AIR PROTECTION BRANCH

2019 Air Quality Report

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Last updated: 12/15/2020

Informational Publication

This document is published annually by the Ambient Monitoring Program, in the Air Protection Branch of the Georgia Department of Natural Resources, Environmental Protection Division.

DISCLAIMER: Any reference to specific brand names is not an endorsement of that brand by the Georgia Environmental Protection Division.

ENVIRONMENTAL PROTECTION DIVISION

Air Protection Branch

Ambient Monitoring Program

4244 International Parkway Suite 120 | Atlanta, GA 30354

Web: https://airgeorgia.org/

Phone: 404-363-7000

Contents

Page intentionally left blank

Introduction

EPD Mission

The Environmental Protection Division (EPD) protects and restores Georgia's environment. We take the lead in ensuring clean air, water, and land. With our partners, we pursue a sustainable environment that provides a foundation for a vibrant economy and healthy communities.

Who We Are

- This report is prepared by the Ambient Monitoring Program (AMP), a program of the Air Protection Branch of the Georgia Environmental Protection Division (EPD), the State's lead environmental agency and a Division of the Georgia Department of Natural Resources.

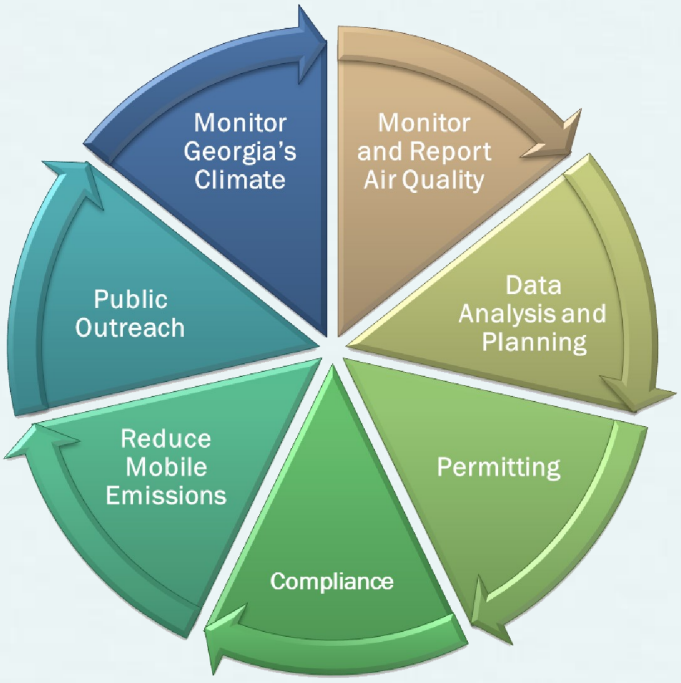
- The Air Protection Branch ensures clean air in Georgia in support of Georgia EPD's mission.

- The environmental professionals (scientists, meteorologists, and engineers) who make this report possible make sure Georgia produces air quality data that is accurate, complete, and readily available for public use.

- The Air Protection Branch has six programs:
    1. Ambient Monitoring
    2. Mobile and Area Sources
    3. Planning and Support
    4. Radiation Protection
    5. Stationary Source Compliance
    6. Stationary Source Permitting

What We Do

- Monitor air quality in Georgia
- Forecast air quality for public use
- Develop plans to maintain or attain the National Ambient Air Quality Standards (NAAQS)
- Issue permits to regulated stationary sources (industrial facilities and power plants)
- Enforce all state and federal requirements through compliance activities (inspections)
- Oversee federally required emission testing on cars



Air Quality in Georgia: 2019

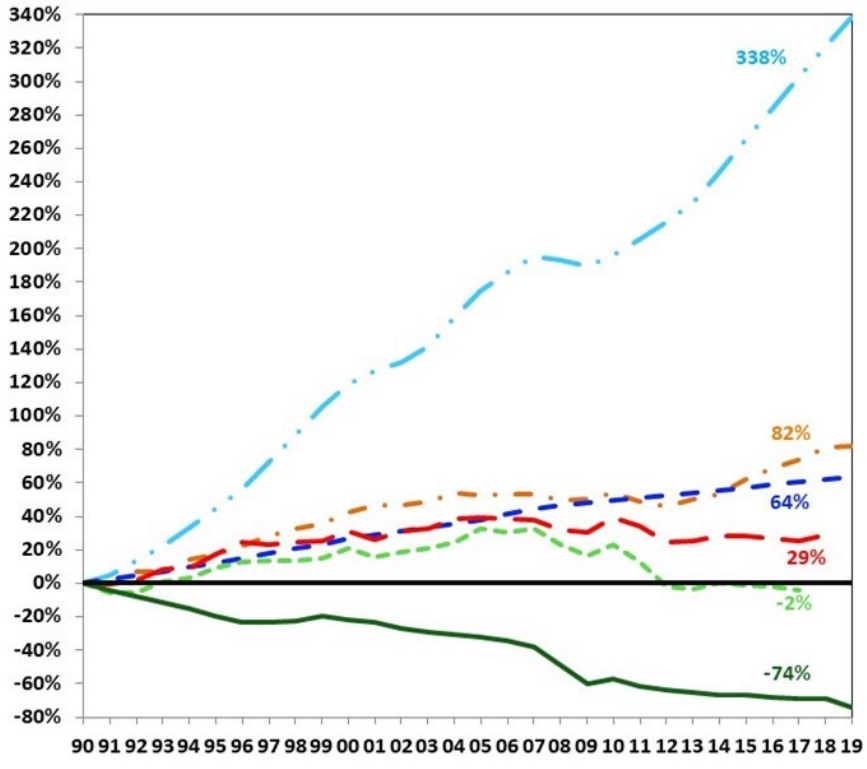
The Ambient Monitoring Program of the Georgia Environmental Protection Division's Air Protection Branch has been monitoring air quality in the State of Georgia for more than forty-five years. During that time, the list of monitored compounds has grown to more than 200 pollutants at 39 sites in 28 counties across the state. This monitoring is performed to protect public health and environmental quality. The resulting data is used for a broad range of regulatory and research purposes, as well as to inform the public.

This report includes monitoring data from 2019 and shows that the air quality in Georgia has steadily improved over the last few decades.

A lot has changed in 45 years of air quality monitoring.

How are we doing as a state?

Between 1990 and 2019, total emissions of the six principal air pollutants dropped by 74 percent, while the gross domestic product increased by 338 percent.



Air Monitoring FAQs

Where are the monitors located?

Over 100 air samplers (called monitors) are located throughout Georgia that measure for nearly 200 air pollutants. These pollutants can be gaseous such as ground-level ozone, or can be very fine particles such as particulate matter 2.5 ($PM_{2.5}$), also known as particle pollution.

How are air samples collected?

There are two types of collection methods depending on the pollutant and the monitor:

- **Continuous** - The air pollutant is measured continuously and the data is automatically recorded at a centralized location into a database.
- **Non-Continuous** – A canister or filter is used to collect the air pollutant over a period of time (8-hr, 24-hr). A technician collects the canister or filters and takes them to an approved laboratory for analysis.

How do we know the air quality data is accurate?

Both the continuous and non-continuous data are screened for errors by validation specialists. When the data is certified as valid, it can be reported to the public and used to compare to the National Ambient Air Quality Standards, and to previous years' data for trend information. The validated data is also used by scientists and policy makers.

- **Validated data** is used to prepare publications such as the Annual Reports and EPD's Annual Network Plan.
- **Non-Validated data** includes hourly data from continuous monitors published as the Air Quality Index (AQI) on the Georgia Air Monitoring website (https://airgeorgia.org/) and AirNow, a national air quality database, to provide real-time information.

What is the Air Quality Index (AQI)?

The Air Quality Index, or AQI, is a color-coded indicator of what the air quality is like taking into consideration measurements of multiple pollutants including ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide.

Good	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	Health alert: everyone may experience more serious health effects

What is the air quality like where I am?

Real time, hourly, air quality data for your area is available on the Georgia Air Monitoring Website at https://airgeorgia.org/. Georgia's air quality data is also uploaded to a national air quality information database called AirNow (https://airnow.gov) and available to the public in real time.

Why don't we have monitoring everywhere?

The number of monitoring sites and their location can vary from year to year. The cost associated with establishing and running a monitoring station is significant. It involves maintaining equipment and collecting samples to produce quality data for public use. EPD does not own land at any of its ambient air monitoring stations, we are always either a guest or a leaseholder. Each monitoring station must meet federal siting criteria set by EPA and be approved by the landowner. Before deciding to establish a new monitoring station, EPD has to consider regulatory needs, funding limitations, and finding an appropriate location where a long-term arrangement is possible. If EPD determines a change is needed, EPA has to review and approve the changes before the changes can happen.

Air Quality FAQs

What are National Ambient Air Quality Standards (NAAQS)?

Under the Clean Air Act, EPA is required to set National Ambient Air Quality Standards (40 CFR part 50) for air pollutants that may be harmful to public health and the environment. There are two types of National Ambient Air Quality Standards. ***Primary standards*** protect public health, including protecting populations considered "sensitive," such as children, the elderly, and asthmatics. ***Secondary standards*** protect public welfare, including protection against damage to animals, crops, vegetation, and buildings, and decreased visibility in national parks and protected areas.

The EPA has set National Ambient Air Quality Standards for six pollutants, called "criteria" air pollutants. These standards are periodically reviewed, as required by the Clean Air Act, and revised, as appropriate.

What is 'attainment?'

With the criteria pollutants, a geographic area that meets or does better than the national ambient air quality standard (NAAQS) is called an ***attainment area***. An area that does not meet this standard is called a ***nonattainment area***. (www.epa.gov)

Where do we get emission inventory?

The National Emissions Inventory (NEI) is a detailed estimate of air emissions that include criteria pollutants and hazardous air pollutants. It is released every three years and it is based on data provided by the State, Local and Tribal Agencies.

Examples of Air Monitors in Georgia

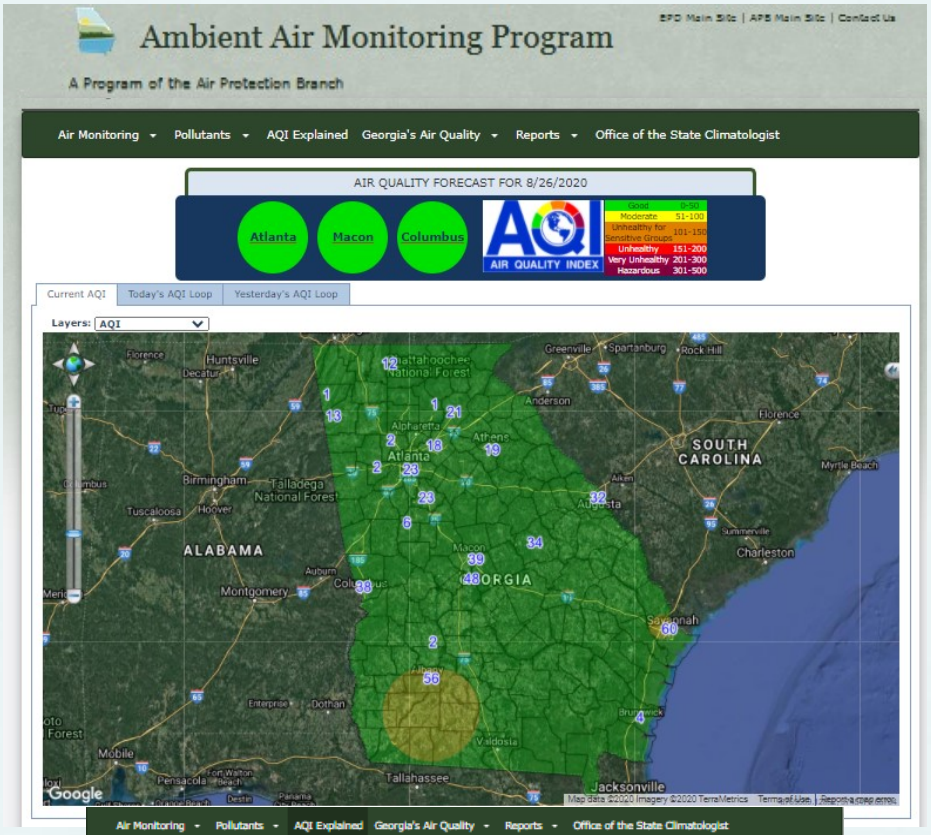
Communication and Partnerships

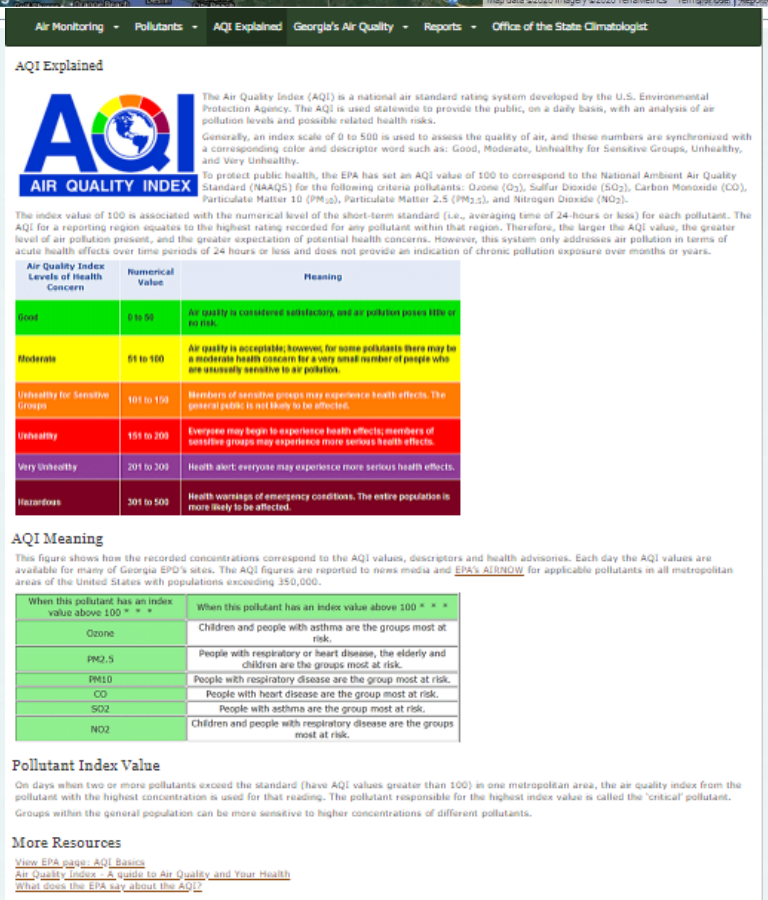
Georgia EPD's Ambient Air Monitoring Website

- Air Quality Forecast
- Site Information
- Links to Annual Reports
- Trends in Georgia's Air
- Pollutant Information

And So Much More...

Visit us at https://airgeorgia.org/





AQI Explained

AIR QUALITY INDEX

The Air Quality Index (AQI) is a national air standard rating system developed by the U.S. Environmental Protection Agency. The AQI is used statewide to provide the public, on a daily basis, with an analysis of air pollution levels and possible related health risks.

Generally, an index scale of 0 to 500 is used to assess the quality of air, and these numbers are synchronized with a corresponding color and descriptor word such as: Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, and Very Unhealthy.

To protect public health, the EPA has set an AQI value of 100 to correspond to the National Ambient Air Quality Standard (NAAQS) for the following criteria pollutants: Ozone (O_3), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Particulate Matter 10 (PM_{10}), Particulate Matter 2.5 ($PM_{2.5}$), and Nitrogen Dioxide (NO_2).

The index value of 100 is associated with the numerical level of the short-term standard (i.e., averaging time of 24-hours or less) for each pollutant. The AQI for a reporting region equates to the highest rating recorded for any pollutant within that region. Therefore, the larger the AQI value, the greater level of air pollution present, and the greater expectation of potential health concerns. However, this system only addresses air pollution in terms of acute health effects over time periods of 24 hours or less and does not provide an indication of chronic pollution exposure over months or years.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

AQI Meaning

This figure shows how the recorded concentrations correspond to the AQI values, descriptors and health advisories. Each day the AQI values are available for many of Georgia EPD's sites. The AQI figures are reported to news media and EPA's AIRNOW for applicable pollutants in all metropolitan areas of the United States with populations exceeding 350,000.

When this pollutant has an index value above 100 * * *	When this pollutant has an index value above 100 * * *
Ozone	Children and people with asthma are the groups most at risk.
PM2.5	People with respiratory or heart disease, the elderly and children are the groups most at risk.
PM10	People with respiratory disease are the group most at risk.
CO	People with heart disease are the group most at risk.
SO2	People with asthma are the group most at risk.
NO2	Children and people with respiratory disease are the groups most at risk.

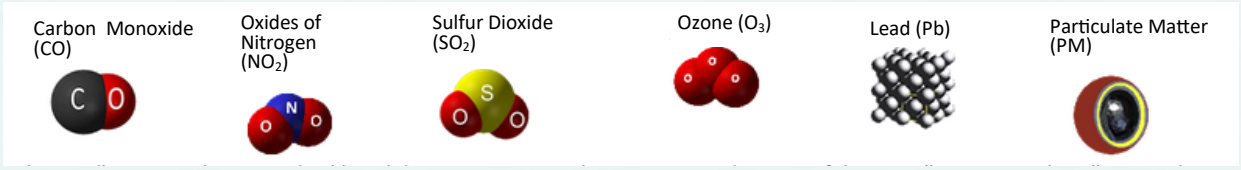
Pollutant Index Value

On days when two or more pollutants exceed the standard (have AQI values greater than 100) in one metropolitan area, the air quality index from the pollutant with the highest concentration is used for that reading. The pollutant responsible for the highest index value is called the 'critical' pollutant.

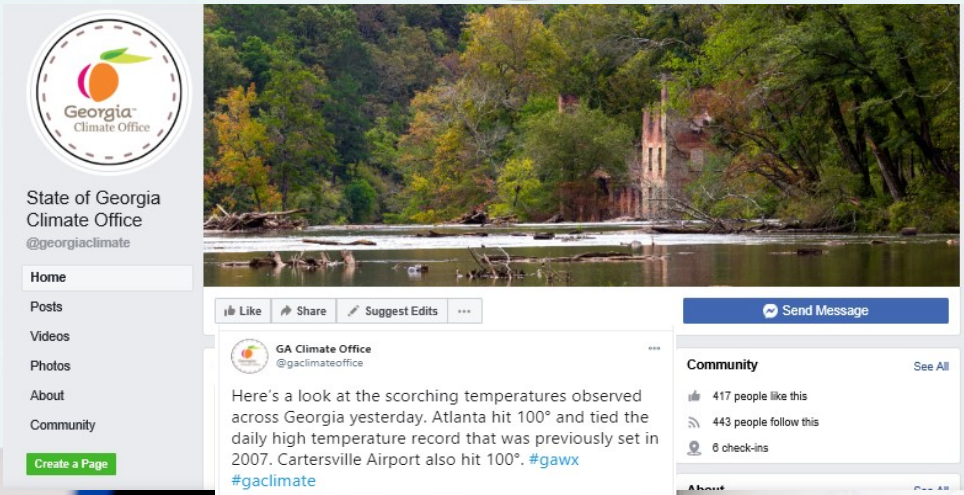
Groups within the general population can be more sensitive to higher concentrations of different pollutants.

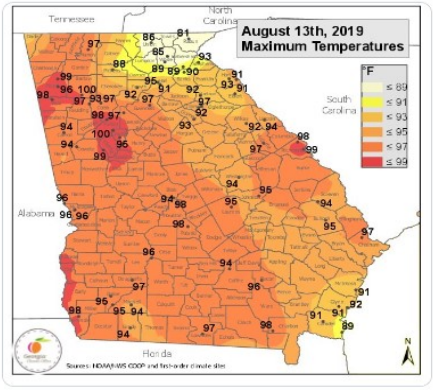
More Resources

View EPA page: AQI Basics
Air Quality Index - A guide to Air Quality and Your Health
What does the EPA say about the AQI?



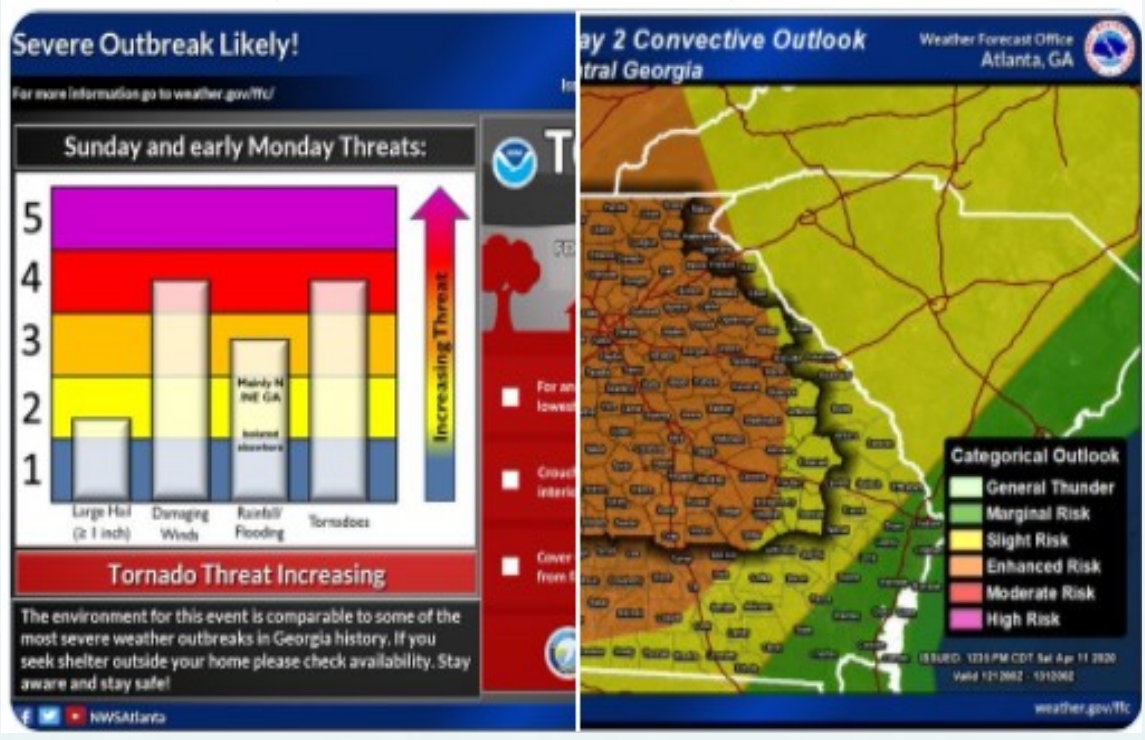
Social Media
Georgia Climate Office





https://www.facebook.com/georgiaclimate/

https://twitter.com/gaclimateoffice





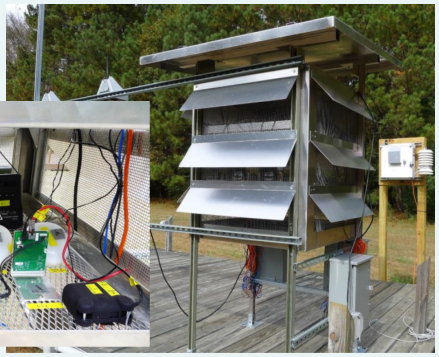


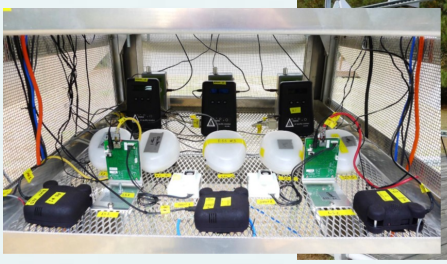

Working Together

Field and laboratory personnel involved in producing ambient air quality data took tours to see how the whole process works together to prepare the data for the public.

Special Projects

The Ambient Monitoring Program is involved in several special air quality monitoring projects. Details are discussed below.





CAIRSENSE– (2014-2016) EPA testing various sensors, including mesh-net communication. Sensors included: Air Egg (NO_2, CO, VOCs, PM), Cairpol Cairclip (NO_2/O_3), Dylos (PM particle counter), AirBeam ($PM_{2.5}$), and Aeroqual (O_3).

EPD Sensor Testing Project– (2016-2020) to gain understanding of what is involved with the operation of various types of sensors available to the general public. Comparison with regulatory monitors, maintenance, repairs, communication, data formatting and manipulation, etc., and how to explain issues and discuss proper considerations with the public. Sensors include: Aeroqual (O_3), Aeroqual (SO_2), Cairclip (NO_2/O_3), Dylos (PM), and a Met One Neighborhood Monitor (PM).

Gwinnett Technical College– (2018-2020, Kathryn Zimmerman) Gainesville, South DeKalb, NR-285, Gwinnett Technical College – passive PUF samplers, analyzed by students on a GC at school.

GA State University– (2019-2020, Dr. Christina Hemphill Fuller) – NR-GA Tech, NR-285 – Particle Barrier Study to see to what degree barrier walls or shrubbery mitigates particle impacts from nearby roadways. Looking at ultrafine particles using TSI Nanoscan (PM) and AethLabs Microaeth (BC) for portable, continuous data, compared to the fixed monitors at nearby sites for mass comparison.

EPA/Office of Research and Development Long Term Performance Project– (2019-2020) to investigate the durability and stability of operating various sensors over an extended period of more than a year. Attention to seasonal response variations, response drift over time, sensitivity degradation, maintenance issues, and other factors associated with extended operation at various (6) locations around the country (DE, AZ, CO, OK,WI, GA). Instruments are: PurpleAir (PM), Applied Particle Tech [PM, Temperature (T), relative humidity (RH)], Sensit RAMP (CO,O_3, NO_2, SO_2, $PM_{2.5}$) Clarity (CO_2, $PM_{2.5}$, T, RH), Aeroqual (O_3, NO_2, PM $_{2.5}$, T, RH), Aerodyne QuantAQ (O_3, NO_2, NO, CO, CO_2, PM, T, RH, Wind Speed, Wind Direction, light, noise).

University of Central Florida– (2019, Haofei Yu) South DeKalb – sensor evaluation study in comparison with regulatory monitors. Sensors are Salibri Cooper SCI-608 O_3, CO, SO_2, NO_2, and PM; and a Sapiens NAS-200 PM, O_3, NO_2, CO, and SO_2.

EPA/Region 4 Rail and Port Sensor (RAPs) Project– (2018-2020) to investigate the usefulness of portable, inexpensive, sensors to evaluate the impacts of Ports on immediately surrounding areas. Sensor "Pods" with Solar panels and batteries were deployed at most sites. Locations selected were in the area of the Inman Railyard in metro-Atlanta. Sensors are predominantly Purple Air PM, and also MicroAeth Black Carbon, and a portable meteorological station.

Savannah/Harambe House– (2019-2020, Dr. Mildred McClain, Dr. Sacoby Wilson) – Began with EPA Ports Study in 2016-2018. Became a community-based citizen science and environmental justice project for residents of Hudson Hills and surrounding neighborhoods to learn how they could use sensors to determine the impacts on their residences of the nearby Port of Savannah and its proposed expansion. An overlapping effort is the GA Tech SMART sea level sensor project to help detect and alert citizens about tidal surges and inland flooding (Dr. Russell Clark, Dr. Kim Cobb, Nick Defley – Savannah Office of Sustainability, Randall Mathews – Chatham County Emergency Mgmt.). Six Purple Air PM sensors have been donated by Dr. Fuller (GA State University) and will be collocated at the EPD Savannah-L&A site for "calibration", then deployed into neighborhood locations.

AMOD – Emory/NASA/CSU– (2020, Yang Liu, Jeremy Sarnat) Sun tracking, Aerosol Mass Optical Depth sensor which uses Plantronics PM sensors (like PurpleAir) and also collects a filter based sample; developed by Colorado State University. Deployment at South DeKalb, pending development of mounting platform.

Georgia Institute of Technology (GA Tech)– (2016-2020, Dr. Jennifer Kaiser, Dr. Ted Russell) NR-GA Tech– A Markes Agilent GC along with various PM sensors. Pandora– in collaboration with NASA, a study of the impacts of the pandemic shutdown of air traffic at ATL and BWI airports. Deployment of two PANDORA NO_2 optical depth trackers, a standard NOx monitor, formaldehyde (HCHO) monitoring, a full sky camera, and a meteorological suite.

Ethylene Oxide Monitoring Project

Background:

- The National Air Toxics Assessment (NATA), which is updated approximately every three years, provides estimates of the risk of cancer and other serious health effects from inhaling air contaminated with toxic pollutants from large and small industrial sources, from on- and off-road mobile sources, and from natural sources such as fires. The latest available NATA report uses the 2014 National Emission Inventory (NEI), and in August of 2018, the NATA presented the updated estimated cancer risks at the census tract level. With this updated information, the NATA report identifies 18 areas of the U.S. that potentially have elevated long-term (chronic) cancer risks due to ethylene oxide emissions from stationary industrial sources. The Atlanta-Sandy Springs-Roswell Metropolitan Statistical Area (Atlanta MSA) was identified as one of these areas. EPD began collecting ethylene oxide data in 2019. The map below shows the areas where EPD has ethylene oxide monitors.

Sources and uses of ethylene oxide:

- Manufacture of ethylene glycol (antifreeze), solvents, detergents, adhesives and other products, fumigant and a sterilant for surgical equipment and plastic devices

Objectives of the study include:

- Characterizing ethylene oxide concentrations in the ambient air near identified facilities in Georgia
- Providing background concentrations for comparison at two previously established GA AAMP network sites, South DeKalb and the General Coffee monitoring station
- Providing quality data for risk characterization by other agencies

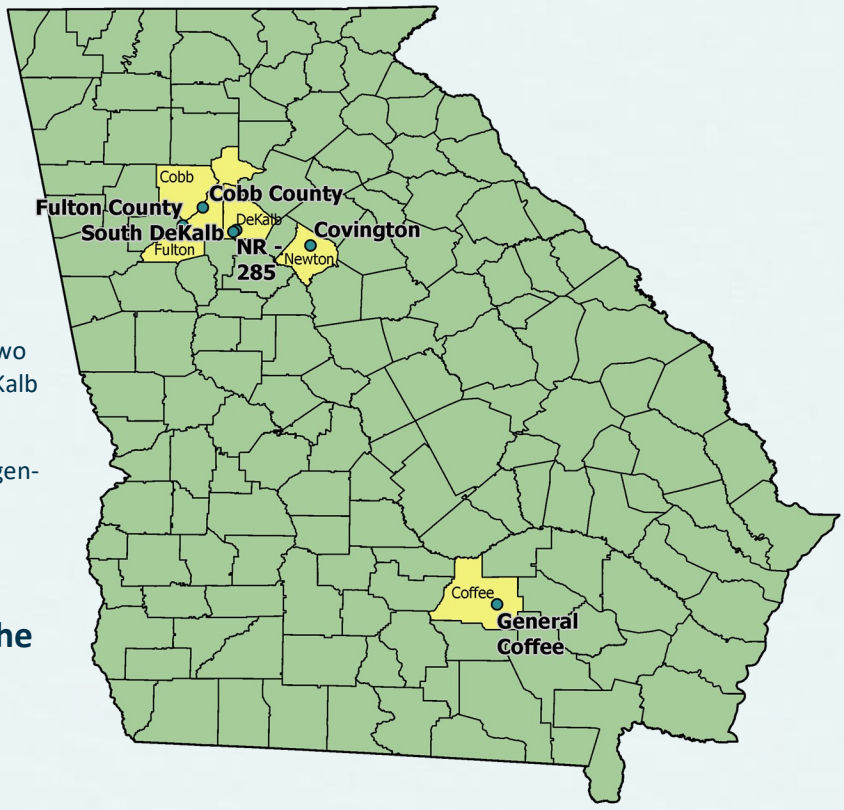


Figure 1. Areas of ethylene oxide monitors in Georgia

For more information and data, check out the EPD's website:

https://epd.georgia.gov/ethylene-oxide-information

Figure 2. Monitors used to collect ethylene oxide monitors in Georgia (from left to right: ATEC 2200, Xonteck 911, Entech CS1200E passive sampler, Xonteck 910)

Air Quality Awareness Week (AQAW)

In 2019, the Air Protection Branch hosted its second annual Air Quality Awareness Week. Multiple activities took place throughout the week which are highlighted here.

