

# RECOMMENDED STRATEGIES AND AIR EMISSION CONTROL MEASURES



## WAKE COUNTY AIR QUALITY TASK FORCE

Prepared  
JULY 25, 2003  
Wake County, North Carolina

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## Executive Summary

- **Goals-** eliminate ozone action days by 2010, comply with National Ambient Air Quality Standards by 2007.
  
- **Health Effects of ozone:**
  - Irritates airways
  - Causes inflammation
  - Impairs lung defenses
  - High ozone levels are linked to increased hospital admissions
  
- Emerging evidence
  - Premature mortality in elderly
  - Asthma in children associated with outdoor activity and high ozone exposures
  - High ozone exposures related to increased school absenteeism
  
- Groups more at risk
  - Children and adults who are active outdoors
  - People with lung disease
  - People who are unusually sensitive to ozone
  
- **Particulate Matter** is linked to:
  - Premature death from heart and lung diseases
  - Aggravation of heart and lung diseases
  
- Particles affect the lungs:
  - Irritation of airways
  - Decreased lung function
  - Airway inflammation
  - Asthma attacks, bronchitis
  - Chronic bronchitis
  
- Particles affect the heart:
  - Changes in heart rate and heart rate variability
  - Blood component changes
  - Cardiac arrhythmias
  - Heart attacks
  
- Particulate Matter is possibly linked to:
  - Lung cancer deaths
  - Infant mortality
  - Developmental problems, such as low birth rate.
  
- **National Ambient Air Quality Standards-** Triangle area will not attain new standards for ozone. Wake County complies with Particulate Matter 2.5 standards, but is close to nonattainment. Implications of ozone nonattainment include:
  - New and expanding industries will be subject to strict emission controls
  - Area transportation plans must conform to Division of Air Quality State Implementation Plan motor vehicle emissions budget

- **Recommended control measures**
  - 13 strategies, include measures to:
    - Establish regional air quality agency
    - Address vehicle miles traveled
    - Reduce emissions from internal combustion engines of all types
- **1. Develop regional partnerships**
  - Create a regional air quality agency
  - Support NC Air Awareness Program
  - Support Triangle Clean Cities Coalition
- **2. Commuter choice and e-business**
  - Employers become best workplaces for commuters
  - Implement Commute-trip reduction programs
  - On-line services
- **3. Transportation Improvements**
  - Include air quality and energy conservation in transportation planning process
  - Expand public transportation alternatives
  - Improve transit amenities and multimodal transit infrastructure
  - Traffic signal and intersection improvements
  - Expand bike and pedestrian facilities
  - High occupancy vehicle lanes
  - High occupancy toll lanes.
- **4. Cleaner Fuels and Alternative Fuel Vehicles**
  - Early introduction of ultra-low sulfur fuels
  - Fleets participate in Triangle Clean Cities Coalition
  - Promote ULEV and SULEV vehicles
  - State incentives for alternative fuel vehicles and refueling infrastructure
  - Voluntary emission reduction programs
  - Convert school buses from diesel to alternative fuels
- **5. Reduce emissions from existing vehicles**
  - Replace leaking gas caps
  - Enforce “smoking vehicle” legislation
- **6. Land use**
  - Include air quality and energy conservation in land use planning process
  - Implement incentives for development to occur in areas with public infrastructure
- **7. Energy conservation**
  - Require energy conservation plan for construction projects
  - Implement urban heat island initiatives

- Implement a Cool Cities program
- **8. Reduce emissions from diesel engines**
  - Require contractors to achieve emission reductions
  - Accelerate replacement of on-road and non-road diesel fleets
  - Prohibit testing and maintenance of stationary engines during mornings in ozone season
- **9. Reduce emissions from non-road gasoline engines.**
  - Accelerate replacement of gas equipment with electric equipment
- **10. Airport Clean Air Program**
  - Alternative fuel vehicles for administrative and maintenance uses
  - Voluntary emission reduction agreements between agencies and the airlines
  - Convert ground support equipment to electric vehicles
  - Bubble and cap emissions
  - Market transit to RDU
- **11. Ozone Action Day Programs**
  - Restrict early operation of equipment
  - Idling restrictions
  - Free bus rides
- **12. Outreach/Education**
  - Expand air quality education
  - Implement “stop at the click” program at gas stations
  - Limit engine idling
- **13. Promote Efficient Freight and Delivery Transport**
  - Work with freight operators and delivery services to identify appropriate control measures.

## I. Introduction

### Background

Wake County grew by over 200,000 people between 1990 and 2000, according to the US Census, and by an additional 74,000 people between 2000 and 2003, according to Wake County Planning Department estimates. The Wake County Planning Department projects Wake County's growth to continue through 2010 by about 24,500 per year, or over 67 people per day. While this growth offers opportunities, it also presents challenges to maintain the area's quality of life.

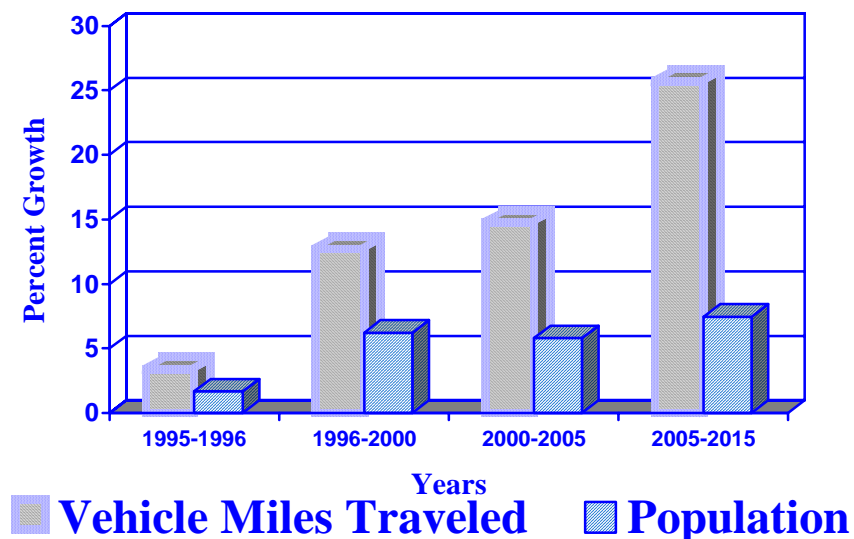
In response to these challenges, the Wake County Board of Commissioners has adopted an Environmental Stewardship Agenda that establishes goals and actions to maintain and improve air quality, water quality, open space, solid waste management, environmental health and safety and environmental education/ environmental information. The Wake County Board of Commissioners has also worked with other local governments and stakeholders to prepare a countywide Growth Management Strategy, a Watershed Management Plan and a Consolidated Open Space Plan. The Wake County Board of Commissioners has also initiated a comprehensive groundwater investigation and updated its transportation plan.

Because of the health effects of air pollution, (also see attached power point slide show by John Bachmann from EPA) especially ground level ozone, the Wake County Environmental Services Committee and the Human Services Board have established a goal to eliminate ozone action days in the Triangle by 2010. The Human Services Board created the Wake County Air Quality Task Force to prepare recommendations to achieve this goal. This report is the result of the Air Quality Task Force's work.

While ozone action days were the impetus for this report, the Air Quality Task Force recognized that particulate matter is also an emerging area of health concern. Therefore, the Task Force also included recommendations that would also help reduce the amount of particulate matter in our air.

### The Source of Air Quality Problems

According to Brock Nicholson, of the Division of Air Quality of NC Department of Environment and Natural Resources, the major causes of degraded air quality are growth in population and the activity of this population,



North Carolina Population Growth and Vehicle Miles Traveled  
 Source: Division of Air Quality, NC Department of Environment and Natural Resources

especially use of motor vehicles (From his presentation at the Wake County Community Success- Partnerships for the Environment Forum September 5, 2002). As is shown in the graph above, in North Carolina, as the population has grown, the vehicle miles traveled by that population has grown even faster. Between 1996 and 2000, the State's population increased by about 6%, but vehicle miles traveled increased by about 13%. This disparity is projected to increase between 2005 and 2015, when the population is projected to increase by about 8% and vehicle miles traveled by about 26%.

