Air Quality Management Plan: A Prototype

Colonial National Historical Park

Natural Resources Report NPS/NRAQD/NRR-91/01



United States Department of the Interior • National Park Service

Air Quality Management Plan: A Prototype

This document was developed as an addendum to the Colonial National Historical Park Resources Management Plan (RMP). The park had identified air quality as its number one natural resource management problem, and felt the need to develop a more detailed description of the problem and potential solutions than what could be contained in one or more RMP project statements.

The draft Air Quality Management Plan was distributed to a wide variety of reviewers - federal, state, and local agencies; industries; citizen interest groups; and the public - for comments. This final document is the result of the two-year preparation and review process. This plan presents a comprehensive regional view of the air pollution problem at Colonial and suggests several actions that the park and other organizations can cooperatively take to deal with the problem.

We believe this document should serve as a prototype for other National Park System units that need to address air pollution problems in a more comprehensive way, especially since no NPS requirement or guideline exists for such action.

The recent Clean Air Act Amendments (November 15, 1990) have not changed the objectives or elements of this plan. However, the amendments will result in a new round of planning and regulatory development activities which will provide additional opportunities to promote the park's air quality goals.

The National Park Service, Air Quality Division, is responsible for preserving, protecting, and enhancing air quality and "air quality related values" in the National Park System by ensuring compliance with the requirements of the Clean Air Act and the National Park Service Organic Act. Air quality related values include visibility, flora, fauna, cultural and historical resources, soil, water quality, and virtually all resources that are dependent upon and affected by air quality. The Air Quality Division monitors air quality; reviews proposed major emitting sources, air quality legislative and regulatory proposals, and NPS and other federal or state air quality plans; develops data on sensitive park resources; researches acid precipitation; and develops meteorology and atmospheric dispersion modeling.

The National Park Service disseminates reports on high priority, current resources management information, with managerial application for managers, through the Natural Resources Report Series. Technologies and resource management methods; "how to" resource management papers; proceedings on resource management workshops or conferences; and natural resources program recommendations and descriptions and resource action plans are also disseminated through this series. Documents in this series usually contain information of a preliminary nature and are prepared primarily for internal use within the National Park Service. This information is not intended for use in open literature.

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Introduction

Colonial National Historical Park is a 10,221-acre historic park located in the southern tidewater region of Virginia (Figures 1 and 2). The park was established in 1930 by Public Law 510 to commemorate the Battle of Yorktown and Jamestown, the first permanent English settlement of North America.

Currently, the park is developing a General Management Plan to identify overall objectives and needed planning. The park's Statement for Management contains the following management objectives:

1. "To protect and preserve the Revolutionary and Civil War historic structures, objects and other resources of Yorktown and the battlefield area and to arrest their deterioration."

2. "To preserve and protect the cultural resources associated with . . . the site of Colonial Jamestown, including the remains of the seventeenth century structures associated with the plantations that followed the settlement in the eighteenth and nineteenth centuries."

3. ". . . native flora and fauna will be enhanced and perpetuated within zones managed for their natural values and water and air resources contributing to visitor use and enjoyment and natural integrity will be maintained or restored."

4. "To promote public understanding of natural resources and processes through . . . public information activities."

5. "To ensure that diverse opportunities for interpretation and resource compatible recreational uses, such as picnicking, hiking, bicycling, and fishing are made available. . . ."

The park's Resource Management Plan guides the management of cultural and natural resources within the park. The Air Quality Management Plan is an action plan in response to problems identified in the Resource Management Plan.

Although little is known about demonstrable effects of air pollutants on park resources, some research has been conducted that gives an indication of the adverse effects which may be caused by air pollution. An air quality monitoring program in the park would provide baseline inventory and monitoring information to assist in determining the effects air pollution has on park resources. It may allow the park to act to protect cultural and natural resources from further degradation from air pollution.

The park air quality objectives are as follows:

1. Determine the types, extent, and sources of air pollution and its impact upon cultural and natural resources.

2. Increase coordination with the Virginia Department of Air Pollution Control (Appendix A).

3. Increase public education and information programs on air pollution impacts upon the park resources.

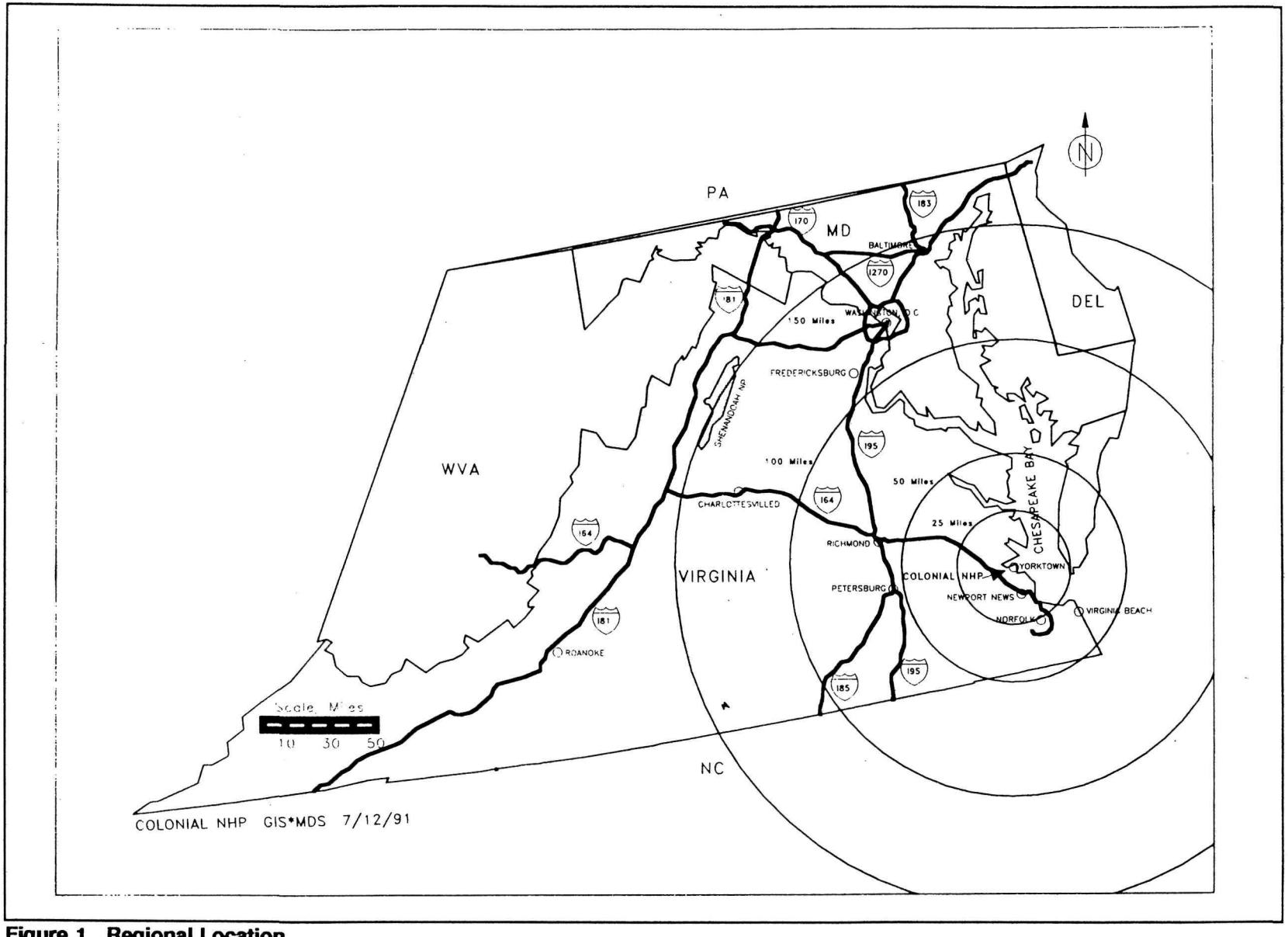


Figure 1. Regional Location

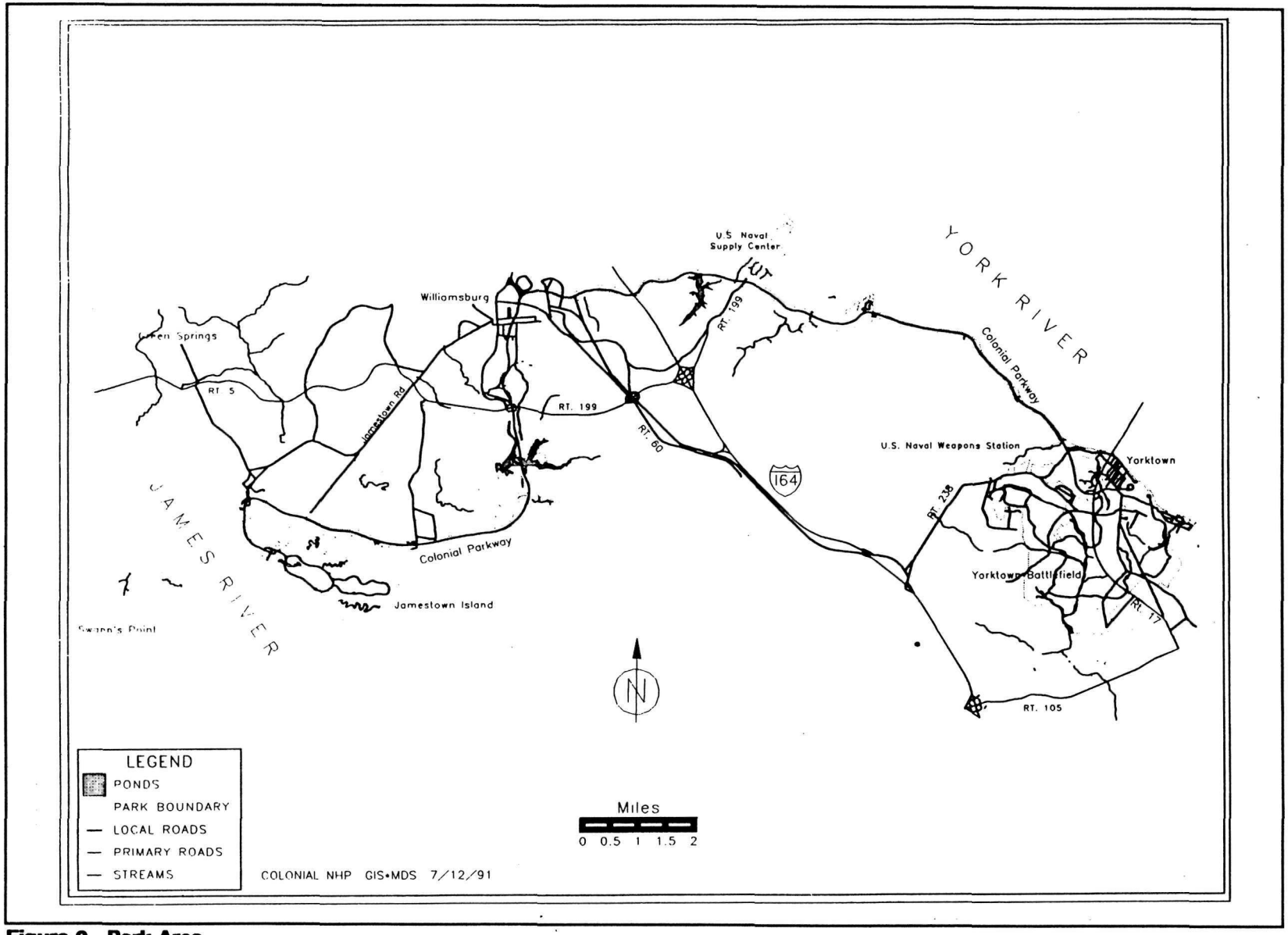


Figure 2. Park Area

Legislative Authority

The legislation summarized in this section provides the authority and impetus for the park to undertake the development of an Air Quality Management Plan.

Public Law 510

Public law (46 Stat. 855), July 3, 1930, authorizing Colonial National Monument states that the purpose of acquiring the parklands is "the preservation of the historical structures and remains thereon for the benefit and enjoyment of the people."

Act of August 25, 1916

The National Park Service Organic Act of August 25, 1916, states that the authority and responsibility of the National Park Service are to protect all resources within park boundaries.

The Organic Act states that the purpose of the National Park System is to conserve the resources of the system unimpaired for the enjoyment of future generations (18 USC 1). In 1970, Congress enacted legislation emphasizing that all units of the National Park System are united through their interrelated purposes and resources into one national park system as cumulative expressions of a single national heritage (Act of Administration, 18 USC 1a). This act made it clear that the Organic Act and other protective mandates applied equally to all units of the National Park System, regardless of the type or title of the unit.