Left and above: Special presentations were given by guest speakers from Georgia Tech and from Norfolk Southern Railroad, as well as from employees within EPD.

Below: Tours were given at the South DeKalb air monitoring site, and at the APB's Workshop.

CLEAR THE DECK

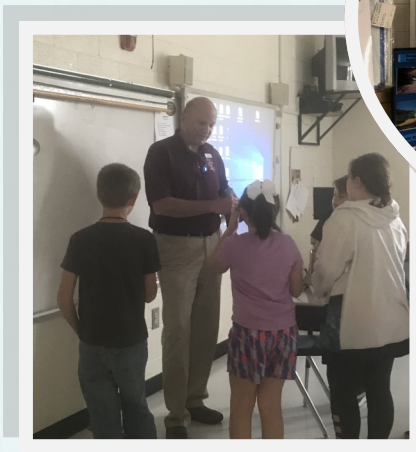
GEORGIACOMMUTEOPTIONS

The APB also participated by sending out informational resources via email and the Clear the Deck campaign where people were allowed to telework in an attempt to reduce the number of cars in the parking lot/deck.

Reaching out into the Community

Educating school children and incorporating air quality information into the classroom-learning environment is an outreach strategy for the GA EPD Ambient Monitoring Program (AMP). AMP staff visit Georgia classrooms to discuss air quality, forecasting, and monitoring. Each program presented by the AMP is designed to supplement grade-specific curricula. Learning opportunities include meteorological lessons and forecasting techniques, among other relevant topics.

In many situations, these lessons involve hands-on activities and mini-field trips to the monitoring sites. High School students simulate forecasting conditions and use scientific methods to create their own forecasts. AMP staff also participate in Career Days at both elementary and high schools to promote environmental and meteorological careers.



GA EPD air quality forecasters presenting to local schools and judging science fairs.

Students from Georgia State University visited the South DeKalb site as part of a class project to learn more about environmental monitoring stations.

Voluntary Emissions Reductions Programs– GA EPD Partners

Encouraging fewer vehicles on the road...

GEORGIACOMMUTEOPTIONS

Get More by Driving Less

http://gacommuteoptions.com/

- Sponsored by the Atlanta Regional Commission (ARC).
- Distributes daily ozone forecasts (as well as $PM_{2.5}$ forecasts produced by EPD and Georgia Tech) during the ozone season to enable citizens in the sensitive group category, as well as industries, to alter activities on days that are forecasted to have high ozone levels.
- Forecasts for the Atlanta metropolitan area.
- Rewards commuters for trying an alternative to driving alone to and from work (e.g. carpooling or trying transit).

GaDeR

Georgia Diesel Emissions Reduction Program

Taking a bite out of Georgia's diesel emissions SM

With a focus on reducing all sources of diesel emissions in Georgia, the GADER program not only encompasses the Georgia School Bus Retrofit initiative, but also assists with funding, and education assistance and outreach for voluntary measures such as idling reduction, Truck Stop Electrification, the use of cleaner fuels, and diesel emissions controls to rail yards, long haul and delivery truck fleets, construction equipment, and more.

Helping schools afford cleaner school buses...

- Older diesel school buses are replaced early, and the newer buses come equipped with an emissions control device to reduce emissions of oxides of nitrogen (NO_X).
- Selective catalytic reduction (SCR) is an emissions reduction technology used in diesel engines to convert NO_X pollution into harmless atmospheric nitrogen and water. The technology is enhanced when the engines run on low sulfur diesel fuel, the dominant fuel today.
- Diesel powered commercial trucks can add particulate trap filters to capture particulate matter pollution exhausted from their engines.

Encouraging the use of alternative fuels...

Helping promote Truck Stop Electrification Stations...

- Diesel powered commercial trucks can produce emissions of oxides of nitrogen (NO_X) due to idling. Truck drivers are typically required to rest 8 hours for every 10 hours of travel time and their diesel engines are often idled during rest times to power air conditioning and heating systems.
- Truck stop electrification allows truck drivers to run their air conditioning, heating, electronic devices without having to run their diesel powered engines.
- Cool and warm air can be pumped into the trucks via a hose hookup at the electrified truck stops.

Working to reduce locomotive and rail yard emissions...

NORFOLK SOUTHERN

41 LOCOMOTIVES CONVERTED INTO 25 MOTHERS AND 16 SLUGS

CSX TRANSPORTATION

9 CONVERSIONS

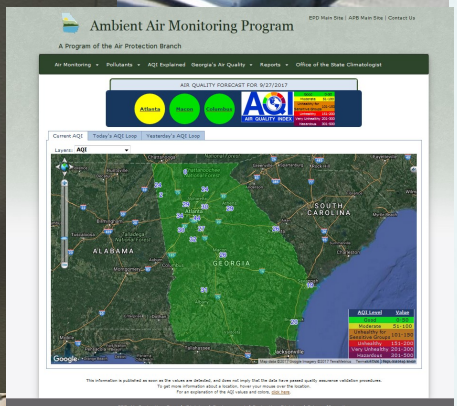
GaDeR
Georgia Diesel Emissions Reduction Program

ARGOS

1 LOCOMOTIVE CONVERTED INTO A TIER-4 GENSET

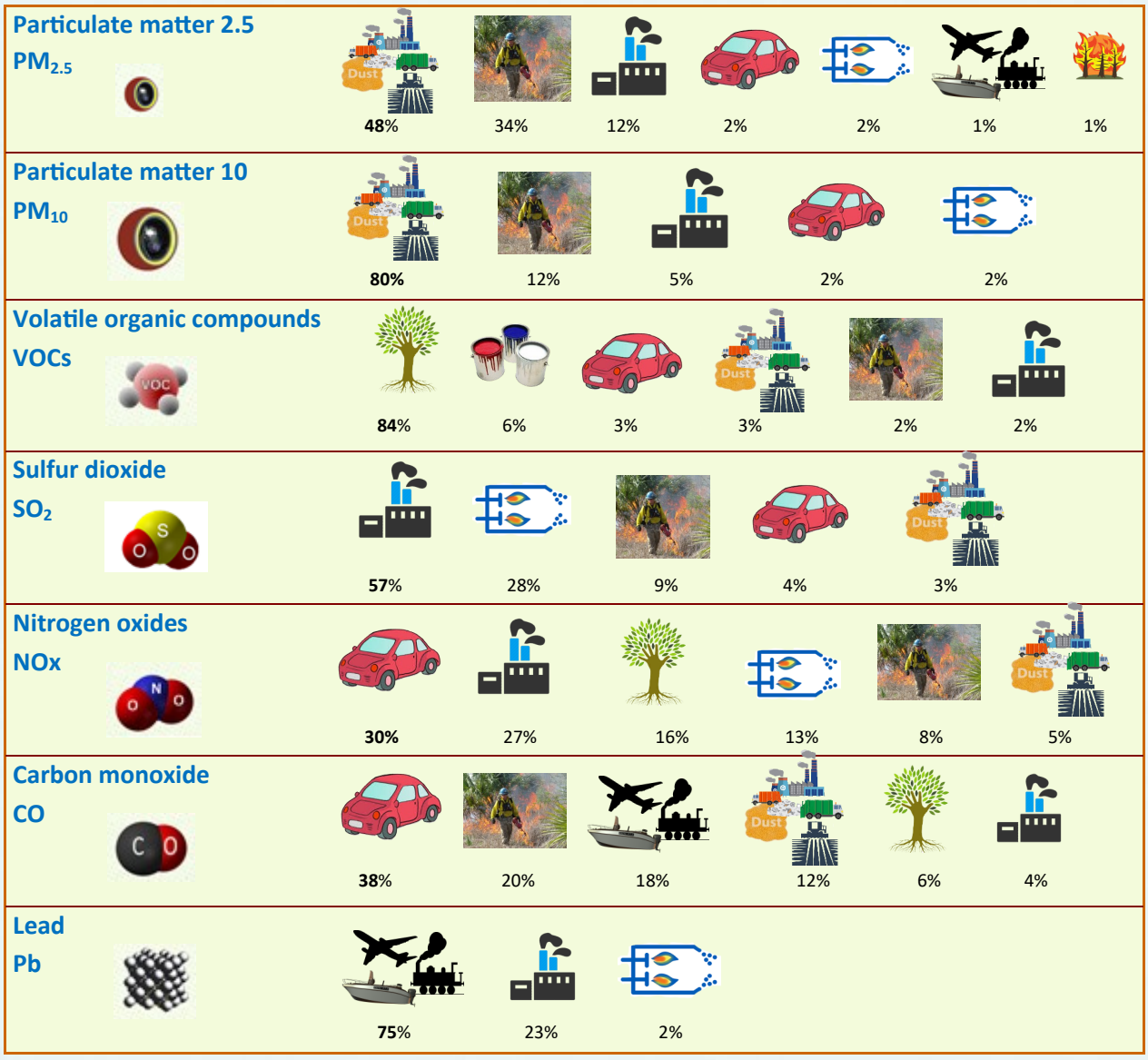
- Locomotives were retrofitted with cleaner technology to help improve air quality.
- Argos completed 1 “genset” conversion. The genset uses two smaller TIER 4 diesel engines that replaces one large older diesel engine. The new genset may be operated with just one engine or both engines depending on the power demand thereby improving efficiency.
- CSX completed 9 (TIER 3) conversions using in-cylinder strategies including improved fuel injection, inlet air cooler and rings along with an improved oil separator for crank case ventilation.
- Norfolk Southern completed 41 conversions. 25 locomotives were converted to Mother locomotives that use TIER 3 in cylinder strategies. 16 locomotives were converted into slugs.
- ‘Mother’-‘Slug’ sets operate in tandem. A Mother locomotive generates electricity using a diesel engine. The electricity is used to power electric traction motors on both the Mother and Slug. The slug has no diesel engine, so it relies on electrical power from the Mother.
- Norfolk Southern installed electrical plugin stations used to power electric block heaters that prevent coolant water from freezing during the winter, which minimizes the need to idle diesel engines.

Air Quality in Georgia



Pollutants of Concern and Their Sources in Georgia

The list below shows the most common air pollutants in Georgia by percentage and their sources as found in the 2017 National Emissions Inventory (NEI). Across the state of Georgia, miscellaneous construction and farming equipment, on-road mobile sources including vehicles, non-road mobile sources including aircraft and boats, stationary sources, and emissions from vegetation contribute the most to pollution in Georgia.



***CO is more of a concern for indoor air quality than it is for outdoor air quality.**

Key:

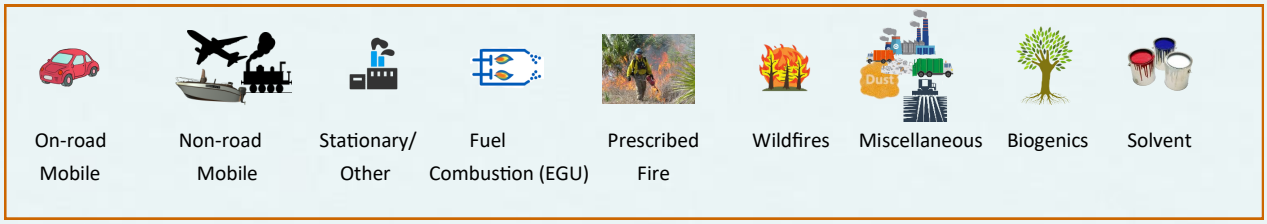


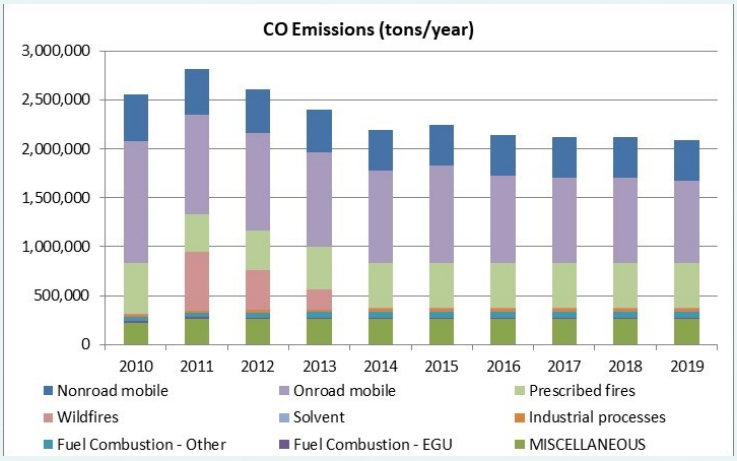
Figure 1. Pollutants of Concern and Their Sources in Georgia

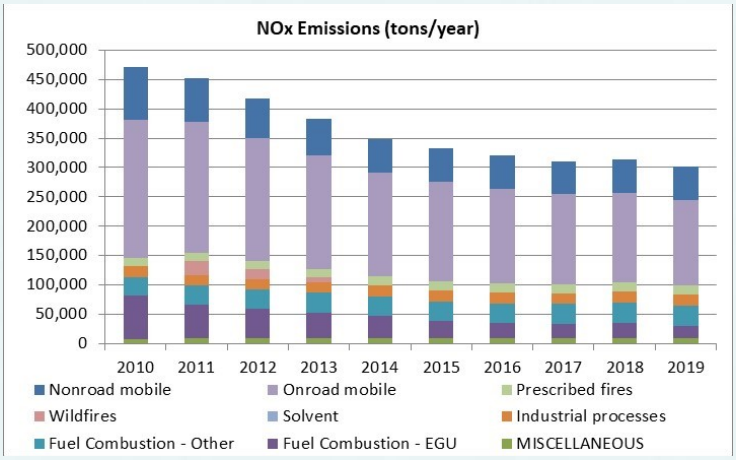
Source: 2017 National Emissions Inventory

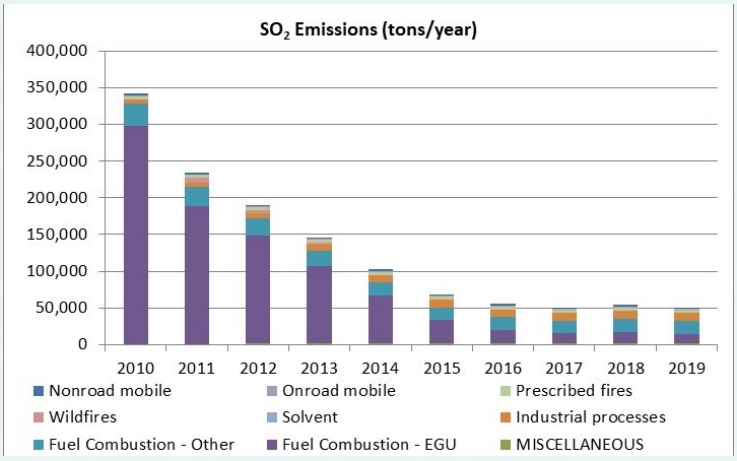
Emissions Trends in Georgia

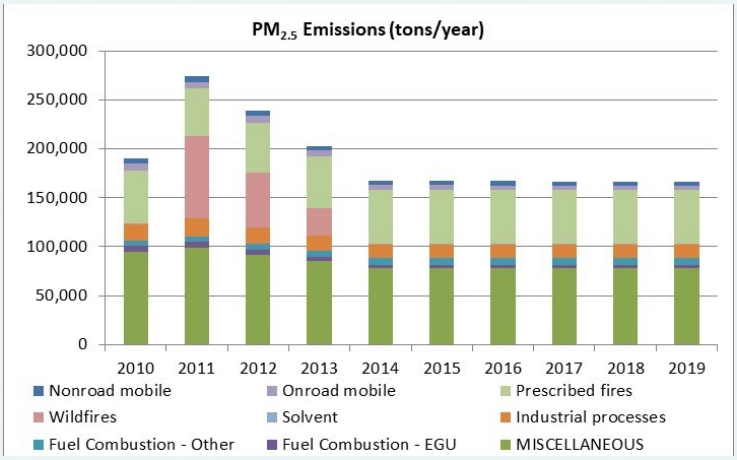
The sources of pollutants seen on the previous page were assembled into seven categories for the following graphs. The major contributors for CO and NO_x are highway vehicles, while the largest contributors of SO_2 are electric utilities. Wildland and prescribed fires can have a large impact on $PM_{2.5}$ emissions, and VOCs come from a variety of stationary sources. There is a downward trend shown here for all emissions from 2010 through 2019. In 2011, there was a wildfire in the Okefenokee Swamp area that showed an uptick in the data for that year.

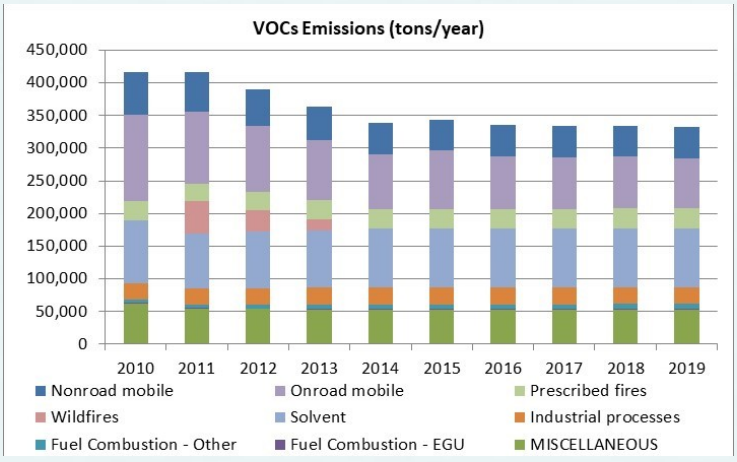
Georgia's air quality is improving...











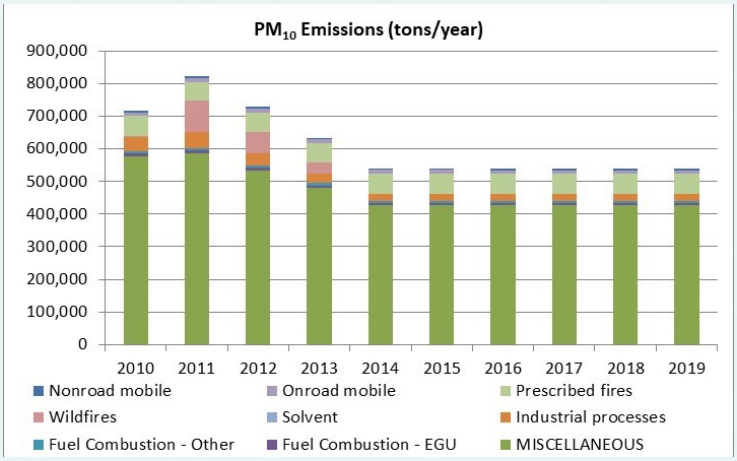


Figure 2. Emissions Trends in Georgia

Georgia's Ambient Air Monitoring Sites

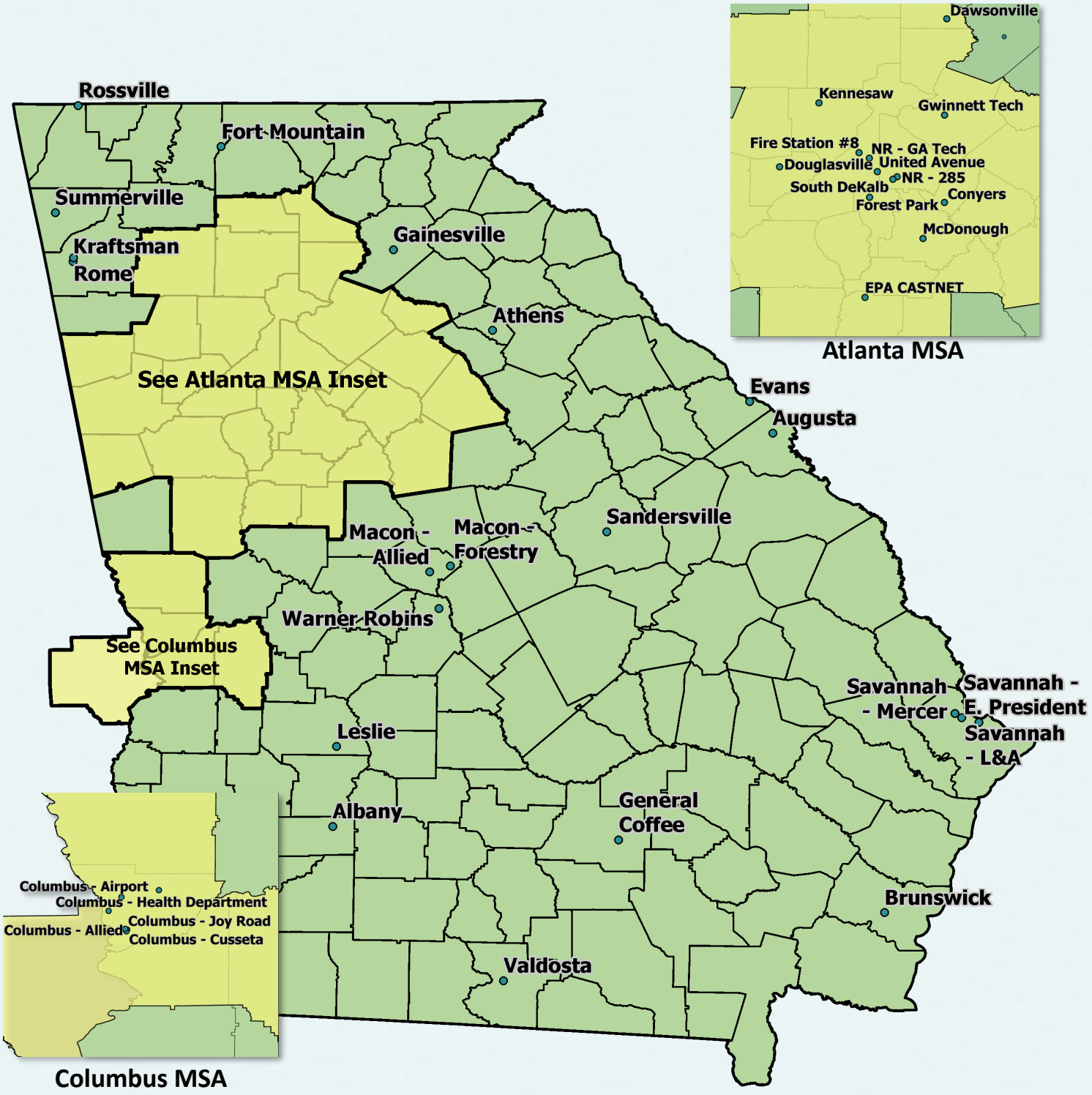


Figure 3. Georgia's ambient air monitoring sites

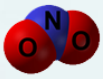
For more detailed site information, see page 71.

Criteria Pollutants (six most common regulated pollutants)

The Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (EPA) to identify pollutants that may endanger public health or welfare. Under the CAA, the EPA sets **National Ambient Air Quality Standards (NAAQS)** for six common air pollutants, also referred to as "criteria" pollutants based on the current science regarding their known health effects. The NAAQS are divided into primary standards that protect public health and secondary standards that protect the public welfare and environment. EPA reviews the NAAQS periodically, based on new findings about the health effects of air pollution. For more information about the NAAQS, please refer to EPA's website (https://www.epa.gov/criteria-air-pollutants/naaqs-table).

NAAQS have been established for six common air pollutants called criteria pollutants:

Carbon Monoxide (CO)



Oxides of Nitrogen (NO_2)

Sulfur Dioxide (SO_2)

Ozone (O_3)

Lead (Pb)

Particulate Matter (PM)

We monitor for these criteria pollutants and much more. Our monitoring network takes the guess work out of knowing what pollutants are in the air you breathe.

Carbon Monoxide (CO)

What is it?

- Carbon Monoxide is an odorless, colorless, and poisonous gas that is a by-product of incomplete burning.

  Learn more: https://www.epa.gov/co-pollution

Where does it come from?

- Carbon and oxygen can combine to form two different gases. When combustion of carbon is complete, in the presence of plenty of air, the product is mainly carbon dioxide (CO_2). Sources of carbon include; coal, coke, charcoal. When combustion of carbon is incomplete, *i.e.* there is a limited supply of air, only half as much oxygen adds to the carbon, and instead you form carbon monoxide (CO).
- In Georgia, 56% of the carbon monoxide comes from mobile sources including cars, construction equipment, aircraft, locomotives, and on the coast commercial marine vessels.

38% 20% 18% 12% 6% 4%

See page 20 for icon key.

Health Impacts

- Increased risk of lower blood flow, anemia, and reduced heart activity.
- Sensitive groups include fetuses, young infants, pregnant women, elderly people, and individuals with anemia or emphysema.

Georgia Monitoring Information for CO

Figure 4. Georgia carbon monoxide monitoring sites

Measurement Technique

Measured continuously with infrared light[1]

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUE

1 https://www.thermofisher.com/order/catalog/product/48I

National Ambient Air Quality Standards for Carbon Monoxide

Primary NAAQS: 8-hour average not to exceed 9 ppm more than once per year

1-hour average not to exceed 35 ppm more than once per year

Secondary NAAQS: None

Attainment Designation

All of Georgia is in attainment of both the 8-hour and 1-hour standards for carbon monoxide. Figure 5 and Figure 6 show how Georgia's CO compares to the two NAAQS.

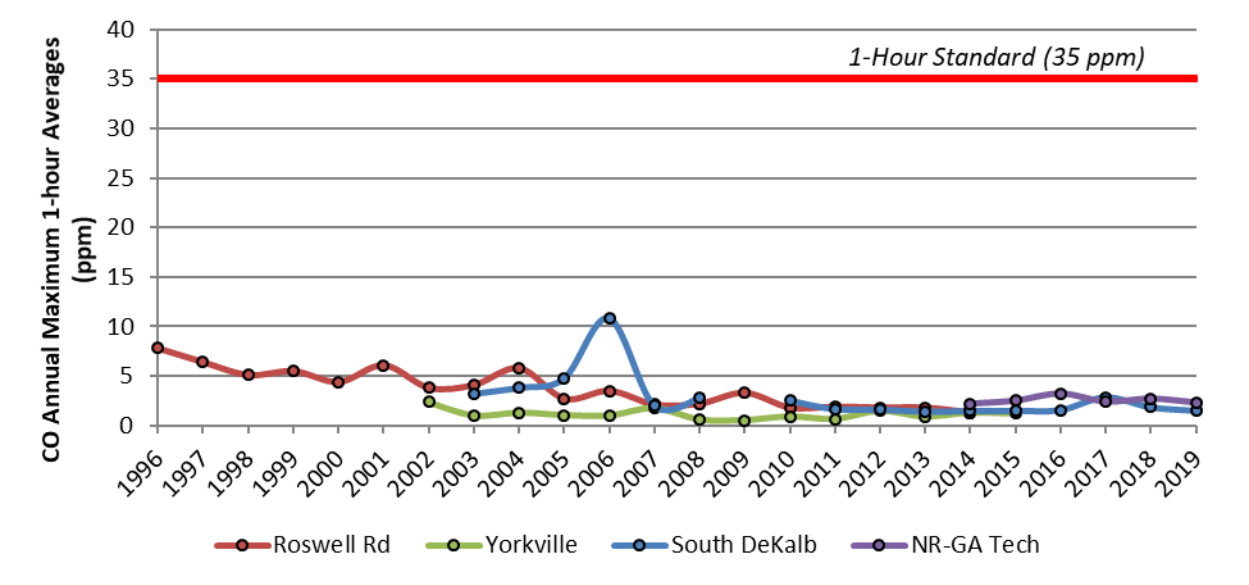


Figure 5. Carbon monoxide annual maximum 1-hour average compared to the 1-hour standard

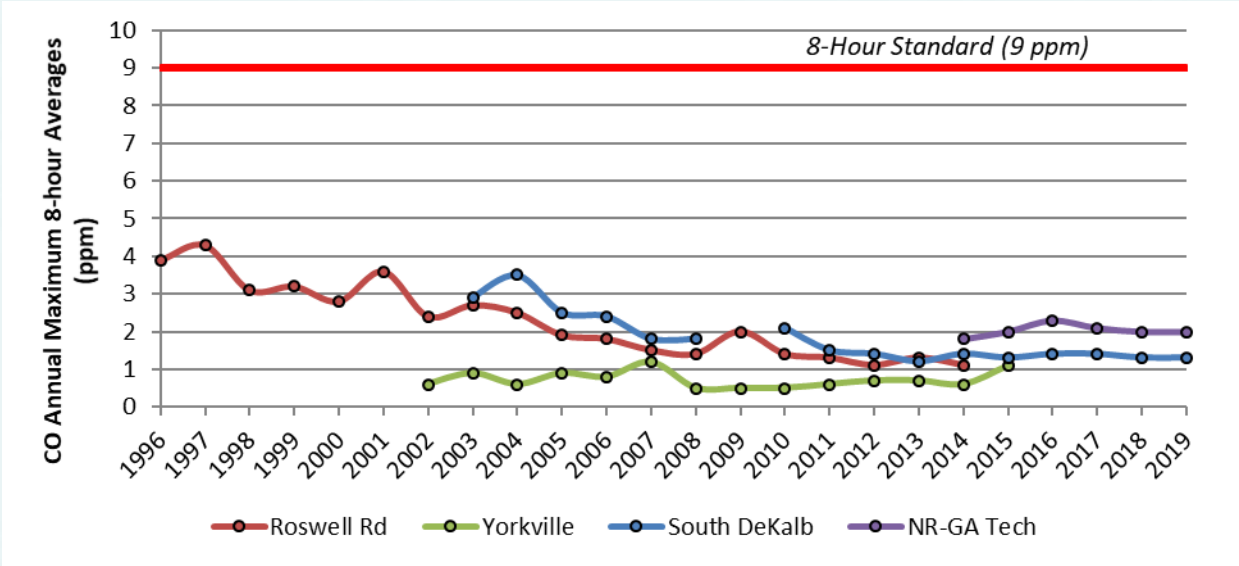
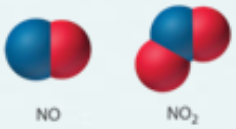


Figure 6. Carbon monoxide annual 8-hour average compared to the 8-hour standard

Oxides of Nitrogen (NO, NO_2, NO_x and NO_Y)



What is it?

- Oxides of nitrogen are a mixture of gases that are composed of nitrogen and oxygen and primarily produced during combustion. Learn more: https://www.epa.gov/no2-pollution

Where does it come from?

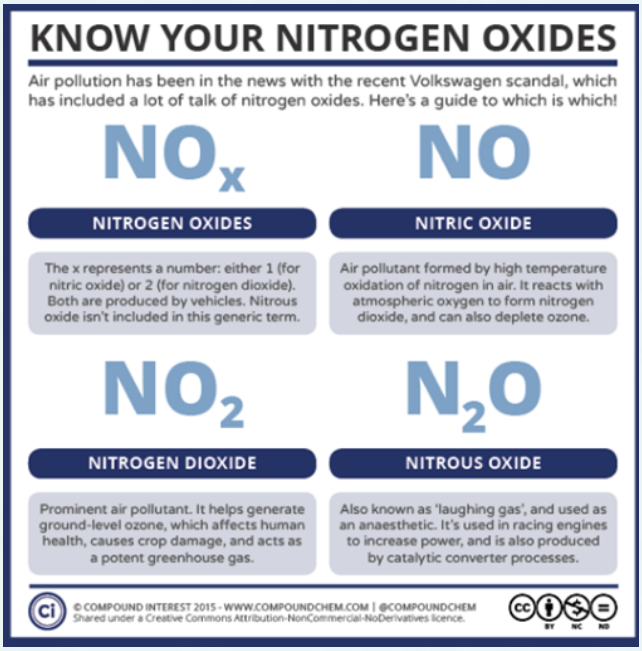
- Nitrogen oxides (NO_x) are usually products of combustion from mobile sources such as vehicle engines and construction equipment engines. They also come from large industrial boilers, turbines, and kilns, as well as fires. In Georgia, 30% of NOx comes from vehicles.
- NO_2 is formed from the oxidation of nitric oxide (NO).
- NO_Y consists of all atmospheric reactive nitrogen oxide compounds.