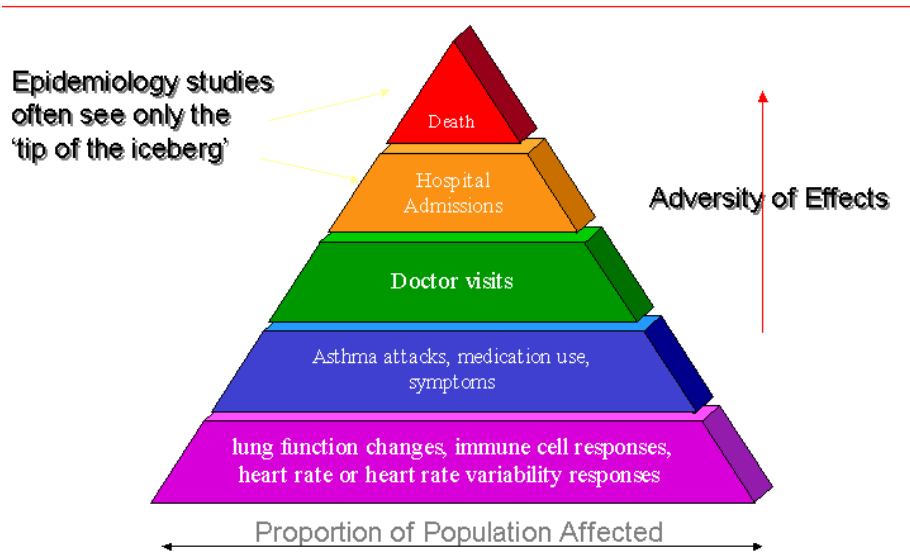
**The effects of air pollution**

We learn about the effects of air pollution from three types of studies-

1. Epidemiological studies- from the real world
2. Controlled human exposure in laboratories
3. Animal studies in labs

Studies have shown that there is a pyramid of effects, as illustrated below. Starting from the top of the pyramid are deaths, followed by hospital admissions and doctor visits, which represent a decrease in the adversity of effects, but affect a larger proportion of the population. Epidemiology studies often only see the top of the pyramid. Asthma attacks, medication use, followed by lung function changes, immune cell responses and heart rate responses, which are less adverse in their effects, affect a larger proportion of the population.

## A Pyramid of Effects

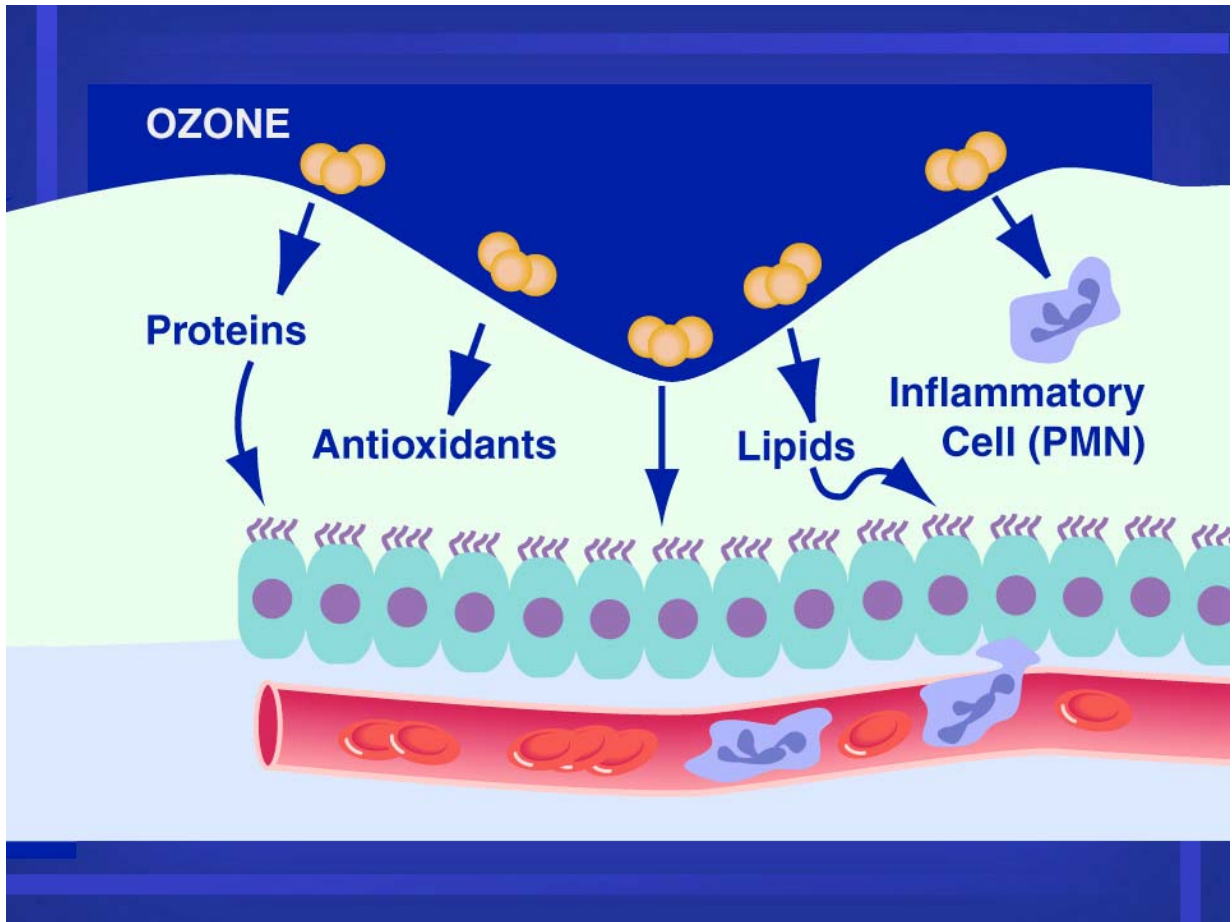


**The pollutants of concern in the Triangle Area**

Ozone is a gas composed of three oxygen atoms. "Good" ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface and forms a layer that protects life on earth from the sun's harmful rays. "Bad" ozone, or ground level ozone is a key component of smog. It is formed by a chemical reaction between Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NO<sub>x</sub>) in the presence of heat and light in the lower earth's atmosphere.

The illustration below shows, from the bottom up, a blood vessel with red and white blood cells (white blood cells in blue), ciliated epithelial cells that line the upper airways and epithelial lining fluid (ELF) and ozone in the airways. Ozone reacts with biomolecules in the ELF forming reactive oxygen species, such as lipid peroxides. These

molecules do most of the damage to the epithelium. When the epithelium is injured, it sends signals causing white blood cells to migrate to the area, causing inflammation. The cells in the epithelium die and are shed and replaced, similar to sunburn. It takes 12- 24 hours for the effect to occur, and it may take weeks for the epithelial lining to return to normal. The cells that replace the dead ones do not have cilia at first, so one of the lung's primary mechanisms for clearing out pollutants is lost while the new epithelium is maturing.



Health effects of excessive ozone exposure are as follows:

1. Respiratory symptoms, including:
  - Repeated cough,
  - Chest pain when breathing deeply, resulting in inability to take a deep breath
  - Wheezing,
  - Sore or scratchy throat, and
  - Shortness of breath.
2. Impairment of respiration.
  - Ozone impairs the normal function of lungs.
  - The impairment is greater when ozone exposure concentrations are high, people engage in some type of vigorous activity, and exposure periods are prolonged.
  - In addition, the onset of reduced lung function is rapid after exposure.
3. Impairment of lung defenses, which:
  - Reduces a person's ability to clear and remove particles from the lungs,
  - Reduces the number and effectiveness of alveolar macrophages, which attack and destroy invading microbes in the lungs, and
  - Reduces the lung's ability to defend against respiratory infection and disease.
4. Inflammation of lung tissue.
  - Ozone reacts completely in the surface layer of lungs.
  - It forms reactive oxygen molecules in lung tissue, which can cause further damage in lung tissue.
  - Inflammation of lung tissue also damages cells that line the airways.
5. Cycles of injury and healing may lead to permanent scarring of lung tissue.
6. Slower rates of lung growth among children.
7. Permanent changes in lung structure, which may result in a reduced quality of life later in life.