Legislation enacted in 1978 to expand Redwood National Park also contained an important section amending the Act of Administration and reaffirming that:

> the protection, management and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established except as may have been or shall be directly and specifically provided by Congress (16 USC 1a-l).

Clean Air Act

The main purpose of the Clean Air Act (42 USC 7401 *et seq.*) is to protect and enhance the air quality of the Nation. States are assigned the primary responsibility to develop programs to prevent and control air pollution, and the U.S. Environmental Protection Agency (EPA) provides technical and financial assistance to state and local governments.

Under section 110 of the act, states adopt plans (State Implementation Plans - SIPs) to achieve national ambient air quality standards (NAAQS) established by the Environmental Protection Agency to protect public health and welfare. NAAQS have been established for several pollutants: inhalable particulate matter (PM-10), sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, and lead. These pollutants can have adverse impacts on park resources and/or the visitor experience.

The 1977 Amendments to the Clean Air Act added new requirements to prevent significant deterioration (PSD) of the air quality in areas where the air is cleaner than NAAQS. One of the objectives of the PSD requirements is "to preserve, protect and enhance the air quality in national parks . . . wilderness areas . . . and other areas of special national or regional natural, recreational, scenic or historic value."

Three categories of allowable air quality deterioration are established for National Park System areas (class I, II, III). Colonial National Historical Park is a class II area. The state may permit a moderate amount of new air pollution (particulates, sulfur dioxide, and nitrogen oxides) around the park as long as neither NAAQS nor the maximum allowable increases (increments) over established baseline concentrations are exceeded (Appendix B, Tables 1 and 2). The baseline concentration is set for an area at the time of the first PSD application. The maximum allowable increase over baseline concentration is a total of all applications, and not per application. The act also mandates that parks comply with all federal, state, and local air pollution control laws and regulations (Section 118 - Control of Pollution from Federal Facilities).

Park Air Quality Related Values

Air quality related values (AQRVs) are defined as those values possessed by an area that are or could be affected by changes in air quality. AQRVs include visibility and scenic, cultural, biological, and recreational resources. Resources that may be adversely affected by changes in air quality are visibility, vegetation, wildlife, water quality, soils, historic and archeological objects and resources, and visitor enjoyment.

Fauna

Wildlife at the park includes a variety of birds, mammals, and reptiles. Squirrels, rabbits, white-tailed deer, turkey, rabbits, opossums, raccoons, red and gray fox, beaver, small hawks, quail, egrets, Canadian geese, bobwhite quail, red-headed and pileated woodpeckers, owls, and geese are found in the park. Bald eagles have been sighted along Colonial Parkway. Rookeries of great blue herons are located next to the park, in Newport News Park, and within the park at Jamestown Island and Swann's Point. Reptiles include black snakes, northern water snakes, frogs, and turtles. The park provides habitats for a variety of aquatic species. A 1987 U.S. Fish and Wildlife Service (USFWS) fish survey conducted in the park's Yorktown unit waters found 19 species represented by 15 genera, in 12 families. Species found include perch, sunfish, bluegill, striped bass, largemouth bass, and spotted sea trout. Crustaceans include crayfish and blue crab. The waters surrounding the park support oyster beds and clams.

Flora

Park vegetation is approximately 80% forest and 20% fields of grass, sedges, wildflowers, brush, and landscaped lands. Extensive wetlands are found throughout the park. The historic pattern of forest to field in the park is essential to understanding the battles that took place within the park boundaries. Park flora serve as visual buffers from modern intrusions, enhancing the historical integrity of the park environment. Forested areas are stands of loblolly and Virginia pine and hardwood stands. Some species of flowering native flora enhancing the visitors experience are dogwood, redbud, paper mulberry, scotch broom, and the Yorktown onion. Tree species in the park sensitive to ozone include loblolly pine, sycamore, sweet gum, aspen, yellow poplar, black cherry, and ash. Other vegetation in the park sensitive to ozone includes common milkweed (*Asclepias syriaca*).

A parkwide survey of rare, threatened, and endangered flora and fauna is being conducted by the Virginia Natural Heritage Program. Also, a park-wide vegetation classification project is being conducted under a cooperative agreement with North Carolina State University, School of Forestry. The main emphasis is fire management.

Historic and Cultural Objects and Resources

The park includes a wide variety of historic and cultural resources relating to

1. Jamestown Island, and the first permanent English settlement in America. This includes the foundations of many excavated seventeenth century homes. Also, remaining is the seventeenth century Old Church Tower and monument.

2. Colonial period, including Colonial Williamsburg, historic Green Springs, Ringfield and Bellfield plantations, and the village of Yorktown.

3. Revolutionary War period, including the Yorktown battlefield with its miles of British, French, and American earthworks, and the many historic Yorktown brick and wooden structures (e.g., Moore house, Nelson house, Grace Church, the Customhouse and a national cemetery).

4. Civil War period, with its extensive earthen defenses throughout Yorktown, Jamestown Island, and the Colonial Parkway.

5. Yorktown Victory monument, erected in 1881 to commemorate the centennial of victory over Lord Cornwallis's British Army.

Soils

The elevation of the park ranges from about sea level to 130 feet above mean sea level. Jamestown Island is within the Levy-Pamunkey-Dogue soil series. This is a deep, predominantly clayey or loamy soil. The terrain is nearly level or gently sloping.

The Yorktown unit along the York River is in the Emporia-Bohicket-Slage soil series. The soils are predominantly loamy or clayey. The terrain is nearly level to very steep.

The main Yorktown battlefield is within the Bethera-Izagora-Slagle soil type. The soil is predominantly clayey or loamy. The terrain is nearly level to gently sloping.

Hydric soils dominate much of the park. Extensive wetlands are found throughout the park. The quality of the soils is important to the health of park flora. Changes in soil Ph levels or uptake of toxics which have been deposited on the soil can have adverse effects on vegetation.

Visibility

Visibility is a value essential to the national park experience. Scenic vistas are recognized as an important natural and cultural resource within the National Park System. The scene at Colonial National Historical Park is essential to the interpretation of the historic events commemorated by the park. Important vistas are those of the James River upon which the Jamestown settlers arrived, the York River where naval actions occurred during the Battle of Yorktown, and the Yorktown battlefield area where Cornwallis surrendered his troops.

Water Quality

Interstate 64 is the approximate watershed drainage divide between the York River on the north and the James and Chickahominy rivers on the south and west, respectively.

The park is bounded on either side by approximately 30 miles of the York and James rivers. Wetland areas are found throughout the park. The tidal marshes are saline or brackish. There are over 14 miles of streams within the park. Waters within the Yorktown section of the park include Wormley Pond, Great Run Creek, Baptist Run Creek, Beaver Dam Creek, Yorktown Creek, and Ballard Creek. Jamestown Island is mostly wetlands. Bodies of water on Jamestown Island include Sandy Bay, Back River, Kingsmill Creek, Passmore Creek, and the Thorofare. Eleven bodies of water along the Colonial Parkway include Roosevelt Pond, Indian Field Creek, Felgates Creek, Kings Creek, Queens Creek, Cheatham Pond, Jones Mill Pond, Halfway Creek, College Creek, Papermill Creek, and Powhatan Creek. Fingerling striped bass and spotted sea trout found in Yorktown Creek indicate that the marsh may be used as a nursery area by different fish species (USFWS Survey 1987).

The park is embarking on the development of a Water Resource Management Plan. This is proposed as a cooperative project with the Virginia Polytechnic Institute and State University, Virginia Water Resources Research Center. The project will provide a detailed hydrological overview of the park and identify management issues. This project, combined with the vegetation classification project, will be updating the USFWS 1974 Wetlands delineation maps.

Visitor Enjoyment

Poor air quality degrades the park's historic scenic vistas, and causes deterioration of the natural and cultural resources. Visitors come to the park to enjoy and learn from the natural environment and historic resources. NPS studies suggest that visibility conditions, clean air, and clear vistas are integral to the visitor's experience and enjoyment. Furthermore, the park visitor experience is diminished when the visitor is confronted with damaged historic and natural resources. Finally, visitor health may be adversely affected by air pollution (e.g., irritants to eye, nose, and throat).

Sources of Air Pollutants

Colonial National Historical Park is concerned with air pollution and its potential detrimental effects on the park's resources and the visitor experience. Air pollutants of NPS concern are sulfur dioxide (SO_2), nitrogen oxides (NO_x), photochemical smog, hydrocarbons, ozone (O_3), carbon monoxide (CO), particulate matter (PM), hydrogen sulfide (H_2S), and hydrogen fluoride (HF) (Tables 1 and 2). Information on the characteristics, effects, and major sources of major pollutants can be found in Appendix C.

Internal Sources

Internal air pollution sources are those that result from activities within the park.

Current

Air pollution generated within the park boundaries includes windblown soil and dust, construction activities, smoke from residential fireplaces, automobile emissions, and infrequent forest fires.

Traffic on Colonial Parkway is probably the major internal contributor to park air pollution. The parkway has become a major commuter route from Gloucester and Yorktown to Williamsburg. An average of 175,000 vehicles per month use the parkway for nonrecreational purposes. This compares with an average recreational use of the park of 70,000 vehicles per month (based on monthly traffic counts).

Projected

The only major change in park management activities being considered which could affect air quality is the possible introduction of prescribed burning. Seasonal air pollution impacts could occur from this activity. Future open fields management practices should reduce air pollution from soil and dust disturbance because of improved best management practices and vegetative cover.

External Sources

External air pollution sources are those that originate outside the park's boundaries. These are the major sources of air pollution affecting Colonial National Historical Park.

Current

The park is located in an urban area of increasing size and population. The park is affected by regional air pollution generated by surrounding residential and industrial land uses (Appendix D). It is possible that the park may be adversely impacted by air pollution sources 30 to 100s of miles from its borders. Long-range transport models used by the National Park Service at Shenandoah National Park show that under some meteorological conditions, 75% of the airborne sulfate concentration at that park is a result of emission sources located more than 100 kilometers from the Shenandoah. However, local sources also dominate under other meteorological conditions.

For ozone, the Norfolk-Virginia Beach-Newport News, Virginia, area has been declared an ozone non-attainment area based on 1988 data. There were four recorded exceedances in 1988. For 1989 the region was within standards for ozone.

In addition to localized pollution sources, there are many potential regional influences on park air quality, such as the Richmond area industrial plants, Hopewell chemical industries, and Providence Forge and West Point wood and pulp production plants. In the Hampton Roads area sources include construction, shipbuilding, power generation, industrial production, and considerable automobile and air traffic (Figure 3).

Projected

Most projected external air pollution problems and issues facing the park are related to future regional development. Because air pollution travels long distances, projects located some distance (30, 60, 100 miles or more) from the park could have an adverse effect on park resources. The park's air quality would be affected by significant increases in industrial and residential development and area traffic.

Table 1. Sources of Pollutants

Source	Pollutants
Cars, trucks, airplanes	Hydrocarbons, CO, NO_x
Dry cleaning	Volatile organic compounds (VOC)
Fireplaces, wood stoves	PM, NO_x, CO
Incinerator	PM, SO_x, NO_x, VOC
Industrial boilers	PM, SO_x, NO_x, CO, VOC, trace metals
Industrial processes	VOC
Oil refining	SO_2, H_2S, VOC, NO_x, PM
Paper plants	PM, SO_2, NO_x, H_2S
Ships	CO, NO_x, PM, SO_2, hydrocarbons

Source: Virginia Department of Air Pollution Control

Table 2. Major Emitting Facilities in Colonial Area

- Amoco Oil Refinery
- Anheuser-Busch Brewery - boilers
- automobile emissions from the heavily traveled surrounding roadways
- Ball Metal (can coating)
- Eastern State Hospital - boilers
- gas stations, dry cleaning plants
- Hampton Roads Sanitation Treatment District (sludge incineration and waste water treatment)
- Hampton Refuse Fired Steam Generating Facility - incinerator
- Hampton Roads Sanitation District Plant, James River
- Hampton University - boiler
- Maida Development Company (manufacturers capacitors)
- MICA Corporation of Canada (manufactures mica sheets)
- military bases - boilers
- NASA, Langley - boilers
- Newport News Shipbuilding
- open burning from leaf burning, and land clearing
- Patrick Henry International Airport
- Phil Carter Systems
- residential fireplaces and woodstoves
- ships and shipbuilding - boilers and process
- Somerville Packaging (printing)
- Virginia Power Electric Generating Plant

Source: Virginia Department of Air Pollution Control.