30% 27% 16% 13% 8% 5%

See page 20 for icon key.

Health Impacts

- Increases risk of respiratory infections, respiratory diseases and asthma



Source: http://www.compoundchem.com/2015/09/30/vehicle-emissions/

Georgia Monitoring Information for Oxides of Nitrogen

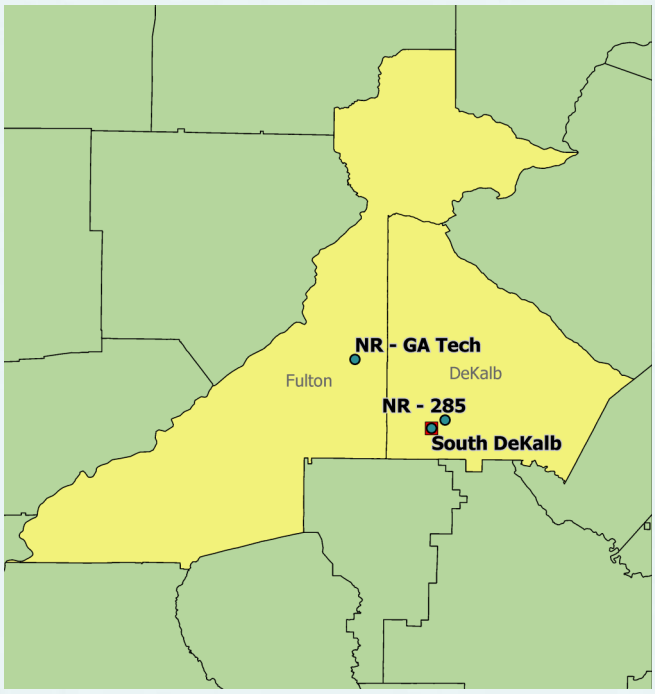


Figure 7. Georgia's $NO/NO_2/NO_x$ monitoring sites (green circles) and NO_Y site (red square)

Measurement Techniques

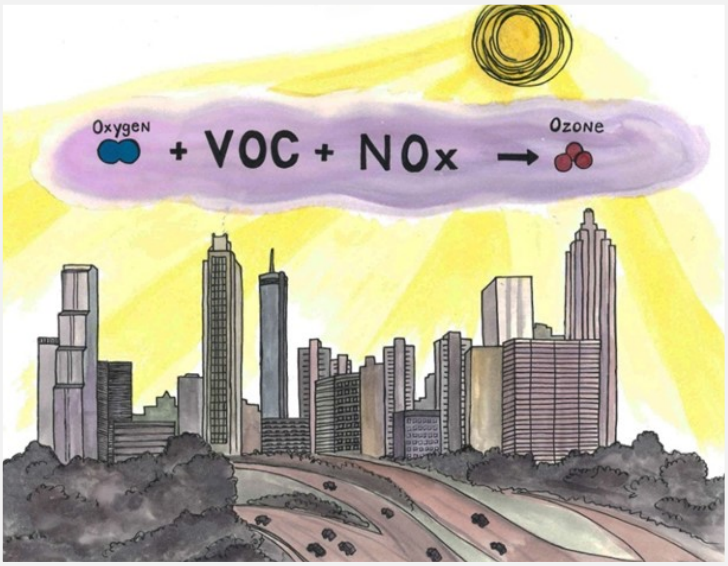
Measured continuously with a chemiluminescent method[2].

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUE

[2] https://www.thermofisher.com/order/catalog/product/42I

NO_x Daily Cycle

NO_x reacts with volatile organic compounds in the presence of sunlight to form ground level ozone (O_3) pollution which causes NO_x levels to drop in the middle of a sunny day and increase at night on a daily basis.



(Courtesy of Jamie Smith)

Because this pattern typically reoccurs each day within a 24-hour period, this is known as a diurnal cycle.

The following graph shows a comparison of the daily average of hourly NO_2 data at the near-road sites, NR-285 and NR-Georgia Tech, compared to the South DeKalb NO_2 site.

- The two near-road sites (shown in green and red) display the highest daily averages.
- The cyclical diurnal pattern of lower concentrations mid-day and higher concentrations in evening is shown below.

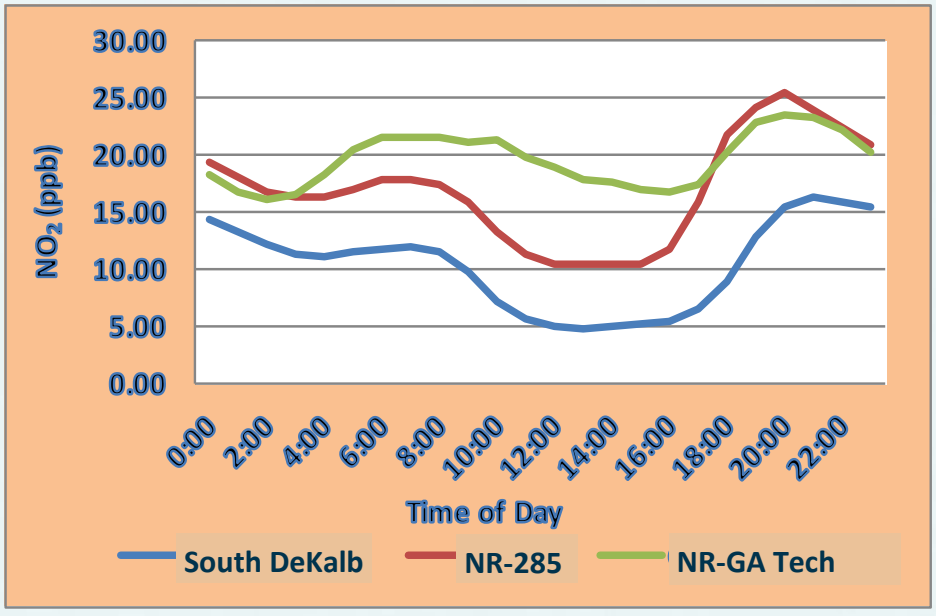


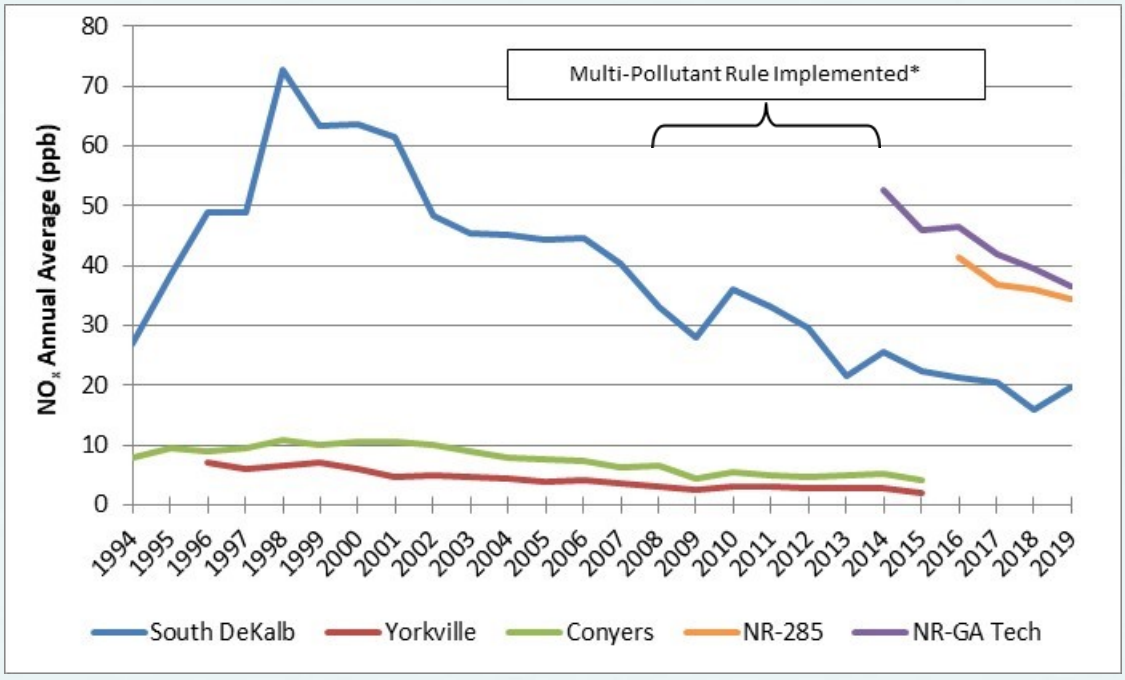
Figure 8. Diurnal Pattern of NO_2

Reducing NO_x Emissions in Georgia

Ozone formation in the southeastern United States is driven by emissions of nitrogen oxides (NO_x) in large urban areas with high vehicle traffic. Therefore, Georgia has focused efforts on reducing the emissions of NO_x, particularly in the Atlanta ozone nonattainment area.

- Our vehicle emissions inspection program, also known as Georgia's Clean Air Force, which covers the counties of Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale, helps reduce NO_x, the main precursor to ozone.

- A series of Georgia air quality rules were implemented in 1999 through 2014 specifically targeting NO_x emissions from combustion sources such as industrial boilers and electric steam generating units at power plants, especially large coal-fired units. Figure 9 shows how NO_X pollution in Georgia declined as NO_x controls were implemented at large stationary sources from 1999 through 2014. The Georgia multi-pollutant rule, implemented 2008-2014, required additional NO_x reductions at power plants in addition to reductions in mercury and sulfur dioxide emissions. During the same time, national manufacturing standards required greater efficiency and performance from engines in vehicles, construction equipment, and generators which also helped reduce NO_X emissions nationwide, including Georgia.



*Multi-pollutant Rule is discussed on page 27.

Figure 9. Implementation of NO_x Controls

National Ambient Air Quality Standards for Nitrogen Dioxide

Primary NAAQS: Annual mean must not exceed 53 ppb
3-year average of the 98th percentile of daily maximum one-hour averages must not exceed 100 ppb

Secondary NAAQS: Annual mean must not exceed 53 ppb

Attainment Designation

- NO_2 monitoring is required in urban areas with populations exceeding one million. The Atlanta-Sandy Springs-Roswell Metropolitan Statistical Area (MSA) is the only urban area in Georgia required to perform NO_2 monitoring.
- Figure 10 shows Georgia's annual average NO_2 concentrations from 2000 to 2019. Annual average concentrations are well below the standard of 53 ppb.
- EPD operates two near-road monitoring sites (NR-GA Tech and NR-285) to study the effects of traffic pollution.
- Figure 11 indicates that Georgia's 1-hour design values are well below the 100 ppb national standard.

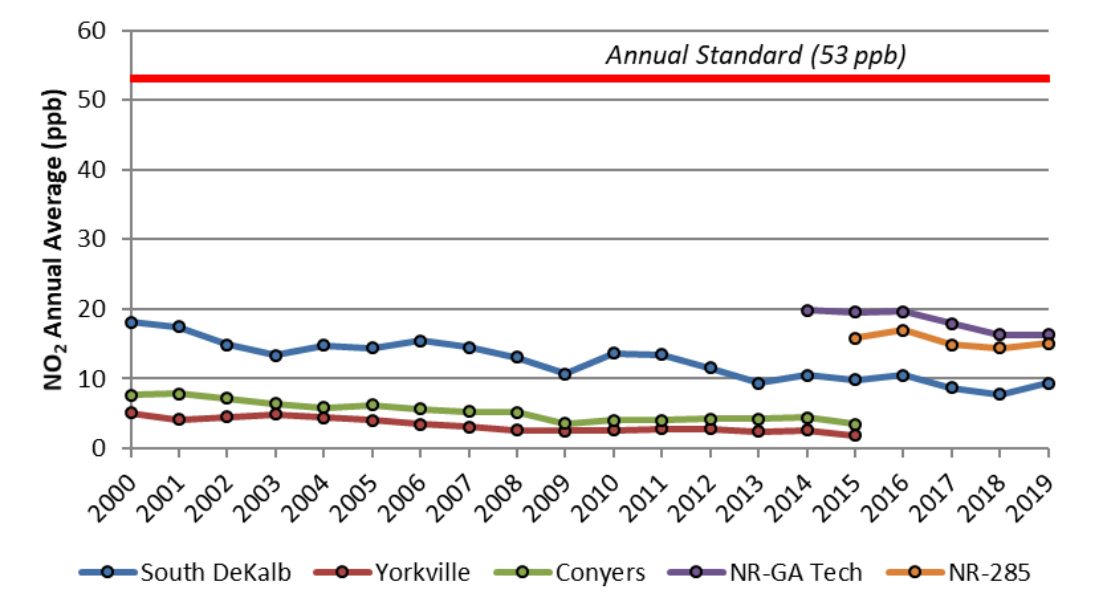


Figure 10. Nitrogen dioxide annual averages compared to the annual standard

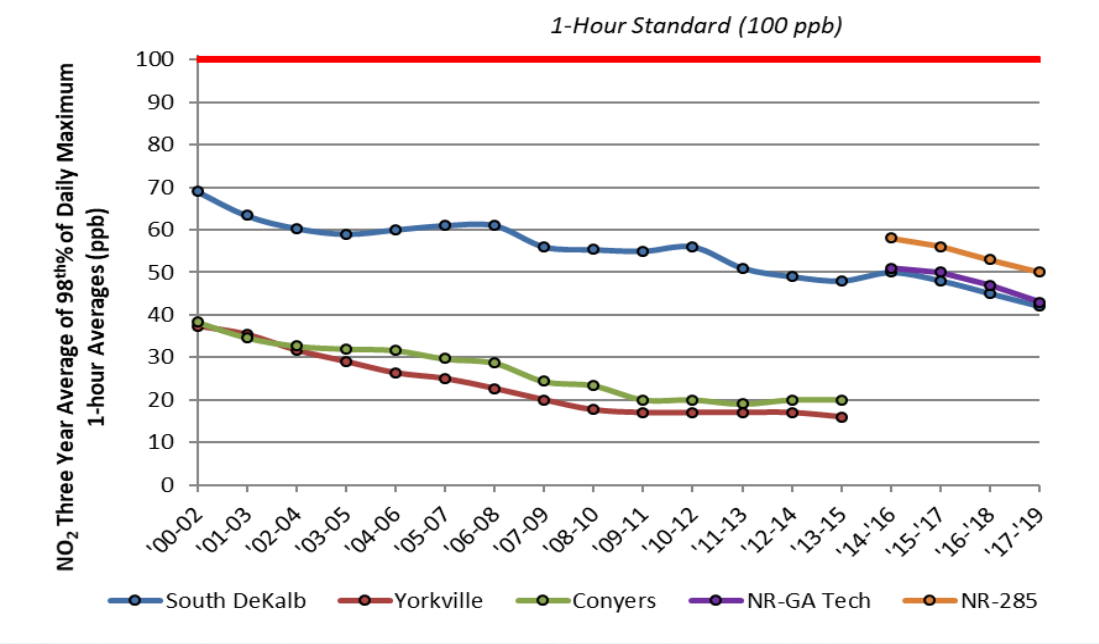


Figure 11. Nitrogen dioxide 1-hour design values compared to the 1-hour standard

Sulfur Dioxide (SO_2)

What is it?

- Sulfur dioxide (SO_2) is a colorless reactive gas that is formed by burning sulfur-containing material, such as coal or diesel fuel, or by processing sulfur-containing clays. Learn more: https://www.epa.gov/so2-pollution

Where does it come from?

- 85% of SO_2 emissions in Georgia come from industrial processes and fuel combustion (electric generation).
- SO_2 can be oxidized in the atmosphere into sulfuric acid, and form acid rain.
- Sulfur is oxidized to form SO_2 during combustion. SO_2 then can react with other pollutants to form aerosols, which are solid or liquid particles in a gas. SO_2 can also form sulfate particles, that contribute to the formation of fine particulate matter ($PM_{2.5}$).
- In liquid form, SO_2 may be found in clouds, fog, rain, aerosol particles, and in surface liquid films on these particles.

57% 28% 9% 4% 3%

See page 20 for icon key.

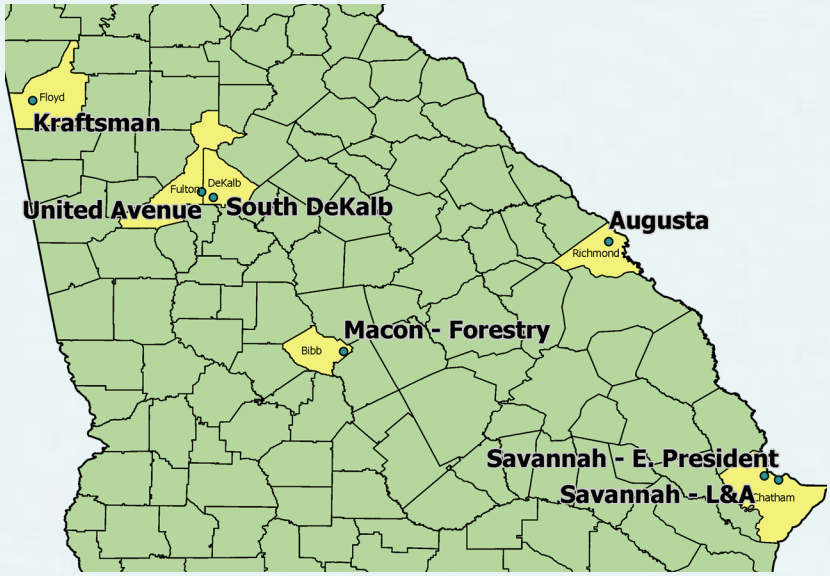
Environmental Impacts

Both SO_2 and NO_2 can form acid rain that lead to acidic deposition[3].

Health Impacts

- SO_2 can impair respiratory function, increase respiratory disease, and reduce lung's ability to clear foreign particles especially in sensitive groups like children, the elderly, and individuals with asthma, hyperactive airways, and cardiovascular disease.
- Short-term peak exposures can cause significant constriction of air passages in sensitive asthmatics, wheezing, shortness of breath, and coughing in these sensitive groups, and affect ability to perform exercise.

Georgia Monitoring Information for Sulfur Dioxide (SO_2)



Measurement Technique

Continuous ultraviolet fluorescence[3]

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUE

[3] https://www.thermofisher.com/order/catalog/product/43I

Figure 12. Georgia's sulfur dioxide monitoring sites

[3]Acid deposition causes damage to forests, man-made structures, and streams and lakes, which can be deadly for aquatic wildlife.

Reducing SO_2 in Georgia

Georgia's Multi-Pollutant Rule

- In 2007, Georgia implemented State Rule 391-3-1-.02(2)(sss), which affects the 13-county Atlanta nonattainment area plus surrounding counties.
- This multi-pollutant control measure for electric steam generating units at electric utilities required coal fired power plants to install controls to reduce three criteria pollutants, PM, NO_2, and SO_2, and had rolling start dates between 2008 and 2014.
- The controls are called Selective Catalytic Reduction (SCR) for NO_x and Flue Gas Desulfurization (FGD) for SO_2 and PM.
- Figure 13 shows the decrease in SO_2 concentrations as these controls have been implemented across the state.

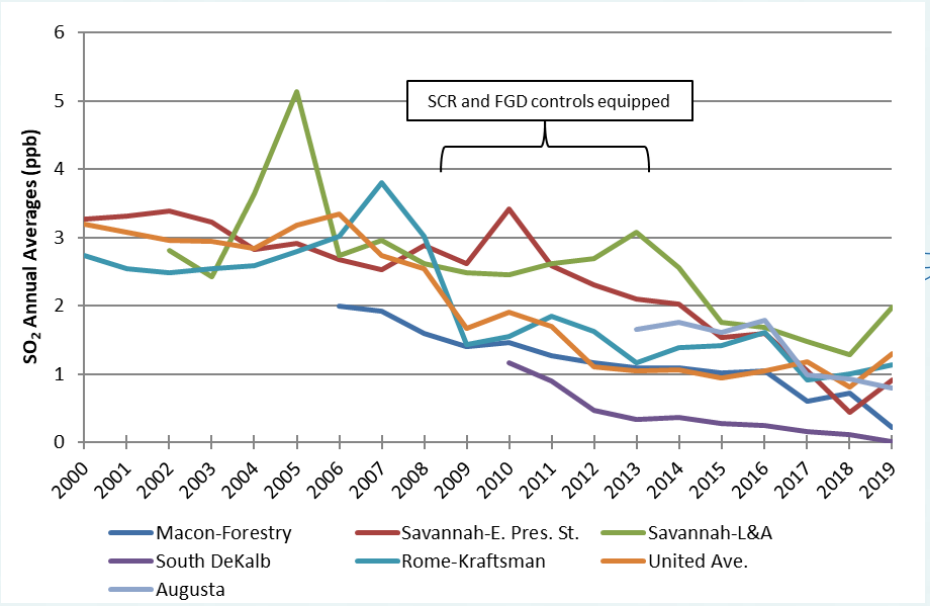


Figure 13. Implementation of SO_2 Controls

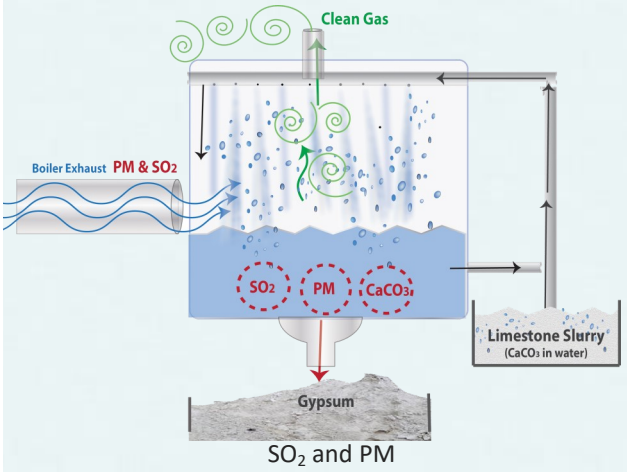


Figure 14. Schematic design of the absorber of an FGD

Statewide SO_2 Concentration Comparison from 2005 to 2016

- Figure 15 compares the concentrations of sulfur dioxide from 2005 and 2016 in Georgia on a scale of 0 to 0.8 in Dobson units (DU)[5].
- These maps were created by NASA using satellite data and depict averages of sulfur dioxide concentrations over the eastern United States.
- According to analyses of satellite data, in the eastern U.S., levels of sulfur dioxide have dropped by about 80 percent between 2005 and 2016.

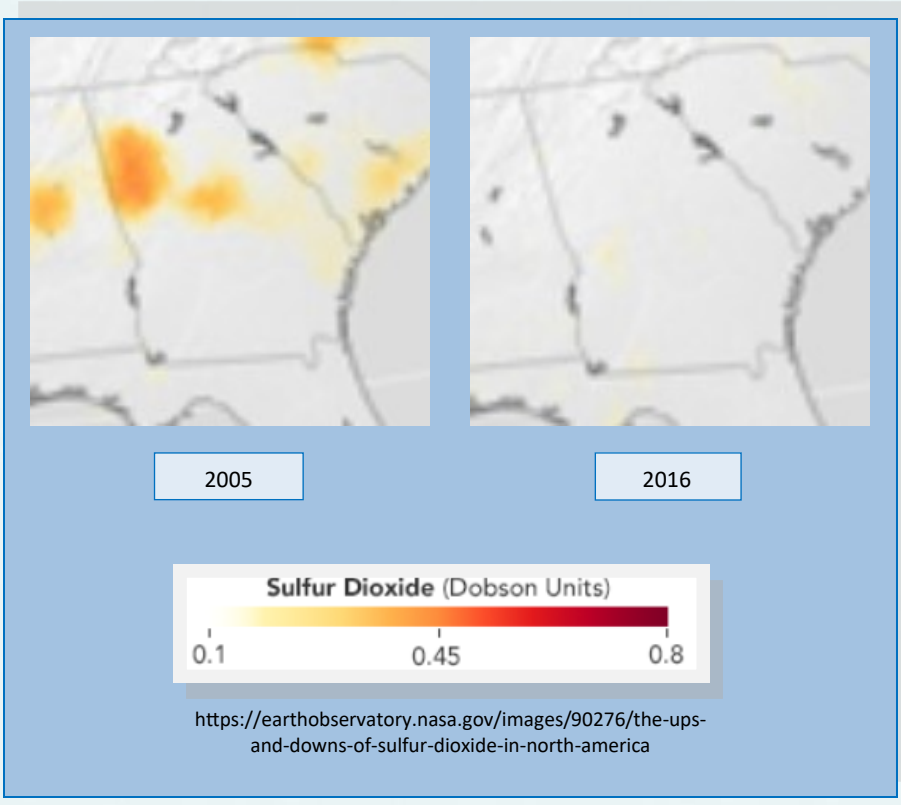


Figure 15. SO_2 Statewide Concentration Comparison from 2005 to 2016

[5]A Dobson unit (DU) is a measurement of density of a gas in a column of the Earth's atmosphere.

National Ambient Air Quality Standards for Sulfur Dioxide

Primary NAAQS:	**3-year average of 99th percentile of the daily maximum 1-hour concentration not to exceed 75 ppb**
Secondary NAAQS:	**3-hour concentrations not to exceed 0.5 ppm (500 ppb) more than once per year**

Attainment Designation

- EPA strengthened the SO_2 primary National Ambient Air Quality Standard (NAAQS) in 2010 and has developed a 4-phase process for designations. Please refer to EPA's information on the SO_2 data requirement rules for more details[6].
- All the SO_2 design[7] values, for 2017-2019 in Georgia, were below the 1-hour standard, with the highest design value occurring at the Augusta site (52 ppb).

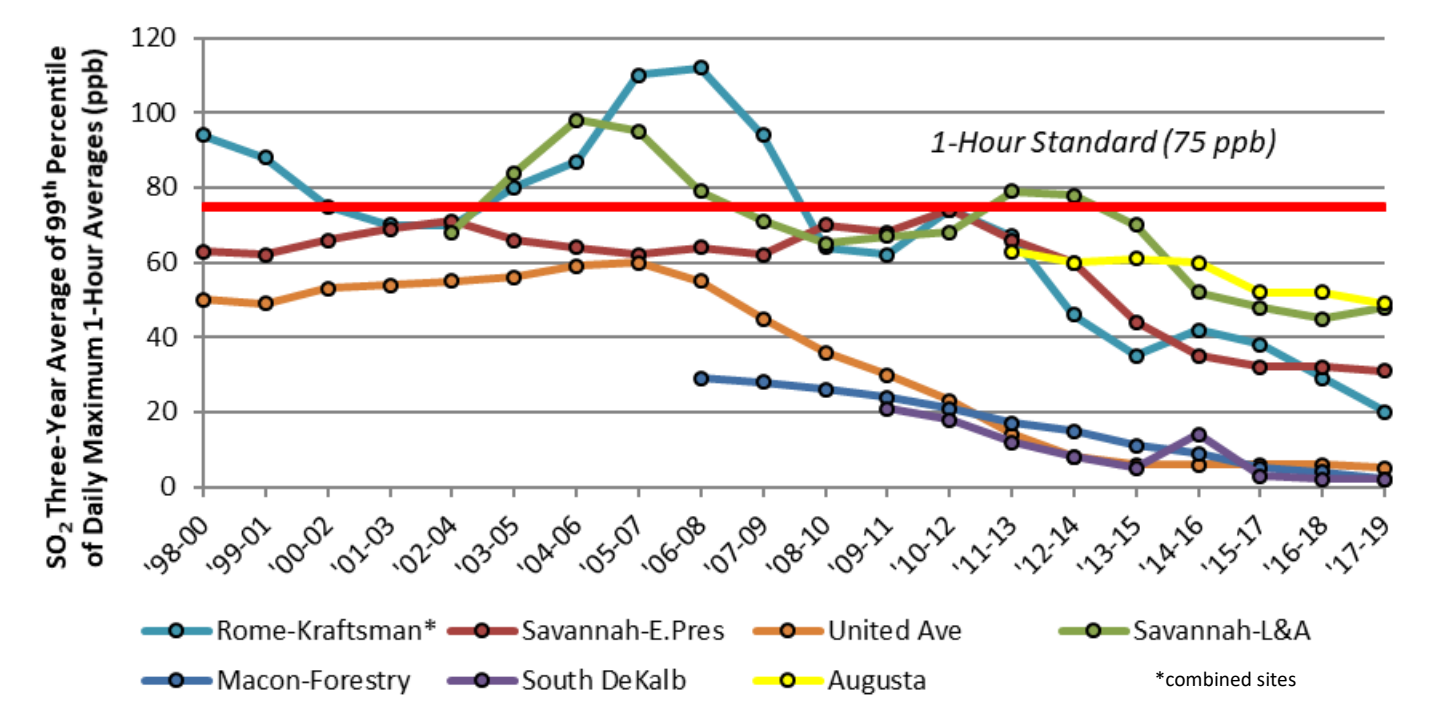


Figure 16. SO_2 three-year averages of the 99th percentile of annual daily max 1-hour averages

[6] https://www.epa.gov/so2-pollution/final-data-requirements-rule-2010-1-hour-sulfur-dioxide-so2-primary-national-ambient

[7] Three-year average of the 99th percentile of annual daily maximum 1-hour averages

Ozone (O_3)

What is it?

Ozone is a form of oxygen. But unlike oxygen (O_2), ozone (O_3) is not a stable gas. Ozone is highly reactive and unstable - corrosive and capable of damaging living cells. Ground-level ozone can be harmful at high concentrations and is a regulated pollutant. NOTE: Ozone occurs naturally in the Earth's upper atmosphere (stratosphere) where it protects life on Earth from the sun's harmful ultraviolet (UV) rays. This is the good ozone. "Good Up High, Bad Nearby."
Learn more: https://www.epa.gov/ozone-pollution

Where does it come from?

Ground-level ozone is not emitted directly into the air, but is created by chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Major sources of NO_x include emissions from industrial facilities, electric utilities and motor vehicle exhaust. In Georgia, the major sources of VOC are natural sources such as trees and vegetation. Other VOC sources include gasoline vapors and chemical solvents.

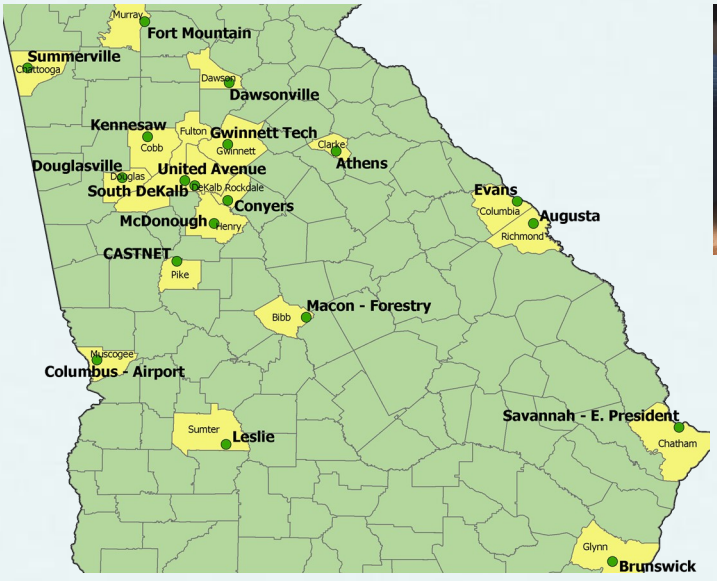
(Courtesy of Jamie Smith)

Figure 17. Ozone formation process

Health Impacts

- Ozone can irritate the mucous membranes of the nose, throat, and airways which can lead to coughing and chest pain.
- It can increase risk of respiratory infections in people with asthma and respiratory disease.
- Ozone reduces the ability to perform physical exercise by impairing normal lung function.
- Repeated exposure may cause permanent scarring of lung tissue.