The types of effects for people with and without respiratory disease are similar, but the impact for those with respiratory disease is greater than for healthy persons due to the impaired nature of their respiratory systems.

Emerging evidence of ozone exposure's health effects are as follows:

1. Premature mortality in elderly people.
2. Increased numbers of children admitted to hospitals for respiratory problems.
3. Incidence of newly diagnosed asthma in children.
4. Increased school absenteeism.

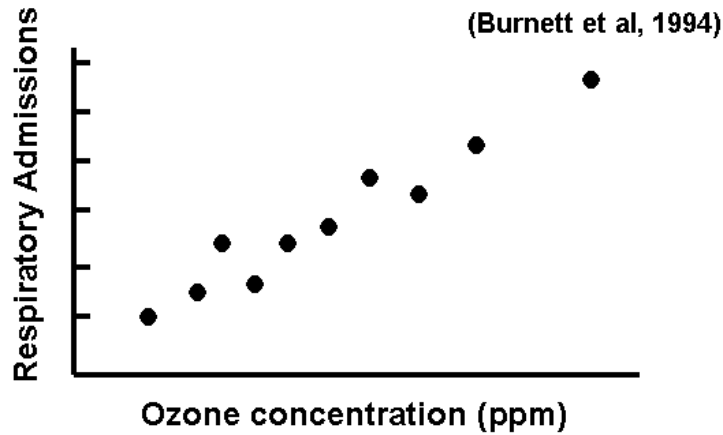
Other observations of the effects of ozone include:

- Children and adults who are active outdoors are particularly sensitive to ozone because physical activity causes people to breathe faster and more deeply.
- Children are at highest risk from ozone exposure because they often spend a large part of the summer playing outdoors, their lungs are still developing, they breathe more air per pound of body weight, and they are less likely to notice symptoms.
- People with asthma or other respiratory diseases that make the lungs more vulnerable to the effects of ozone will generally experience health effects earlier and at lower ozone levels than less sensitive individuals.
- Some people who do not suffer from respiratory diseases but who are unusually susceptible to ozone are also at risk. They experience adverse health effects at more moderate levels of outdoor exertion or at lower ozone levels than the average person might experience.

(Source: Dr. David Mc Kee, US EPA Office of Air Quality Planning and Standards, Health and Ecosystems Effects Group)

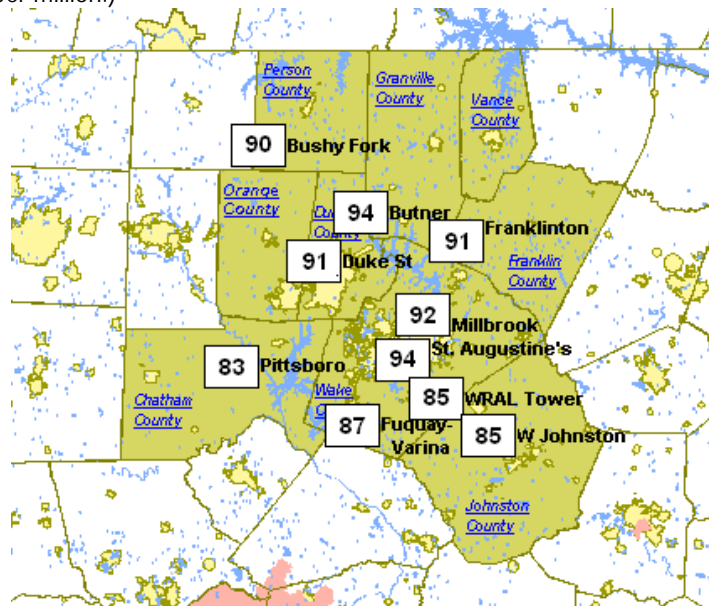
According to a study by Burnett, higher ozone levels are linked to increased hospital admissions the next day.

## Higher ozone levels means increased hospital admissions the next day



### Ozone in the Triangle Area

The US Environmental Protection Agency has established National Ambient Air Quality Standards for various air pollutants. The current standard for ozone is 0.080 parts per million (ppm) measured over an eight hour period. Since 1997 the Triangle area (Wake, Durham and Orange Counties plus surrounding counties) has experienced numerous code orange and red days during which ground level ozone is at unhealthy levels. The ozone readings from ten monitors in the Triangle in the map and Table 1 below show that for the period 2000- 2002, most locations in the Triangle have exceeded the new National Ambient Air Quality Standards (NAAQS) for ozone. (Note that the readings below are expressed in parts per billion, so the reading at Bushy Fork of 90 parts per billion on the chart is the same as .090 parts per million.)



The design values for these monitors over time are shown in Table 1, below.

**Table 1. Triangle Ozone Monitor Design Values**  
 8-hour ozone values in parts per million (ppm)

	94-96	95-97	96-98	97-99	98-00	99-01	00-02
Millbrook	0.082	<b>0.086</b>	<b>0.092</b>	<b>0.101</b>	<b>0.098</b>	<b>0.094</b>	<b>0.092</b>
St. Augustine	<b>0.086</b>	<b>0.091</b>	<b>0.095</b>	<b>0.097</b>	<b>0.095</b>	<b>0.093</b>	<b>0.094</b>
Butner	<b>0.087</b>	<b>0.094</b>	<b>0.097</b>	<b>0.098</b>	<b>0.094</b>	<b>0.092</b>	<b>0.094</b>
Duke St.	0.084	0.083	<b>0.086</b>	<b>0.088</b>	<b>0.091</b>	<b>0.087</b>	<b>0.091</b>
Franklinton	0.083	<b>0.086</b>	<b>0.092</b>	<b>0.093</b>	<b>0.09</b>	<b>0.086</b>	<b>0.091</b>
Bushy Fork			<b>0.093</b>	<b>0.095</b>	<b>0.091</b>	<b>0.089</b>	<b>0.09</b>
Tower	0.084	<b>0.089</b>	<b>0.093</b>	<b>0.099</b>	<b>0.094</b>	<b>0.088</b>	<b>0.085</b>
W. Johnston	0.084	<b>0.087</b>	<b>0.089</b>	<b>0.095</b>	<b>0.091</b>	<b>0.087</b>	<b>0.085</b>
Fuquay-Varina	<b>0.087</b>	0.082	<b>0.087</b>	<b>0.088</b>	<b>0.092</b>	<b>0.086</b>	<b>0.087</b>
Pittsboro	0.079	<b>0.085</b>	<b>0.086</b>	<b>0.088</b>	<b>0.085</b>	0.081	0.083

8-hour ozone NAAQS = 0.08 parts per million (ppm). Note that design values are deemed to exceed the NAAQ Standard when they exceed 0.085 parts per million of ozone. Those values are in **bold** type.

Source: NC Department of Environment and Natural Resources, Division of Air Quality

All monitor values are reported annually to the U.S. Environmental Protection Agency (EPA). For each monitor, the fourth highest annual values are averaged over three consecutive years – this is known as the “design value” for that monitor. If a monitor’s design value exceeds the NAAQ Standard, that monitor indicates a “violation” and some area (usually the county in which it is located) around the monitor must be designated nonattainment.

EPA set the 8-hour ozone standard at 0.08 parts per million (ppm). However, in evaluating the monitoring data, EPA allows a rounding convention to account for the uncertainty in the monitoring devices. Therefore, a monitored three-year average of 0.084 ppm is considered to meet or attain the standard, while a three-year average of 0.085 ppm or greater is considered to violate the ambient standard. The Secretary of the NC Department of Environment and Natural Resources has submitted recommended nonattainment areas which in the Triangle area include all of Wake, Durham and Orange counties and parts of Person, Granville, Franklin, Johnston and Chatham counties.