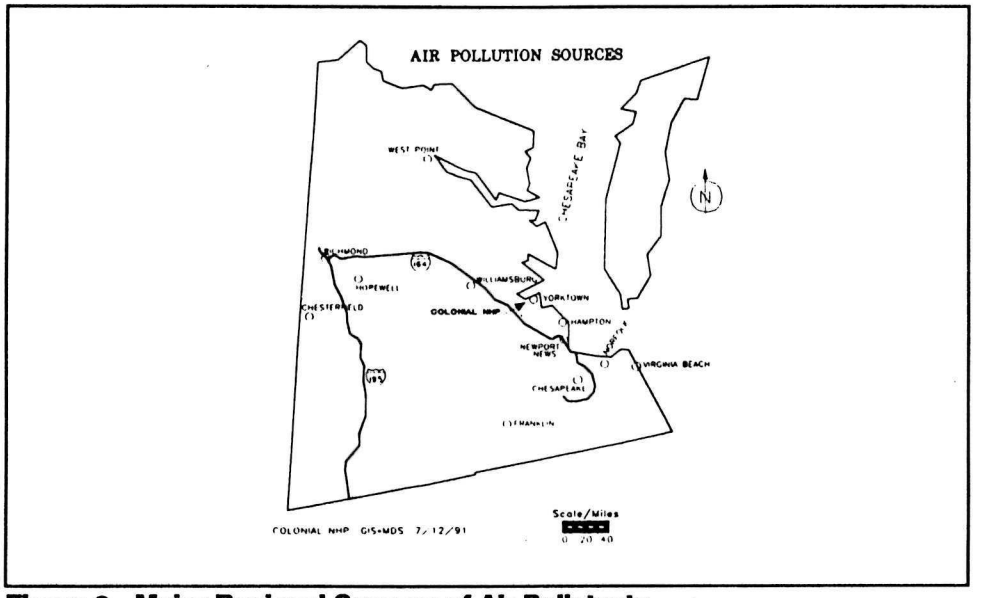


Figure 3. Major Regional Sources of Air Pollutants

Hampton	Hampton Refuse Fired Steam Generating Facility Hampton University Maida Development Company NASA, Langley
Newport News	Hampton Roads Sanitation District Treatment Plant MICA Corporation of Canada Military Base Newport News Shipbuilding Patrick Henry International Airport Phil Carter Systems
West Point	Chesapeake Paper Corporation
Williamsburg	Anheuser-Busch Brewery Ball Metal BASF Eastern State Hospital Mann Industries Military Base Somerville Packaging
Yorktown	Amoco Oil Refinery Military Bases Virginia Power Plant

Air Quality Problems and Issues

Problem Statement

Air pollution from park operations is minor. Park-generated pollution includes windblown soil and dust, construction activities, mowing operations, smoke from residential fireplaces, automobile emissions, and infrequent forest fires.

External local sources of air pollution include automobile traffic, residential use (fireplaces, wood stoves, furnaces), and industrial uses (boilers, oil refinery, electric power generation, airplanes, ships, gas stations, and dry cleaning operations). Possible regional influences include shipbuilding, air traffic, pulp paper production, power generation, chemical factories, and other industrial production plants.

Fauna

Little emphasis has been placed on air pollution effects on fauna. Because flora are excellent early indicators of air pollution damage, most research has concentrated on air pollution effects on flora. However, some adverse effects of air pollutants on fauna have been documented. Developing monarch butterfly larvae are dependant upon the leaves of the milkweed plant for survival. Ozone injury to milkweed leaves may affect the life cycle of the monarch butterfly. Nitrogen oxide may increase the susceptibility of animals to infections. Sulfur dioxide has been found to be irritating and damaging to the lungs of both animals and humans. Hydrogen sulfide can be deadly to animals in significant concentrations. Hydrogen fluoride (HF) accumulation in pastures can adversely affect grazing animals. A possible effect of long-term ingestion of HF-contaminated fodder is chronic fluorosis, which causes defects in teeth and bones as well as disruption of enzyme functions. Grazing animals may also experience weight and appetite loss, lameness, reduction in fertility and milk production, and eventually death.

Continued deposition of pollutants on plant leaf surfaces can lead to high ingested levels of trace elements by herbivores. Since these elements are typically not excreted, they accumulate and undergo biomagnification, which is the accumulation and concentration of elements through the food chain.

Research on acid rain impacts shows that some amphibians have proven extremely sensitive to increased acidity. This is especially true for their eggs. Even a slight acidic increase, in laboratory experiments, caused eggs to die, while other eggs became deformed tadpoles. Acidity in the water can cause a lower growth rate. In other cases, amphibians have adapted to the increased acidity.

Flora

The most common effect of air pollution on biological resources found in national parks has been foliar injury (damage to leaves) due to ozone. A summer of 1984 NPS survey of 25 eastern parks, including Colonial National Historical Park, disclosed widespread foliar injury to milkweed. A recent study conducted within the park found ozone damage to loblolly pine, yellow poplar, and grape (Davis 1988). Damage found during this study may have been light due to extreme drought conditions in 1988, which may have prevented the uptake of gases including ozone.

Sustained ambient ozone concentrations are high in the eastern United States, and foliar injury from ozone is quite common. The NAAQS for ozone is set at 120 ppb per 1 hour (the level at which ozone is thought to be harmful to humans). But, the National Park Service believes that levels as low as 60 ppb over an 8-hour period may cause foliar injury. Foliar damage by ozone appears as dark spots on the upper surfaces of leaves of deciduous species and yellow mottling of needles on evergreens. The presence of leaf damage means that

metabolic impairment and cell injury have occurred, indicating probable additional effects on growth and reproduction. Evidence suggests that reduced growth and increased mortality of some sensitive species are occurring in heavily polluted areas. The National Park Service is testing a hypothesis that adaptation of deciduous tree species to elevated ozone levels may have occurred in the more polluted parks. If sensitive genotypes are being eliminated from more polluted National Park System units, the species may become more vulnerable to other stresses due to decreased fitness, and species biodiversity may be decreased.

Other pollutants known to cause foliar injury are sulfur dioxide, hydrogen fluoride, and nitrogen dioxide. Sulfur dioxide is found to cause injury and growth loss to deciduous trees, pines, shrubs, and crops (including alfalfa, squash, grapes, and apples). There is evidence that long-term exposure to SO_2 below the NAAQS results in the disappearance of sensitive lichen species. This is commonly observed at annual SO_2 concentrations of about 15 ppb but has been observed at concentrations as low as 6 ppb. Hydrogen fluoride can be damaging to flora at very low levels causing leaf injury, leaf mortality, and reduction in growth in pines, firs, hardwood trees, mosses, and ferns.

Another possible source of foliar injury is trace elements. Trace elements, primarily heavy metals, contained in particulate air pollution may be deposited on plant surfaces. These elements can be metabolized by plants and build-up to damaging levels, causing foliar injury, stunted growth, or death. Elevated levels of sulfur and lead have been found in lichens at Shenandoah National Park.

The ecological effects of air pollution are under study by the National Park Service. Effects that may be the result of air pollution include tree mortality, decreased growth, premature leaf drop, reduced numbers of fruit and seed, smaller fruits and cones, impaired pollen germination, delayed bud break, decreased understory canopy, lower shrub productivity, increased susceptibility to winter injury, increased susceptibility to diseases and pests, altered plant competition, and decreased lichen diversity and abundance.

Historic Resources

The historic structures and objects are important resources at Colonial National Historical Park. These resources are susceptible to air pollution damage. Acid precipitation causes deterioration and discoloration of lead-based paint and deterioration of marble and other building surfaces.

Soils

Acid deposition can leach vital plant nutrients such as calcium from the soil and can kill essential soil microorganisms. It also releases aluminum ions, which normally bind to soil particles, into soil and water where they damage fine root filaments and reduces uptake of water and nutrients from the soil.

Water Quality

Acid deposition can threaten water quality in the park. The burning of fossil fuels results in emission of several pollutants, including sulfur dioxide and nitrogen oxides. If moisture is present, sulfuric and nitric acid are formed and are sometimes converted to particulate sulfates and nitrates. These can be deposited dry or may fall with precipitation. Acid deposition increases the acidity of surface and ground waters. This increased acidity can adversely affect water plants, eggs of fish and amphibians, and other resources.

The 1987 USFWS study conducted at Yorktown concluded that water quality within the park was very good for the parameters tested. The survey also concluded that because the streams are so small any activity within the watersheds that would degrade water quality would have a major negative impact on the aquatic life in the streams. The protection of park waters from acidification is therefore imperative for the protection of aquatic habitats.

Visibility

Although weather conditions certainly affect visibility, results from the NPS visibility monitoring program reveal that reduced visibility is mainly associated with the presence of anthropogenic airborne particles. Fine particles (diameter less than 2.5 microns) are the major contributor to visibility impairment. In most of the United States, sulfates are the greatest contributors to visibility impairment. Photochemical smog also contributes, often seen as a brown haze or cloud. Visual range at Colonial varies seasonally with excellent visibility in the winter and the worst visibility in the summer. Visibility is monitored at nearby Shenandoah National Park where the average median visual range for 1983 was 18 km (as opposed to 100 km at most western parks). The average airport visual range in the eastern United States for 1975-1983 was less than 28 km. Reduced visibility affecting the park is a regional problem. Studies examining the differences between airport visual range trends in eastern urban and suburban areas have found a significant decline in visual range in suburban areas, such as Yorktown. Monitoring at Colonial is necessary to determine the extent and sources of visibility impairment.

Visitor Enjoyment

Air pollution can affect visitor enjoyment through decreased visibility in the park. Also, air pollution may cause health problems for some visitors (e.g., eye, nose, lung irritation). EPA-collected data indicates that even healthy individuals, and especially those who exercise strenuously outdoors, may suffer adverse respiratory effects from concentrations of ozone that meet the current NAAQS. Photochemical smog is irritating to the eyes, nose, and throat. CO is extremely toxic to humans at low doses, especially to people with heart disease, anemia, asthma, and other respiratory ailments.

The park is used heavily for outdoor recreation (biking, jogging, picnicking, fishing), and air pollution may be impacting upon visitor enjoyment and health.

Toxics

Toxic compounds in the air (air toxics) are becoming an important air pollution control issue (Appendix C, Figure 1). The Environmental Protection Agency Region III selected Virginia to be the lead state for the federal air toxics pollution program. Virginia is one of only 14 states in the Nation that has regulations controlling toxic air pollutants. Virginia's regulations are more comprehensive than federal rules, and they include both new and existing sources of toxic air pollution. The state's program is just 4 years old. The state set up a pilot program to (Appendix D, Table 2):

1. identify sources of 61 toxic pollutants
2. identify the amount of pollutants emitted from each source
3. measure the concentration of these pollutants in ambient air
4. ascertain the effects on public health and the environment in general
5. implement control measures if the pollutant amounts released warrant them

The state then set up guidelines to determine allowable ambient concentrations of toxic pollutants. The guidelines are based on the threshold limit values set by the American Conference of Governmental Industrial Hygienists.

With experience gained in the pilot program, the state began a full-scale toxics program in July 1988 to evaluate all existing sources in Virginia. The state is developing an inventory of sources of toxic pollutants. Computer modeling is used to predict ambient air concentrations (PAAC) from each source and compared to the significant ambient air concentration guidelines (SAAC). If the PAAC is above the SAAC for that pollutant, the source has three options available, as follows:

1. challenging the standard
2. challenging the model
3. controlling the emissions to meet the SAAC

In the area surrounding the park, according to state statistics, several sources of toxic include the Amoco Oil Refinery, Newport News Shipbuilding, MICA Company of Canada, Inc., Mann Industries, BASF Fibers (BASF sold Mann Industries its acrylic fiber operations in 1989), and Ball Packaging Products Group. Toxic chemicals of concern include benzene, acrylonitrile, ethylbenzene, propylene, toluene, xylene, tetrachloroethylene, methanol, acetone, and freon 113 (Appendix D, Table 2).

Prevention of Significant Deterioration

Prevention of significant deterioration (PSD) is a program established under the Clean Air Act to regulate allowable future increases in air pollution in clean air regions of the country and to plan and manage the allocation and use of air resources (Appendix B, Table 2).

The baseline date for a NAAQS pollutant in the park's airshed is that date after August 7, 1977, on which the first complete PSD permit application was filed with the state of Virginia. According to a study conducted by Pacific Environmental Services, Inc., for the U.S. Environmental Protection Agency and the Virginia Department of Air Pollution Control, the baseline dates for SO_2 and total suspended particulates (TSP) were both triggered on June 28, 1978, in the two counties surrounding the park.

PSD permits previously issued in the Hampton Roads region are presented in Table 3.