Georgia Monitoring Information for Ozone



Measurement Technique

Continuous ultraviolet photometric method[4]

More information about measurement technique

[4] https://www.thermofisher.com/order/catalog/product/49I

Figure 18. Georgia's ozone monitoring

EPA's CASTNET Site

- As part of the Clean Air Status and Trends Network (CASTNET), EPA established a monitoring site in Pike County, Georgia in 1988.
- The CASTNET site is part of a national air quality monitoring network put in place to assess long-term trends in atmospheric deposition and ecological effects of air pollutants.
- The CASTNET site is one of 95 regional sites across rural areas of the United States and Canada measuring nitrogen, sulfur, and ozone concentrations, and deposition of sulfur and nitrogen.
- Like the South DeKalb ozone monitor, the CASTNET ozone monitor also collects data year-round. https://www.epa.gov/castnet

More Information about Ground Level Ozone

- Ground level ozone formation occurs through a complex series of photochemical reactions that take place in the presence of sunlight, causing a diurnal pattern (high ozone during the day, low ozone at night, see Figure 19).

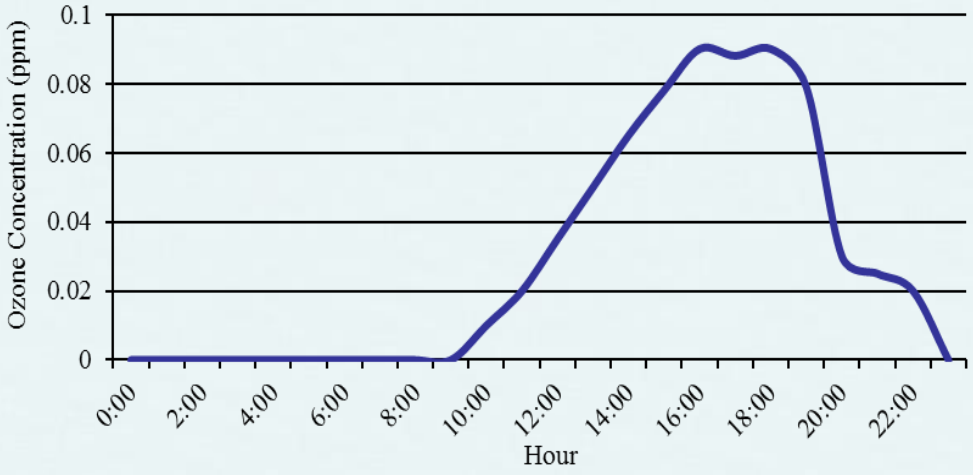
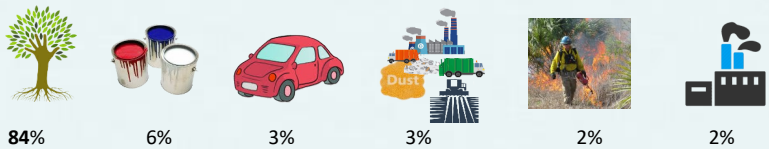


Figure 19. Typical urban 1-hour ozone diurnal pattern

- The photochemical reactions require a reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs).
- Since there will always be strong sunshine in the summer, and the naturally-occurring (or biogenic) levels of VOCs in Georgia are high, the most effective way to control ozone production in Georgia is to reduce emissions of NO_x in the summer.
- Examples of the most common reactive VOCs that contribute to ozone formation are: hydrocarbons found in automobile exhaust (benzene, propane, toluene); vapors from cleaning solvents (toluene); and biogenic emissions from plants and trees (isoprene). In Georgia, biogenic emissions account for 84% of the VOCs.

Volatile Organic Compounds
VOCs



84% 6% 3% 3% 2% 2%

See page 20 for icon key.

- With the exception of the South DeKalb and CASTNET sites, ozone in Georgia, unlike other pollutants previously discussed, is monitored March through October, complying with federal monitoring regulations (in 40CFR Part 58). Ozone is prevalent in urban areas in the summer but can appear in other areas due to weather patterns that can move air for many hundreds of miles.

National Ambient Air Quality Standards for Ozone

Primary NAAQS: 3-year average of 4th highest daily maximum 8-hr concentration not to exceed 0.070 ppm

Secondary NAAQS: Same as the Primary Standards

Attainment Designation

- Ozone monitoring has been in place in the Atlanta area since the 1970's.
- Currently the Atlanta-Sandy Springs-Roswell MSA ozone network includes nine monitors located in nine counties.
- On March 27, 2008 the ozone primary standard level was lowered to 0.075 ppm for the 8-hour averaging time, fourth maximum value, averaged over three years (Federal Register, Vol. 73, No. 60, page 16436).
- With the implementation of this ozone standard, the boundary of the Atlanta nonattainment area was defined as a 15-county area.
- With the 2013-2015 ozone data, the entire state of Georgia (including Atlanta) met the 2008 ozone standard of 0.075 ppm for ozone.

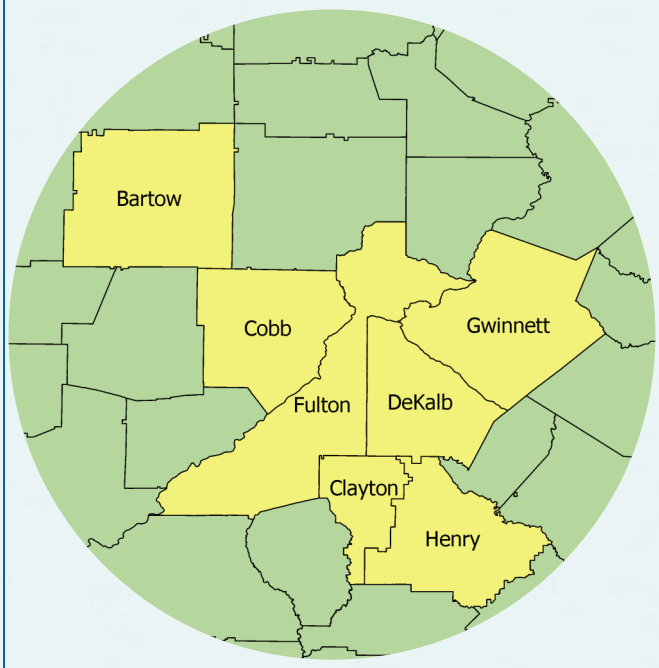


Figure 20. Georgia's 8-hour ozone nonattainment area (NAA) map for the 2015 standard

- Georgia was redesignated to attainment of the 2008 standard on May 22, 2017.
- On October 1, 2015, EPA lowered the ozone standard to 0.070 ppm[5].
- Then for this 2015 standard, and with the 2014-2016 data, the Atlanta area was redesignated to include only a 7-county area for the non-attainment area (Figure 20) (Federal Register, Vol. 83, No. 107, page 25776).
- A violation of the standard is determined by using an 8-hour average of the fourth maximum daily value, averaged over three years. There has been a gradual reduction in the number of days exceeding the ozone standards (Figure 21).

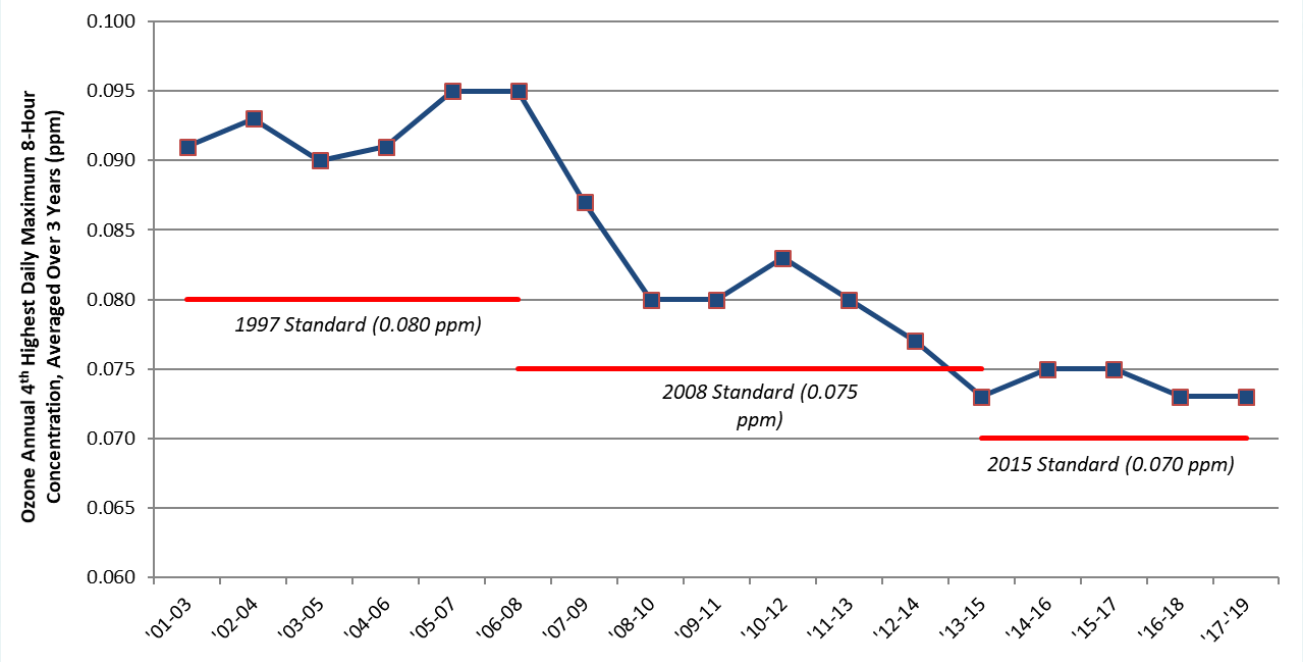


Figure 21. Ozone design values for Atlanta-Sandy Springs-Roswell MSA

[5] https://www.epa.gov/ozone-pollution/2015-revision-2008-ozone-national-ambient-air-quality-standards-naaqs-supporting

8-hour ozone exceedances in Atlanta-Sandy Springs-Roswell MSA

In 2019, the Atlanta-Sandy Springs-Roswell MSA area had a total of 18 days that exceeded the current (0.070 ppm) 8-hour standard. In 2017 there were 11 days, and in 2018 there were 10 days.

The term 'exceedance' is defined as a daily maximum 8-hour average greater than the standard. The Atlanta-Sandy Springs-Roswell MSA ozone monitors which exceeded the 8-hour ozone standard (0.070 ppm) in 2019 are mapped in Figure 22.

Site	2017	2018	2019
United Ave.	6	4	7
Dawsonville	2	2	1
Douglasville	1	0	5
Gwinnett Tech	0	0	1
McDonough	3	3	7
South DeKalb	1	0	4
Kennesaw	0	0	1
CASTNET	1	1	3
Conyers	1	2	5

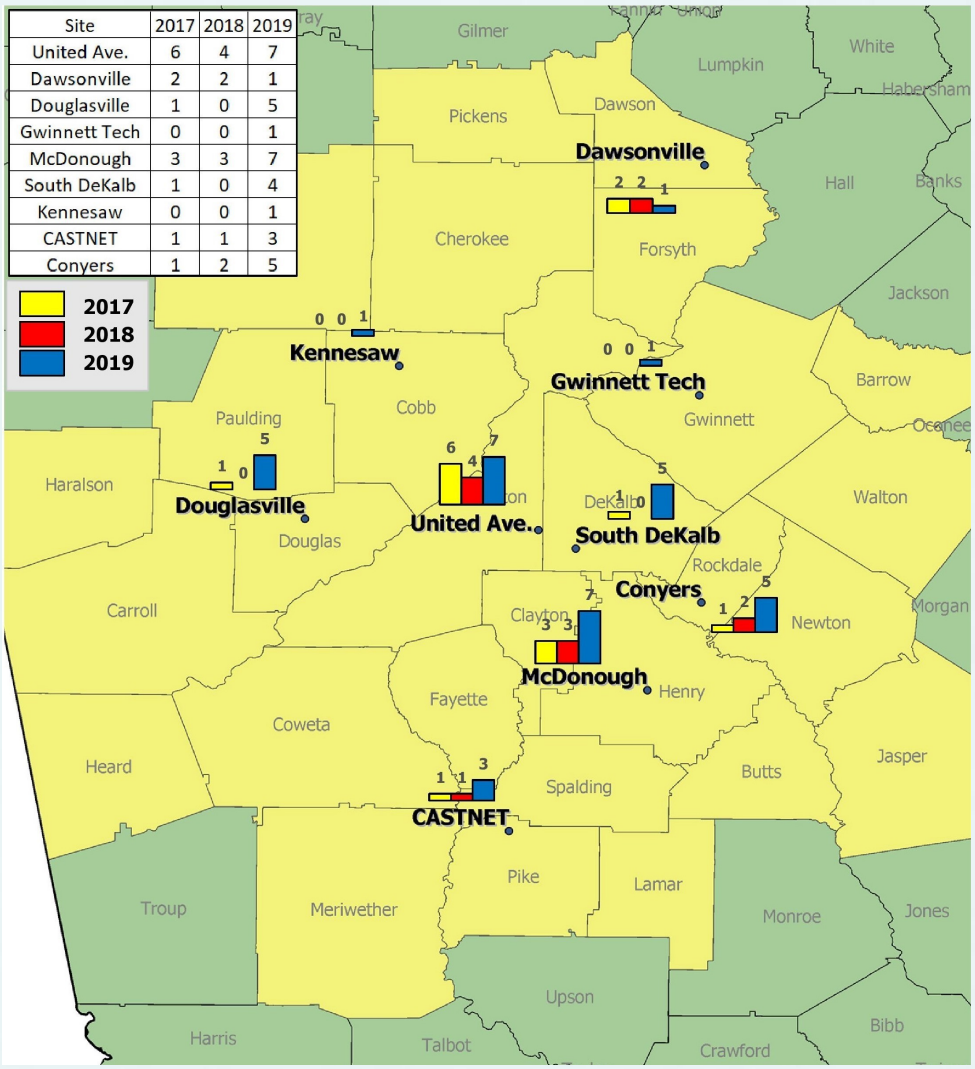


Figure 22. Map of 2019 Georgia Ozone Exceedances

Statewide 8-hour ozone concentrations

Figure 23 shows the three-year of ozone values across the state. The larger and darker circles indicate higher values.

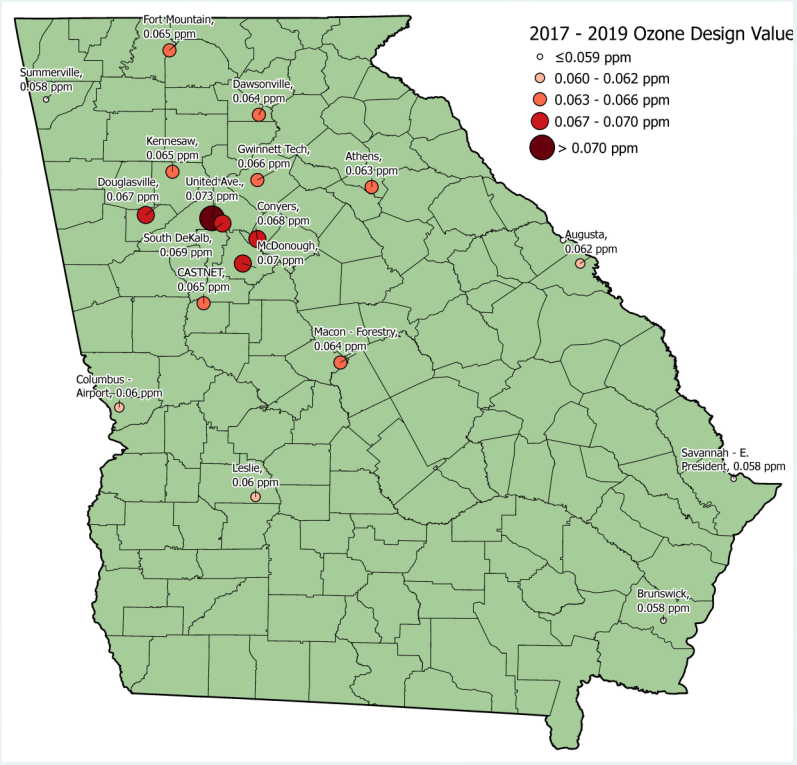


Figure 23. 2017-2019 Statewide Ozone Design Values

Lead (Pb)

What is it?

Lead is a naturally occurring element found in small amounts in the earth's crust. While it has some beneficial uses, it can be toxic to humans and animals causing detrimental health effects. Learn more: https://www.epa.gov/lead

Where does it come from?

- In the past, the Clean Air Act required extensive lead monitoring to detect the high levels of airborne lead that resulted from the use of leaded gasoline. With the phase-out of leaded gasoline, lead concentrations decreased drastically by the late 1980s. Figure 24 shows the drop in annual averages from 1990 through 2019.
- A major source of lead is acid battery plants. Lead can also come from the dust of vehicle traffic, construction activities, and agricultural activities and deposit on leaves and plants.

75% 23% 2%

See page 20 for icon key.

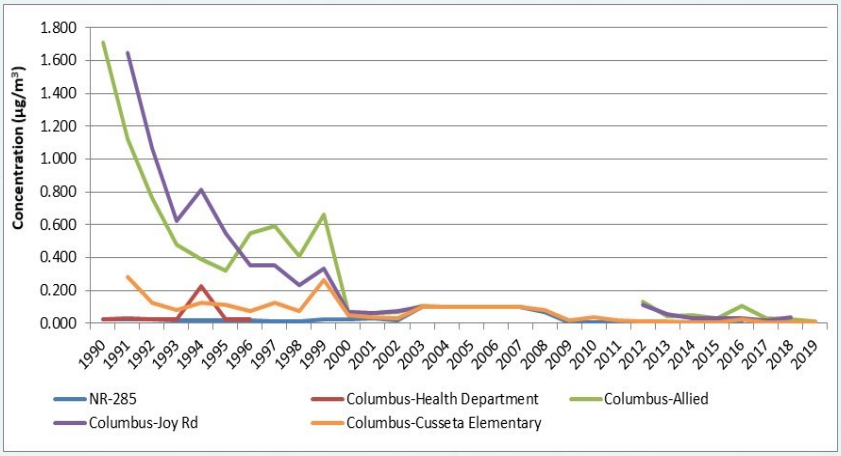


Figure 24. Georgia's Annual Lead Averages

Health Impacts

- Exposure mainly through inhalation and ingestion of lead in food, water, soil, or dust.
- Puts children at particular risk exposure since they commonly put hands, toys, and other items in their mouths, which may come in contact with lead-containing dust and dirt.
- Bioaccumulates in blood, bones, and tissues.
- Can damage kidneys, liver, and nervous system.
- Excessive and repeated exposure leads to neurological impairments that can cause seizures, mental retardation, and behavioral disorders especially in children, infants, and fetuses.
- Lead toxicity is rarely attributed to a single exposure or digestive event, it is the product of chronic exposure over time.
- May be a factor in high blood pressure and subsequent heart disease.

Georgia Monitoring Information for Lead

Figure 25. Georgia's lead monitoring sites

Measurement Technique

24-hour total suspended particulate (100 microns or less) on 8"x10" pre-weighed fiberglass filter[6]

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUE

[6] https://tisch-env.com/high-volume-air-samplers/

National Ambient Air Quality Standards for Lead

Primary NAAQS: Rolling 3-month average, not to exceed 0.15 ug/m^3

Secondary NAAQS: Same as the Primary Standards

Attainment Designation

- Figure 26 shows how Georgia's lead data compares to the rolling three-month average standard for 2012 through 2018.
- The last of the three months used for each average is indicated on the graph.
- The monitors in the Columbus GA-AL MSA are located near a lead battery manufacturer, and in November 2016, there was a violation of the lead standard in Columbus due to a malfunction on a silo control and is reflected in the graph below.

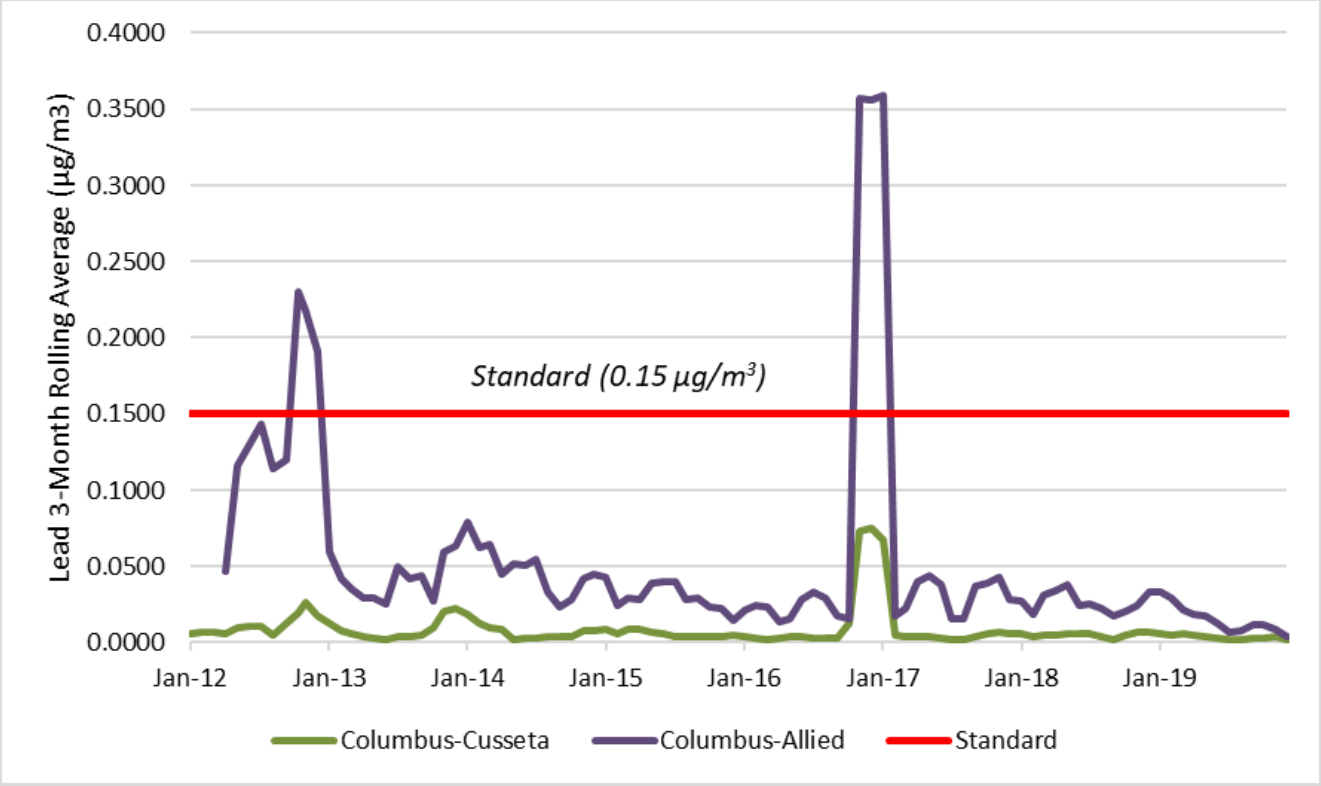


Figure 26. Georgia's three-month rolling averages, 2012-2019

Particulate Matter PM_{10} and $PM_{2.5}$

Learn more: https://www.epa.gov/pm-pollution

- Particulate matter includes a broad range of material that consists of solid particles, fine liquid droplets, or condensed liquids absorbed onto solid particles.
- Airborne particulates are not a single pollutant as discussed for the other criteria pollutants, but rather a mixture of many different air pollutants.
- There are two ways that particulate matter is formed, known as primary and secondary.
- Primary sources that emit particles directly include combustion, incineration, construction, mining, metals smelting, metal processing, and grinding sources.
- Other primary sources include diesel engine exhaust, road dust, wind blown soil, forest fires, open burning of vegetation for land clearing or waste removal, ocean spray, and volcanic activity.
- A great deal of particulate matter is in form of gaseous air pollutants that readily react with oxygen and each other. While many of those reactions produce other gases, they frequently produce particles. Particles formed through this process are known as secondary particulate matter such as sulfate particles, nitrate particles, and calcium nitrate or sodium nitrate particulates.
- Alternative diesel fuels are available that emit less particulate matter, as well as other pollutants.
- Ultra-low sulfur diesel fuel is one fuel that emits less sulfur dioxide, a source of particulate matter formation.
- Biodiesel fuel emits less particulate matter, carbon monoxide, hydrocarbons, and air toxics.
- Also, emulsified diesel emits less nitrogen oxides and particulate matter.
- Particulate pollution may be categorized by size since there are different health impacts associated with the different sizes of particulate matter.
- We currently monitor for three sizes of particles: **PM_{10}** (up to 10 microns in diameter), **$PM_{2.5}$** (up to 2.5 microns in diameter) and **PM_{coarse}** (PM_{10} minus $PM_{2.5}$). To illustrate the size differences, Figure 27 shows how approximately ten PM_{10} particles can fit on a cross section of a human hair, and approximately thirty $PM_{2.5}$ particles would fit on a cross section of a hair.
- These particles and droplets are invisible to the naked eye, and composition and sources can vary greatly by region.
- Regional relative humidity can affect the level of water present within the particles and affect how much dissolved gases or reactive species enter the lungs when particles are inhaled.

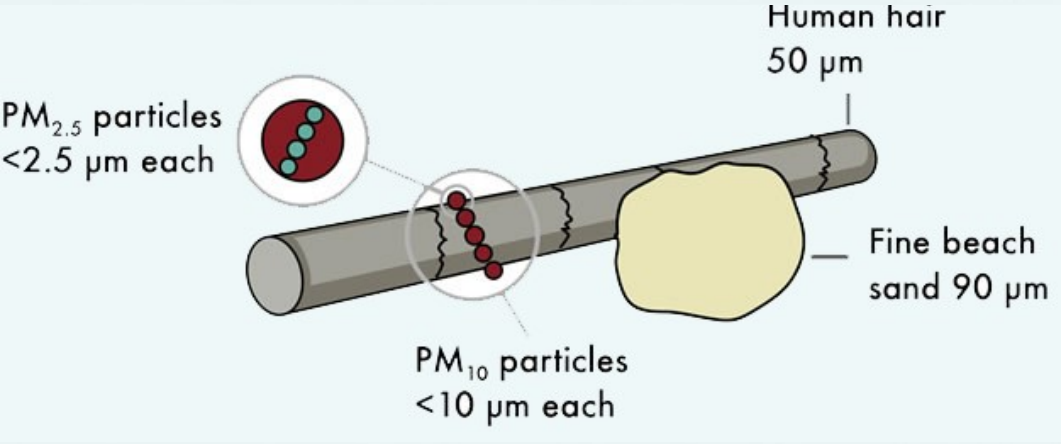


Figure 27. Comparison of particulate matter size to human hair

PM_{10}

What is it?

PM_{10} are dust particles that are up to 10 micrometers in diameter.

Where does it come from?

Sources include crushing or grinding operations and dust stirred up by vehicles on roads.

80%

12%

5%

2%

2%

See page 20 for icon key.

Health Impacts

- Penetrate deeply into the lungs.
- Breathing and respiratory problems, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense system against inhaled materials and organisms, and damage to lung tissue.
- Individuals with chronic lung or cardiovascular disease, individuals with influenza, asthmatics, elderly people, and children are most effected.

Georgia Monitoring Information for PM_{10}

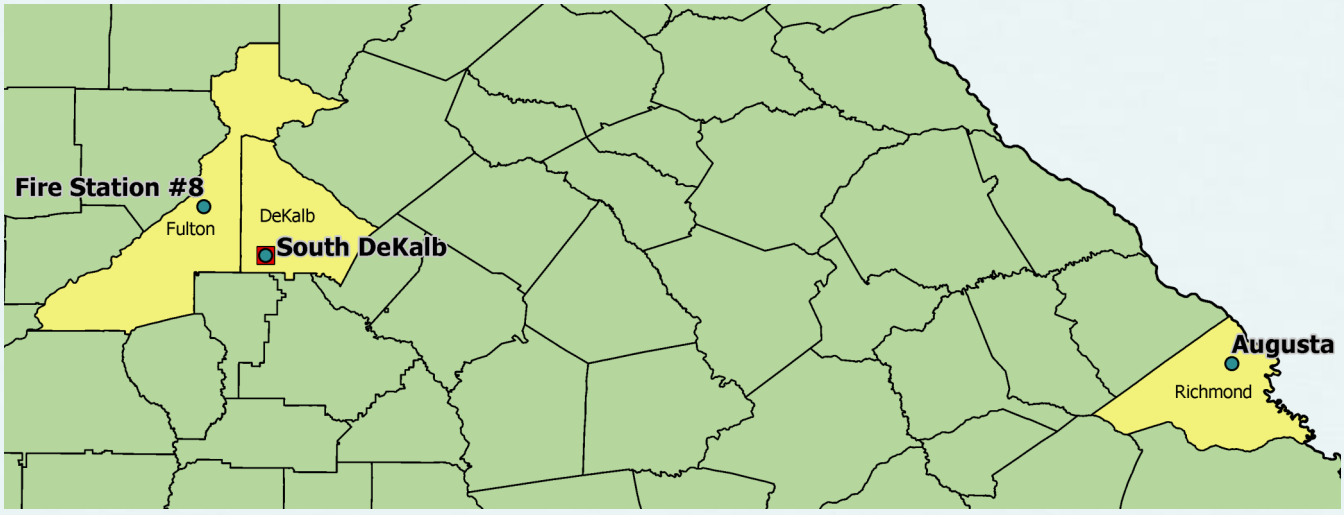


Figure 28. Georgia's PM_{10} and PM_{coarse} (red square) monitoring sites

Measurement Techniques

- Two categories of EPA-approved reference or equivalent monitors are used to determine attainment with the PM_{10} standard (integrated and continuous):

⇒ Integrated low-volume monitor that collects a 24-hour sample through an impaction inlet device that only allows particles with 10 microns or less in size to reach the filter media.[7]

⇒ Continuous Teledyne T640X monitor and tapered element oscillating microbalance (TEOM) method with an inlet designed to cut out particles larger than 10 microns in size.[8,9]

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUES

[7] https://tisch-env.com/low-volume-air-sampler/

[8] http://www.teledyne-api.com/products/particulate-instruments/t640

[9] https://www.thermofisher.com/order/catalog/product/1400AB

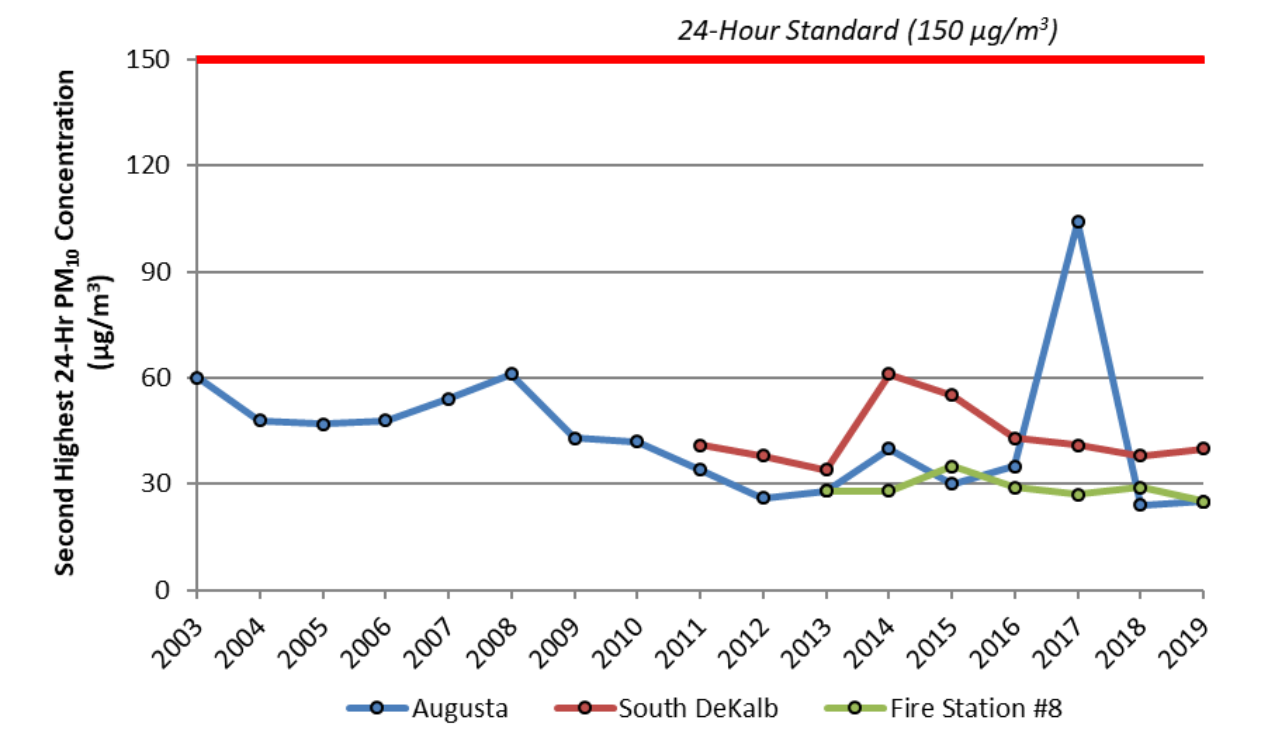
National Ambient Air Quality Standards for Particulate Matter PM_{10}

Primary NAAQS: Number of days with a maximum of 24-hour concentration of 150 µg/m^3 must not exceed more than once per year on average over 3 years

Secondary NAAQS: Same as the Primary Standards

Attainment Designation

- Figure 29 shows how Georgia compares to the 24-hour standard for PM_{10}, which is 150 µg/m^3.
- The standard allows one exceedance per year, averaged over a 3-year period; therefore, this chart shows the second highest 24-hour average for each site. All three samplers collected data well below the standard.