Implications of an 8-hour ozone nonattainment designation are as follows:

- New and expanding industry will be subject to strict emissions controls, which may impair recruitment of new industry.
- The State must submit a State Implementation Plan (SIP) describing how areas will attain the NAAQ Standard by the target attainment year. The SIP describes additional control measures needed to attain the NAAQS and must quantify the effects of new and existing control measures.
- Area transportation plans must conform to the State Implementation Plan (SIP) motor vehicle emissions budget.

**Particulate matter, or PM**, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope.

Some particles are directly emitted into the air. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood.

Other particles may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.

**Health Effects of Particulate Matter-** Many scientific studies have linked breathing PM to a series of significant health problems, including:

- Aggravated asthma
- Increases in respiratory symptoms like coughing and difficult or painful breathing
- Chronic bronchitis
- Decreased lung function
- Premature death

Particulate Matter is associated with increased hospital admissions and emergency room visits for people with heart and lung disease.

Particulate Matter is associated with work and school absences.

Health problems for sensitive people can get worse if they are exposed to high levels of PM for several days in a row.

**Atmospheric deposition-** Particles can be carried over long distances by wind and then settle on ground or water.

The effects of this settling include:

- Making lakes and streams acidic
- Changing the nutrient balance in coastal waters and large river basins
- Depleting the nutrients in soil
- Damaging sensitive forests and farm crops
- Affecting the diversity of ecosystems settles on soil and water and harms the environment by changing the nutrient and chemical balance.
- Aesthetic damage- soot, a type of pm, causes erosion and staining of structures including culturally important objects such as monuments and statues.

### **Particulate Matter in Wake County**

EPA has established standards for Particulate Matter 2.5 micrometers (or microns, as they are commonly known) in size and smaller, known as PM<sub>2.5</sub>. According to the most recent available data, the Triangle area complies with EPA PM<sub>2.5</sub> standards. However, three-year averaged annual PM<sub>2.5</sub> concentrations in Wake County are 14.6 micrograms per liter, which is just below the 15-micrograms/liter annual standard. Readings above 15 do not comply with National Ambient Air Quality Standards.

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## II. Wake County Air Quality Task Force

The Wake County Human Services Board (a consolidation of Health, Social Services and Mental Health Boards) created the Environmental Services Committee primarily to address environmental health issues.

Federal and state governments have implemented measures to improve air quality. However, by proactively implementing local air quality control measures, Wake County and other local governments in the Triangle area will achieve better air quality sooner than by merely relying on federal and state actions alone. That is why, at its July 12, 2002 meeting, the Environmental Services Committee unanimously recommended that the Human Services Board establish the following goal "There will be no ozone action days in Wake County by 2010". To this end, the Environmental Services Committee recommended that the Human Services Board create an Air Quality Task Force to address air quality issues. The Air Quality Task Force was tasked to coordinate efforts to increase public awareness of air quality issues and promote community action toward improving air quality. The Environmental Services Committee recommended that the Task Force consist of local and state government representatives, members of the Environmental Services Committee and other stakeholders. The Human Services Board adopted those recommendations in August 2002.

In January 2003, representatives from various groups were appointed to become members of the Wake County Air Quality Task Force. The members and the groups they represent are as follows:

- Sig Hutchinson- Chair of the Air Quality Task Force- Wake County Environmental Services Committee
- Leo Stander and Jeffrey West- General Public
- Frank Eagles- NC Motor Fleet Management
- Tom Kuryla- Wake County General Services Administration- Fleet Division
- Kim Crawford, John Tallmadge and Richard Lucia- Triangle Transit Authority
- Pam Wall- Greater Triangle Regional Council
- Julian Prosser- City of Raleigh
- Michael Fischer- Raleigh-Durham Airport Authority
- Kortni Campbell- Greater Raleigh Chamber of Commerce
- Sherry Johnson- Capital Group of the Sierra Club
- Kevin Hicks, Mangum Asphalt- Paving Contractor
- John O'Neil- American Lung Association
- Donnie Woodlief- Agricultural Community
- Chris Sinclair- Development Community
- Frank Koontz- Wake County Public School System
- Timothy Muth- NC State Energy Office
- Gibbie Harris- Human Services – Community Health and Asthma Coalition
- Ed Johnson and Kenneth Withrow- Capital Area Metropolitan Planning Organization
- Jeri Gray- League of Women Voters of Wake County
- Cheryl Vetter- Progress Energy

Resource people to the Air Quality Task Force include:

- Brock Nicholson, Sheila Holman, Marti Mattox, Milli Hayman and Vicki Chandler- NC Division of Air Quality
- John Hodges-Copple and Anne Tazewell- Triangle J Council of Governments
- Rick Rowe, Dicke Sloop, Mike Jennings, Rebecca Robbins, Luki Mahanani, Deborah Peterson, Suzanne Harris and Andre Pierce- Wake County Environmental Services Department

### Process

The Wake County Air Quality Task Force met from January 31 to July 25, 2003. In addition to the goal "There will be no ozone action days in Wake County by 2010", the Task Force added a goal that "Wake County will comply with

U.S. Environmental Protection Agency National Ambient Air Quality Standards by 2007." The Task Force went through the following process:

- **Education-** the Task Force became informed about air quality issues and identified information that they needed to know. Staff from the Division of Air Quality of the NC Department of Environment and Natural Resources, the Mecklenburg County Air Quality Department, Environmental Protection Agency and the Triangle Transit Authority gave briefings on air quality issues.
- **Identify control measures** included in similar plans. The Task Force decided to use information from other areas that had addressed air quality issues, including Charlotte-Mecklenburg and the Triad area in North Carolina, the Cities of Austin and Houston-Galveston in Texas, and the State of Arizona.
- **Rank control measures** as a first cut to determine which ones to research further.
- **Research and analyze** highly ranked control measures.
- **Develop consensus** on preferred control measures.
- **Prepare and finalize report.**

### Considerations

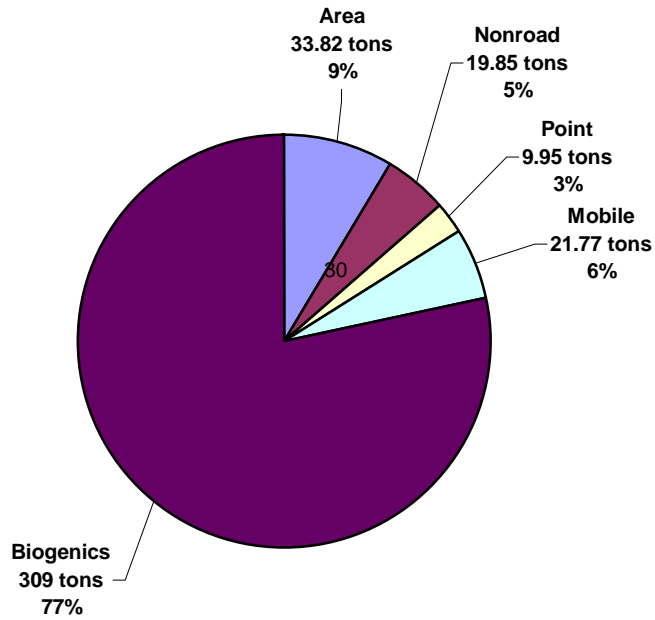
**Ozone-** The Air Quality Task Force attempted to identify methods that would most effectively improve air quality. The task force first looked at the components of ozone, which are Nitrogen Oxides and Volatile Organic Compounds. The pie charts on the next page from the NC Division of Air Quality show the 1995 composition of both components in Wake County. Biogenics are natural generators of Volatile Organic Compounds, such as trees. Mobile sources include automobiles, trucks and buses, etc. and nonroad sources include construction equipment, etc. Point sources include industries, dry cleaners, etc. Area sources include a wide variety of sources not included in the other categories.