Table 3. PSD Permits for Hampton Roads Region

Company	Date Issued	Source Type
Lone Star LaFarge Inc.	06/10/77	Cement
Virginia Power, Chesapeake Energy Center	07/27/84	Coal-fired utility boilers
U.S. Navy RDF Boiler Plant	03/26/84	Refuse derived fuel/coal-fired boilers
Cargill	06/04/84	Coal-fired boiler
Union Camp Corporation	07/01/85	Coal-fired boiler
Union Camp Corporation	11/15/85	Multi-effect evaporators and condensate stripper
Cogentrix	12/23/86	Coal-fired boilers (Cogeneration)
Hadson Power 11 - Southampton	02/06/90	Coal-fired boilers (Cogeneration)

Park Resource Management Project Statements

- COLO-N-003 Acid Deposition
- COLO-N-005 Air Pollution

NPS Servicewide Issues

- N3 - Impacts on Threatened, Endangered and Other Sensitive Plants
- N14 - Visibility Impairment and Biological Damage Caused by Air Pollution (includes wet and dry deposition)
- N20 - Lack of Basic Data, insufficient understanding of park ecosystem and threats to them

Recommended Course of Action

The park's planned course of action will be a multifaceted approach to air quality management in the park. The program, depending on funding, would consist of in-park monitoring of selected air pollutants and meteorological conditions. Also included would be research on air pollution impacts on park cultural and natural resources. Interpretative programs to inform visitors and the community of park air quality issues would be developed. External relations with the state of Virginia concerning regional air quality problems and permits would be increased. An in-park air quality program would provide for more effective management and protection of park resources. This course of action will provide the most useful baseline and monitoring information and promote further investigation into air pollution effects on park AQRVs.

Monitoring Actions

The NPS Air Quality Division (AQD) has recommended establishing a permanent air quality monitoring station, located and operated under EPA standards, within the park. The Air Quality Division reviewed the monitoring sites of the state of Virginia located closest to the park (Appendix E) and determined that they did not adequately reflect park air quality. The Yorktown Visitor Center was chosen for constructing the monitoring station because of its easy accessibility, secure location, and access to power. Also, this location is near many sources of pollution (i.e., Amoco Oil Refinery, Virginia Power Station, major transportation routes, industrial plants, and shipbuilding).

Currently, there are no private monitoring location stations within the peninsula area. The Virginia Electric Power Company monitored ozone, sulfur dioxide, and meteorological parameters within the park, near Surrender Field, from April 1981 to December 1987 (Appendix D). The state of Virginia operates a particulate (PM-10) monitoring station at Tabb Elementary School, approximately 7 miles south of Yorktown (Appendix D). Also, the state monitors PM-10, ozone, and sulfur dioxide at the Virginia School, Hampton, approximately 14 miles southwest of the park. A TSP monitoring station, across the river from Yorktown, at Gloucester Point, was discontinued in 1987 because of the consistently low readings.

The parameters chosen to be monitored included ozone, sulfur dioxide, particulate matter (including PM-10), and meteorological data (wind speed and direction, dew point, relative humidity, precipitation, and solar radiation). The meteorological station would serve a secondary role as a fire weather station. The Virginia Power Yorktown Plant presently records meteorological data. The Amoco Yorktown Refinery will have a meteorological station soon. These parameters were chosen

based on sources of air pollution that might impact the park AQRVs. The station would be operated by trained park personnel, with guidance and assistance from the Air Quality Division and the Virginia Air Pollution Control Board. The state of Virginia, because of limited resources and staffing, would not conduct quality assurance audits of this station. Therefore, it would not become part of the state air monitoring network.

Also, an automated camera visibility monitoring system is proposed, to be established at the Yorktown Visitor Center. This site affords a view of the York River and battlefield. The camera would record the same vista (to be determined) two or three times per day, and document changes in visibility. The scene at Colonial is essential to the interpretation of the historic events commemorated by the park. Important vistas are those of the James River upon which the Jamestown settlers arrived, the York River where naval actions occurred during the Battle of Yorktown, and the Yorktown battlefield area where Cornwallis surrendered his troops.

Data collected from fine particle monitors would provide information on the types of particles that are impairing visibility.

Research Needs

In September 1988, a study (Davis) was conducted to determine the feasibility of establishing permanent biomonitoring plots for ozone injury to vegetation in the park. The study included 13 stops in Jamestown, Yorktown, and along the Colonial Parkway. Vegetation at each site was examined for ozone damage and evaluated for use as possible permanent biomonitoring plots. One site was highly recommended as a permanent biomonitoring plot. Possible ozone injury was found at 7 of the 13 stops. Species that showed damage were loblolly pine, grape, and yellow poplar. It was concluded that significant bioindicator species are present within the park.

In June 1989 a follow-up study to the September 1988 study was conducted (Bennett and Wallner). Specific recommendations were made for establishing a monitoring network of biological indicators of air pollution at Colonial National Historical Park, Fredericksburg National Military Park, and Petersburg National Battlefield.

The proposal would reestablish the annual milkweed ozone study according to established AQD protocol (Bennett and Stolte 1985). Yellow poplar plots will be established to document annual trends of ozone injury on a woody, dominant species. For monitoring heavy metals and sulfur in vegetation, lichen elemental sampling will be used and will follow the methodologies used in Shenandoah National Park.

A series of biomonitoring plots will be established during the summer of 1991 to indicate the presence of air pollutants (especially O_3 and SO_2), provide trend data on the effects of ambient air pollutants on plants, and establish baseline vegetation conditions. The degree of severity of injury on selected indicators will be quantitatively evaluated. Another objective is to document the geographic extent of injury. Finally, types and possible sources of various pollutants may be identified using diagnostic techniques.

Also, a survey of park historic and modern structures would be planned to determine if any impacts from acid deposition is occurring. Future courses of action will be determined based on this survey. Air quality data collected by the park will be used by the Air Quality Division to conduct modeling studies and prepare recommendations for the mitigation of possible impacts from proposed new air pollution sources.

Interpretation

Displays informing visitors about air quality monitoring equipment and data would be incorporated into the park interpretative program. Stationary interpretive displays would be established in the Yorktown and Jamestown visitor centers to explain the purpose and function of air quality programs at the park. Visitors would be informed about how the park AQRVs are impacted by air pollution, and what actions the park staff are taking to deal with the problem. Visitors will be informed of what they can do to help alleviate air pollution during their visits and at home (conserve energy, use clean energy, car pool/mass transit, etc.).

Air quality discussions would be established as part of the park interpretive talks and slide programs, as appropriate. This will reinforce the information visitors receive at the stationary displays at the visitor center. Also, an interpretive poster based on the stationary display would be established for distribution to schools, community groups, etc.

External Relations

Park staff will continue to strengthen communications with nearby communities, military, state of Virginia, universities, secondary schools, and other organizations on air quality matters. This will include attendance and testimony at hearings regarding proposed developments near the park, permit review of major sources (A-1), environmental impact statement review and comment, coordination with other agencies on planning matters with air pollution implications, static displays, and interpretative talks. Increased involvement will occur with the Virginia Department of Air Pollution Control concerning the new source regulatory permitting process to mitigate future (and some current) impacts from pollution sources. Also, all of the previously mentioned activities by the park will be closely coordinated with the Mid-Atlantic Regional Office and the Air Quality Division.

Compliance

Environmental Compliance

This Air Quality Management Plan is categorically excluded from the NEPA process. This determination is based on the guidelines provided in the *United States Departmental Manual*:

- 516 DM, Appendix 7, 7.4(B)(4) - This plan would only involve nondestructive data collection, inventory, study, research, and monitoring activities.

The park has worked with the Air Quality Division and the Mid-Atlantic Chief Scientist John Karish, and the Virginia Department of Air Pollution Control in developing this plan.

Also, copies of this plan were provided to those individuals, companies, and agencies listed in Appendix F for review and comment.

Comments

Comments were received from Superintendent Gould, Colonial National Historical Park; the Air Quality Division; the Mid-Atlantic Regional Office; the regional resource management specialist; the BASF Corporation; Dr. Don Davis at Pennsylvania State University; Virginia Department of Air Pollution Control; Mr. Dave Haskell at Shenandoah National Park; and Dr. Wallace Reed from the University of Virginia.

All comments received were favorable. Minor recommendations for additions and changes were incorporated into the final draft. The state of Virginia in its final review stated that "this department has reviewed the plan and finds it to be a well-founded, comprehensive procedure to study and determine the air pollution impacts on the park. . . . The plan is recommended as consistent with the overall program of air pollution control." Ms. Katherine Jope of the Mid-Atlantic Regional Office stated, ". . . an excellent job. . . ."

Funding

Park Base

For FY92, increased funding has been requested for two additional permanent FTE positions, environmental protection specialist and biological technician. One of the duties will be to work on air and water quality monitoring programs. These positions are specifically targeted for inventory and monitoring activities including air, water, wetlands, vegetation management, and geographic information systems. Also, funding has been requested for capital equipment acquisition and operation. The likelihood of actual funding is currently unknown.

Fee Money

The status of the NPS fee program is not encouraging for additional funding for natural resource management and operations. In FY89-90, fee monies were targeted for acid deposition monitoring and a seasonal employee, but the Washington Office reprogrammed the monies to other operating programs. The park has no plans now to rely upon fee monies as a source of operating funds for air quality monitoring.

Servicewide Accounts

The park has prepared and submitted 10-238s for NRPP funding for a GIS/LTEM program. The request has been placed on the servicewide priority list for FY91-92, subject to the director's approval. Although part of this would be for air quality monitoring and management, it would not be sufficient funding sources for capital equipment acquisition and operation/analysis. When the needed equipment is itemized, the park will prepare appropriate 10-238s for servicewide AIR funding.

Air Quality Division

The Air Quality Division will continue to supply personnel services in the form of technical assistance to review results of research and monitoring programs, and to advise in the ongoing operation of the park's air quality management program.

Mid-Atlantic Regional Natural Science Program

The Mid-Atlantic Regional Natural Science Program will provide periodic financial support for the initiation of certain research and monitoring programs and costs of technical assistance.

Other Agencies - Federal, State, Local

Contacts have been made with the Virginia Department of Air Pollution Control regarding surplus monitoring equipment for use in the park. Equipment is not available now. Also, because of state staffing they would not be able to provide quality control assurance inspections of park-operated equipment.

Other

The park has not yet investigated the possibilities of donated equipment and services. Possible sources include local universities and private corporations.

Cost

The costs for the air quality monitoring stations acquisition, installation, and operation are in Table 4.

Table 4. Park Air Quality Monitoring Station Acquisition, Installation, and Operation Costs

Funding Source	Equipment Acquisition[1]	Yearly Analysis	Research	Interpretation[1]	Personnel (Park)
Air	$ 72,000	42,000		15,000	
Region	10,000		2,000		
Park	5,000				20,000
Subtotal	87,000	42,000	2,000	15,000	20,000
Grand Total	$166,000				

Annual Operation Cost = $64,000

One Time Acquisition/Installation Cost = $102,000

[1] Equipment acquisition includes equipment and installation cost. Proposed equipment includes a visibility camera, ozone, sulfur dioxide, PM-10, and weather station monitoring equipment. Other costs would include the acquisition and installation of an air quality monitoring station shed. Also, the cost for the design and production of air quality interpretative exhibits for both park visitor centers.