Note: A house fire nearby the Augusta site caused values to be higher than normal. In addition, the sampler at this site began collecting hourly data.

Figure 29. PM_{10} annual second maximum 24-hour concentrations

$PM_{2.5}$

What is it?

- $PM_{2.5}$ are particles that are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides.

Where does it come from?

- Fine particles are produced from dust and all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

48% 34% 12% 2% 2% 1% 1%

See page 20 for icon key.

Health Impacts

- Can penetrate deep into lung tissue and even enter the bloodstream. This may cause significant respiratory or cardiovascular problems that can shorten an individual's lifespan.
- High risk groups include children, the elderly, and people with cardiovascular or lung diseases such as emphysema and asthma.

Georgia Monitoring Information for $PM_{2.5}$

Measurement Techniques

- Two types of methods: integrated and continuous.
- The integrated samplers are the official reference method (FRM) used for determining which areas in Georgia are attainment (meeting the national standard). Integrated samplers collect samples on Teflon filters for 24 hours, using a 2.5 microns particle size sorting device.[10]
- The continuous method consists of four types of instruments.
  - ⇒ The beta attenuation method (BAM) is designed for the inlet to cut out particles larger than 2.5 microns in size. As of March 2019, the one site (Albany) where EPD had a BAM[11] sampler running as an Federal Equivalent Method (FEM) sampler was replaced with a Teledyne T640 (see below) which can be used for attainment determinations as well .
  - ⇒ The Teledyne T640 is an optical aerosol spectrometer that converts optical measurements to mass measurements by determining sampled particle size via scattered light using 90° white-light scattering with polychromatic LED.[12] These samplers are also FEMs and collect data that can be used for attainment determinations.
  - ⇒ The tapered element oscillating microbalance (TEOM) method is used to support the development of air quality models and forecasts, including the Air Quality Index (AQI), and provide the public with information about pollutant concentrations in real time. As set up at EPD's sites, these samplers cannot be used for making attainment determinations.[13]
  - ⇒ The nephelometer determines PM concentrations by measuring the shutter count which allows the light source to stabilize, and wavelengths which shows the average diameter of the measured particle size.[14] These samplers cannot be used for attainment determinations.
- Continuous $PM_{2.5}$ data is reported every hour on Georgia's Ambient Air Monitoring web page located at https://airgeorgia.org/. The immediate availability of this data allows the public to make informed decisions regarding their outdoor activities.

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUES

[10] https://www.thermofisher.com/order/catalog/product/2025I

[11] http://www.metone.com/products/air-quality-monitors/

[12] http://www.teledyne-api.com/products/particulate-instruments/t640

[13] https://www.thermofisher.com/order/catalog/

[14] https://www.ambilabs.com/nephelometer

Figure 30 shows the location of Georgia's $PM_{2.5}$ FRM monitors and Figure 31 shows the location of $PM_{2.5}$ continuous and speciation monitors.

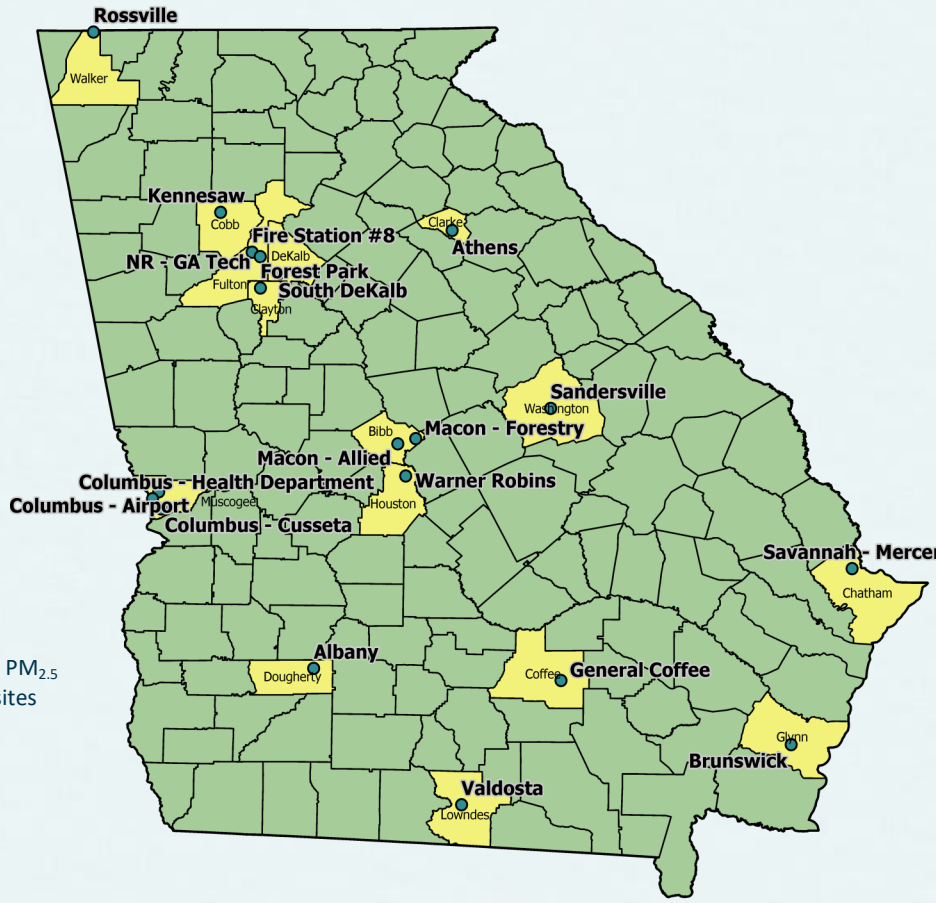


Figure 30. Georgia's $PM_{2.5}$ FRM monitoring sites

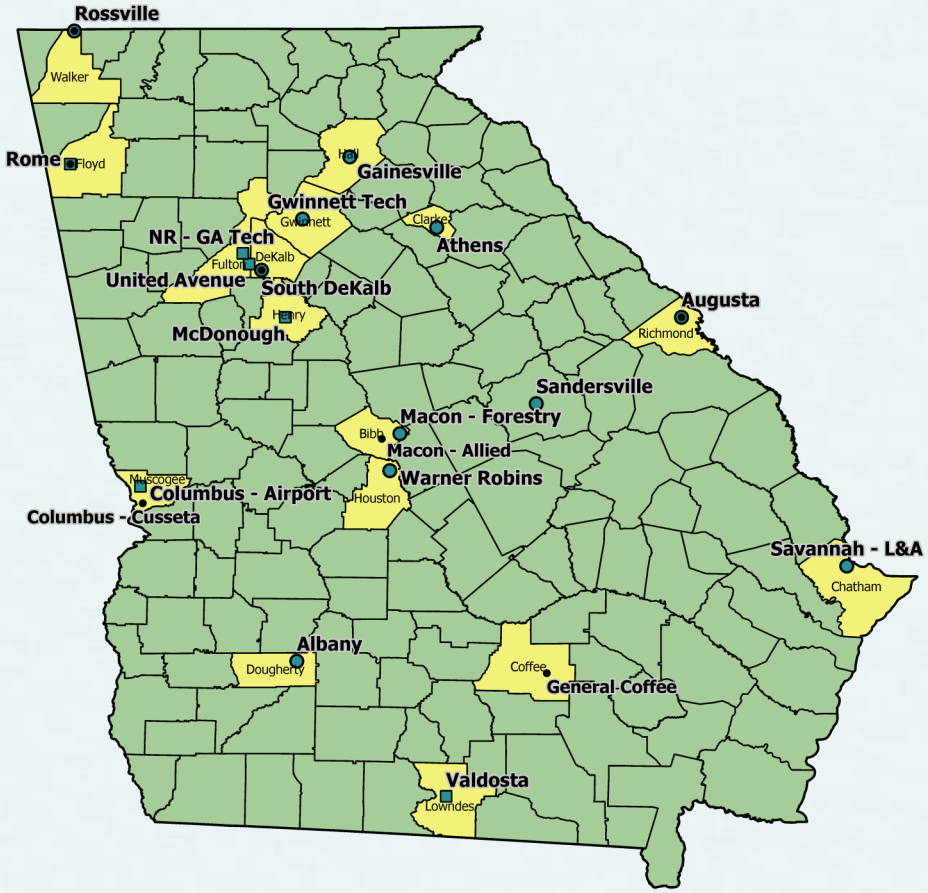


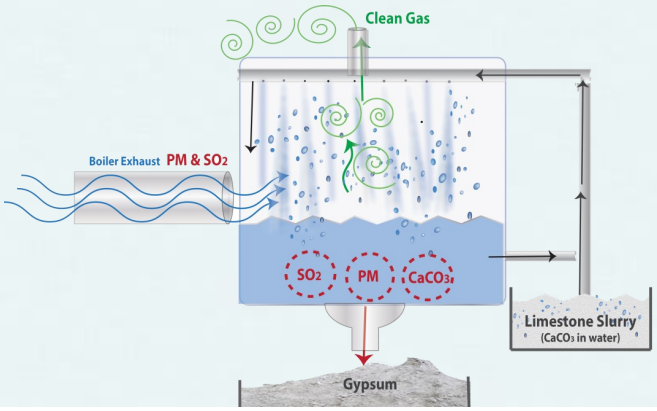
Figure 31. Georgia's $PM_{2.5}$ continuous (green circles) and $PM_{2.5}$ speciation (black dots) monitoring sites

Reducing $PM_{2.5}$ Emissions in Georgia

PM Controls

Georgia's Multi-Pollutant Rule

- In 2007, Georgia implemented State Rule 391-3-1-.02(2)(sss), which affects the then 13-county Atlanta nonattainment areas plus surrounding counties.
- This multi-pollutant control measure that affected electric steam generating units at electric utilities required coal fired power plants to install controls to reduce three criteria pollutants, PM, NO_2, and SO_2, and had rolling start dates between 2008 and 2014.
- The controls that were added are called Selective Catalytic Reduction (SCR) for NO_x and Flue Gas Desulfurization (FGD) for SO_2 and PM.
- Figure 32 shows the decrease in $PM_{2.5}$ concentrations as these controls were implemented across the state.



SO_2 and PM

Schematic design of the absorber of an FGD

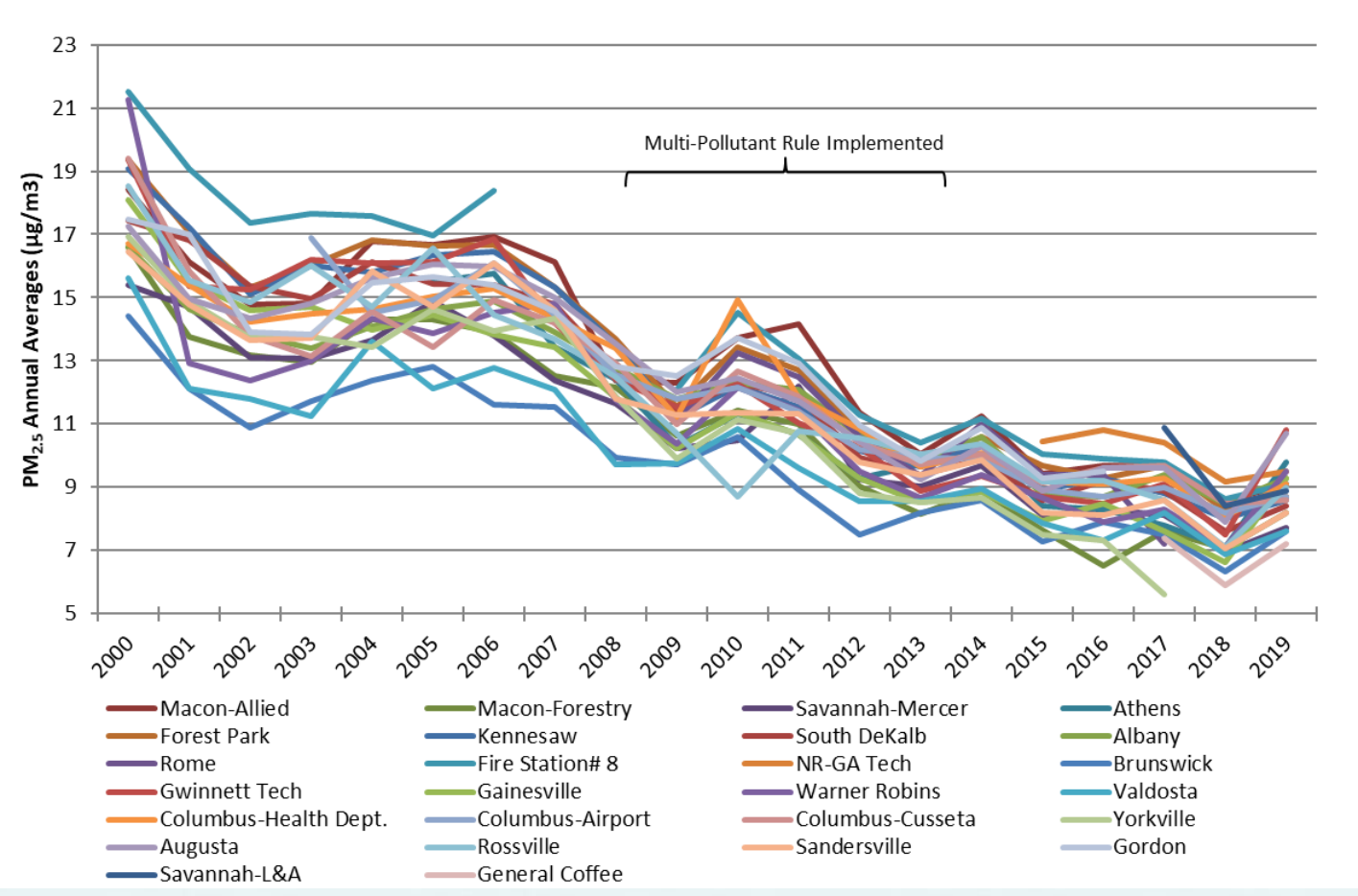


Figure 32. Implementation of PM Controls

National Ambient Air Quality Standards for Particulate Matter $PM_{2.5}$

Primary NAAQS: 3-year average of the annual weighted mean not to exceed 12.0 µg/m^3

3-year average of the 98th percentile of 24-hour concentration not to exceed 35 µg/m^3

Secondary NAAQS: 3-year average of the annual weighted mean not to exceed 15.0 µg/m^3

3-year average of the 98th percentile of 24-hour concentration not to exceed 35 µg/m^3

Attainment Designation

- For an area to be in attainment of the annual ambient air $PM_{2.5}$ standard, the three-year average of the annual average concentrations has to be less than or equal to 12.0 µg/m^3.
- In addition, the 24-hour primary and secondary standard requires that the three-year average of the 98th percentile of the 24-hour concentrations be less than or equal to 35 micrograms per cubic meter.
- Currently all areas of Georgia are designated unclassifiable/attainment for the 2012 annual $PM_{2.5}$ standard because they are meeting the national standard.

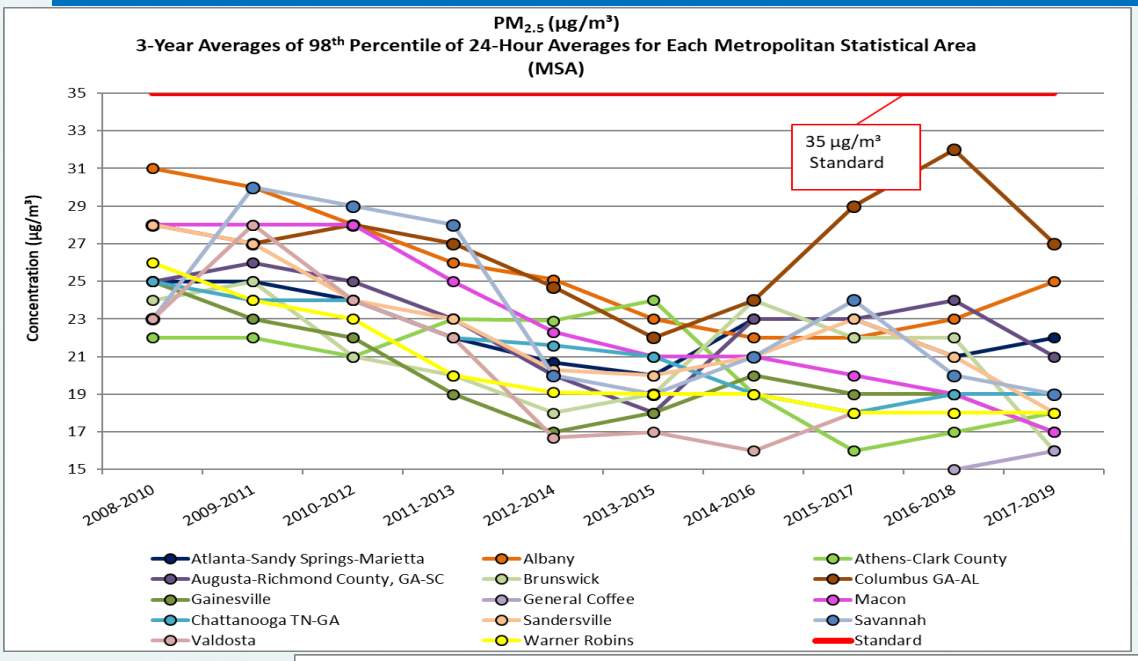


Figure 33. Comparison of the three-year averages of the 98th percentile of $PM_{2.5}$ 24-hour data

Note: Wildfires and prescribed fires in the Columbus, GA-AL MSA caused values to be higher than normally observed in this area.

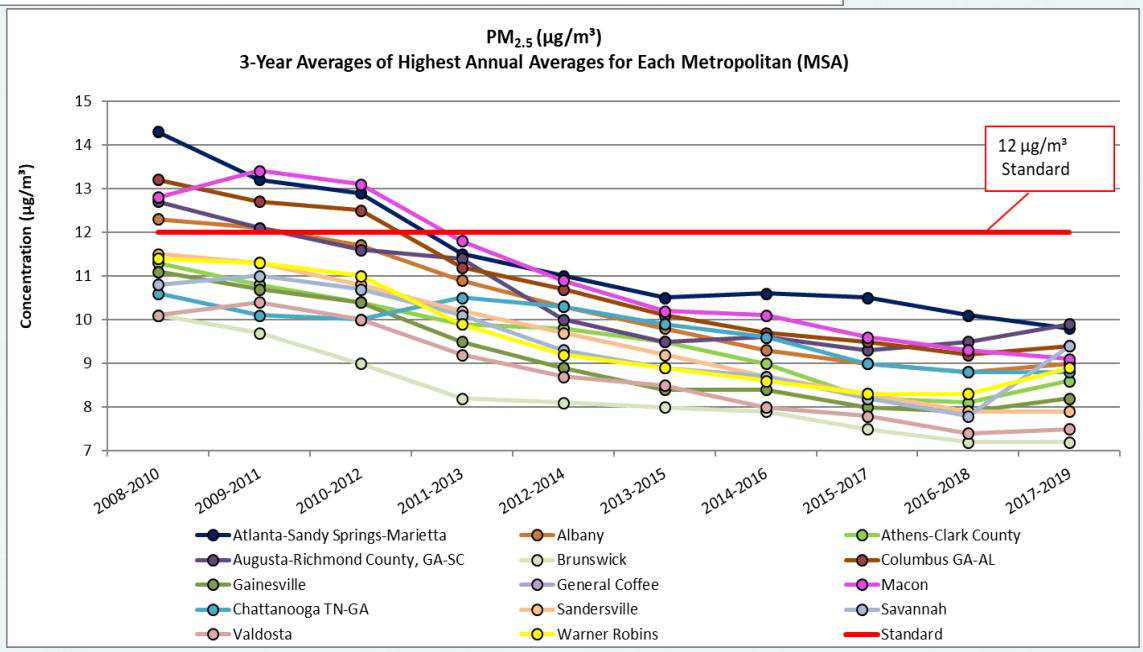


Figure 34. Comparison of the $PM_{2.5}$ three-year annual averages to the annual standard

$PM_{2.5}$ Speciation

Particle speciation measurements are performed to support the regulatory, analytical, and public health purposes of the program. These measurements help scientists and regulators track the progress and effectiveness of newly implemented pollution controls. The data also improves scientific understanding of the relationship between particle composition, visibility impairment, and adverse human health effects.

Each individual particle, regardless of its source, has a distinct chemical composition which depends on local sources and a variety of other factors. Each has varying health effects based on its size and chemical composition.

Georgia currently monitors fifty-three species in particulate matter. Of these, sulfate and organic carbon are detected in the highest concentrations, with magnitudes of up to five to nine times greater than the other major species.

Refer to Figure 31 for a map of Georgia's $PM_{2.5}$ Speciation monitors.

Figure 35 compares the percent composition of $PM_{2.5}$ for each site based on 2019 annual averages.

- Organic carbon makes up 42-56% of $PM_{2.5}$ for all sites with Augusta having the largest percentage.
- Sulfate is the second largest portion of $PM_{2.5}$ for all sites and ranges from 15-18%.
- Nitrate, crustal, elemental carbon, and ammonium ion each generally make up no more than about 4-12% of $PM_{2.5}$ for all sites.
- The chemical elements typical of the Earth's crust are grouped together as "crustal".

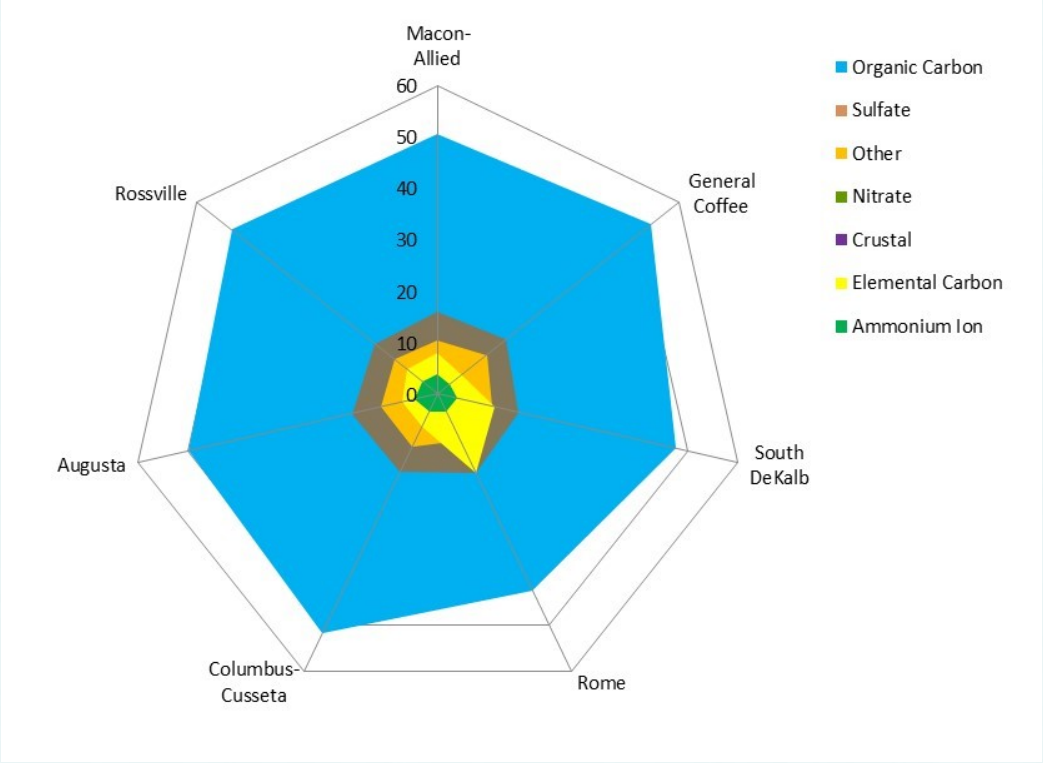


Figure 35. Percentages of 2019 Speciation Data

Measurement Techniques[15,16]

- Filter media with laboratory techniques using gravimetric (microweighing) analysis
- X-ray fluorescence and particle-induced X-ray emission for trace elements; Ion chromatography for anions and selected cations
- Controlled combustion for carbon
- Gas chromatography/mass spectroscopy (GC/MS) for semi-volatile organic particles

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUES

[15] http://www.urgcorp.com/index.php/systems/manual-sampling-systems/urg-3000n-carbon-sampler

[16] http://www.metone.com/?wpfb_dl=228

PREDOMINANT SPECIES FOUND IN $PM_{2.5}$

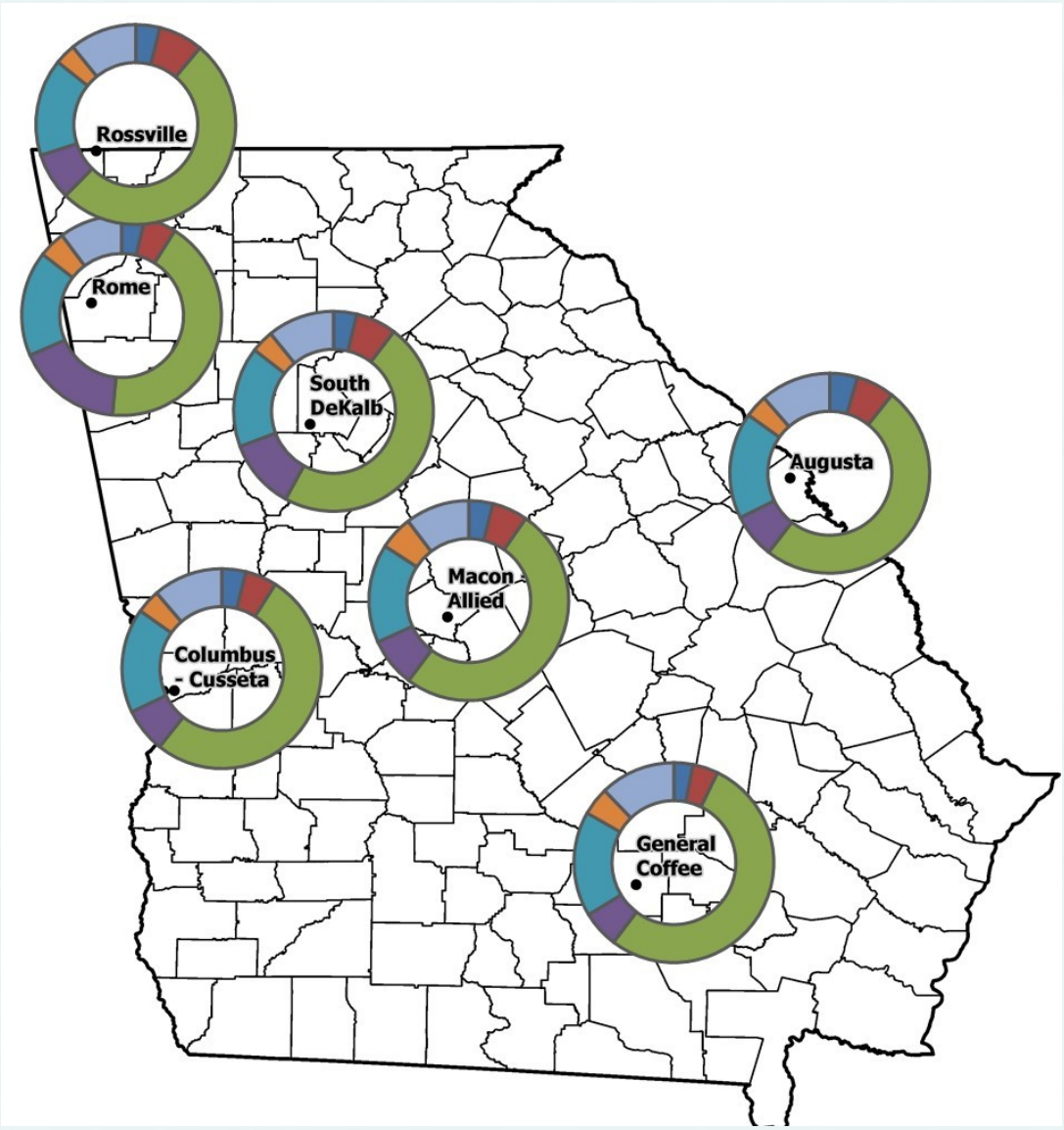


Figure 36 presents each site with all species making up the composition at each location.

- Ammonium Ion
- Sulfate Products
- Nitrate Products
- Crustal Products
- Elemental Carbon
- Organic Carbon
- Other

Ammonium Ion: commonly released by fertilizer production, livestock production, coke production, and some large refrigeration systems. Ironically, it can be emitted by NO_x control systems installed on large fossil fuel combustion systems, which use ammonia or urea as a reactant.

Sulfate Products: formed during the oxidation of SO_2 in the atmosphere.

Nitrate Products: formed through a complex series of reactions that convert NO_x to nitrates - vehicle emissions and fossil fuel burning.

Crustal Products: components that are the result from the weathering of Earth's crust—ocean salt and volcanic discharges— aluminum, calcium, iron, titanium, and silicon—released by metals production, and can be resuspended in the atmosphere by mechanisms that stir up fine dust, such as mining, agricultural processes, and vehicle traffic.

Elemental Carbon: carbon in the form of soot- diesel engine emissions, wood-burning fireplaces, and forest fires.

Organic Carbon: may be released directly, but are also formed through a series of chemical reactions in the air, mostly as a result of the burning of fossil fuels and wood.

The Air Quality Index

The Air Quality Index (AQI) is a national air standard rating system developed by the U.S. Environmental Protection Agency. The AQI is used statewide to provide the public, on a daily basis, with an analysis of air pollution levels and possible related health risks.