**Volatile Organic Compound** emissions total about 395 tons, 77% of which was generated naturally by biogenics. Only about 11% is from mobile and nonroad sources.

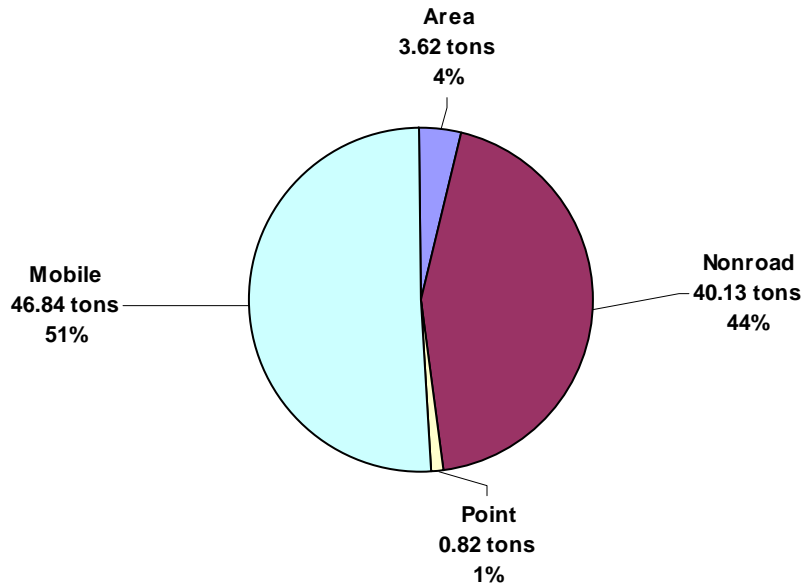
Conversely, **Nitrogen Oxides** total about 91 tons, and about 87% were created by mobile and nonroad sources.

Since both Volatile Organic Compounds and Nitrogen Oxides are needed to form ozone, and it is impractical to try to reduce naturally occurring Volatile Organic Compounds, the Task Force has concentrated on measures that will reduce Nitrogen Oxides. However, the Task Force recognizes that reduction of both Volatile Organic Compounds and Nitrogen Oxides from mobile sources in urban areas will be beneficial.

Wake County's 1995 Average Summer Day VOC Emissions



Wake County's 1995 Average Summer Day NOx Emissions



**Particulate Matter-** While particulate matter was not the primary impetus for preparing these recommendations, the Task Force recognized that Particulate Matter is an emerging area of concern in the Triangle, and since one of the sources of fine particulate matter is Volatile Organic Compounds and Nitrogen Oxides, therefore, many of the control measures address the formation of particulate matter. A concern was raised about the use of biodiesel fuel in place of regular diesel fuel. While biodiesel results in a slight increase in Nitrogen Oxides, it significantly reduces Volatile Organic Compounds and particulate matter, so it is included in the recommended control measures.

**Selection of Control Measures-** The Air Quality Task Force did not research intensively and extensively available measures but instead identified control measures that appear effective and that are likely to be implemented. In addition to making recommendations appropriate to local governments, the Task Force attempted to identify what governments, businesses and the general population could do. Given the need to move quickly in recommending control measures for further consideration, the Task Force used general terms to quantify the cost or effectiveness of implementing various control measures, based on information provided in other studies. More detailed studies on individual control measures should be undertaken as part of the regional collaboration, outlined below, and in the selection of recommended control measures. The following paragraphs summarize the nature of the recommended control measures, which are outlined in more detail in the next section of this report.

**Regional collaboration-** The Task Force recognizes that air quality issues can best be addressed on a regional basis. Therefore the Task Force recommends that a formally constituted regional air quality agency be developed to deal with air quality in the Triangle area. The agency should include business, community and transportation entities. Such an agency would allow the Triangle area to address air quality in a comprehensive manner.

**Vehicle miles traveled-** The Air Quality Task Force recognizes that the most effective way to control Nitrogen Oxides and Particulate Matter is to control emissions from mobile sources, especially motor vehicles. According to the Division of Air Quality, although there has been improvement in recent history in the emission rates of on-road vehicles, in this area the increase in VMT has off set these emission reductions. In the future as the number of cars that are required to meet the EPA Tier II tailpipe standards increases as a portion of the fleet, the emissions will begin to drop dramatically. However, working on VMT growth now will help prolong the effects of the emission reductions from Tier II. Sometime in the future we may face the same issues we face today.

In a study entitled **Sprawl and Urban Growth** Edward Glaeser and Matthew Kahn address air pollution in the Los Angeles area. Their information indicates that while the population increased by 11.9% between 1990 and 1999, the annual count of days when ambient ozone exceeded the one hour standard near the median monitoring station was five, as compared to 33 between 1980 and 1989. They attribute this environmental gain to the greening of the automobile.

The Task Force recommendations include strategies to reduce vehicle miles traveled, which could result in changes to the way we plan our communities and transportation systems.

**Other control measures-** The Task Force also recommends control measures to reduce emissions from vehicles, through the use of new fuels and technologies and to address energy conservation, non-road engines, airport operations, ozone action days and outreach to the community.

**Secondary impacts of improving air quality-** The Task Force noted that these recommendations would also positively affect other quality of life factors in the Triangle, such as:

- Traffic congestion is a problem that affects everyone, especially during morning and evening peak hours. By providing alternatives to single-occupant motor vehicle travel, especially during peak hours, traffic congestion can be reduced.
- By providing alternatives to gasoline and diesel fuel, we can lessen our dependence upon oil, especially foreign oil. Alternative fuels such as biodiesel and ethanol are derived from agricultural products, thereby providing a

ready market for such crops as soybeans and corn for farmers, and in turn providing opportunities for developing new and expanding existing processing plants for ethanol and biodiesel.

- By addressing urban heat islands through vegetation and increasing the tree canopy throughout the community, we also address water quality issues.

By reducing energy consumption, we can save money devoted to energy costs.

### III. Recommended Air Quality Control Measures

The Air Quality Task Force recommends the following list of air quality control strategies:

#### Strategy 1: Develop Regional Partnerships

This strategy encourages working together to implement regional control measures throughout the Triangle. Such measures are intended to foster cooperation among local governments, business, community, regional transportation entities and other interested stakeholders. This long-term strategy is essential to the success of our efforts to improve air quality.

1. Develop a formally constituted regional air quality agency to deal with air quality in the Triangle area. The agency should include business, community and transportation entities. The agency should be empowered to recommend area wide measures on behalf of governments in the Triangle area to be included in the State Implementation Plan, including more coordination between land use and transportation planning and decision-making.
2. Support and promote the NC Air Awareness program and the Triangle Clean Cities Coalition. Increase business and industry participation in both programs. <http://daq.state.nc.us/airaware/> and [www.trianglecleancities.org](http://www.trianglecleancities.org)

#### Strategy 2: Commuter Choice and e-business

This strategy is designed to reduce employee vehicle miles traveled (VMT), which will decrease the amount of Nitrogen Oxides and Volatile Organic Compounds emitted to the atmosphere. Employers and governments can implement best Workplace and e-business control measures.

