appendix A. Air Pollution Monitoring Agencies

North Carolina State Headquarters

[Through 1995]
Division of Environmental Management
Archdale Building
512 North Salisbury Street
P O Box 29535
Raleigh, North Carolina 27626-0535
(919) 733-3340

[Effective 1996]
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
(704) 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
(919) 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, Stanly and Union.

Raleigh Regional Office
3800 Barrett Drive
P.O. Box 27687
Raleigh, North Carolina 27609
(919) 571-4700

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

Washington Regional Office
1424 Carolina Avenue
P.O. Box 1507
Washington, North Carolina 27889-3314
(919) 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 Extension
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 27107-3256
(910) 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
(919) 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 and Haywood Counties)
Buncombe County Courthouse Annex
Asheville, North Carolina 28801-3569
(704) 255-5655

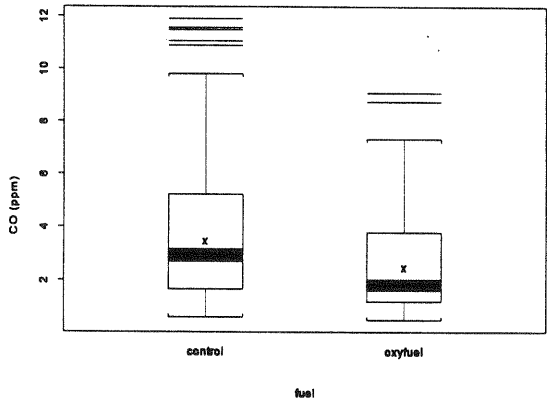
Appendix B. Exceptional Events

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. Non-Attainment and North Carolina

What is non-attainment 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 "non-attainment".

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. 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. Volatile organic compounds react with nitrogen oxides and sunlight in warm weather to produce ozone.

Why is my county non-attainment?

Unless the state can demonstrate a better alternative, EPA has indicated that they will designate non-attainment 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 non-attainment, 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 process. 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 non-attainment 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 1991. Guilford and Forsyth counties started I/M programs in July 1991. 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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