Generally, an index scale of 0 to 500 is used to assess the quality of air, and these numbers are synchronized with a corresponding descriptor word such as: Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, and Very Unhealthy. To protect public health the EPA has set an AQI value of 100 to correspond to the NAAQS for the following criteria pollutants: Ozone (O_3), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Particulate Matter 10 (PM_{10}), Particulate Matter 2.5 ($PM_{2.5}$), and Nitrogen Dioxide (NO_2).

The AQI for a reporting region equates to the highest rating recorded for any pollutant within that region. Therefore, the larger the AQI value, the greater level of air pollution present, and the greater expectation of potential health concerns. However, this system only addresses air pollution in terms of acute health effects over time periods of 24 hours or less and does not provide an indication of chronic pollution exposure over months or years. Figure 37 shows how the recorded concentrations correspond to the AQI values, descriptors and health advisories. Each day the AQI values are available to the public through Georgia EPD's Ambient Air Monitoring website at https://airgeorgia.org/.

Maximum Pollutant Concentration									
$PM_{2.5}$ (24hr) $\mu g/m^3$	PM_{10} (24hr) $\mu g/m^3$	SO_2 (1hr)* ppm	O_3 (8hr)^ ppm	O_3 (1hr) ppm	CO (8hr) ppm	NO_2 (1hr) ppm	AQI Value	Descriptor	EPA Health Advisory
0.0–12.0	0– 54	0– 0.035	0.000–0.054	None	0.0–4.4	0–0.053	0 to 50	Good (green)	Air quality is considered satisfactory, and air pollution poses little or no risk.
12.1–35.4	55–154	0.036–0.075	0.055–0.070	None	4.5–9.4	0.054-0.100	51 to 100	Moderate (yellow)	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to the condition of the air may experience respiratory symptoms.
35.5–55.4	155 – 254	0.076 – 0.185	0.071 – 0.085	0.125 – 0.164	9.5–12.4	0.101-0.360	101 to 150	Unhealthy for Sensitive Groups	Members of sensitive groups (people with lung or heart disease) are at greater risk from exposure to particle pollution. Those with lung disease are at risk from exposure to ozone. The general public is not likely to be affected in this range.
55.5–150.4	255–354	0.186–0.304*	0.086–0.105	0.165–0.204	12.5–15.4	0.361-0.649	151 to 200	Unhealthy (red)	Everyone may begin to experience health effects in this range. Members of sensitive groups may experience more serious health effects.
150.5–250.4	355–424	0.305–0.604*	0.106–0.2	0.205–0.404	15.5–30.4	0.650–1.249	201 to 300	Very Unhealthy (purple)	AQI values in this range trigger a health alert. Everyone may experience more serious health effects. When the AQI is in this range because of ozone, most people should restrict their outdoor exertion to morning or late evening hours to avoid high ozone exposures.
250.5–350.4	425–504	0.605–0.804*	None^	0.405 – 0.504	30.5–40.4	1.250–1.649	301 to 400	Hazardous (maroon)	AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.
350.5–500	505–604	0.805–1.004*	None^	0.505–0.604	40.5–50.4	1.650–2.049	401 to 500		

Figure 37. The AQI, *AQI values of 200 or greater are calculated with 24-hr SO_2 concentrations, ^AQI values of 301 or greater are calculated with 1-hr O_3 concentrations. ***AQI numbers above 100 may not be equivalent to a violation of the standard*

2019 AQI Values Summary for Georgia

Air Quality Index Summary by CBSA Number of Days						
Pollutants Monitored in 2019	**Good (0-50)**	**Moderate (51-100)**	**Unhealthy for Sensitive Groups (101-150)****	**Unhealthy (151-200)****	**Very Unheathy (201-300)****	**Hazardous (>300)****
Albany						
$PM_{2.5}$	236	118	2	-	-	-
Americus						
O_3	211	27	-	-	-	-
Athens-Clark County						
O_3, $PM_{2.5}$	245	120	-	-	-	-
Atlanta-Sandy Springs-Roswell						
O_3, NO_2, $PM_{2.5}$, CO, SO_2, PM_{10}	164	185	15	1	-	-
Augusta-Richmond County, GA-SC						
O_3, $PM_{2.5}$, PM_{10}	219	144	2	-	-	-
Brunswick						
O_3, $PM_{2.5}$	254	25	-	-	-	-
Chattanooga, TN-GA						
O_3, $PM_{2.5}$	230	135	-	-	-	-
Columbus, GA-AL						
O_3, $PM_{2.5}$	257	108	-	-	-	-
Dalton						
O_3	211	39	-	-	-	-
General Coffee						
$PM_{2.5}$	107	14	-	-	-	-
Gainesville						
$PM_{2.5}$	259	81	-	-	-	-
Macon						
O_3, SO_2, $PM_{2.5}$	241	121	2	1	-	-
Rome						
SO_2, $PM_{2.5}$	217	148	-	-	-	-
Savannah						
O_3, SO_2, $PM_{2.5}$	295	70	-	-	-	-
Summerville						
O_3	231	13	-	-	-	-
Valdosta						
$PM_{2.5}$	255	54	-	-	-	-
Warner Robins						
$PM_{2.5}$	246	106	1	1	-	-

Table 1. 2019 AQI summary data, most days had an AQI value in the 'Good' (0-50) category for all the sites.

Atlanta-Sandy Springs-Roswell MSA

Figure 38 shows in more detail the AQI values for the Atlanta-Sandy Springs-Roswell MSA. There were 18 days with an AQI value above 100 in 2019. Ozone is a major driver of an elevated AQI and can be higher in the summer months due to increased sunlight. Higher ozone and $PM_{2.5}$ concentrations are the primary sources of AQI values in the "Unhealthy for Sensitive Groups" category in the Atlanta-Sandy Springs-Roswell MSA.

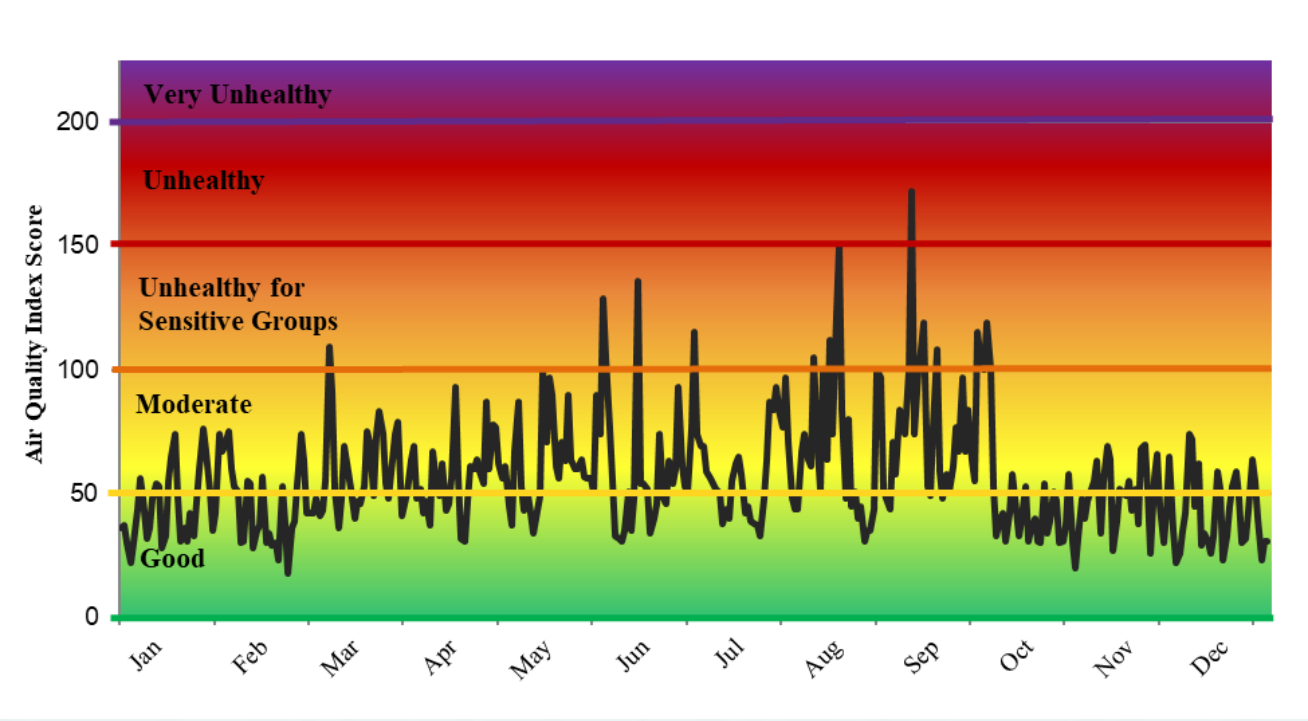


Figure 38. 2019 AQI Values for the Atlanta-Sandy Springs-Roswell MSA

PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

To better understand ozone formation, EPD monitors oxides of nitrogen, volatile organic compounds (VOCs), carbonyl compounds, and meteorological parameters at the PAMS site.

Isoprene, the tracer for VOCs emissions from vegetation, is by far the largest contributor to ozone formation at the PAMS site. It is naturally released in large quantities by conifer trees, which are very abundant in the Southeastern United States.

Georgia Monitoring Information

Figure 39. Georgia's PAMS monitoring site

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUE

[17]https://www.perkinelmer.com/lab-solutions/resources/docs/APP_Analysis-of-VOCs-in-Air-Using-EPA-Method-TO-17-011909_01.pdf

Measurement Techniques

- Historically from June through August, volatile organic compounds and hydrocarbon samples are analyzed hourly at the South DeKalb PAMS site using a gas chromatography unit with a Flame Ionization Detector (FID).[17] However, this instrument was inoperable in 2019 and is being replaced.

The amount of isoprene emissions from conifers varies seasonally, with emissions increasing as length of daylight and temperature increases (Figure 40).

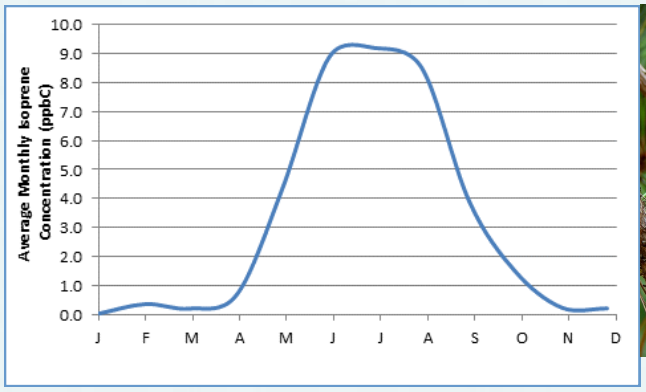


Figure 40. Average yearly profile of isoprene

Toluene (generally the most abundant anthropogenic species in urban air) reaches the air from a variety of sources such as combustion of fossil fuels and evaporative emissions, motor vehicle fuel and is also used as a common solvent in many products such as paint. It is relatively constant throughout the year, suggesting a steady level of emissions year-round (Figure 41).

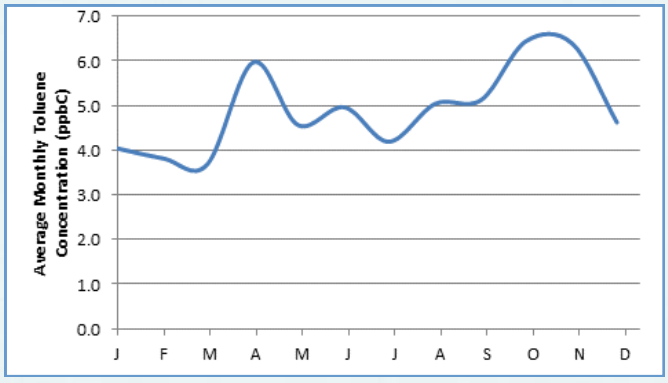


Figure 41. Toluene average annual occurrence

Carbonyl Compounds

Carbonyl compounds define a large group of organic compounds, which include acetaldehyde, acrolein, and formaldehyde. These compounds can lead to ozone formation.

Sources of carbonyl compounds include vehicle exhaust, cigarette smoke, paper production, stationary internal combustion engines and turbines, solvents, polymers, plastics, and the combustion of wood.

Depending on the amount inhaled, exposure to these compounds can cause irritation to the eyes, ears, nose, and throat, dizziness, and damage to the lungs.

Figure 42. Georgia's carbonyls monitoring site

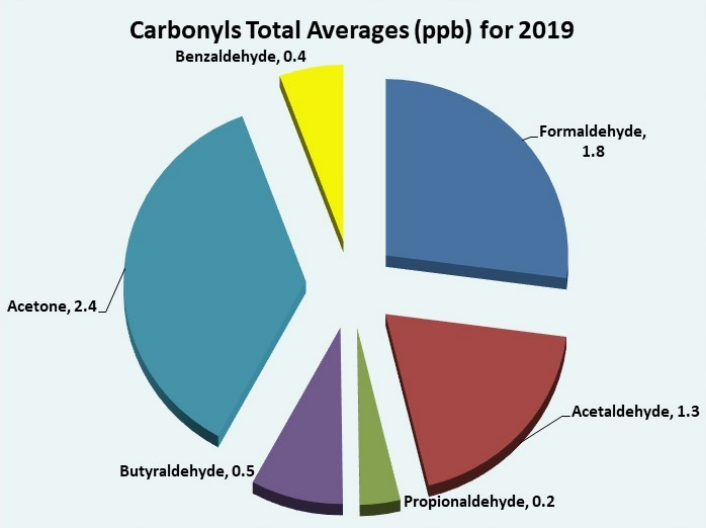


Figure 43. Total Average 24-hour carbonyl concentrations by species

Measurement Techniques

The carbonyls are sampled with two types of methods.

- One method includes an absorbent cartridge filled with dinitrophenylhydrazine (DNPH), using High Performance Liquid Chromatography analysis. [18]
- Another collection method is the canister sampler that is used for sampling volatile organic compounds at the South DeKalb and NR-285 sites. Acrolein is analyzed using this method. The graph to the right shows this data.

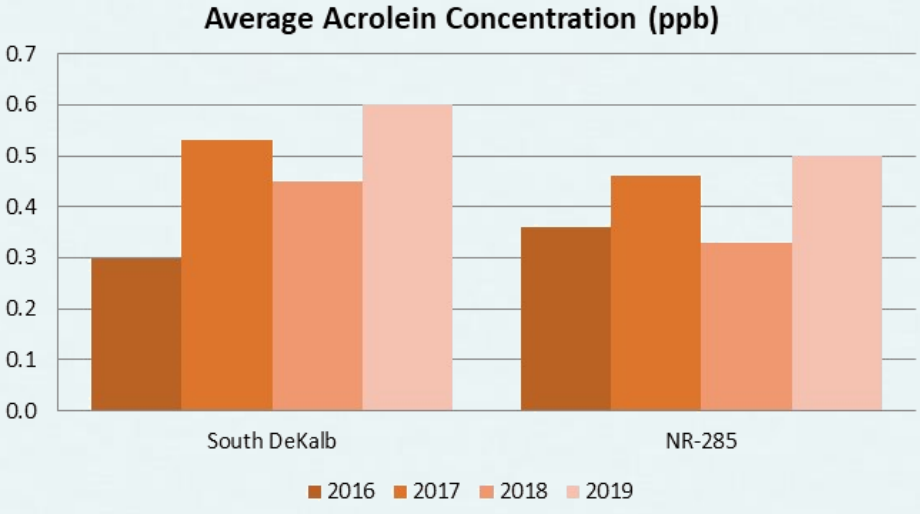


Figure 44. Acrolein concentrations, 2016-2019

MORE INFORMATION ABOUT MEASUREMENT TECHNIQUES

[18] http://www.atec-online.com/

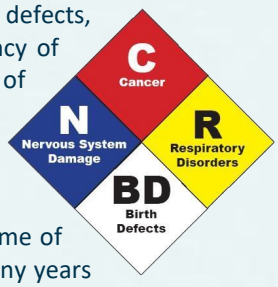
AIR TOXICS MONITORING

In order for EPD to expand the understanding of the quality of Georgia's air regarding ambient concentrations of hazardous air pollutants, EPD began state-sponsored air toxics monitoring activities.

Air Toxics are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

Air toxic pollutants, or hazardous air pollutants (HAPs), are a group of air pollutants that have a wide variety of sources—mobile sources (such as vehicles), stationary industrial sources, small area sources, indoor sources (such as cleaning materials), and other environmental sources (such as volcanoes and wildfires). The lifetime, transportation, and make-up of these pollutants are affected by both weather (rain and wind) and landscape (mountains and valleys). In addition, some HAPs that are no longer used, but were commonly used in the past, can still be found in the environment today.

Negative effects on human health range from headaches, nausea, and dizziness to cancer, birth defects, problems breathing, and other serious illnesses. These effects can vary depending on frequency of exposure, length of exposure time, health of the person that is exposed, along with the toxicity of the compound.



People can be exposed to HAPs by breathing contaminated air, consuming food or water contaminated by air pollutants, or touching contaminated water or soil.

Some of the substances tend to have only one critical effect, while others may have several. Some of the effects may occur after a short exposure and others appear after long-term exposure, or many years after being exposed.

These air pollutants also affect the environment. Wildlife experience symptoms similar to those in humans and pollutants accumulate in the food chain. Many air pollutants can also be absorbed into waterways and have toxic effects on aquatic wildlife.

From the list of 187 HAPs compounds identified by EPA, toxic compounds monitored include metals, volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs), and carbonyl compounds.

NATTS

The National Air Toxics Trends Station (NATTS) network was established in 2003 at the South DeKalb site and is intended for long-term operation for the purpose of discerning national trends. The NATTS Network consists of 27 sites nationwide, 20 urban and 7 rural. A risk assessment is performed on the air toxics monitoring data. In addition to the NATTS site, EPD operates a VOCs sampler at the NR-285 site (mapped below).

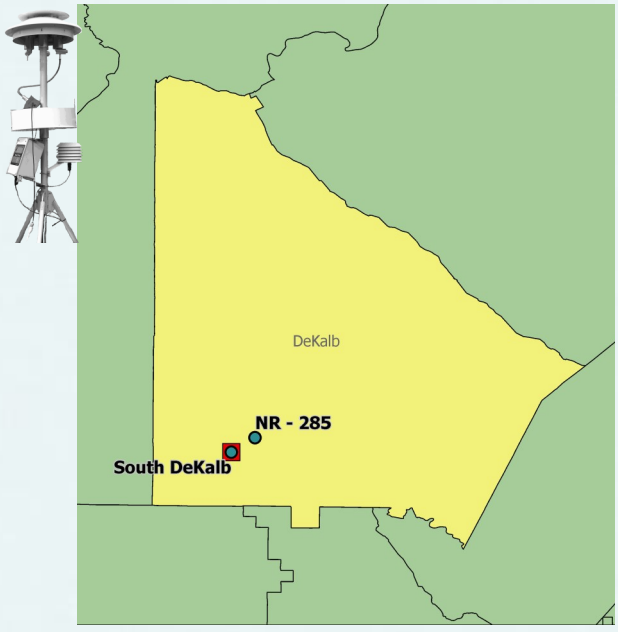


Figure 45. Air Toxics monitoring sites, NATTS site indicated by red box

Monitoring Techniques

- The PM_{10} metals sampler collects quartz fiber filters that are analyzed on an inductively coupled plasma mass spectrometry (ICP-MS).[19]
- PUF (polyurethane foam) sampler is used for sampling semi-volatile organic compounds (SVOCs)—A multi-layer cartridge is prepared which collects both the particulate fraction and the volatile fraction of this group of compounds, analyzed using a gas chromatograph.[19]
- The canister sampler for VOCs is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS). [20,21]
- Carbonyls are collected with absorbent cartridge filled with dinitrophenylhydrazine (DNPH), using High Performance Liquid Chromatography analysis, as discussed on the previous page.

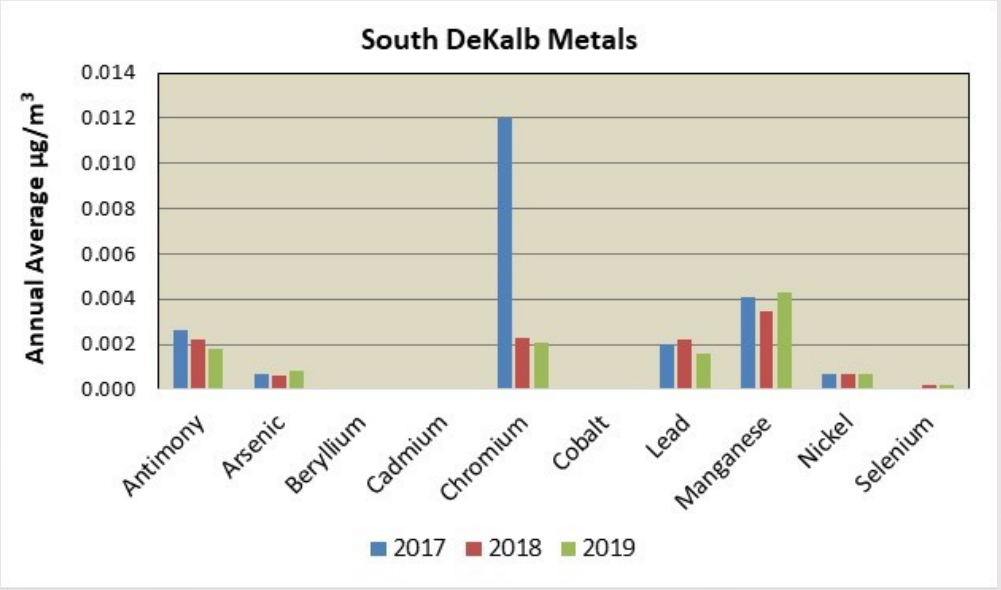
MORE INFORMATION ABOUT MEASUREMENT TECHNIQUES

[19] https://tisch-env.com/high-volume-air-samplers/
[20] https://xonteck.com/
[21] http://www.atec-online.com/atec_003.htm

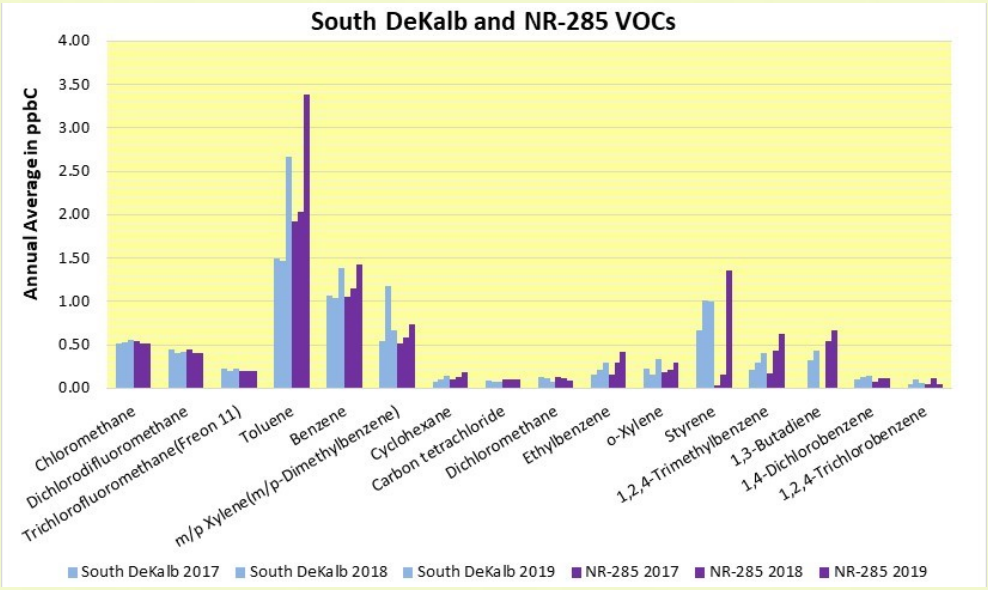
METALS

Sources include:

- gasoline and diesel exhaust
- batteries
- soil and water
- burning coal
- emissions from iron and steel production
- lead smelters
- operation of iron and steel production plants
- by-product of mining and smelting sulfide ores
- used in industrial processes
- tires
- radioactive metal in radiotherapy
- photocells and solar panels



VOLATILE ORGANIC COMPOUNDS



Sources include:

- various industrial, stationary and mobile sources

SEMI-VOLATILE ORGANIC COMPOUNDS

Sources include:

- burning of coal, oil, gas, and garbage
- found in dyes, cigarette smoke, coal tar, plastics, and pesticides

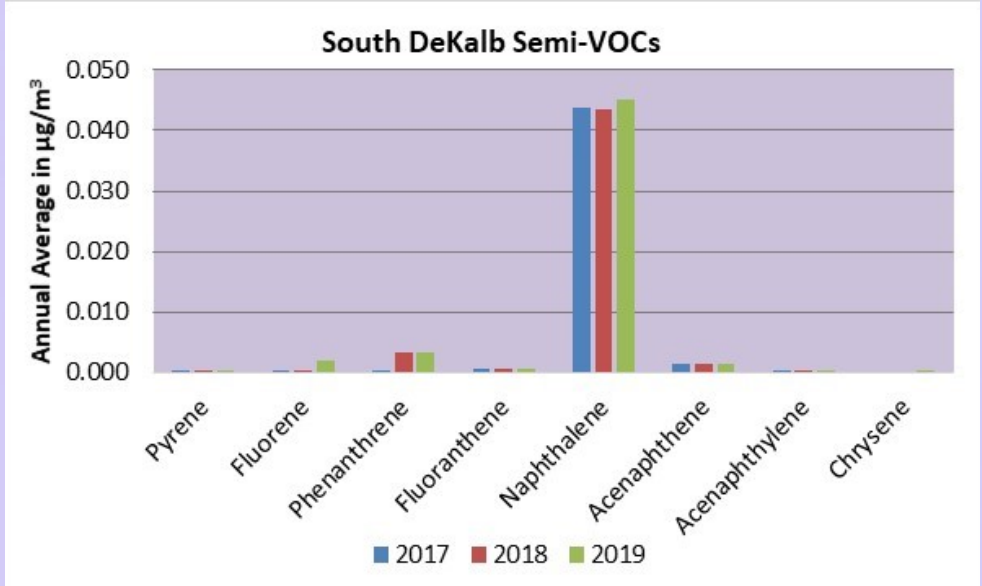
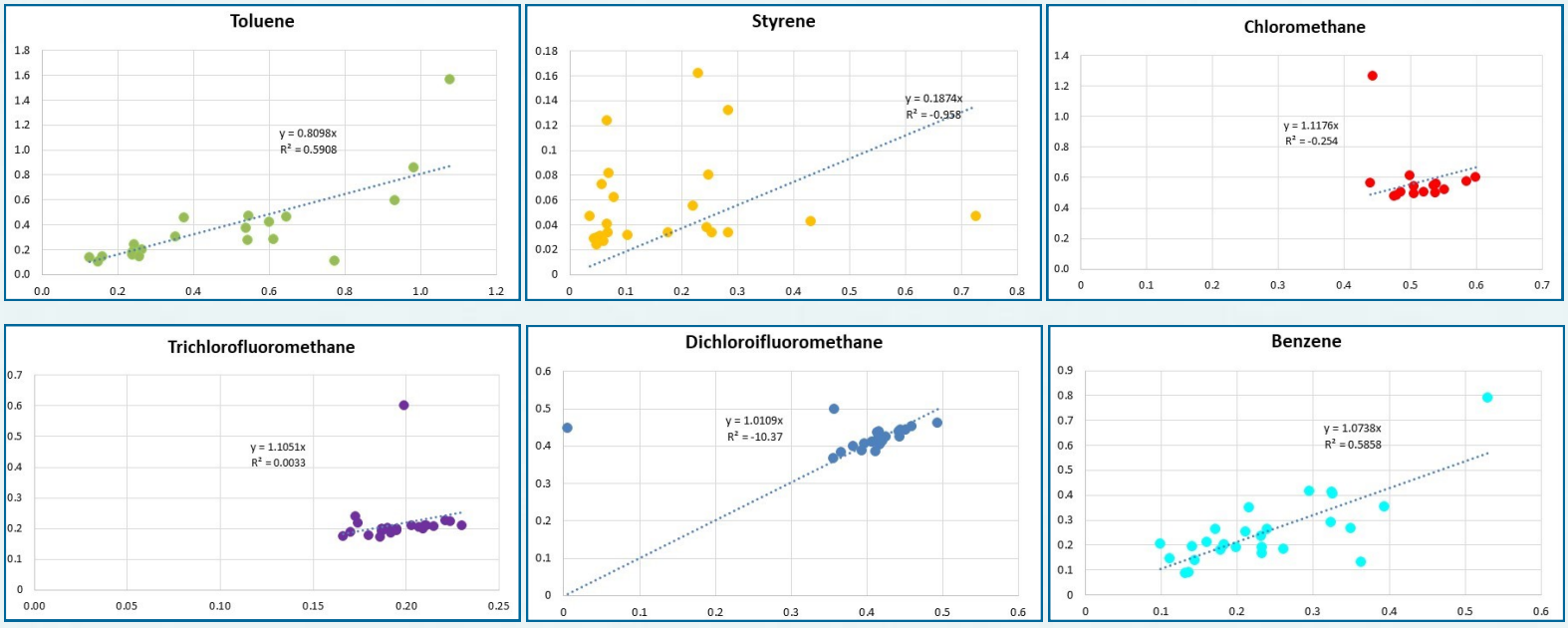


Figure 46. Air Toxics Data

Near-Road VOCs

The NR-285 site is set up as part of the Near-Road Monitoring Network and is located within 40 meters of I-285, a heavily traveled interstate. The South DeKalb site is approximately a mile away from the NR-285 site and is located 580 meters from the same interstate.

The following scatterplots and correlations were created to compare select VOCs that had several pollutant detections at both the South DeKalb and NR-285 sites.



VOC	Correlation Coefficient (r)
Toluene	0.774503
Styrene	0.102607
Chloromethane	-0.33498
Trichlorofluoromethane	0.122161
Dicholrodifluoromethane	-0.01921
Benzene	0.765385

Figure 47. Comparison of select VOCs at the South DeKalb and NR-285 sites

The correlations between the VOCs collected at the South DeKalb and NR-285 sites would indicate that there could be different sources influencing each site, with most correlation values below 0.5. There are a few VOCs, as seen in the above graphs, that have samples collected relatively close in concentration, but then have a few samples that were very different in concentration causing the R^2 value to be lower. This is indicated by the colored dots falling closely along the blue trendline, or falling further away from the blue trendline.

RISK ASSESSMENT

The 2019 Air Toxics Risk Assessment was prepared by the Risk Assessment Program of EPD to understand whether long-term exposure to specific air toxics in ambient (outdoor) air around two air monitoring sites (South DeKalb and NR-285) in the State of Georgia could be harmful to human health. The risk assessment is included as Appendix D of this document.

For questions, please contact:

Amy Potter
Program Manager
Risk Assessment Program
Land Protection Branch-Hazardous Waste Management
GA EPD
404.657.8658
Amy.Potter@dnr.ga.gov

METEOROLOGICAL REPORT

State Climatology and Meteorological Summary of 2019

- The climate across North and Central Georgia varies based on a variety of factors, the most prominent of which is terrain.
- The Gulf of Mexico and the Atlantic Ocean are the two nearby maritime bodies that exert an important influence on the North Georgia climate, acting as major sources of moisture support.
- A complete suite of meteorological instrumentation is used to characterize meteorological conditions around metropolitan Atlanta. See Appendix B for details.