Appendixes

Appendix A. Virginia Department of State Air Pollution Control Organization

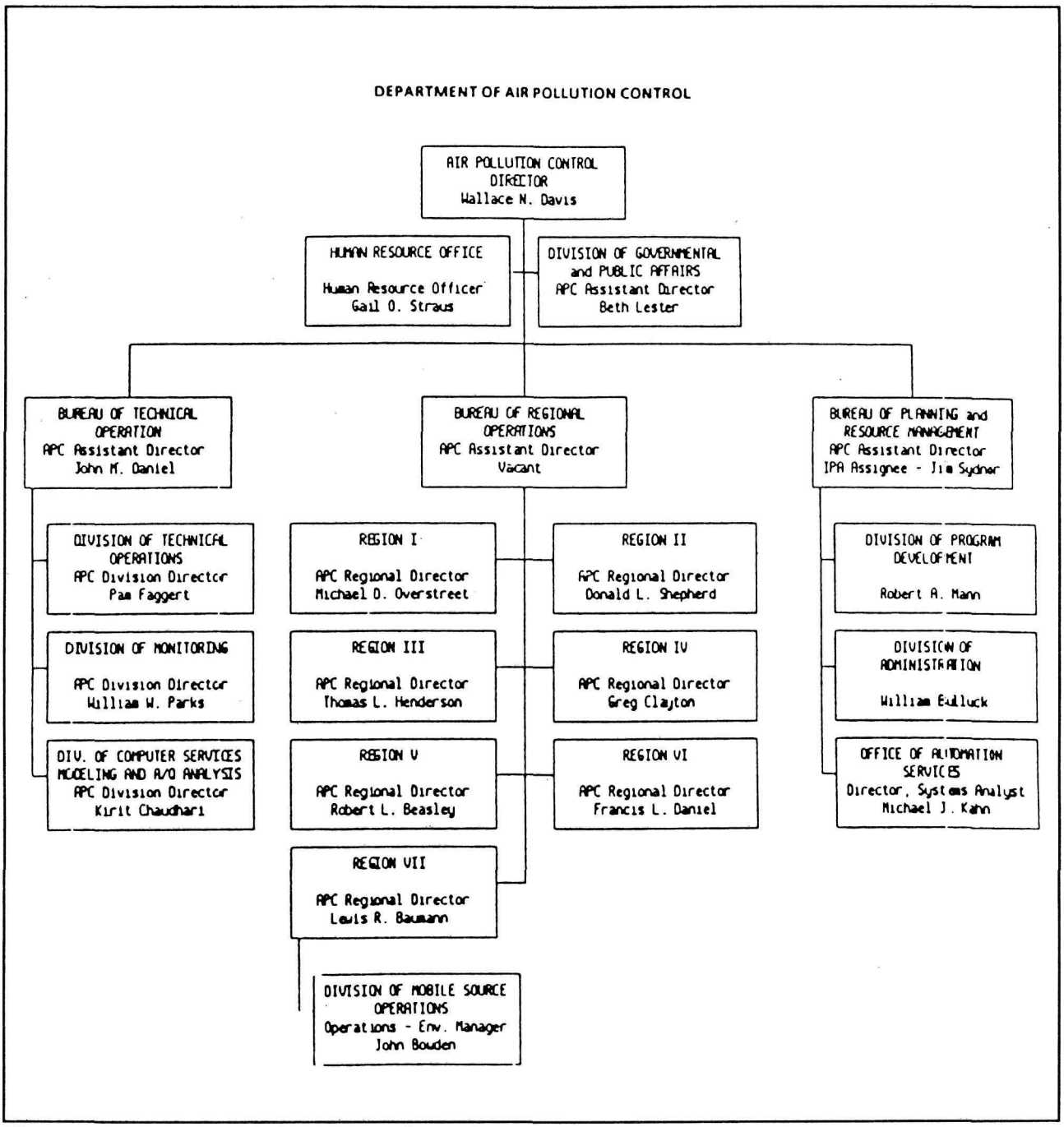


Figure 1. Department of Air Pollution Control

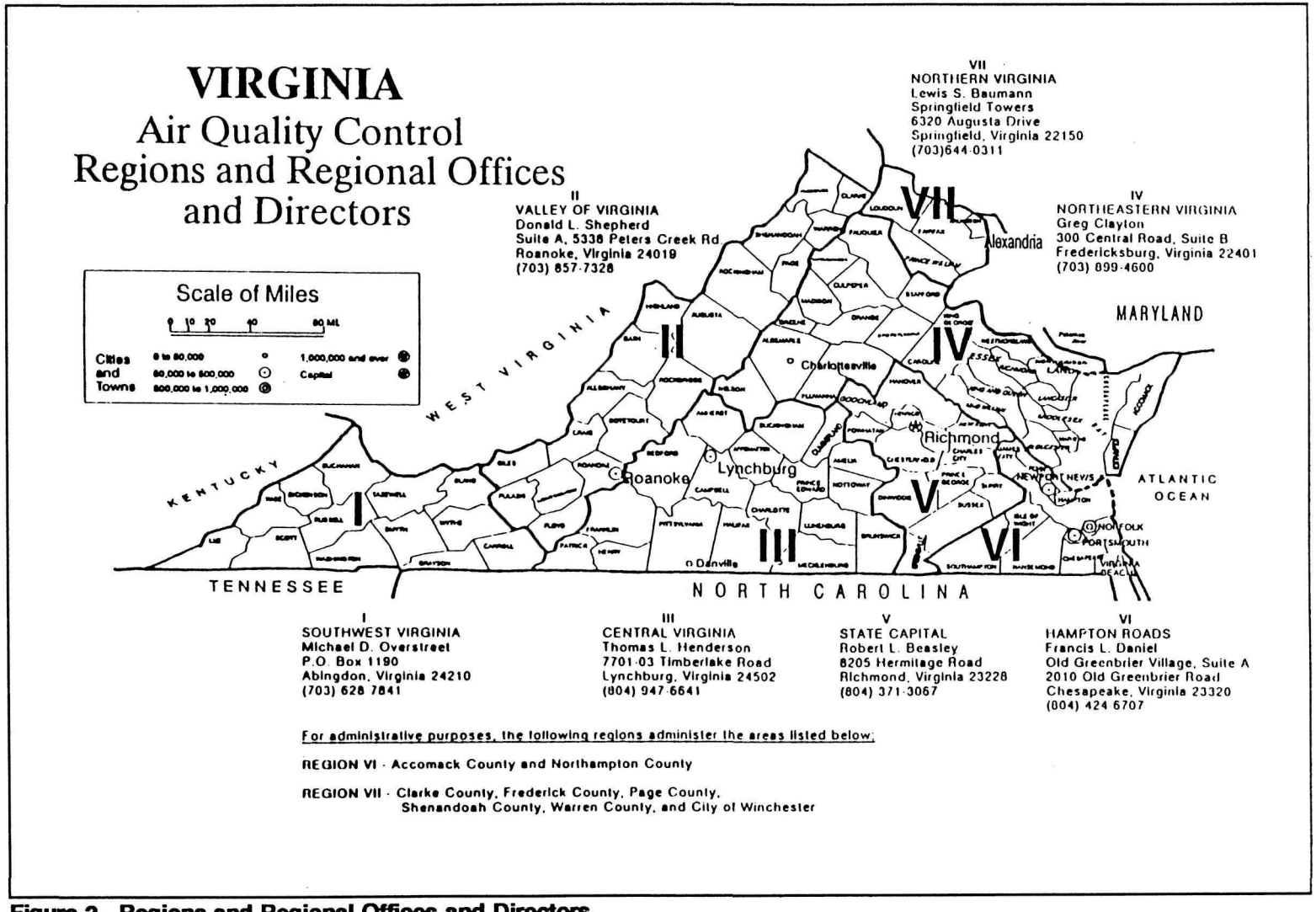


Figure 2. Regions and Regional Offices and Directors

Appendix B. National Air Quality Standards

Table 1. National Ambient Air Quality Standards

	Primary		Secondary	
	ug/m³	ppm	ug/m³	ppm
Sulfur Dioxide				
annual arithmetric mean	80	0.03	none	none
24-hour mean	365*	0.14	none	none
3-hour mean	none	none	1300	0.5*
PM-10(Particulate Matter)				
annual arithmetric mean	50	none	same as primary	
24-hour mean	150*	none	same as primary	
Carbon monoxide				
8-hour mean	10,000	9.0*	same as primary	
1-hour mean	40,000	35.0*	same as primary	
Ozone				
1-hour mean	235**	0.12**	same as primary	
Nitrogen dioxide				
annual arithmetic mean	100	0.05	same as primary	
Lead				
quarterly arithmetic mean	1.5	none	same as primary	

ug/m³ = micrograms per cubic meter
ppm = parts of pollutants per million parts of air by volume

*Not to be exceeded more than once a year
**Not to be exceeded more than 1 day per year (3 year average)
***A guide for assessing the achievement of 24-hour standards
Primary standard: Set to protect public health
Secondary standard: Set to protect public welfare

Table 2. Maximum Allowable Increases in Ambient Concentrations by all New Sources in Class I and Class II Areas (Prevention of Significant Deterioration)

	(ug/m³) Class I	Class II
Total Suspended Particulates*		
annual geometric mean	5	19
24 hour maximum	10	37
Sulfur Dioxide		
annual geometric mean	2	20
24 hour maximum	5	91
3 hour maximum	25	512
Carbon Monoxide 1 & 8 hour	none	none
Ozone 1 hour	none	none
Nitrogen Dioxide annual arithmetric mean	2.5	25
Lead calendar quarter mean	none	none

* PM-10 increments under development

Appendix C. Summary Information on Key Pollutants

Table 1. Key Pollutants of Concern to Colonial

Sulfur Dioxide (SO_2)

General Characteristics
- acrid gas
- atmospherically converted to acidic fine particulate sulfate (SO_4)
- toxic concentrations to plants and animals being as low as 0.03 ppm

Effects
- extremely corrosive to building materials, paint, metals
- damaging to human lung in original and sulfate form
- causes chlorosis of leaves, necrosis of conifer needles
- impairs visibility in sulfate form

Major Sources
- fossil fuel-fired power plants
- industrial boilers (coal fired)
- chemical production and processing
- oil refining
- kraft pulp and paper plants

Visual Signs of Effects
- chlorosis of leaf tissue in some species with veins remaining green, some leaves may take on a water soaked appearance later becoming desiccated and bleached

Nitrogen Oxides (NO_x)

General Characteristics
- occurs in several forms, the most important of which is nitrogen dioxide (NO_2)
- NO_2 is a visible yellow-brown to reddish-brown gas
- atmospherically converted to acidic fine particulate nitrate (NO_3)
- key pollutant contributor to photochemical smog

Effects
- eye, nose, throat irritation
- may increase susceptibility of humans and animals to infection
- suppresses plant growth at very low levels
- causes chlorosis of leaves
- impairs visibility in nitrate form

Major Sources
- coal fired power plants
- diesel and gasoline powered motor vehicles
- industrial boilers
- chemical production and processing
- oil refining
- kraft pulp and paper plants

Visual Signs of Effects
- suppressed plant growth
- brown cloud or plume

Photochemical Smog (photochemical oxidants)

General Characteristics
- results from atmospheric interactions of various pollutants, most frequently hydrocarbons and nitrogen oxides, in the presence of sunlight
- comprised of so called photochemical oxidants, the most significant of which is ozone (0_3), a colorless, unstable gas with a somewhat sweet odor
- toxic concentrations of ozone to plants begin as low as 0.06 ppm

Effects
- vegetation damage
- high levels cause eye irritation and aggravate respiratory problems
- damage to paint and textiles, accelerated cracking of rubber

Major Contributing Sources
- diesel and gasoline powered motor vehicles, especially in urban areas
- fossil fuel fired power plants
- chemical production and processing
- oil refining

Visual Signs of Effects
- leaf spotting (stippling) on upper surfaces of leaves
- cracking of rubber (hoses, tires, etc.)

Carbon Monoxide (CO)

General Characteristics
- a colorless, odorless gas
- results from incomplete combustion of carbon in fuels
- extremely toxic to humans in very low concentrations
- tends to be found as a localized, rather than a long-range, pollution problem

Effects
- human health effects range from dizziness and headaches to death (especially dangerous to people with heart disease, anemia, and respiratory ailments)

Major Sources
- automobiles, trucks, buses
- fires

Visual Signs of Effects
- difficult to detect on the basis of visual signs

Particulate Matter

General Characteristics
- may be particles of liquid or solid, toxic or nontoxic, organic or inorganic materials
- may be easily visible, or so small as to be microscopic

Effects
- depending on types of particulate pollutant, may cause cancer, damage to lungs, brain and central nervous system, and other health problems
- interferes with metabolism, respiration of plants
- causes visibility degradation

Major Sources
- diesel powered mobile sources
- almost all types of industrial processing
- forest fires

Visual Sign of Effects
- leaf rot, wilting, necrosis
- soiling, discoloration of buildings, man-made materials
- visibility degradation

Fine Particulates ("Fines", especially sulfates and nitrates)

General Characteristics
- often are derivative rather than primary pollutants
- can be transported in the atmosphere over long distances
- can cause serious damage to human health via inhalation

Effects (vary with the chemical composition of the particles)
- degradation of visual range and acuity
- acidification of soils, surface and ground waters
- particularly dangerous to aquatic populations reproducing in acidified waters
- leaching and corrosion of man-made materials

Major Contributing Sources
- all sources of SO_2, NO_x

Visual Signs of Effects
- regional haze reducing visual range and acuity
- reduced fish population in lakes and streams
- leaf spotting from acidic rain

Hydrogen Sulfide (H_2S)

General Characteristics
- highly toxic and corrosive gas
- easily identified by unpleasant rotten egg odor
- produced from natural sources (e.g., swamps, geysers) and from man-made sources

Effects
- may be deadly to humans and animals
- causes structural and functional damage to plant species

Major Sources
- oil refining
- kraft pulp and paper plants
- chemical production and processing

Visual Signs of Effects
- light brown-white scorching on inner vienal areas of leaves

Hydrogen Fluoride (HF)

General Characteristics
- gaseous pollutant which is readily taken up and accumulated in meadow and pasture plants
- can be extremely dangerous to grazing animals because of potential for fodder plants to accumulate toxic quantities from the air
- toxic concentrations to plants and animals begin as low as 0.0001 ppm

Effects
- disruption of metabolic processes and internal injury to plants leading to needle death, leaf injury and mortality
- tooth and bone defects, and other effects possibly leading to death in grazing animals