1. Recommended control measures for employers:  
Become a Best Workplace for Commuters Employer through the EPA's Commuter Choice Leadership Initiative. <http://www.epa.gov/otaq/transp/comchoic/ccweb.htm> In order to qualify, employers must implement the following actions:
  - Designate a central point of contact
  - Centralize commuter benefit information
  - Promote the availability of commuter benefits to employees
  - Provide access to a Emergency Ride Home for employees who do not drive alone to work
  - Provide at least one of the following benefits:
    - Provide transit or vanpool passes or vouchers
    - Provide Parking Cash Out of at least \$30 per month. Encourage alternative commutes by offering monthly cash payments to employees who forgo a parking place.
    - Telecommuting: This program allows eligible employees to work from home, one or more days per week typically connected to the office via computer. Managers and teleworkers must evaluate issues of hardware and software compatibility, high-speed access and security.
    - Provide three or more measures from the following:
      - i. Participation in the NC Air Awareness Program or another employer-based commuter program
      - ii. Promote TTA On-line Commuter Matching Service
      - iii. Provide pre-tax transit or vanpool benefits
      - iv. Provide a parking cash-out for employees who forgo parking.
      - v. Provide shuttles from transit stations

- vi. Provide intelligent (i.e., real-time) commuting information
  - vii. Provide preferred parking for carpools and vanpools
  - viii. Reduce parking costs for carpools and vanpools
  - ix. Promote Triangle Transit Authority vanpools <http://www.ridetta.org/vanpool.html>. Provide employer-assisted vanpools
  - x. Employer-provided membership in a carsharing program (visit [www.carsharing.net](http://www.carsharing.net) to learn more)
  - xi. Secure bicycle parking, showers, and lockers
  - xii. Employee commuting awards programs
  - xiii. Compressed work schedules
  - xiv. Lunchtime shuttle
  - xv. Encourage proximate commute (where employees work at locations closer to their homes)
  - xvi. Incentives to encourage employees to live closer to work
  - xvii. Incentives to encourage employees to use alternative transportation (e.g., additional vacation time)
  - xviii. On-site amenities (e.g., food service, convenience mart, dry cleaning, etc.)
  - xix. Concierge services
  - Direct Deposit.
  - Compressed workweek. Support all aspects of "Best Workplaces for Commuters" and "the Wake County Good Neighbor Commuter Initiative".
2. Support and fund commute trip reduction outreach programs for employers in respective jurisdictions
    - Implement commute-trip reduction programs for employers in respective jurisdictions:
      - Expand Park and Ride facilities.
      - Implement TTA On-line Commuter Matching Service. <http://www.ridetta.org/formcvm.html>
      - Ensure that parking facilities accommodate vans such as ensuring adequate vertical clearance for vans in parking garages.
  3. Encourage government and businesses to provide on-line services for the public to reduce traffic.
    - Implement e-government and e-business initiatives for public use, such as applications, registrations, and bill payments on-line to reduce traffic congestion and vehicle miles traveled.

### Strategy 3: Transportation Improvements

This strategy supports and promotes the better use of public transportation and capital facilities to decrease traffic congestion and in turn emissions of Volatile Organic Compounds and Nitrogen Oxides. These recommended control measures apply to all local governments and transportation providers.

1. Include air quality and energy conservation goals in the transportation planning process. Coordinate transportation planning with land use planning.
2. Expand and encourage public transportation alternatives such as Triangle Transit Authority's regional rail transit, bus rapid transit, vanpools, etc. Support and promote Wake Coordinated Transportation Services (WTCS), Transportation and Rural Access (TRACS), Triangle Transit Authority (TTA), Town of Cary (C-Tran), Chapel Hill Transit, Durham Area Transit Authority and Capital Area Transit (CAT).
3. Provide signal improvement/regional computerized traffic signal system, including signal prioritization for transit vehicles, which increase the average speed on local surface streets through signal timing and other traffic management programs.
4. Improve and expand bike and pedestrian facilities. Include bike/pedestrian improvements on all transportation improvements unless an analysis demonstrates that such improvements would be impracticable.
5. Improve intersections, including grade separations and roundabouts where appropriate.
6. Improve transit amenities such as bus shelters and on-line trip planning.
7. Improve multimodal transit infrastructure to create easy transfers between buses, rail, walking, biking, etc.
8. Implement regional on-line trip planning service.

9. Implement High Occupancy Vehicle Lanes.
10. Implement High Occupancy Tolling Lanes.

#### **Strategy 4: Cleaner Fuels and Alternative Fuel Vehicles**

This strategy encourages the use of cleaner fuel, advanced technology and alternative fuel vehicles to reduce emissions. Alternative fuels include biodiesel, electricity, ethanol, hydrogen, liquefied petroleum gas, methanol, natural gas (CNG/LNG), P-series fuels, propane (LPG), and hybrid gasoline/electric. These measures are applicable to any business or government that has a fleet of vehicles as well as to the general public.

1. Participate in a regional initiative to seek early introduction of ultra low sulfur fuels to the southeast earlier than scheduled.
2. All public and private motor vehicle fleets should participate in the Triangle Clean Cities Coalition and implement plans to use cleaner burning transportation fuels as vehicle replacement occurs. Fleet replacement policies should:
  - Require the purchase of ULEV and SULEV certified vehicles wherever possible.
  - Require purchase of cleaner burning alternative fuels.
  - Cooperate regionally to develop publicly accessible refueling infrastructure and policies to increase the use of cleaner transportation fuels.
3. Promote and encourage greater usage of both Ultra Low-Emission vehicles and Super Ultra Low-Emission Vehicles to the general public.
4. Support state legislation to provide incentives, such as grants and rebates for alternative fuel vehicles (AFVS), alternative fuels and refueling infrastructure.
5. Develop a Memorandum of Agreement between local governments, businesses and NC DENR division of air quality for a voluntary emission reduction program. Quantify emissions reductions to be reported to the Division of Air Quality.
6. Convert school bus fleets from diesel to Alternative Fuels.

#### **Strategy 5: Reduce Emissions from Existing Vehicles**

This strategy is intended to support the use of environmentally appropriate vehicles. The recommended control measures apply to local and State governments.

1. Encourage the public to check gas cap leaks and replace the cap if it is found leaking. Also have the gas cap checked during annual inspection and maintenance.
2. Have law enforcement agencies in all local governments enforce North Carolina General Statute 20-128.1 – “Control of Visible Emissions” regarding motor vehicles with visible emissions from tailpipes and require smoking vehicles to be repaired. Many smoking vehicles may need to be replaced or the cost to eliminate the problem may be costly for the vehicle owners

#### **Strategy 6: Land Use**

This strategy is intended to reduce mobile-source emissions by reducing the need to use motor vehicles for trips, thus moderating vehicle miles traveled. It includes measures to encourage urban infill and walkable districts and promote the planting of trees, which absorb pollutants. These recommended control measures apply to all local governments.

1. Include air quality and energy conservation goals in the land use planning process. Coordinate land use planning with transportation planning.
2. Implement incentives for development to occur in areas served or planned to be served by public services, such as water and sewer, schools, transportation and parks. Incentives are recommended to include: vertical zoning, mixed used zoning, enhanced mobility choices, reducing distances between home sites, work sites and service sites and transit oriented development. Encourage the construction of residential units in existing urban areas.

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### Strategy 7: Energy Conservation

This strategy is intended to encourage using less electricity. These recommendations apply to all local governments and businesses.

1. Require development of a plan to reduce energy use. This plan could include retrofitting buildings and improving street light efficiency, i.e., "Energy Star" program <http://www.energystar.gov/>, "white roofs", etc., promoting transportation alternatives, and encouraging recycling and composting. Other measures include:
  - Use programmable thermostat and lighting to lessen use when rooms are not in use.
  - Turn off computers, printers and other office equipment when not in use.
  - Promote use of more reflective glass, efficient buildings, tougher energy use standards, native plants, and adding more trees for new and existing structure throughout each jurisdiction.
  - Apply and promote the energy plan to the community voluntarily and/or as a requirement for new and modified construction.
2. Implement an urban heat island initiative. Dark-colored impermeable surfaces absorb heat in urban areas, creating "heat islands." The resulting higher temperatures not only increase ozone in an area, but also increase electrical usage. The initiative combines rooftop gardens with other mitigation strategies such as white roofs, using reflective roofing materials, and strategic landscaping to reduce summertime urban temperatures.
3. Implement a Cool Cities program. Promote a strategy of public tree planting, tree ordinances, and examine the benefits of tree canopy coverage in the region.

### Strategy 8: Reduce Emissions from Diesel Engines, on-road and non-road

This strategy ensures the use of the cleanest diesel engines and diesel fuels. The Air Quality Task Force recommends that alternatives to diesel engines be pursued. If diesel engines are to be used, that use of biodiesel fuel should be encouraged and the following recommendations be implemented. These recommendations are long term in nature and apply to all governments and businesses.