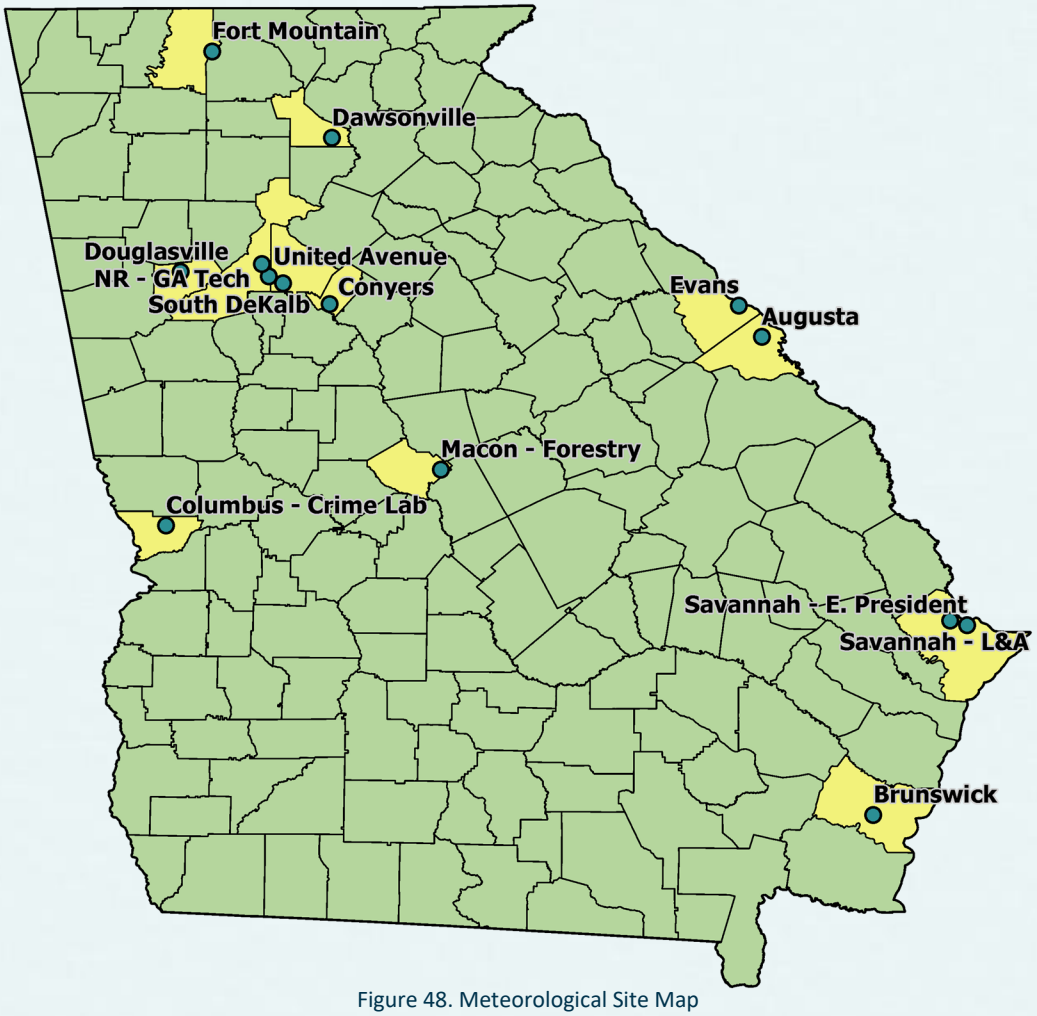


Figure 48. Meteorological Site Map

Figure 49. Sample meteorological instrumentation at EPD sites:
a) ceilometer, b) sonic anemometer, c) Temperature probe and relative humidity monitor, d) tipping bucket

2019 Severe Weather

- Valentine's Day tornado outbreak—4 EF-0 rated tornadoes reported.
- An EF-1 rated tornado was reported on Feb 24th in Moreland, GA.
- March experienced the biggest severe weather outbreak of the year on the 3rd as a strong low-pressure system swept through the area. Half-dollar sized hail and 14 tornadoes were reported with this system. The strongest tornado in Georgia was an EF-2/EF-3 rating in the cities of Ellerslie and Talbotton.
- More severe weather in April produced numerous tornadoes and flooding across north and central Georgia mid-month.

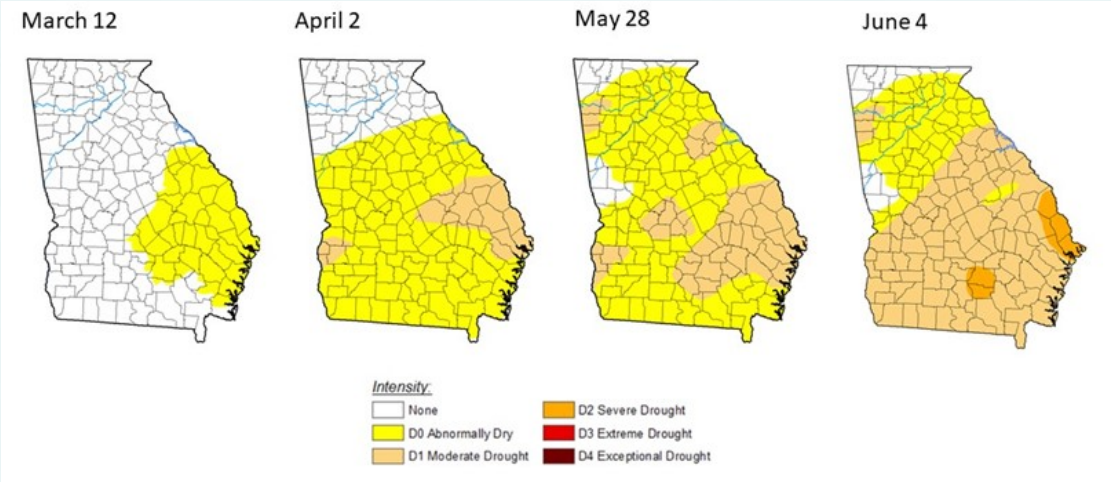
Figure 50. Rainfall across the state in April and a flooded road in Troup County (images from NWS Peachtree City)

- By September, the outer bands of Hurricane Dorian impacted coastal Georgia bringing peak wind gusts to several EPD sites: 42.51 mph at Savannah L&A, 41.6 mph at Savannah East President, and 41.3 mph in Brunswick. Gusts were even higher at some barrier islands.
- Numerous high temperature records were set in September and October during a stretch of abnormally hot and dry conditions. This led to the onset of a flash drought across the region.
- Overall, 2019 was the warmest year on record for Atlanta and Macon.
- No snowfall was recorded throughout 2019 at the Atlanta, Macon, Columbus, and Athens climate sites.

For more information regarding the Georgia Climate Office, see https://epd.georgia.gov/office-state-climatologist.

2019 Drought Conditions for Georgia

- The year started with drought-free conditions for the first two months before abnormally dry (D0) and moderate (D1) drought conditions were introduced into the state in March.
- By April 9th, 79% of the state experienced drought conditions (D0 or worse) and 14% was under D1 conditions. Drought conditions fluctuated geographically but remained prevalent through June.
- Drought conditions improved significantly in November and December due to abundant rain and less heating. By the end of the year, the entire state was drought free except for the southwest corner with a small area under D0 conditions.



- In August, a slight increase in abnormally dry and moderate drought conditions across the state was observed, which set the stage for a major flash drought event. A flash drought is an event during which an area experiences degradation by two or more drought categories in a four-week period, based on the U.S. Drought Monitor.

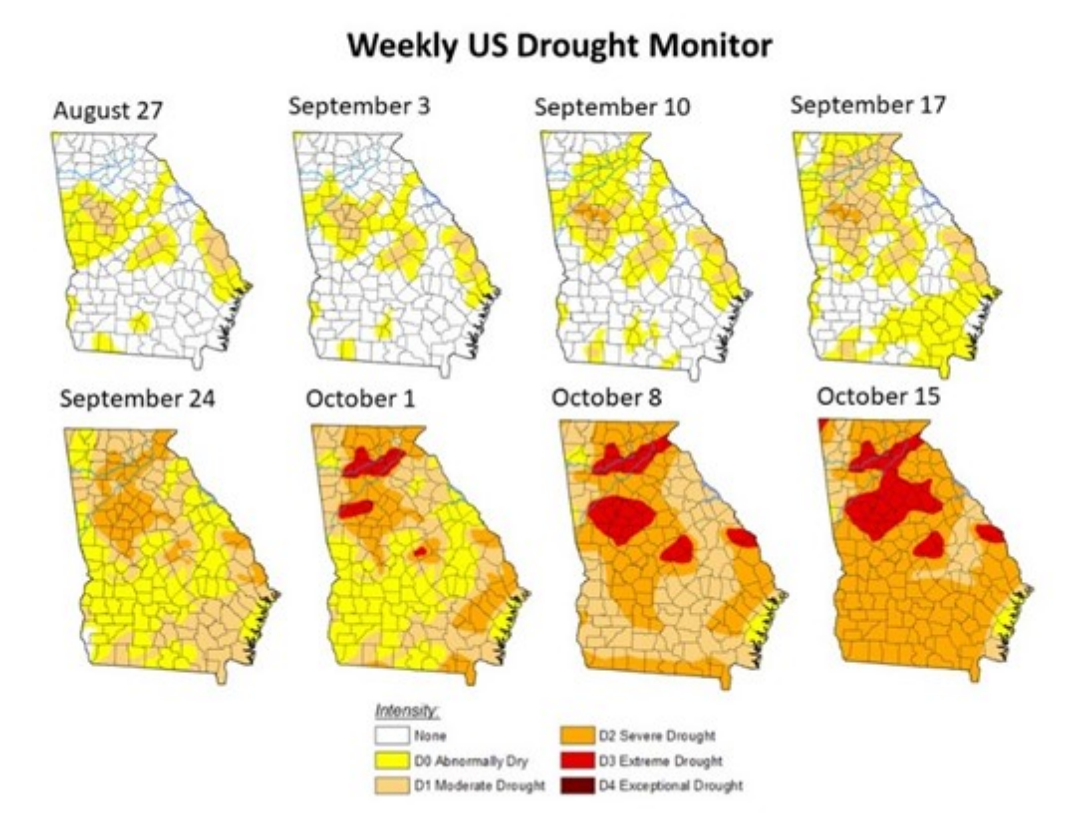


Figure 51. Drought Conditions in Georgia

- A rapid deterioration in drought conditions across the state was observed in September and October due to intense daytime heating, lack of rainfall, and sudden increase in evapotranspiration.

Agricultural Impacts

- A wet winter continued in the beginning of the year. Premature fruit blooms were seen in some species. Many cattle producers throughout the state were feeding hay because of the poor grazing conditions caused by the rain. Growers noted lower grades in cotton and soybeans left to rot in fields due to the excess rainfall.
- In March, livestock producers throughout the state were feeding hay where grazing conditions were still poor. Late frosts negatively impacted some peach and blueberry crops causing minimal losses. There were reports in southwest Georgia of cotton fields which were never harvested due to the wet winter.
- Dry conditions became a concern in May and early June. Corn started to show some wilting. Planting stopped on non-irrigated acres in some counties. The weather conditions helped the small grain harvest, but other crops like corn suffered.
- Corn rust and increasing activity of aphids were reported in July.
- The flash drought from the end of August to early November caused significant damage and loss. Cattle experienced stress and were being sold or fed hay. In some counties, nearly all peanut and cotton harvesting stopped due to the dry conditions. Ponds dried up and pastures and hayfields were dry and unproductive. The weather conditions prevented planting of winter grazing crops and delayed the application of fertilizer and pre-emergent herbicides to fall forages. Many pine and oak trees died.
- Despite the adverse weather conditions in 2019, corn for grain production increased 12% from 2018. Cotton production was up 36% from the 2018 crop which was significantly damaged by Hurricane Michael. Peanut production was down 4%. Soybeans gave the lowest production since 1963, mainly due to low planted acreage. Tobacco production in 2019 was the lowest since 1932 for the same reason.

Air Quality Forecasting Statistics

Table 2: Observed Air Quality in 2019

		Observed # of Days in AQI Category			
Metro Area and Pollutant	Total # of days in record	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Atlanta Ozone	214	119	77	17	1
Macon Ozone	209*	179	29	1	0
Atlanta $PM_{2.5}$	361**	197	164	0	0
Columbus $PM_{2.5}$	365	268	97	0	0

Note: Total number of days in record based on AirNow data for observed measurements.

* In Macon in 2019, AirNow does not have any observed ozone data for 5/9, 5/13, 5/14, 5/15, and 7/31.

** In Atlanta in 2019, AirNow does not have any observed PM2.5 data for 5/9, 5/13, 5/14, and 5/15.

Table 3: Predicted Air Quality in 2019

	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
Atlanta Ozone	6	12	6	0.7 ppbv	5.7 ppbv	0.84	92	76
Macon Ozone	0	1	0	1.9 ppbv	5.7 ppbv	0.77	99.5	89
Atlanta $PM_{2.5}$	0	0	0	-0.4 $\mu g/m^3$	2.6 $\mu g/m^3$	0.71	100	78
Columbus $PM_{2.5}$	0	0	0	-0.6 $\mu g/m^3$	2.6 $\mu g/m^3$	0.66	100	81

Notes:

Hits are the number of days on which an observed exceedance of the daily NAAQS was correctly predicted.

Misses are the number of days on which an observed exceedance of the daily NAAQS was not predicted.

False Alarms are the number of days on which an exceedance of the daily NAAQS was predicted, but was not later observed.

Bias is the average tendency to over-predict (positive bias) or under-predict (negative bias) the observed pollutant concentration.

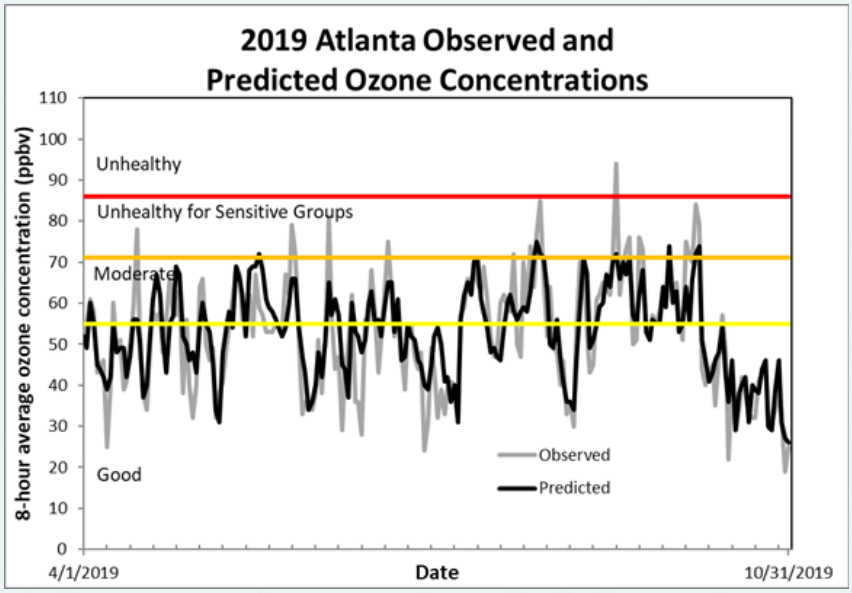
Gross Error is the average absolute error of the predictions relative to the observations.

Correlation is a measure of the ability to predict the relative change in observed concentrations. Higher positive correlation implies that the predictions are accurately anticipating changes in the observed concentrations.

% Accurate 2 categories is the percentage of days when the forecast prediction correctly matched the observation for the "no smog alert" / "smog alert" condition (i.e. 2 categories).

% Accurate 5 categories is the percentage of days when the forecast prediction correctly matched the observation for five categories of the Air Quality Index (Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, and Very Unhealthy).

Observed and Predicted Air Quality:



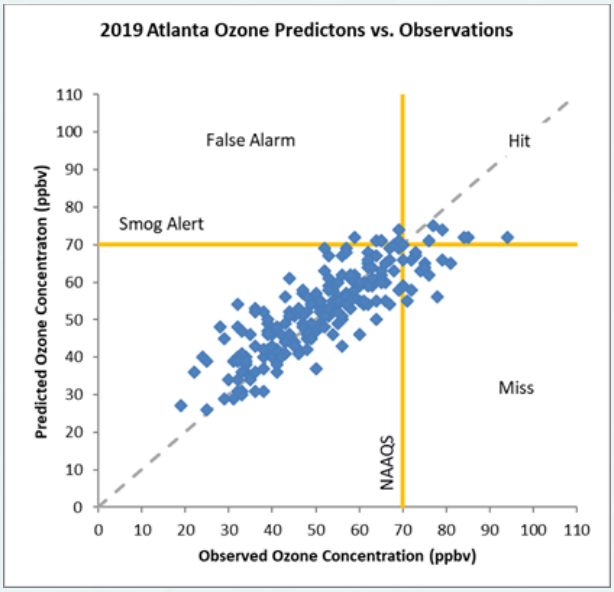


Figure 52. Atlanta observed and predicted ozone, 2019

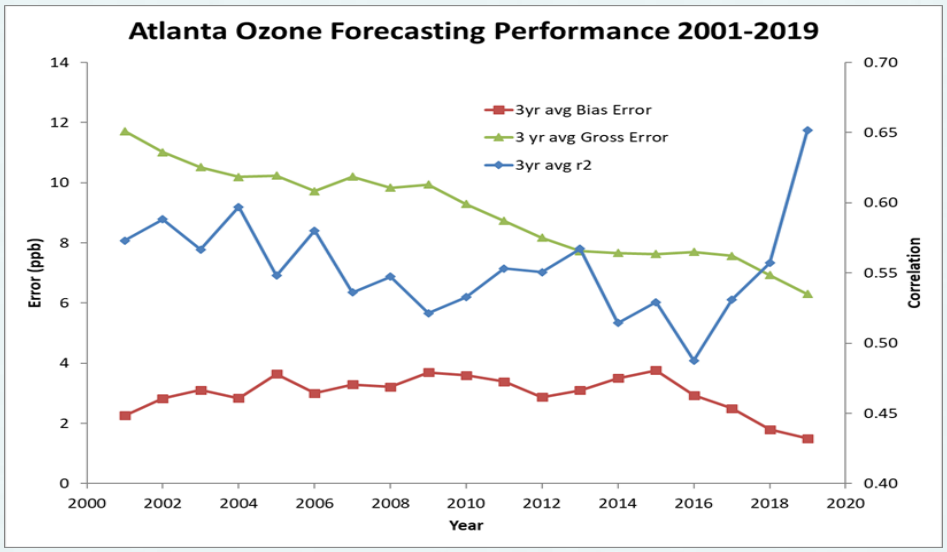
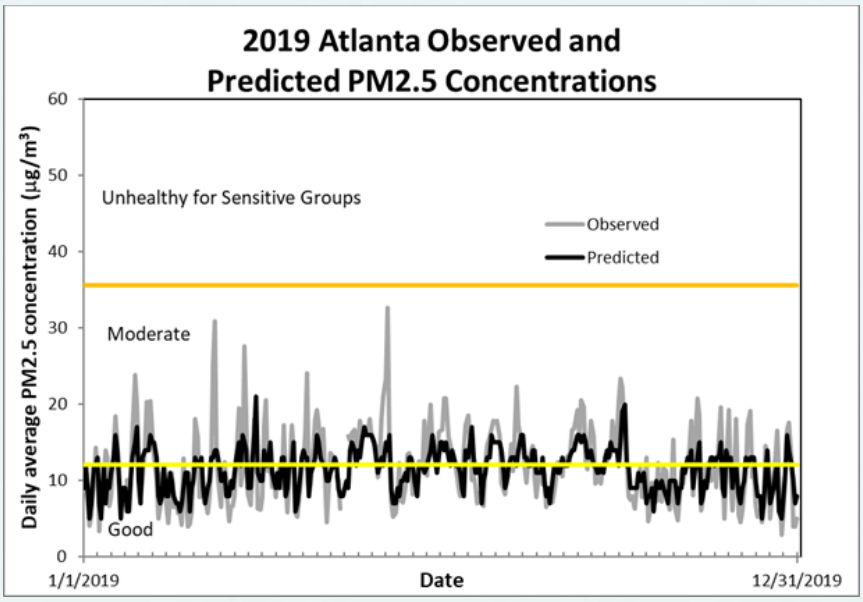


Figure - Atlanta ozone forecasting performance 2001-2019.



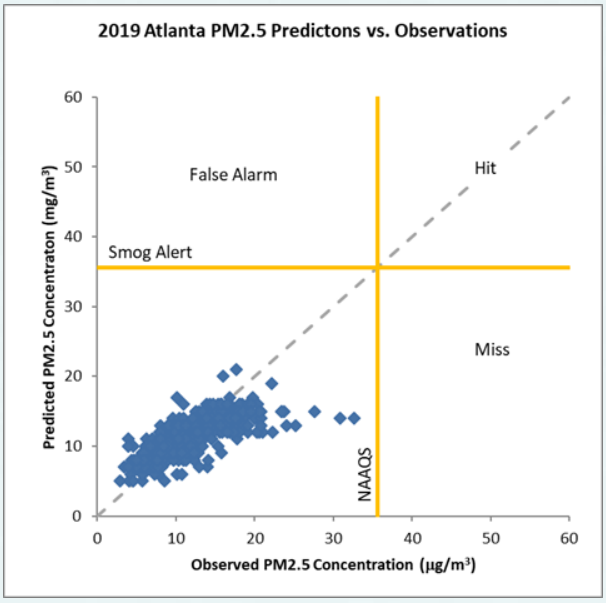
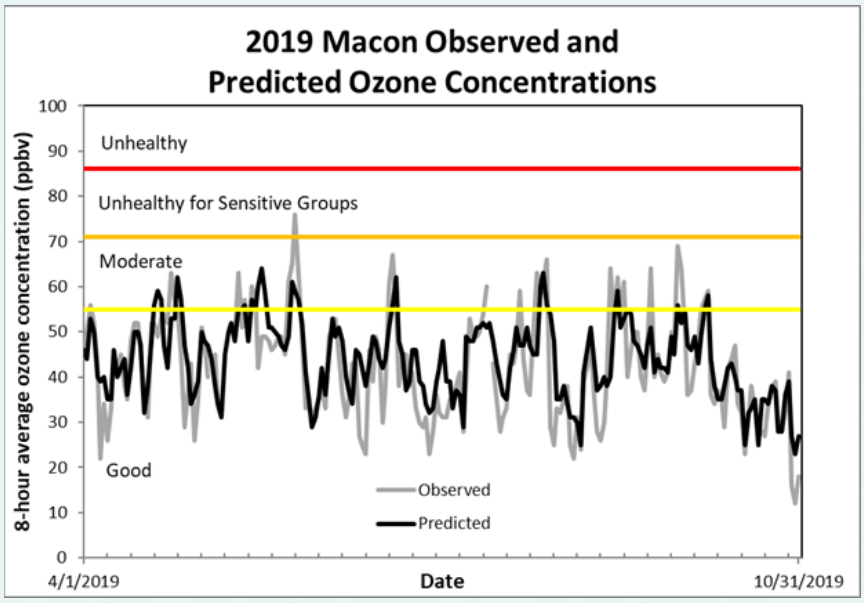


Figure 53. Atlanta observed and predicted $PM_{2.5}$, 2019

Observed and Predicted Air Quality:



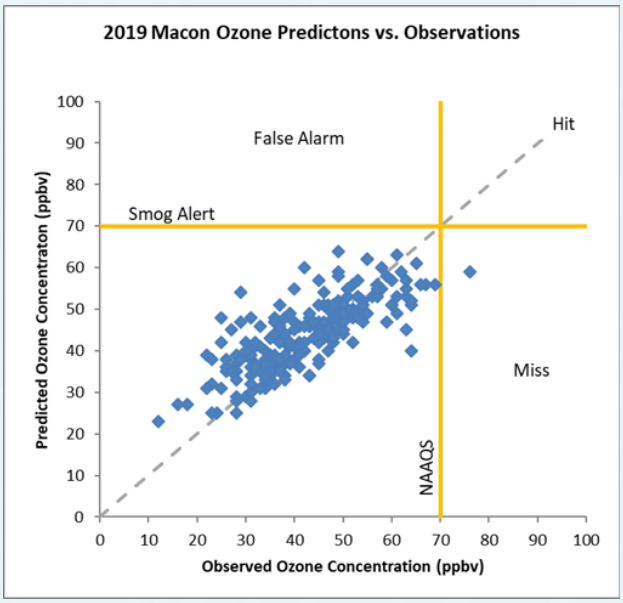
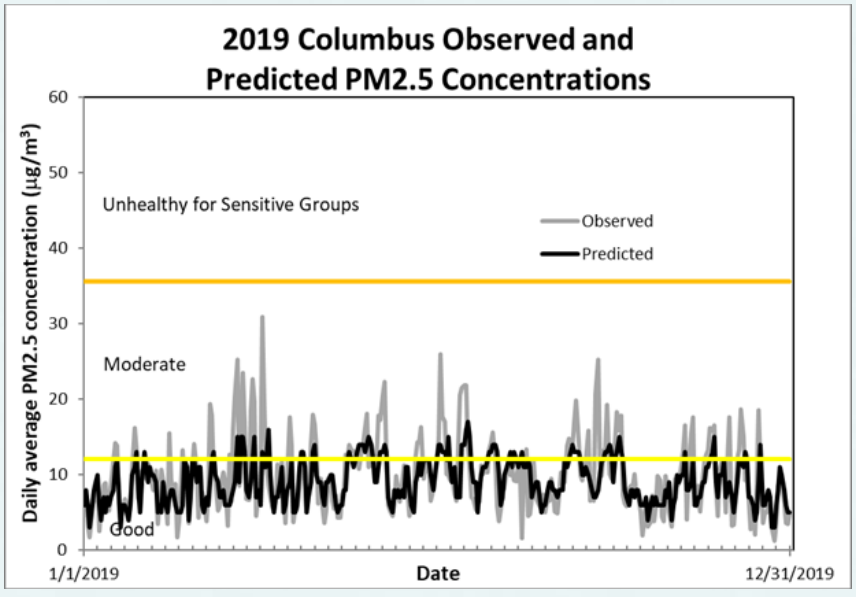


Figure 54. Macon observed and predicted ozone, 2019



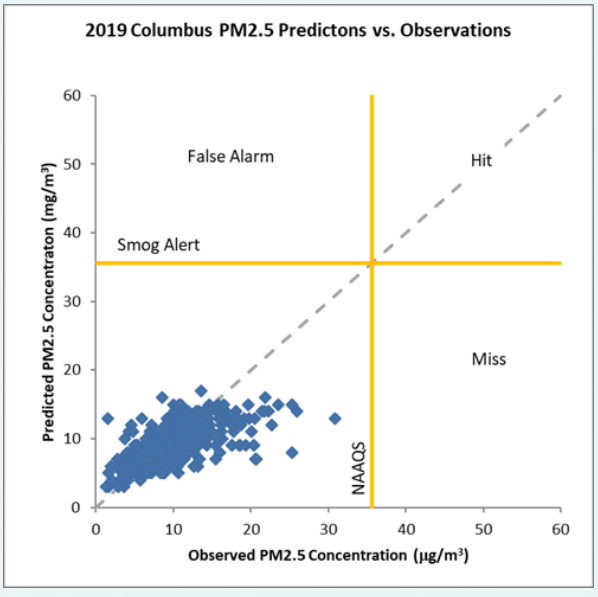


Figure 55. Columbus observed and predicted $PM_{2.5,}$ 2019

Quality Assurance/Quality Control Program

The purpose of the QA/QC Program is to assure the quality of data from EPD's air monitoring network. The GA EPD meets or exceeds the QA requirements defined in 40 CFR 58 and all applicable appendices. With the QA Program, GA EPD independently challenges the ambient air monitors to ensure they meet the requirements of 40 CFR 58.

The QA/QC program includes but is not limited to the following activities:

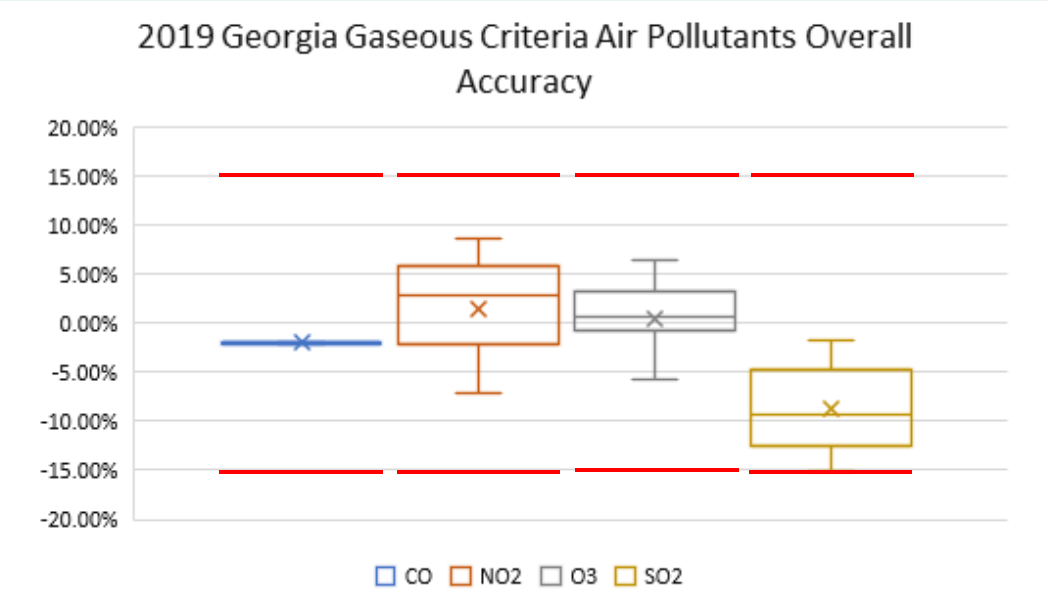
- Instrument performance audits
- Monitor siting evaluations
- Precision and span checks
- Bias determinations
- Flow rate determinations
- Leak checks
- Data validation

For additional independent quality assurance activities, the EPD participates in EPA's National Performance Audit Program (NPAP) and Performance Evaluation Program (PEP) for criteria pollutants. EPD's samplers are compared on a national basis through these independent audits.

As the Primary Quality Assurance Organization (PQAO) for ambient air monitoring activities in Georgia, the Ambient Monitoring Program operates under an EPA approved Quality Management Plan and utilizes Quality Assurance Project Plans (QAPPs) for each state wide monitoring network. The primary purpose of the QAPP is to provide an overview of the project, describe the need for the measurements and define QA/QC activities to be applied to the project. All other ambient air monitoring initiatives, including state and industrial projects, must have an approved monitoring plan for each specific project.

The two following graphs show how GA EPD's criteria audit data compare to EPA's target limits. Each target limit is shown in the box below each graph for each pollutant.