Major Sources
- aluminum smelters

Visual Signs of Effects
- marginal necrotic areas on leaves bounded by reddish band
- loss of weight, appetite, reduced lactation and fertility in grazing animals

Table 2. Toxic Chemicals of Public Health Concern and Effects

Acetone
- eye, mucous membrane irritant
- narcosis

Acrylonitrile
- dermatitis
- eye, skin, upper respiratory irritant
- suspected carcinogenic

Benzene
- aplastic anemia
- carcinogenic
- central nervous system depressant
- eye, skin, respiratory irritant
- neurotoxic
- oncogenic

Ethylbenzene
- eye, skin and mucous membrane irritant
- narcosis

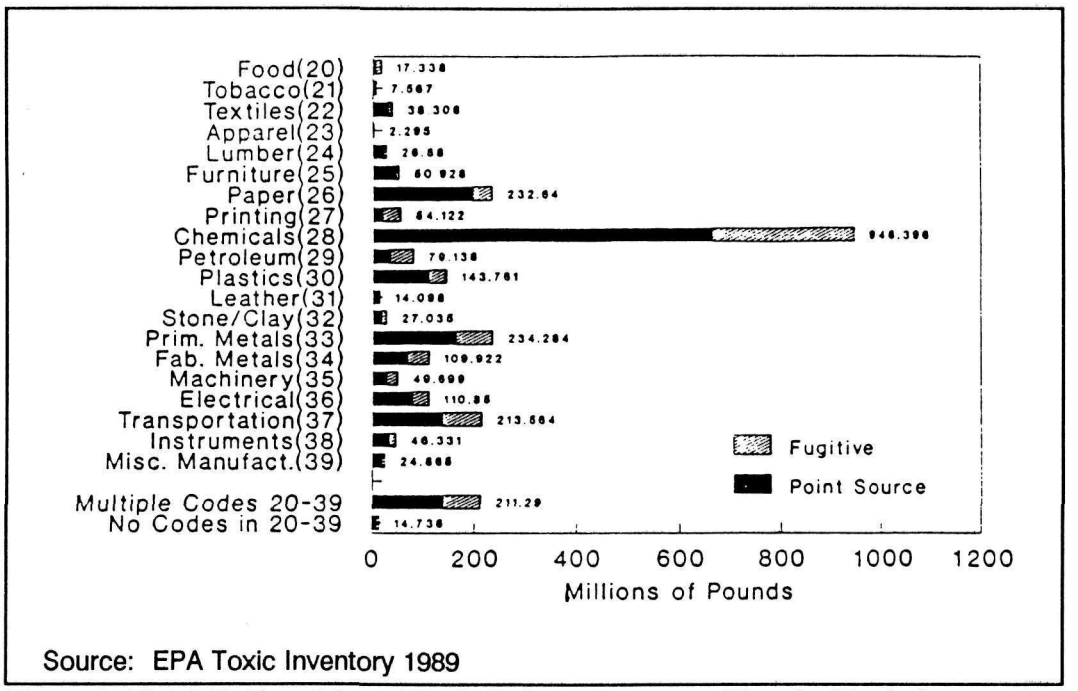
Freon 113
- cardiac sensitizer
- central nervous system depressant
- mild mucous membrane irritant

Propylene
- central nervous system depressant
- eye, nose, throat irritant
- unpleasant odor

Toulene
- central nervous system depressant
- eye, nose, throat irritant
- dermatitis

Tetrachloroethylene
- central nervous system depressant
- gastrointestinal system
- toxic to liver

Xylene
- eye, skin and mucous membrane irritant
- narcosis, at high concentrations



Source: EPA Toxic Inventory 1989

Figure 1. Total Air Emmision of Toxic Release Inventory Chemical by Industry, 1987

Table 3. 25th (TRI) Chemicals with Largest Air Emissions, 1987

TOTAL TRI RELEASE/ TRANSFER Rank	CHEMICAL NAME	FORMS REPORTING TRI AIR EMISSIONS Number	TOTAL TRI AIR EMISSIONS Pounds	Percent	TRI AIR POINT SOURCE EMISSIONS Pounds	Percent	TRI AIR FUGITIVE EMISSIONS Pounds	Percent
7	AMMONIA	2,015	316,028,225	11.98	263,255,197	14.53	54,773,028	6.49
9	TOLUENE	3,052	258,279,298	9.73	158,224,319	8.73	100,054,979	11.85
8	METHANOL	1,870	196,038,365	7.38	150,553,896	8.31	45,484,469	5.39
11	ACETONE	1,981	178,348,341	6.72	93,382,054	5.16	84,966,287	10.07
14	1,1,1-TRICHLOROETHANE	2,915	151,233,854	5.70	67,675,070	3.74	83,558,784	9.90
13	METHYL ETHYL KETONE	2,019	145,810,523	5.49	107,662,482	5.94	38,148,041	4.52
12	XYLENE (MIXED ISOMERS)	2,625	137,243,778	5.17	104,988,124	5.80	32,255,654	3.82
18	CARBON DISULFIDE	76	136,167,830	5.13	132,832,898	7.33	3,334,932	0.40
17	DICHLOROMETHANE	1,329	118,439,343	4.46	76,552,562	4.23	41,886,781	4.96
19	CHLORINE	1,179	110,349,352	4.16	104,616,580	5.78	5,732,772	0.68
2	ALUMINUM OXIDE	880	83,845,554	3.16	50,721,534	2.80	33,124,020	3.92
24	ETHYLENE	236	60,792,720	2.29	22,949,800	1.27	37,842,920	4.48
25	FREON 113	991	53,105,656	2.00	17,576,656	0.97	35,529,000	4.21
4	HYDROCHLORIC ACID	1,980	52,512,848	1.98	47,506,062	2.62	5,006,786	0.59
26	TRICHLOROETHYLENE	621	50,254,196	1.89	26,613,963	1.47	23,640,233	2.80
39	PROPYLENE	275	38,156,393	1.44	12,371,697	0.68	25,784,696	3.05
28	GLYCOL ETHERS	907	38,067,081	1.43	30,987,766	1.71	7,079,315	0.84
31	N-BUTYL ALCOHOL	864	32,640,700	1.23	24,462,853	1.35	8,177,847	0.97
35	TETRACHLOROETHYLENE	601	32,163,556	1.21	15,922,299	0.88	16,241,257	1.92
27	STYRENE	795	30,197,425	1.14	17,984,050	0.99	12,213,375	1.45
43	BENZENE	455	28,233,524	1.06	9,077,750	0.50	19,155,774	2.27
33	METHYL ISOBUTYL KETONE	698	27,522,278	1.04	16,806,167	0.93	10,716,111	1.27
45	CHLOROFORM	160	25,368,084	0.96	17,581,278	0.97	7,786,808	0.92
52	CARBONYL SULFIDE	19	20,882,955	0.79	20,877,594	1.15	5,361	0.00
5	SULFURIC ACID	2,279	19,408,368	0.73	17,076,332	0.94	2,330,036	0.28
	SUBTOTAL	31,002	2,343,088,247	88.23	1,606,258,981	88.79	734,829,266	87.05
	TOTAL FOR ALL OTHERS	20,279	312,454,463	11.77	203,125,677	11.21	109,328,786	12.95
	GRAND TOTAL	51,281	2,655,542,710	100.00	1,811,384,658	100.00	844,158,052	100.00

Source: EPA Toxic Inventory 1989

Table 4. Total TRI Air Emissions by Chemical Class, 1987

TOTAL TRI RELEASE/ TRANSFER Rank	CHEMICAL NAME	TOTAL TRI AIR EMISSIONS Pounds	PERCENT OF TOTAL TRI AIR EMISSIONS	TRI POINT SOURCE AIR EMISSIONS Pounds	Percent	TRI FUGITIVE AIR EMISSIONS Pounds	Percent
	Acids/Bases/Salts						
1	SODIUM SULFATE (SOLUTION)	5,702,418	0.21	5,586,409	0.31	116,009	0.01
3	AMMONIUM SULFATE (SOLUTION)	6,381,186	0.24	6,114,997	0.34	266,189	0.03
4	HYDROCHLORIC ACID	52,512,848	1.98	47,506,062	2.62	5,006,786	0.59
5	SULFURIC ACID	19,406,368	0.73	17,076,332	0.94	2,330,036	0.28
6	SODIUM HYDROXIDE (SOLUTION)	7,880,603	0.30	2,448,469	0.14	5,432,134	0.64
10	PHOSPHORIC ACID	1,615,570	0.06	1,224,960	0.07	390,610	0.05
	Subtotal	93,498,993	3.52	79,957,229	4.41	13,541,764	1.60
	TOTAL FOR ALL OTHERS IN CLASS	27,718,837	1.04	22,623,901	1.25	5,094,936	0.60
	TOTAL FOR CLASS	121,217,830	4.56	102,581,130	5.66	18,636,700	2.20
	Halo-organics						
14	1,1,1-TRICHLOROETHANE	151,233,854	5.70	67,675,070	3.74	83,558,784	9.90
17	DICHLOROMETHANE	118,439,343	4.46	76,552,562	4.23	41,886,781	4.96
25	FREON 113	53,105,656	2.00	17,576,656	0.97	35,529,000	4.21
26	TRICHLOROETHYLENE	50,254,196	1.89	26,613,963	1.47	23,640,233	2.80
35	TETRACHLOROETHYLENE	32,163,556	1.21	15,922,299	0.88	16,241,257	1.92
	Subtotal	405,196,605	15.26	204,340,550	11.28	200,856,055	23.79
	TOTAL FOR ALL OTHERS IN CLASS	65,966,407	2.48	41,900,791	2.31	24,065,616	2.85
	TOTAL FOR CLASS	471,163,012	17.74	246,241,341	13.59	224,921,671	26.64
	Metals and Metal Compounds						
2	ALUMINUM OXIDE	83,845,554	3.16	50,721,534	2.80	33,124,020	3.92
15	COPPER	2,370,791	0.09	2,121,998	0.12	248,793	0.03
16	ZINC COMPOUNDS	5,753,287	0.22	4,506,127	0.25	1,247,160	0.15
21	MANGANESE COMPOUNDS	2,043,072	0.08	1,495,407	0.08	547,665	0.06
23	ZINC (FUME OR DUST)	4,270,474	0.16	2,925,058	0.16	1,345,416	0.16
	Subtotal	98,283,178	3.70	61,770,124	3.41	36,513,054	4.33
	TOTAL FOR ALL OTHERS IN CLASS	15,481,549	0.58	9,393,671	0.52	6,087,878	0.72
	TOTAL FOR CLASS	113,764,727	4.28	71,163,795	3.93	42,600,932	5.05
	Non-metallic Inorganics						
7	AMMONIA	318,028,225	11.96	263,255,197	14.53	54,773,028	6.49
19	CHLORINE	110,348,352	4.16	104,616,580	5.78	5,732,772	0.68
49	ARSENIC COMPOUNDS	181,371	0.01	146,534	0.01	34,837	0.00
50	ASBESTOS (FRIABLE)	50,455	0.00	39,132	0.00	11,323	0.00
57	CHLORINE DIOXIDE	13,652,773	0.51	11,965,949	0.66	1,686,824	0.20
	Subtotal	442,262,176	16.65	380,023,392	20.98	62,238,784	7.37
	TOTAL FOR ALL OTHERS IN CLASS	98,260	0.01	65,427	0.00	32,833	0.01
	TOTAL FOR CLASS	442,360,436	16.66	380,088,819	20.98	62,271,617	7.38
	Organics (non-halogenated)						
8	METHANOL	196,038,365	7.38	150,553,896	8.31	45,484,469	5.39
9	TOLUENE	258,278,298	9.73	158,224,319	8.73	100,054,979	11.85
11	ACETONE	178,348,341	6.72	93,382,054	5.16	84,966,287	10.07
12	XYLENE (MIXED ISOMERS)	137,243,778	5.17	104,988,124	5.80	32,255,654	3.82
13	METHYL ETHYL KETONE	145,810,523	5.49	107,662,482	5.94	38,148,041	4.52
	Subtotal	915,720,305	34.48	614,810,875	33.94	300,909,430	35.65
	TOTAL FOR ALL OTHERS IN CLASS	584,605,331	22.02	391,970,969	21.64	192,634,362	22.82
	TOTAL FOR CLASS	1,500,325,636	56.50	1,006,781,844	55.58	493,543,792	58.47
34	TOTAL FOR MIXTURES	5,427,665	0.21	3,398,237	0.20	2,029,428	0.24
100	TOTAL FOR TRADE SECRETS	1,283,404	0.05	1,129,492	0.06	153,912	0.02
	GRAND TOTAL	2,655,542,710	100.00	1,811,384,858	100.00	844,158,552	100.00

Source: EPA Toxic Inventory 1989

Appendix D. State Air Quality Monitoring Data for Hampton Roads Area

Table 1. Annual Monitoring Summaries for State of Virginia Sites in Hampton Roads Area

Total Suspended Particulate Matter (ug/m³) Warwick H.S., Newport News, 180-F				
Year	Low 24-hour avg.	High 24-hour avg.	Annual Geometric Mean	Number of Observations
1984	Discontinued			
1983	15	114	42	20
1982	18	83	41	59
1981	22	127	NA	46
1980	25	104	55	43
1979	17	94	NA	51
1978	25	94	46	61
1977	25	113	50	60

Total Suspended Particulate Matter (ug/m³) Williamsburg, Municipal Building, 185-A				
Year	Low 24-hour avg.	High 24-hour avg.	Annual Geometric Mean	Number of Observations
1988	Discontinued			
1987	14	111	NA	42
1986	10	80	NA	52
1985	18	51	NA	13
1984	13	89	39	55
1983	18	114	42	60
1982	24	108	NA	24
1981	22	107	NA	44
1980	16	149	52	57
1979	12	114	41	59
1978	15	89	46	58
1977	25	141	50	25

Source: Virginia State Air Pollution Control Board, Annual Report, 1977-1989.