1. Specify in the request for proposal/bidding process that contractors must achieve emission reductions equivalent to the emission reductions that could be achieved using diesel equipment meeting EPA engine standards for all or a percentage of the non-road diesel equipment used during the project. The taskforce suggested phasing in this program.
2. Accelerate the replacement/turnover of on-road diesel fleets with new engine technology scheduled for introduction in 2004 and 2007. Affected on-road fleets are primarily dump trucks, garbage, truck and buses. Develop incentive programs to accelerate vehicle turnover.
3. Accelerate the replacement/turnover of non-road diesel fleets with new engine technology being introduced in 2001-2005 (Tier 2) and 2006-2008 (Tier 3). Accelerate fleet turnover by providing incentives for citizens and companies that replace older vehicle with Tier 2 vehicles over the next 5-10 years. Affected non-road diesel fleets include bulldozers, excavators, backhoes, and forklifts. Encourage the availability of grant funds for heavy-duty diesel engine replacement/retrofit.
4. Prohibit testing and maintenance of stationary diesel engines such as generators between 6 AM – noon during the ozone season (May through September) and establish non-road engine standards for new / modified engine. Encourage the usage of biodiesel.

### Strategy 9: Reduce Emissions from Non-Road Gasoline Engines

This strategy is designed to reduce emission from non-road gasoline engines. This recommendation applies to all governments and businesses.

1. Develop an incentive-based program, including education; to accelerate replacement of public or private gasoline powered equipment (e.g. chainsaws, lawnmowers, and generators) with electric equipment where available and practicable. Where appropriate non-gasoline alternatives do not exist, replace two-stroke engines

with four-stroke engines. Until appropriate replacements are available for existing two-stroke engines, use synthetic oils.

### **Strategy 10: Airport Clean Air Program**

This strategy is designed to ensure that the RDU Airport takes advantage of available control measures.

The Federal Aviation Administration preempts the US EPA and state and local air quality regulatory agencies from regulating aircraft safety and associated operations. This preemption extends to activities on the ramp/apron, taxiway and runway. Such activities include aircraft servicing (food & baggage handling, fueling, interior cleaning, etc.), aircraft taxiing, landings & take-off (LTO), and use of alternative fuels in Auxiliary Power Units (APU), Ground Power Units (GPU), and other Ground Support Equipment (GSE). These activities are considered "Airsideside."

"Landside" activities are not included in this preemption. Landside activities include facility/property maintenance, fuel storage/transfers (except aircraft), rental car operations, Terminal A & C operations, parking, and ground transportation. These and similar activities are not preempted from environmental regulations.

The Airport consists of the Authority (the "landlord") and tenants, which are private organizations operating on Authority property through an agreement with the Authority. The Authority owns the property operated by the tenants, including hangars, fuel tanks, and utilities (i.e., electric, water, sewer, natural gas). The Authority does not own the tenant's equipment (i.e., GSE, APU, GPU, fuel, aircraft, tenant vehicles, etc.). Therefore, emission reductions should not be placed upon the Airport as a whole, since there are various entities involved. Each entity should be regulated and enforced on an individual basis. However, this does not nullify the option of bubbles and caps on emissions since the Authority has enforcement capabilities

The Authority has an existing Memorandum of Agreement (MOA) with the NC DENR- Division of Air Quality to voluntarily reduce/eliminate emissions. In addition, the Authority has voluntarily decided to operate alternative fuels in the Authority-operated shuttle buses.

The recommended control measures are as follows:

1. Operate alternative fuel (AF) administrative and maintenance vehicles, equipment and AF shuttles from the passenger terminal to the surface parking lots.
2. Create voluntary emission reduction agreements between agencies and the airlines. (Voluntary emission reductions from Airport tenant operations may not be effective without Authority involvement (e.g., infrastructure build-out, Authority enforcement capabilities, etc.))
3. Voluntary replacement of Airport Ground Support Equipment: conversion to electrical vehicles.
4. Ensure that airport emissions are "bubbled" at an appropriate level and cap emissions as appropriate.
5. Conduct a new marketing campaign to promote transit and other shared-ride alternatives for traveling to RDU.

### **Strategy 11: Ozone Action Day programs**

This strategy is planned to reduce ozone emissions on ozone action days, defined as code orange, red or purple days. These recommended control measures are short term in nature and apply to all governments and businesses.

1. Schedule heavy construction, landscaping, and mow activities after noon on ozone action days, or delay certain activities to non ozone-action days. While the Task Force recognizes that this action would limit the creation of Volatile Organic Compounds and Nitrogen Oxides, the Task Force also recognized that if scheduling of such operations was merely changed to the afternoon of the same day, that action would subject equipment operators to the adverse effects of ozone at that time.
2. Implement idling restrictions.
3. Have transit systems provide free bus rides on ozone action days.

### **Strategy 12: Outreach / Education**

This strategy supports air quality improvement by educating and helping the public to realize that their actions can affect and improve air quality. It is applicable to all governments, individuals and businesses.

1. Expand air quality education through a strong locally based program to educate and motivate individuals to take actions to minimize ozone pollution. Implement diverse language outreach program. Include school-based outreach; include information in tax, water and electric bills.
2. Implement a "stop at the click" program: Reduce gasoline vapor emissions through distribution of stickers for gas pumps that encourage individuals to stop when the pump automatically stops working- "at the click."
3. Educate vehicle operators to limit vehicle or equipment engine idling to no more than 5 minutes.

### **Strategy 13: Promote Efficient Freight Transport**

This strategy is designed to reduce emissions from both freight transport and operators' driving.

1. Work with freight operators and delivery services to identify appropriate control mechanisms.

#### IV. APPENDIX. SUMMARY TABLE OF RECOMMENDED CONTROL MEASURES

Strategy 1: Develop Regional Partnerships	Comments
Develop a formally-constituted regional air quality agency	Essential for the success of air quality improvement efforts.
Support and promote NC Air Awareness program and Triangle Clean Cities Coalition.	Air Awareness program is essential for public understanding of and action on air quality. Triangle Clean Cities Coalition's vision is to reduce U.S. dependence on foreign oil and improve air quality by increasing the use of alternative fuels
Strategy 2: Commuter Choice and e-business	Comments
Become a Best Workplace for Commuters Employer	At little cost, program can reduce persons per vehicle, which can reduce vehicle miles traveled. Can result in less cost to employers and employees for parking, enhanced competitiveness in job market for employees.
Support and fund a commute trip reduction outreach programs for employers in respective jurisdictions	Programs can reduce persons per vehicle, which can reduce vehicle miles traveled
Encourage government and businesses to provide on-line services	Can reduce trips for permits, etc.
Strategy 3: Transportation Improvements	Comments
Air quality and energy conservation goals included in transportation planning. Coordinate with land use planning.	Long-term recommendation that can have significant effects. Applicable to all local governments.
Expand public transportation alternatives such as Triangle Transit Authority, CAT, C-Tran, WCTS, DATA and Chapel Hill Transit.	Public Transportation alternatives are necessary to increase persons per vehicle. Need to be paired with development policies, e.g. transit-oriented development, appropriate densities
Signalization improvements	Decrease congestion, time spent idling.
Improve and expand bike and pedestrian facilities	Decrease vehicle miles traveled by mobile sources. Also need facilities for bike storage and showers at destination.
Improve intersections	Decrease congestion, time spent idling.
Improve transit amenities	Encourages use of transit
Improve multimodal transit infrastructure	Encourages use of transit
Implement regional on-line trip planning service	Encourages use of transit
Implement High Occupancy Vehicle lanes	Can reduce persons per vehicle, which can reduce vehicle miles traveled
Implement High Occupancy Toll lanes	Can reduce congestion, also raise revenue.