Total Suspended Particulate Matter (ug/m³), York Co., Tabb Elementary School, 89-F				
Year	Low 24-hour avg.	High 24-hour avg.	Annual Geometric Mean	Number of Observations
1989	Discontinued			
1988	20	108	40	59
1987	17	99	NA	56
1986	12	109	42	60
1985	17	54	30	15
1984	13	89	39	55
1983	14	79	NA	38
1982	12	65	36	59
1981	19	113	NA	43
1980	20	84	47	61

PM10 - Tabb Elem. School, York Co., 89-F				
Year	Low 24-hour avg.	High 24-hour avg.	Annual Arithmetric Mean	Number of Observations
1989	9	40	NA	12

Total Suspended Particulate Matter (ug/m³), Gloucester Pt., VIMS, 90-A				
Year	Low 24-hour avg.	High 24-hour avg.	Annual Geometric Mean	Number of Observations
1987	Discontinued			
1986	12	52	NA	13
1985	11	94	33	59
1984	14	74	35	59
1983	14	93	32	58
1982	13	60	32	53

Source: Virginia State Air Pollution Control Board, Annual Reports, 1980-1989.

Carbon Monoxide (ppm), Newport News, Jefferson Avenue, 180-N				
Year	1-hr Max.	8-hr Max.	Annual Arithmetric Mean	Number of Observations
1989	7.0	4.3	NA	8529
1988	11.4	4.2	NA	8766
1987	9.3	3.5	0.8	742

Carbon Monoxide (ppm), Newport News, Todd Field, 180-H				
Year	1-hr Max.	8-hr Max.	Arithmetric Mean	Number of Observation
1988	Discontinued			
1987	3.3	1.6	0.7	321
1986	12.0	6.0	0.9	8693
1985	10.7	5.8	1.0	2201

Sulfur Dioxide (ppm), Hampton, Va. School, 179-C			
Year	High	Arithmetric Mean	Number of Observations
1989	.034	.006	350
1988	.035	.007	353
1987	.02	.01	361
1986	.03	.01	364
1985	.02	.01	352
1984	.03	.01	321
1983	.03	.01	351
1982	.03	.01	345
1981	.04	.01	336
1980	.05	.01	358
1979	.04	.01	344

Source: Virginia State Air Pollution Control Board, Annual Reports, 1979-1989.

Nitrogen Dioxide (ppm) - Va. Beach, Orn. Res. Sta., 184-G				
Year	Low	High	Arithmetric Mean	Number of Observations
1988	Discontinued			
1987	.00	.088	.017	8642
1986	.00	.06	.02	7173
1985	.00	.08	.02	8636
1984	.00	.08	.02	9714
	.00	.08	.02	8534

Nitrogen Dioxide (ppm) - Norfolk State University., 181-Z			
Year	Low	Arithmetric Mean	Number of Observations
1989	.098	.020	7592

Ozone (ppm), Hampton, Va. School, 179-C				
Year	1-hr Max.	Mean	Days over .12 ppm	Number of Observations
1989	.119	NA	0	8486
1988	.133	NA	2	8404
1987	.127	.03	1	7260
1986	.14	.03	1	8700
1985	.12	.03	0	8700
1984	.11	NA	0	7881
1983	.14	.03	2	8516
1982	.12	.03	0	8505
1981	.116	.028	0	8357
1980	.117	NA	0	6254
1979	.126	NA	1	4733
1978	.167	NA	0	4641
1977	.134	.027	0	7881

Source: Virginia Air Pollution Control Board, Annual Reports 1977-1989.

Table 2. Toxic Air Data, 1988 - lbs./year

Source	Pollutant	Fugitive Emissions	Stack Emissions	Total
Amoco Yorktown	Benzene	25000	19000	44000
	Ethylbenzene	33000	9200	42200
	Ethylene	18000	0	18000
	Propylene	35000	0	35000
	Toluene	120000	74000	194000
	Xylene	160000	52000	212000
	1,2,4 Trimethylbenzene	71000	31000	102000
Maida Dev. Co.	Tetrachloroethylene	250	27000	27250
Mica Co. of Canada	Methanol	6800	129600	135400
	Toluene	0	152300	152300
	Acetone	110000	76000	186000
Newport News Shipbuilding	N-Butyl Alcohol	40000	27000	67000
	Dichloromethane	24800	0	24800
	Freon 113	10000	0	110000
	Xylene	195000	131000	326000
Phil Carter Systems	Acetone	39340	0	39340
	Freon 113	16495	63650	80145
	Toluene	24542	2487	27029

Source: EPA Toxic Inventory 1989

Table 3. Virginia Power Monitoring Station, SO_2 Readings (ppm)

Year	1-hr Max.	24-hr Max.	Annual Arithmetic Average
1988	Discontinued		
1987	.093	.021	.005
1986	.068	.027	.005
1985	.169	.029	.002
1984	.081	.025	.004
1983	.082	.025	.004
1982	.097	.043	.006
1981	.094	.024	.009

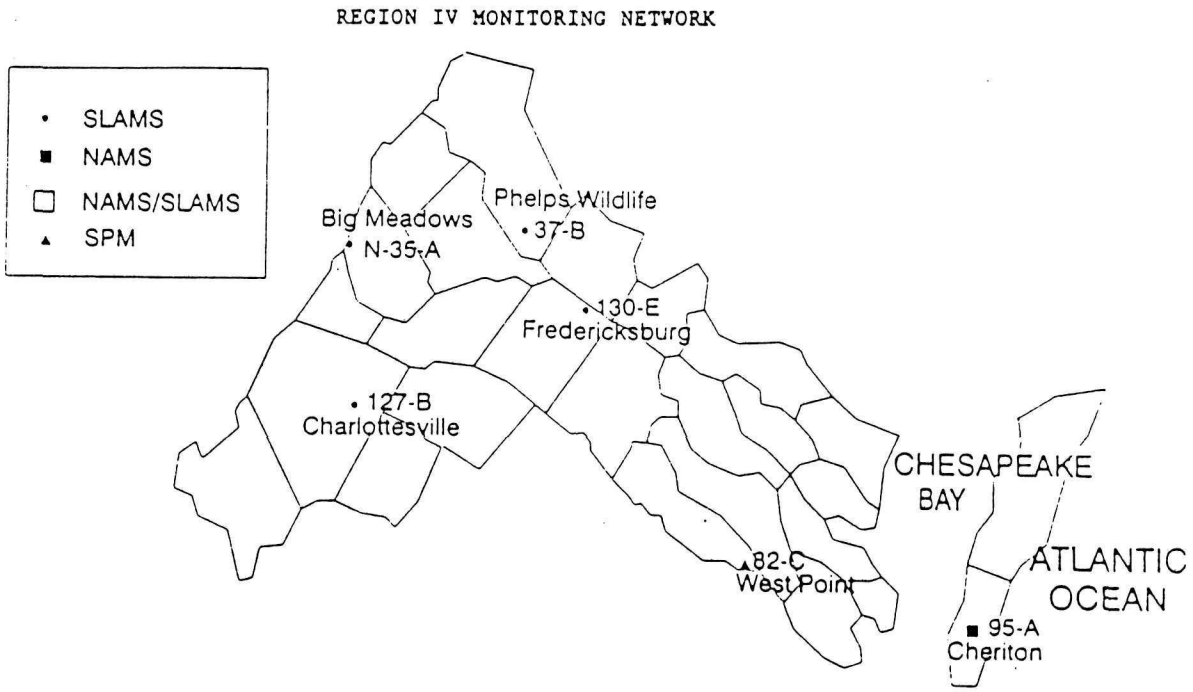
Source: Virginia Power

Table 4. Virginia Ozone Seven Year Trend - Number of Days Primary Standard of .12 ppm Exceeded

Location	Station No.	1983	1984	1985	1986	1987	1988
Region IV							
Fauquier Co.	37-B	1	1	0	0	1	1
Northampton Co.	95-A	5	0	0	0	0	2
Region V							
Charles City Co.	75-B	-	-	-	-	-	5
Chesterfield Co.	71-H	5	1	0	0	1	4
Hanover Co.	73-C	4	1	1	0	4	9
Henrico Co.	72-M	0	2	0	0	0	5
Region VI							
Hampton	179-C	2	0	0	1	1	2
Suffolk	183-C	-	-	-	-	2	4

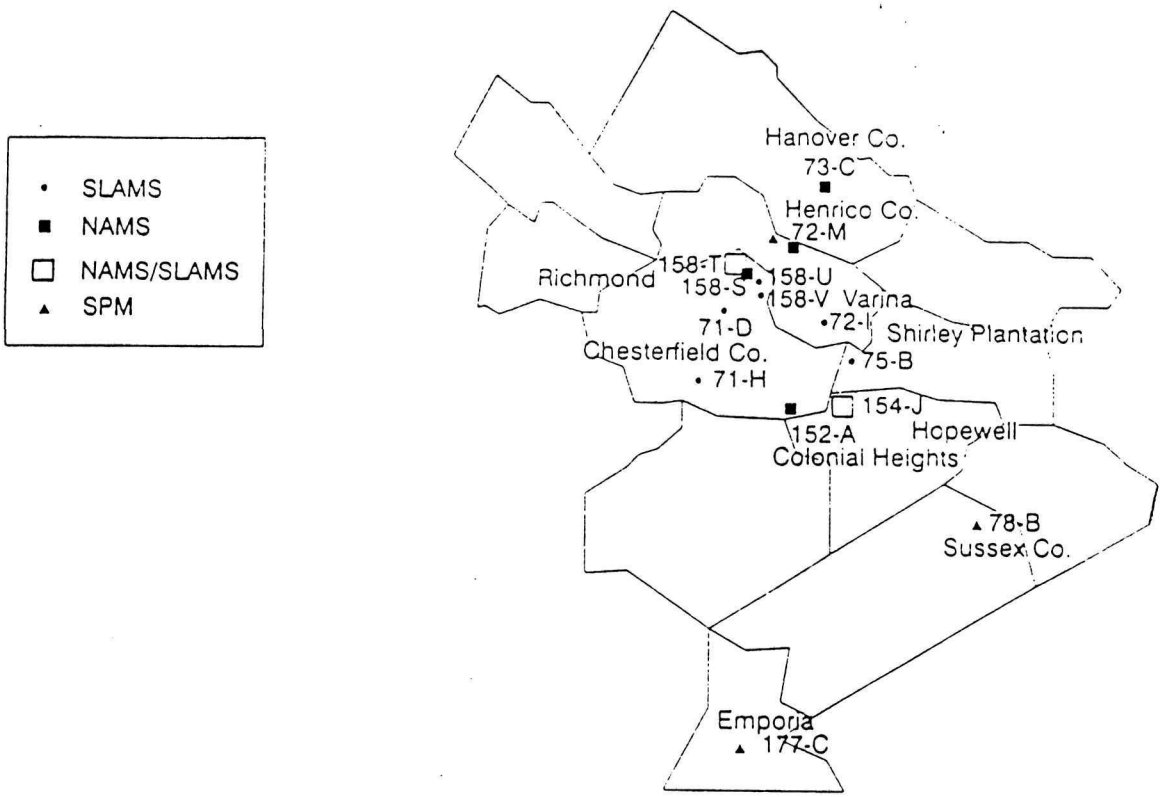
Source: Virginia State Air Pollution Control Board, Annual Reports, 1983-1989.