Strategy 4: Cleaner Fuels and Alternative Fuel Vehicles	Comments
Early introduction of ultra-low sulfur fuels	High potential to reduce emissions. Needs to be done as a regional- Southeast US- effort.
Fleet participation in Triangle Clean Cities Coalition	TCCC provides grants for use of alternative fuels. Triangle Clean Cities Coalition's vision is to reduce U.S. dependence on foreign oil and improve air quality by increasing the use of alternative fuels.
Greater usage of ULEV and SULEV vehicles	High potential to reduce emissions.
State incentives for alternative fuel vehicles, alternative fuels and refueling infrastructure	High potential to reduce emissions. Lack of refueling infrastructure is a major obstacle to use of alternative fuels.
Memoranda of Agreement between local governments, businesses and Division of Air Quality	Creation of plans will incorporate air quality planning into business operations.
Convert school bus fleets from diesel to Alternative Fuels	Good potential for emission reductions. Children are exposed to Particulate Matter by idling school buses.
Strategy 5: Reduce Emissions from Existing Vehicles	Comments
Replace leaking gas caps	Low cost method for reducing emissions.
Enforce "Smoking Vehicle" legislation	Laws are on the books, but apparently not widely enforced. Many owners of smoking vehicles likely cannot afford maintenance and repair needed to eliminate smoking. May be an economic hardship on them.

Strategy 6: Land use	Comments
Include air quality and energy conservation goals in the land use planning process. Coordinate with transportation planning.	Long-term recommendation that can have significant effects. Applicable to all local governments.
Provide incentives for development in areas served by public facilities.	Long-term recommendation that can have significant effects. Applicable to all local governments.
Strategy 7: Energy Conservation	Comments
Require plans to reduce energy use, voluntarily or as a requirement for new and modified construction.	Long-term recommendation that can have significant effects. Applicable to all local governments.
Implement a heat island initiative	Can reduce heat, which is necessary for ozone creation. Also can reduce need for air conditioning.
Implement a Cool Cities Program	Can reduce heat, which is necessary for ozone creation. Also can reduce need for air conditioning.
Strategy 8: Diesel Engines	Comments
Require emission reductions for non-road vehicles, of contractors in proposal process for contracts	Some potential to reduce emissions.
Accelerate the replacement of on-road diesel fleets	Good potential to reduce emissions, if replaced fleet vehicles are not merely sold to others in the area.
Accelerate the replacement of non-road diesel fleets	Good potential to reduce emissions, if replaced fleet vehicles are not merely sold to others in the area.
Prohibit testing and maintenance of stationary diesel engines between 6 am and noon May through September.	Small potential to reduce emissions.
Strategy 9: Non-road Gasoline Engines	Comments
Develop incentive-based program to accelerate replacement of gas-powered equipment with electric powered equipment.	Success will depend upon funding for incentives, availability of electric powered equipment.
Strategy 10: Airport Clean Air Program	Comments
Operate alternative fuel vehicles for administrative,	RDU is implementing this now.

maintenance and passenger shuttles	
Create voluntary emission reduction agreements between agencies and the airlines	Good potential for reductions in emissions. RDU agrees with this recommendation
Conversion of Ground Support Equipment to electric power	Good potential for reductions in emissions. RDU agrees with this recommendation
Bubble and cap emissions	Good potential for reductions in emissions. RDU agrees with this recommendation
Marketing campaign to promote transit and other shared-ride alternatives for traveling to RDU	Moderate reductions in emissions.
<b>Strategy 11: Ozone Action Day Programs</b>	<b>Comments</b>
Restrict early morning operation of equipment in the morning on ozone action days.	Could adversely affect personnel if work schedules were merely moved to the afternoon, when ozone levels are high.
Schedule heavy construction, landscaping, and mow activities outside of morning hours, or delay certain activities to non ozone-action days	Could adversely affect personnel if work schedules were merely moved to the afternoon, when ozone levels are high.
Implement idling restrictions on ozone action days.	Minor inconvenience, but good for raising public consciousness about air quality.
Free bus rides on ozone action days.	Good potential for reducing emissions. Possible carryover effect upon people who normally don't take public transit.
<b>Strategy 12: Outreach/Education</b>	<b>Comments</b>
Expand air quality education through a strong locally based program	Essential for significant changes in behavior toward air quality
Implement a "stop at the click" program	Small potential for emissions prevention, but good for raising public consciousness about air quality.
Educate vehicle operators to limit vehicle or equipment engine idling	Good for raising public consciousness about air quality.
<b>Strategy 13: Efficient Freight Transportation</b>	
Work with freight operators and delivery services to identify appropriate control mechanisms	Good potential for emission reductions.

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## VI Glossary of Terms

**Alveolus**- air sac of lungs at the termination of the bronchiole

**Cilia**- microscopic hairlike process extending from cell surfaces and often capable of rhythmic motion.

**Cool Cities Program** was started in Houston Texas as a control measure to comply with National Ambient Air Quality Standards. The existing tree canopy coverage of the region is used to calculate the economic and environmental benefits that trees provide in terms of pollution mitigation and cooling costs.

**ENERGY STAR** is an EPA-backed program helping businesses and individuals protect the environment through superior energy efficiency. It offers a proven energy management strategy that helps in measuring current energy performance, setting goals, tracking savings, and rewarding improvements.

**Epithelium**- membranous tissue forming the covering of most internal organs and surfaces.

**High-Occupancy Vehicle** lanes are designated along major thoroughfares. During designated times, only vehicles with the minimum number of people may travel in these lanes.

**High-Occupancy Toll** lanes are designated along major thoroughfares. During designated times, vehicles with the minimum number of people may travel in these lanes free. Other vehicles may travel in them during those times, but they must pay a fee to do so.

**Microbes**- minute life forms, especially ones that cause disease

**National Ambient Air Quality Standards**- the Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. The Clean Air Act establishes two types of quality standards. *Primary standards* set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m<sup>3</sup>), and micrograms per cubic meter of air (µg/m<sup>3</sup>).

National Ambient Air Quality Standards

POLLUTANT	STANDARD VALUE *		STANDARD TYPE
<b>Carbon Monoxide (CO)</b>			
8-hour Average	9 ppm	(10 mg/m <sup>3</sup> )	Primary
1-hour Average	35 ppm	(40 mg/m <sup>3</sup> )	Primary
<b>Nitrogen Dioxide (NO<sub>2</sub>)</b>			
Annual Arithmetic Mean	0.053 ppm	(100 µg/m <sup>3</sup> )	Primary & Secondary
<b>Ozone (O<sub>3</sub>)</b>			
1-hour Average	0.12 ppm	(235 µg/m <sup>3</sup> )	Primary & Secondary
8-hour Average	0.08 ppm	(157 µg/m <sup>3</sup> )	Primary & Secondary
<b>Lead (Pb)</b>			
Quarterly Average	1.5 µg/m <sup>3</sup>		Primary & Secondary
<b>Particulate (PM 10)</b> <i>Particles with diameters of 10 micrometers or less</i>			
Annual Arithmetic Mean	50 µg/m <sup>3</sup>		Primary & Secondary
24-hour Average	150 µg/m <sup>3</sup>		Primary & Secondary
<b>Particulate (PM 2.5)</b> <i>Particles with diameters of 2.5 micrometers or less</i>			
Annual Arithmetic Mean	15 µg/m <sup>3</sup>		Primary & Secondary
24-hour Average	65 µg/m <sup>3</sup>		Primary & Secondary
<b>Sulfur Dioxide (SO<sub>2</sub>)</b>			
Annual Arithmetic Mean	0.030 ppm	(80 µg/m <sup>3</sup> )	Primary
24-hour Average	0.14 ppm	(365 µg/m <sup>3</sup> )	Primary
3-hour Average	0.50 ppm	(1300 µg/m <sup>3</sup> )	Secondary

**Nitrogen oxides**, or NO<sub>x</sub>, is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. However, one common pollutant, nitrogen dioxide (NO<sub>2</sub>) along with particles in the air can often be seen as a reddish-brown layer over many urban areas.

Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary sources of NO<sub>x</sub> are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

Ozone Action Days- see attached chart

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**Volatile Organic Compound-** is any compound of carbon that participates in atmospheric photochemical reactions. Excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate

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