Appendix E. State of Virginia Monitoring Locations and Maps



STATION NUMBER REGION IV	POLLUTANTS	LOCATION	CITY/COUNTY
127-B	PM10	CITY HALL ANNEX	CHARLOTTESVILLE
37-B	O_3	PHELP'S WILDLIFE AREA	SUMERDUCK FAUQUIER CO.
130-E	PM10	HUGH MERCER ELEM. SCHOOL	FREDERICKSBURG
82-C	TSP	W. POINT ELEM SCHOOL	WEST POINT
95-A	O_3	CHERITON POST OFFICE	CHERITON NORTHAMPTON CO.
35-A	O_3	SHENANDOAH NP	MADISON CO.

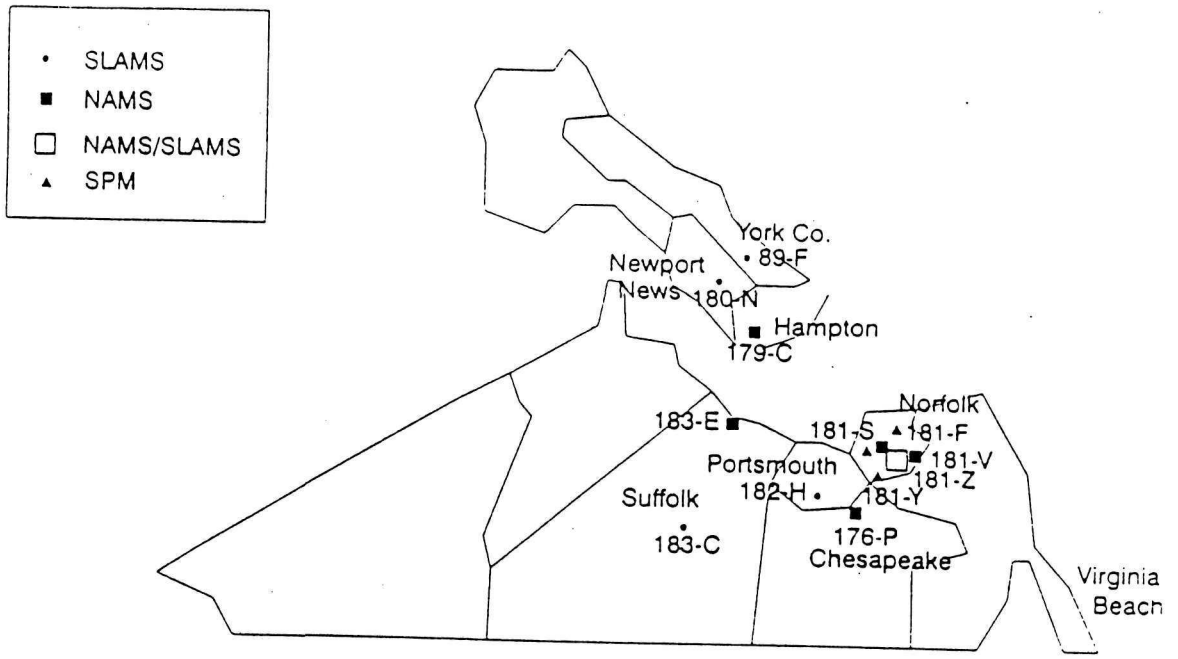
REGION V MONITORING NETWORK



STATION NUMBER REGION V	POLLUTANTS	LOCATION	CITY/COUNTY
75-B	O_3	SHIRLEY PLANTATION	CHARLES CITY CO.
71-D	PM10	BENSLEY ARMORY	CHESTERFIELD CO.
71-H	O_3	BEACH RD. HIGHWAY SHOP	CHESTERFIELD CO.
72-I	PM10	VARINA ELEM. SCHOOL	HENRICO CO.
72-M	O_3 NO_2 NMOC	MATH AND SCIENCE CENTER	HENRICO CO.
73-C	O_3	RAVEN RUN PUMP HOUSE	HANOVER CO.

STATION NUMBER REGION V - cont.	POLLUTANTS	LOCATION	CITY/COUNTY
154-J	PM10 SO_2 HEAVY METALS	WASTEWATER PLANT	HOPEWELL
158-S	TSP PM10	DISTRIBUTOR RD. DAPC MONITORING DIV.	RICHMOND
158-T	CO NO_2 SO_2 NMOC	W. BROAD ST. PARKING LOT #23	RICHMOND
158-U	CO	FIRE STATION FOREST HILL AVE.	RICHMOND
158-V	PM10	PUBLIC WORKS BLDG	RICHMOND

REGION VI MONITORING NETWORK



STATION NUMBER REGION VI	POLLUTANTS	LOCATION	CITY/COUNTY
89-F	PM10	TABB ELEM. SCHOOL	YORK CO.
176-P	TSP PM10 Pb	OSCAR SMITH HS	CHESAPEAKE
179-C	SO_2 O_3 PM10	VIRGINIA SCHOOL	HAMPTON
180-N	CO	CEBAF, JEFFERSON AVE.	NEWPORT NEWS
181-S	PM10 TSP	FIRE STATION #1	NORFOLK

STATION NUMBER REGION VI - cont.	POLLUTANTS	LOCATION	CITY/COUNTY
181-V	CO Pb	POST OFFICE CHURCH ST.	NORFOLK
181-Z	NO_2 SO_2 CO NMOC Pb	NORFOLK ST. UNIV.	NORFOLK
182-H	PM10	MANOR HS	PORTSMOUTH
183-C	PM10	WASHINGTON ELEM SCHOOL AVE.	SUFFOLK
183-E	O_3 TSP	TIDEWATER COMM. COLLEGE	SUFFOLK

Appendix F. Agencies and Persons Consulting or Reviewing

American Oil Company
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P.O. Drawer U
Williamsburg, VA 23187

BASF Corp.
ATTN: Mr. Bruce Roberts
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Williamsburg, VA 23187

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Department of Environmental Science
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City of Newport News Parks and Recreation
Mr. Mike Poplowski
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Newport News, VA 23602

Dr. Robert Byrnes
College of William and Mary
VA Institute of Marine Science
Gloucester Point, VA 20862

College of William and Mary
Dept. of Biology
Dr. Lawrence Wiseman, Chairman
Williamsburg, VA 23185

College of William and Mary
Dept. of Geology
Dr. Gerald Johnson
Williamsburg, VA 23185

Dr. Don Davis
Penn. State University
Dept. of Plant Pathology
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James City County, City of Williamsburg
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Williamsburg, VA 23187

Health Department
Peninsula Health Center
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Newport News, VA 23601

Ms. Sandi Manter
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Charlottesville, VA 22903

Newport News Shipbuilding Co.
ATTN: Environmental Engineering
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Newport News, VA 23607

Old Dominion University
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Hampton Blvd.
Norfolk, VA 23529 Old Dominion University
Dept. of Chemistry
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Old Dominion University
Dept. of Civil Engineering
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USDI, NPS, Colonial NHP, HIP and RA

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USDI, NPS, Mid-Atlantic Region
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University Park, PA 16802

USDI, Shenandoah NP
Mr. Dave Haskell
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Williamsburg, VA 23185

U.S. Coast Guard Reserve Training Center
Captain D. Teetson, Commanding Officer
Yorktown, VA 23690

U.S. Navy
Captain Robert L. Masten
Commanding Officer
Yorktown Naval Weapons Station
Yorktown, VA 23691-5000

U.S. Navy, Cheatham Annex Supply Center
Captain Karl A. Kowalski, Officer-in-Charge
Williamsburg, VA 23185

U.S. Navy
Attn: Mr. Steve Olson
Environmental Programs Division
Naval Base
Norfolk, VA. 23511-6002

University of Virginia
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Richmond, VA 23219

Va. Natural Heritage Program
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Mr. Francis L. Daniel
Regional Director
VA Dept. of Air Pollution Control, Region 6
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Mr. Wallace Davis
Executive Director
VA. Department of Air Pollution Control
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Richmond, VA 23240

Glossary

Aerosol - A dispersion of microscopic solid or liquid particles in a gaseous medium. Smoke and fog are aerosols.

Air quality model - A mathematical representation of the behavior of air pollutants from a source to a receptor.

Air quality related value (AQRV) - A feature or property of an area that is affected in some way by air pollution. Examples include sensitive flora and fauna or visibility.

Attainment area - (Also known as "clean air area") A geographic area in which the quality of the air is better than the applicable national ambient air quality standards. PSD requirements apply in attainment areas.

Baseline concentration - The concentration of a pollutant at the time of the first application for a PSD permit in an attainment area.

Best available control technology (BACT) - An emission limitation applied to a new or modified major stationary source in an attainment area; determined by the permitting authority on a case-by-case basis taking into account environmental consequences, energy considerations, and economic impacts.

Best available retrofit technology (BART) - An emission limitation applied to an existing major stationary source that may reasonably be anticipated to cause or to contribute to impairment of visibility in federal mandatory class I areas.

Class I, II, and III Areas - Regions in where maintenance of good air quality is of high priority. In class I areas, maintenance of air quality is regarded as having the highest priority with respect to other values; in class III areas, air quality has lower priority than it does in the other two areas. Initially, all attainment areas except mandatory class I areas were designated class II.

Environmental impact statement (EIS) - A written documentation of the environmental impacts of a proposed federal action entailing significant impacts on the human environment, prepared in compliance with Section 102(2)(C) of the National Environmental Policy Act of 1969.

Haze - An atmospheric aerosol of sufficient concentration to be visible. The particles are so small that they cannot be seen individually, but are still effective in visual range reduction.

Increments - Maximum allowable increases of air pollution over baseline concentrations of pollutants covered by the PSD provisions in class I, II, and III areas. At present, increments have been established for sulfur dioxide, particulate matter, and nitrogen dioxide.

Major source - Any source in an attainment area that emits at least 250 tons of any pollutant regulated under the Clean Air Act or any source from among 28 categories of sources that emits at least 100 tons per year of any regulated pollutant.

Mandatory class I area - An international park or a national wilderness area larger than 5,000 acres, or a national park larger than 6,000 acres, as of August 7, 1977. States may not reclassify mandatory class I areas.

Mobile source - A pollutant source which moves from place to place, emitting while in motion (e.g., car, truck, ship, plane, etc.).

National ambient air quality standards (NAAQS) - National standards, established under the Clean Air Act by EPA, which prescribe levels of pollution in the outdoor air which may not be exceeded.

Primary NAAQS - Standard set at a level to protect public health from damage from air pollution with an adequate margin of safety.

Secondary NAAQS - Standard set at a level to protect public welfare from damage from air pollution, National Emission Standards for Hazardous Air Pollutants (NESHAPS).

Standards limiting emissions - (or dictating performance or work procedures) for certain identified pollution emission sources. Hazardous pollutants include asbestos, beryllium, and mercury.

New source performance standards (NSPS) - A set of federally established standards limiting the concentrations of pollutants which may be released into the atmosphere from emission points of new and expanded factories and plants.

Nonattainment area - A region where ambient concentrations of criteria pollutants exceed the levels specified as minimal standards for protecting public health and welfare, i.e., the NAAQS. Nonattainment requirements apply in these areas.

Prevention of significant deterioration (PSD) - Program established under the Clean Air Act to regulate allowable future increases in air pollution in clean air regions of the country and for the planning and management of the allocation and use of air resources.

Public Health - is determined by the EPA administrator to protect public health with an adequate margin of safety. Applies to primary NAAQS.

Public Welfare - is defined to include the protection of the types of resources (AQRVs) found in national park areas from all known or anticipated adverse effects. Applies to secondary NAAQS.

Redesignation process - Process authorized under Section 164 of the Clean Air Act, which provides for reclassification of all or part of an attainment area to receive greater or lesser protection from air pollution degradation. Mandatory class I areas cannot be redesignated. Certain national areas over 10,000 acres (parks, wilderness areas, wild and scenic rivers, wildlife refuges, and lake shores and seashores) can only be redesignated from class II to class I. Other attainment areas may be redesignated class I, II, or III.

Source - In atmospheric chemistry, the place, places, group of sites, or areas where substance is injected into the atmosphere. Can include point sources, fugitive sources, and area sources.

State Implementation Plan - A plan devised by a state and approved by the administrator of the EPA for implementing and enforcing provisions of the Clean Air Act. Part of each SIP must describe a PSD program.

Stationary source - A pollutant source which is in a fixed location (e.g., smelter, power plant, etc.).

TRI - Toxic Release Inventory - program of EPA for listed chemicals that are emitted into the air, water, or ground from point and fugitive sources that must be reported.

Visibility - The quality of the atmosphere that affects the ability to see forms, colors, textures, details, and distant objects. Visibility is affected by the amount of light scattered and absorbed in the sight path by air molecules and pollutants.

Visual range - The greatest distance in a given direction of which it is possible to see and identify with the unaided eye a prominent dark object against the sky at the horizon.

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-633 July 1991