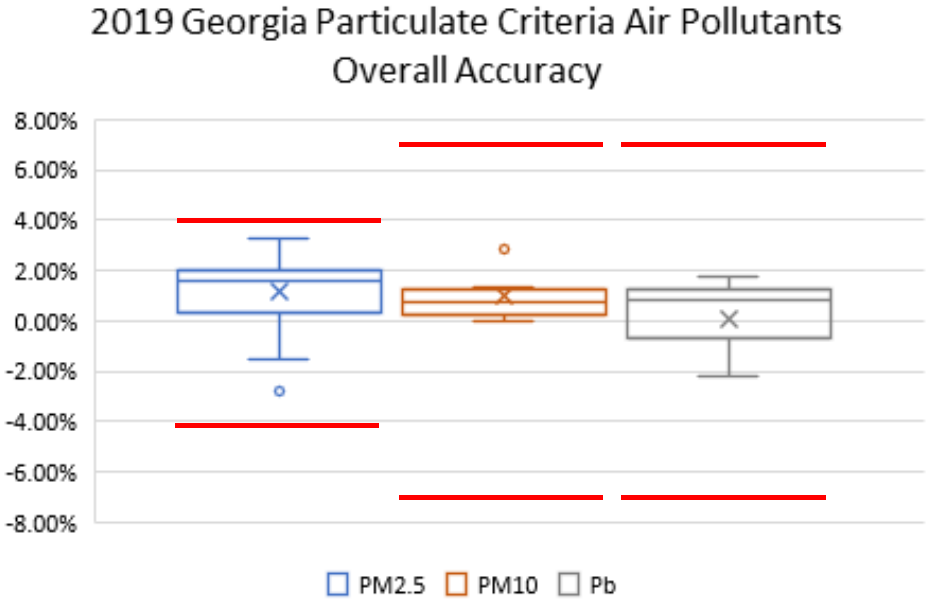
Accuracy Levels



Pollutant	CO	NO2	O3	SO2
Lower (25%) Confidence Limit	-2.10%	2.15%	-0.81%	-12.53%
Median Confidence Limit	-2.05%	2.81%	0.58%	-9.39%
Mean Confidence Limit	-2.05%	1.47%	0.53%	-8.68%
Upper (75%) Upper Confidence Limit	-1.99%	5.76%	3.22%	-4.66%
Targeted Percent Difference	±15%	±15%	±15%	±15%

Figure 56. Gaseous Air Pollutants 2019 Accuracy Data

Accuracy Levels



Pollutant	PM2.5	PM10	Pb
Lower (25%) Confidence Limit	0.30%	0.23%	-0.69%
Median Confidence Limit	1.63%	0.79%	0.80%
Mean Confidence Limit	1.16%	0.98%	0.12%
Upper (75%) Upper Confidence Limit	2.03%	1.26%	1.27%
Targeted Percent Difference	±4%	±7%	±7%

Figure 57. Particulate Air Pollutants 2019 Accuracy Data

Appendix Section

Appendix A: Georgia Air Monitoring Network

SITE ID	Site Name	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	PM Coarse	NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont.	PAMS VOC	VOC	SVOC	Carb-onyls	Met	Black Car-bon	Met-als
Rome MSA																						
131150003	Rome	Floyd				S	X															
131150005	Kraftsman	Floyd										S								NR		
Brunswick MSA																						
131270006	Brunswick	Glynn	S		S															NR		
Valdosta MSA																						
131850003	Valdosta	Lowndes			S	S																
Warner Robins MSA																						
131530001	Warner Rob-ins	Houston			S	S																
Dalton MSA																						
132130003	Fort Moun-tain	Murray	S																	NR		
Albany MSA																						
130950007	Albany	Dougherty			S*	S																
Gainesville MSA																						
131390003	Gainesville	Hall				S																
Athens-Clark County MSA																						
130590002	Athens	Clarke	S		S^	S*	X															
Macon MSA																						
130210007	Macon-Allied	Bibb			S*		X															
130210012	Macon-Forestry	Bibb	S		S	S						S								NR		
Columbus Georgia- Alabama MSA																						
132150001	Columbus-Health Dept.	Muscogee			S																	
132150008	Columbus-Airport	Muscogee	S		S	S																
132150009	Columbus-Allied	Muscogee											S*									
132150011	Columbus-Cusseta	Muscogee			S		X						S									
132151003	Columbus-Crime Lab	Muscogee																		NR		
Savannah MSA																						
130510021	Savannah-E. President St.	Chatham	S									S								NR		
130510091	Savannah-Mercer	Chatham			S^																	
130511002	Savannah-L&A	Chatham				S						S								NR		
Augusta Georgia-South Carolina MSA																						
130730001	Evans	Columbia	S																	NR		
132450091	Augusta	Richmond	S			S	X					S			S					NR		

*QA monitor located at site

^Shut down in 2019

Monitoring Types: S=SLAMS; P=PAMS; C=NCore; X=Supplemental Speciation; T=STN; N=NATTS; R=Near-Road; NR=Non-Regulatory; A=CASTNET

Appendix A: Georgia Air Monitoring Network (continued)

SITE ID	Site Name	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	PM Coarse	NO/ NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont	PAMS VOC	VOC	SVOC	Carb-onyls	Met	Black Car-bon	Met als
Atlanta-Sandy Springs-Roswell MSA																						
130630091	Forest Park	Clayton			S																	
130670003	Kennesaw	Cobb	S		S																	
130850001	Dawsonville	Dawson	S																	NR		
130890002	South DeKalb	DeKalb	S/ P/C	S/ P/C	S/C*	S/C	T/C	C	S/P	S/P	S/P/ C	C			C	P	N	N	P/N	P	N	N
130890003	NR-285	DeKalb							R	R							R				R	
130970004	Douglasville	Douglas	S																	NR		
131210039	Fire Station #8	Fulton			S									S*								
131210055	United Ave.	Fulton	S			S						S								NR		
131210056	NR-GA Tech	Fulton		R	R	R			R	R										R	R	
131350002	Gwinnett Tech	Gwinnett	S			S																
131510002	McDonough	Henry	S			S																
132319991	EPA CAST-NET	Pike	A																			
132470001	Conyers	Rockdale	S/P																	P		
Chattanooga Tennessee-Georgia MSA																						
132950002	Rossville	Walker			S	S	X															
Not In An MSA																						
130550001	Summerville	Chattooga	S																			
130690002	General Coffee	Coffee			S		X										S					
132611001	Leslie	Sumter	S																			
133030001	Sandersville	Washington			S^	S																

*QA monitor located at site

^Shut down in 2019

Monitoring Types: S=SLAMS; P=PAMS; C=NCore; X=Supplemental Speciation; T=STN; N=NATTS; R=Near-Road; NR=Non-Regulatory; A=CASTNET

Appendix B: Meteorological Instruments Used in 2019

PARAMETER	COMPANY	INSTRUMENT	MODEL	LOCATION													
				Augusta	Brunswick	Col Cr Lab	United Ave.	Conyers	Dawsonville	S. DeKalb	Sav. E. Pres	Macon Forestry	Douglasville	Ft. Mtn	Evans	NR-GT	Sav L&A
Wind Speed/Wind Direction	R.M. Young	Ultrasonic Anemometer	81000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ambient Temperature/ Relative Humidity	R.M. Young	TEMP/RH SENSOR, DEG C	41382VC	X		X		X		X	X			X	X		
Barometric Pressure	R.M. Young	Barometric Pressure Sensor	61302V	X		X		X		X	X						
Precipitation	Novalynx	Tipping Bucket Rain Gauge	260-2501	X		X		X		X							
Solar Radiation	Eppley Lab	Standard Precision Pyronometer	PSP/SPP 38380F3					X									
Total Ultraviolet Radiation	Eppley Lab	Total Ultraviolet Radiometer	TUVR 38020					X									
Data Logger	ESC	Data System Controller	8832	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Towers	Aluma Tower Inc.	Crank-Up Tower	T-135	X	X	X	X	X		X	X	X	X			X	X
	Aluma Tower Inc.	Fold-Over Tower	FOT-10						X					X	X		

Appendix C: Pollutant Concentrations

National Ambient Air Quality Standards for Carbon Monoxide

Primary NAAQS: 8-hour average not to exceed 9 ppm more than once per year

Secondary NAAQS: None

Criteria Pollutant Summary Report - 2019

Pollutant: Carbon Monoxide
Data Interval: Hourly
Units: Parts per million (ppm)

Site ID	City	County	Site Name	Hours Measured	Max 1 - Hour		Obs. ≥ 35	Max 8 - Hour		Obs. ≥ 9
					1st	2nd		1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8036	1.500	1.368	0	1.3	1.1	0
131210056	Atlanta	Fulton	NR-GA Tech	8508	2.3	2.2	0	2.0	1.8	0

National Ambient Air Quality Standards for Nitrogen Dioxide

Primary NAAQS: Annual mean must not exceed 53 ppb

3-year average of the 98th percentile of daily maximum one-hour averages must not exceed 100 ppb

Secondary NAAQS: Annual mean must not exceed 53 ppb

Criteria Pollutant Summary Report - 2019

Pollutant: Nitrogen Dioxide
Data Interval: Hourly
Units: Parts per billion (ppb)

Site ID	City	County	Site Name	Hours Measured	98th%	Max 1-Hour		Annual Arithmetic Mean
						1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8006	42.4	48.8	45.9	9.38
130890003	Atlanta	DeKalb	NR-285	8227	50.1	67.4	55	15.10
131210056	Atlanta	Fulton	NR-GA Tech	7402	41.4	50.3	49.3	16.27

Pollutant Summary Report - 2019

Pollutant: NO

Data Interval: Hourly **Units:** Parts per billion (ppb)

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8320	239.2	212.7	10.34
130890003	Decatur	DeKalb	NR-285	8277	279.0	272.5	19.14
131210056	Atlanta	Fulton	NR-GA Tech	7402	213.5	211.3	20.25

Pollutant Summary Report - 2019

Pollutant: NOx

Data Interval: Hourly **Units:** Parts per billion (ppb)

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8006	269.5	238.1	19.72
130890003	Atlanta	DeKalb	NR-285	8277	313.7	306.1	34.34
131210056	Atlanta	Fulton	NR-GA Tech	7402	247.9	234.1	36.55

Pollutant Summary Report - 2019

Pollutant: NOy

Data Interval: Hourly **Units:** Parts per billion (ppb)

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8320	203	203	18.42

National Ambient Air Quality Standards for Ozone	
Primary NAAQS:	3-year average of 4th highest daily maximum 8-hr concentration not to exceed 0.070 ppm
Secondary NAAQS:	Same as the Primary Standards

Criteria Pollutant Summary Report - 2019

Pollutant: Ozone

Data Interval: Hourly **Units:** Parts per million (ppm)

8-Hour Averages

Site ID	City	County	Site Name	Days Meas-ured	1st Max	2nd Max	3rd Max	4thMax	Number of Days >0.070
130210012	Macon	Bibb	Macon-Forestry	245	0.076	0.069	0.067	0.066	1
130510021	Savannah	Chatham	Savannah-E. Pres. St.	245	0.066	0.062	0.062	0.060	0
130550001	Summerville	Chattooga	Summerville	243	0.061	0.060	0.060	0.060	0
130590002	Athens	Clarke	Athens	245	0.066	0.065	0.064	0.063	0
130670003	Kennesaw	Cobb	Kennesaw	242	0.076	0.07	0.07	0.067	1
130730001	Evans	Columbia	Evans	245	0.062	0.061	0.060	0.060	0
130850001	Dawsonville	Dawson	Dawsonville	244	0.078	0.068	0.062	0.062	1
130890002	Decatur	DeKalb	South DeKalb	364	0.089	0.074	0.073	0.073	1
130970004	Douglasville	Douglas	Douglasville	245	0.078	0.073	0.073	0.072	1
131210055	Atlanta	Fulton	United Ave.	245	0.094	0.081	0.076	0.075	3
131270006	Brunswick	Glynn	Brunswick	244	0.064	0.062	0.061	0.060	0
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	245	0.074	0.069	0.068	0.068	0
131510002	McDonough	Henry	McDonough	244	0.085	0.079	0.077	0.075	3
132130003	Chatsworth	Murray	Fort Mountain	242	0.068	0.068	0.067	0.067	0
132150008	Columbus	Muscogee	Columbus-Airport	245	0.067	0.065	0.065	0.063	0
132319991	Williamson	Pike	CASTNET	231	0.084	0.079	0.076	0.068	3
132450091	Augusta	Richmond	Augusta	224	0.071	0.071	0.066	0.066	0
132470001	Conyers	Rockdale	Conyers	240	0.079	0.073	0.073	0.072	1
132611001	Leslie	Sumter	Leslie	238	0.069	0.068	0.065	0.062	0

Criteria Pollutant Summary Report - 2019

Pollutant: Ozone

Data Interval: Hourly **Units:** Parts per million (ppm)

1-Hour Averages

Site ID	City	County	Site Name	Days Measured	1st Max	2nd Max
130210012	Macon	Bibb	Macon-Forestry	245	0.088	0.084
130510021	Savannah	Chatham	Savannah-E. Pres. St.	245	0.089	0.082
130550001	Summerville	Chattooga	Summerville	244	0.072	0.070
130590002	Athens	Clarke	Athens	245	0.076	0.072
130670003	Kennesaw	Cobb	Kennesaw	242	0.087	0.082
130730001	Evans	Columbia	Evans	245	0.070	0.068
130850001	Dawsonville	Dawson	Dawsonville	244	0.093	0.077
130890002	Decatur	DeKalb	South DeKalb	364	0.104	0.091
130970004	Douglasville	Douglas	Douglasville	245	0.093	0.086
131210055	Atlanta	Fulton	United Ave.	245	0.108	0.095
131270006	Brunswick	Glynn	Brunswick	244	0.069	0.068
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	245	0.082	0.080
131510002	McDonough	Henry	McDonough	244	0.105	0.087
132130003	Chatsworth	Murray	Fort Mountain	243	0.092	0.083
132150008	Columbus	Muscogee	Columbus- Airport	245	0.085	0.071
132319991	Williamson	Pike	CASTNET	235	0.093	0.089
132450091	Augusta	Richmond	Augusta	224	0.084	0.082
132470001	Conyers	Rockdale	Conyers	241	0.096	0.092
132611001	Leslie	Sumter	Leslie	238	0.076	0.076

National Ambient Air Quality Standards for Sulfur Dioxide	
Primary NAAQS:	3-year average of 99th percentile of the daily maximum 1-hour concentration not to exceed 75 ppb
Secondary NAAQS:	3-hour concentrations not to exceed 0.5 ppm (500 ppb) more than once per year

Criteria Pollutant Summary Report - 2019

Pollutant: Sulfur Dioxide

Data Interval: Hourly **Units:** Parts per billion (ppb)

Site ID	City	County	Site Name	Hours Measured	Max 24 - Hour		Max 3 - Hour		Max 1-Hour		99th Pctl 1- Hr	Maximum 5-Minute Average	Annual Arithmetic Mean
					1st	2nd	1st	2nd	1st	2nd			
130210012	Macon	Bibb	Macon-Forestry	8687	2.0	1.7	3.8	3.7	5.6	4.6	2.5	15.6	0.21
130510021	Savannah	Chatham	Savannah-E. Pres. St	8564	7.6	7.5	30	24	33.6	30.7	25.4	74.6	0.91
130511002	Savannah	Chatham	Savannah-L&A	8031	17.3	13.9	40.9	33.8	58.0	52.9	50	156.1	1.98
130890002	Decatur	DeKalb	South DeKalb	8537	1.0	0.8	1.9	1.8	2.9	2.3	1.9	4.2	0.00
131150006	Rome	Floyd	Kraftsman	8695	7.6	7.4	40.3	27.5	49.2	39	22.4	92.9	1.14
131210055	Atlanta	Fulton	United Ave.	8251	3.3	3.3	6.6	5.1	10.1	7.7	4.6	15.1	1.30
132450091	Augusta	Richmond	Augusta	8182	8.7	7.6	41.8	35.4	75.2	62.0	49.3	172.8	0.80

National Ambient Air Quality Standards for Particulate Matter $PM_{2.5}$	
Primary NAAQS:	3-year average of the annual weighted mean not to exceed 12.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3
Secondary NAAQS:	3-year average of the annual weighted mean not to exceed 15.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3

Criteria Pollutant Summary Report - 2019

Pollutant: Particulate Matter $PM_{2.5}$

Data Interval: 24-Hour **Units:** Micrograms per cubic meter (µg/m^3)

98th% and Annual Arithmetic Mean

Integrated Sampling (midnight to midnight) Using Federal Reference Method

Site ID	City	County	Site Name	Days Meas-ured	98th Percen-tile	Values Exceeding Applicable Daily Standard	Annual Arith-metic Mean
130210007	Macon	Bibb	Macon-Allied	118	16.8	0	9.07
130210012	Macon	Bibb	Macon-Forestry	119	14.6	0	7.30
130510091	Savannah	Chatham	Savannah-Mercer	60	19.0	0	7.65
130590002	Athens	Clarke	Athens	28	15.6	0	6.03
130630091	Forest Park	Clayton	Forest Park	119	16.9	0	8.67
130670003	Kennesaw	Cobb	Kennesaw	121	17.5	0	8.63
130690002	General Coffee	Douglas	General Coffee	121	17.4	0	7.18
130890002	Decatur	DeKalb	South DeKalb	119	16.3	0	8.34
130950007	Albany	Dougherty	Albany	120	25.8	0	9.26
131210039	Atlanta	Fulton	Fire Station #8	120	18.4	0	9.07
131210056	Atlanta	Fulton	NR-GA Tech	120	19.4	0	9.51
131270006	Brunswick	Glynn	Brunswick	110	17.3	0	7.63

National Ambient Air Quality Standards for Particulate Matter $PM_{2.5}$	
Primary NAAQS:	3-year average of the annual weighted mean not to exceed 12.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3
Secondary NAAQS:	3-year average of the annual weighted mean not to exceed 15.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3

Criteria Pollutant Summary Report - 2019

Pollutant: Particulate Matter $PM_{2.5}$

Data Interval: 24-Hour **Units:** Micrograms per cubic meter (µg/m^3)

98th% and Annual Arithmetic Mean

Integrated Sampling (midnight to midnight) Using Federal Reference Method

Site ID	City	County	Site Name	Days Measured	98th Percentile	Values Exceeding Applicable Daily Standard	Annual Arithmetic Mean
131530001	Warner Robins	Houston	Warner Robins	117	14.7	0	7.82
131850003	Valdosta	Lowndes	Valdosta	114	15.3	0	7.56
132150001	Columbus	Muscogee	Columbus-Health Dept.	118	18.1	0	9.06
132150008	Columbus	Muscogee	Columbus-Airport	118	19.2	0	8.74
132150011	Columbus	Muscogee	Columbus-Cusseta	120	19.9	0	8.6
132950002	Rossville	Walker	Rossville	145	15.6	0	8.22
133030001	Sandersville	Washington	Sandersville	72	16.9	0	8.47

	National Ambient Air Quality Standards for Particulate Matter $PM_{2.5}$
Primary NAAQS:	3-year average of the annual weighted mean not to exceed 12.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3
Secondary NAAQS:	3-year average of the annual weighted mean not to exceed 15.0µg/m^3
	3-year average of the 98th percentile of 24-hour concentration not to exceed 35µg/m^3

Pollutant Summary Report - 2019

Pollutant: Particulate Matter $PM_{2.5}$

Data Interval: 1-Hour **Units:** Micrograms per cubic meter (µg/m^3)

Hourly Averages of $PM_{2.5}$ with Federal Equivalent Method (FEM)

Site ID	City	County	Site Name	Days Measured	98th Percentile	Values Exceeding Applicable Daily Standard	Annual Arithmetic Mean
130210012	Macon	Bibb	Macon-Forestry	323	18.1	2	8.55
130511002	Savannah	Chatham	Savannah-L&A	318	18.2	0	8.90
130590002	Athens	Clarke	Athens	351	20.6	0	9.93
130890002	Decatur	DeKalb	South DeKalb	358	18.1	0	9.58
130950007	Albany	Dougherty	Albany	343	26.6	2	10.7
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	341	23.6	1	10.77
131390003	Gainesville	Hall	Gainesville	340	18.6	0	9.32
131530001	Warner Robins	Houston	Warner Robins	348	19.4	2	10.27
132450091	Augusta	Richmond	Augusta	343	22.2	0	10.69
132950002	Rossville	Walker	Rossville	355	18.1	0	9.36
133030001	Sandersville	Washington	Sandersville	136	26.0	1	8.50

Pollutant Summary Report - 2019

Pollutant: Particulate Matter $PM_{2.5}$

Data Interval: 1-Hour **Units:** Micrograms per cubic meter ($\mu g/m^3$)

Hourly Averages of $PM_{2.5}$ with Non-FEM Method

Site ID	City	County	Site Name	Hours Measured	1st Max	2nd Max	Annual Arithmetic Mean
131150003	Rome	Floyd	Rome	8613	200.6	119.3	11.09
131210055	Atlanta	Fulton	United Ave.	8576	56	47.5	11.27
131210056*	Atlanta	Fulton	NR-GA Tech	6806	57.9	56	8.52
131510002	McDonough	Henry	McDonough	8637	89.8	80	7.58
131850003*	Valdosta	Lowndes	Valdosta	6950	60	54	9.14
132150008	Columbus	Muscogee	Columbus-Airport	8608	147.4	100.6	8.29

*partial year of data, as method changed

National Ambient Air Quality Standards for Particulate Matter PM_{10}	
Primary NAAQS:	Number of days with a maximum of 24-hour concentration of 150µg/m^3 must not exceed more than once per year on average over 3 years
Secondary NAAQS:	Same as the Primary Standards

Criteria Pollutant Summary Report - 2019

Pollutant: Particulate Matter PM_{10}

Data Interval: 24-Hour **Units:** Micrograms per cubic meter (µg/m^3)

24-Hour Integrated Measurements

Site ID	City	County	Site Name	Days Measured	1st Max	Number Values ≥150	Annual Arithmetic Mean
131210039	Atlanta	Fulton	Fire Station #8	60	30	0	15.5

Hourly Continuous Measurements

Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8566	42	17.3
132450091	Augusta	Richmond	Augusta	8266	29	12.4

National Ambient Air Quality Standards for Lead	
Primary NAAQS:	Rolling 3-month average not to exceed 0.15 µg/m^3
Secondary NAAQS:	Same as the Primary Standard

Criteria Pollutant Summary Report - 2019

Pollutant: Lead

Data Interval: 24-Hour **Units:** Micrograms per cubic meter (µg/m^3)

Site ID	132150009	132150011
City	Columbus	Columbus
County	Muscogee	Muscogee
Site Name	Columbus-Allied	Columbus-Cusseta
Number of Obs.	61	56
Nov 2017-Jan 2018	0.0335	0.0056
Dec 2017-Feb 2018	0.0290	0.0053
Jan 2018-Mar 2018	0.0216	0.0061
Feb 2018-Apr 2018	0.0183	0.0047
Mar 2018-May 2018	0.0173	0.0035
Apr 2018-Jun 2018	0.0130	0.0027
May 2018-Jul 2018	0.0073	0.0019
Jun 2018-Aug 2018	0.0079	0.0015
Jul 2018-Sep 2018	0.0119	0.0030
Aug 2018-Oct 2018	0.0119	0.0032
Sep 2018-Nov 2018	0.0091	0.0035
Oct 2018-Dec 2018	0.0041	0.0022
# of Values $\geq$ 0.15	0	0

2019 Metals (concentrations in micrograms per cubic meter (µg/m^3))					
Name	**Site**	**#Samples**	**Avg.**	**1st Max**	**2nd Max**
Antimony	**South DeKalb**	**62**	**0.0018**	**0.0073**	**0.0059**
Arsenic	**South DeKalb**	**62**	**0.0008**	**0.0023**	**0.0023**
Beryllium	**South DeKalb**	**62**	**0.0000**	**0.0001**	**0.0001**
Cadmium	**South DeKalb**	**62**	**0.0001**	**0.0004**	**0.0003**
Chromium	**South DeKalb**	**62**	**0.0021**	**0.0045**	**0.0037**
Cobalt	**South DeKalb**	**62**	**0.0001**	**0.0009**	**0.0008**
Lead	**South DeKalb**	**62**	**0.0016**	**0.0063**	**0.0040**
Manganese	**South DeKalb**	**62**	**0.0044**	**0.0278**	**0.0135**
Nickel	**South DeKalb**	**62**	**0.0007**	**0.0015**	**0.0015**
Selenium	**South DeKalb**	**62**	**0.0002**	**0.0009**	**0.0009**

2019 Semi-Volatile Compounds (concentrations in µg/m^3)					
Name	Site	#Samples	Avg.**	1st Max	2nd Max
Acenaphthene	South DeKalb	59	0.0016	0.0070	0.0047
Acenaphthylene	South DeKalb	59	0.0003	0.0022	0.0019
Anthracene	South DeKalb	59	0.0000	0.0003	0.0003
Benzo(a)anthracene	South DeKalb	59	0.0000	0.0003	0.0002
Benzo(a)pyrene	South DeKalb	56	0.0000	0.0002	0.0002
Benzo(b)fluoranthene	South DeKalb	56	0.0001	0.0008	0.0004
Benzo(e)pyrene	South DeKalb	59	0.0001	0.0005	0.0003
Benzo(g,h,i)perylene	South DeKalb	59	0.0001	0.0006	0.0004
Benzo(k)fluoranthene	South DeKalb	59	0.0000	0.0000	0.0000
Chrysene	South DeKalb	59	0.0001	0.0005	0.0003
Dibenzo(a,h)anthracene	South DeKalb	56	0.0000	0.0001	0.0001
Fluoranthene	South DeKalb	59	0.0008	0.0026	0.0017
Fluorene	South DeKalb	59	0.0019	0.0060	0.0044
Indeno(1,2,3-cd)pyrene	South DeKalb	56	0.0001	0.0005	0.0003
Naphthalene	South DeKalb	59	0.0451	0.1294	0.1244
Phenanthrene	South DeKalb	59	0.0035	0.0097	0.0080
Pyrene	South DeKalb	59	0.0005	0.00010	0.0009
Perylene	South DeKalb	56	0.0000	0.0005	0.0000

2019 Volatile Organic Compounds (concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Freon 113	South DeKalb*	47	0.11	0.2	0.2
	NR-285	22	0.11	0.2	0.2
Freon 114	South DeKalb*	59	0.00	0.1	0.1
	NR-285	28	0.00	0.0	0.0
1,3-Butadiene	South DeKalb*	59	0.43	1.6	1.2
	NR-285	28	0.67	1.7	1.5
Cyclohexane	South DeKalb*	30	0.14	0.4	0.3
	NR-285	14	0.18	0.4	0.3
Chloromethane	South DeKalb*	31	0.56	1.3	1.0
	NR-285	15	0.51	0.6	0.6
Dichloromethane	South DeKalb*	15	0.07	0.1	0.1
	NR-285	7	0.09	0.1	0.1
Chloroform	South DeKalb*	59	0.00	0.1	0.0
	NR-285	28	0.00	0.0	0.0
Carbon tetrachloride	South DeKalb*	61	0.08	0.1	0.1
	NR-285	29	0.10	0.1	0.1
Trichlorofluoro-methane	South DeKalb*	55	0.22	0.6	0.4
	NR-285	25	0.20	0.2	0.2
Chloroethane	South DeKalb*	42	0.00	0.1	0.0
	NR-285	21	0.02	0.0	0.0
1,1-Dichloroethane	South DeKalb*	54	0.00	0.0	0.0
	NR-285	25	0.00	0.0	0.0
Methyl chloroform	South DeKalb*	59	0.00	0.0	0.0
	NR-285	28	0.00	0.0	0.0

2019 Volatile Organic Compounds (continued)					
(concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Ethylene dichloride	South DeKalb*	59	0.01	0.1	0.1
	NR-285	28	0.00	0.1	0.0
Tetrachloroethylene	South DeKalb*	61	0.01	0.2	0.1
	NR-285	29	0.02	0.1	0.1
1,1,2,2-Tetrachloroethane	South DeKalb*	61	0.00	0.0	0.0
	NR-285	29	0.00	0.0	0.0
Bromomethane	South DeKalb*	58	0.00	0.0	0.0
	NR-285	28	0.00	0.0	0.0
1,1,2-Trichloroethane	South DeKalb*	61	0.00	0.0	0.0
	NR-285	29	0.00	0.0	0.0
Dichlorodifluoromethane	South DeKalb*	50	0.42	0.6	0.5
	NR-285	23	0.40	0.5	0.5
Trichloroethylene	South DeKalb*	56	0.00	0.1	0.0
	NR-285	27	0.00	0.0	0.0
1,1-Dichloroethylene	South DeKalb*	59	0.00	0.0	0.0
	NR-285	28	0.00	0.0	0.0
1,2-Dichloropropane	South DeKalb*	59	0.00	0.1	0.0
	NR-285	28	0.00	0.0	0.0
trans-1,3-Dichloropropene	South DeKalb*	52	0.00	0.0	0.0
	NR-285	25	0.00	0.0	0.0
cis-1,3-Dichloropropene	South DeKalb*	50	0.00	0.0	0.0
	NR-285	23	0.00	0.0	0.0
cis-1,2-Dichloroethene	South DeKalb*	59	0.00	0.0	0.0
	NR-285	28	0.00	0.0	0.0

2019 Volatile Organic Compounds (continued) (concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Ethylene dibromide	South DeKalb*	56	0.00	0.0	0.0
	NR-285	27	0.00	0.0	0.0
Hexachlorobutadiene	South DeKalb*	61	0.00	0.1	0.0
	NR-285	29	0.02	0.0	0.0
Vinyl chloride	South DeKalb*	59	0.00	0.0	0.0
	NR-285	28	0.00	0.0	0.0
m/p Xylene	South DeKalb*	9	0.67	1.5	1.0
	NR-285	4	0.73	1.5	0.7
Benzene	South DeKalb*	56	1.39	4.8	2.5
	NR-285	27	1.42	3.2	2.4
Toluene	South DeKalb*	42	2.66	11.0	6.0
	NR-285	20	3.38	7.5	6.9
Ethylbenzene	South DeKalb*	46	0.29	0.9	0.8
	NR-285	22	0.42	1.1	0.8
o- Xylene	South DeKalb*	11	0.33	1.1	0.5
	NR-285	4	0.30	0.6	0.3
1,3,5-Trimethylbenzene	South DeKalb*	15	0.11	0.2	0.2
	NR-285	7	0.14	0.3	0.2
1,2,4-Trimethylbenzene	South DeKalb*	24	0.41	1.0	0.9
	NR-285	11	0.63	1.7	1.4
Styrene	South DeKalb*	49	1.00	25.9	1.5
	NR-285	23	1.36	5.8	3.4
Benzene,1-ethenyl-4-methyl	South DeKalb*	44	0.05	0.2	0.2
	NR-285	10	0.10	0.3	0.3

2019 Volatile Organic Compounds (continued) (concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Chlorobenzene	South DeKalb*	61	0.00	0.0	0.0
	NR-285	29	0.00	0.0	0.0
1,2-Dichlorobenzene	South DeKalb*	52	0.01	0.1	0.1
	NR-285	25	0.00	0.0	0.0
1,3-Dichlorobenzene	South DeKalb*	50	0.00	0.0	0.0
	NR-285	24	0.00	0.0	0.0
1,4-Dichlorobenzene	South DeKalb*	38	0.14	0.3	0.3
	NR-285	18	0.12	0.3	0.2
Benzyl chloride	South DeKalb*	39	0.00	0.0	0.0
	NR-285	18	0.00	0.0	0.0
1,2,4-Trichlorobenzene	South DeKalb*	49	0.06	0.1	0.1
	NR-285	23	0.04	0.1	0.1

*Sample collected every 6 days

2019 Carbonyl Compounds, 8-hour (concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Formaldehyde	South DeKalb	84	2.28	7.4	6.8
Acetaldehyde	South DeKalb	86	1.00	3.4	2.7
Propionaldehyde	South DeKalb	86	0.24	1.2	0.9
Butyraldehyde	South DeKalb	86	1.335	3.616	3.609
Acetone	South DeKalb	85	2.04	8.6	8.2
Benzaldehyde	South DeKalb	85	0.50	2.7	1.3

2019 Carbonyl Compounds, 24-hour (concentrations in ppbC)					
Name	Site	#Samples	Avg.	1st Max	2nd Max
Formaldehyde	South DeKalb*	61	1.77	4.3	4.2
Acetaldehyde	South DeKalb*	61	1.28	2.8	2.7
Propionaldehyde	South DeKalb*	61	0.24	0.6	0.5
Butyraldehyde	South DeKalb*	61	0.5488	1.889	1.889
Acetone	South DeKalb*	61	2.43	6.9	6.9
Benzaldehyde	South DeKalb*	61	0.37	4.0	3.2
Acrolein (with canister method)	NR-285	12	0.33	1.0	0.6
	South DeKalb*	6	0.60	0.7	0.7

* Sample collected every 6 days

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

2019 Ambient Air Surveillance Report
Air Toxics Risk Assessment

Prepared by Georgia Environmental Protection Division Risk Assessment Program (RAP)
12-15-2020

Table of Contents

Tables

Figures

Appendices

Appendix A – Organized Data Files
Appendix B – Original Data Files
Appendix C – List of Data Qualifiers
Appendix D – November 2020 Resident Air Regional Screening Levels (RSL) Table
Appendix E – COPC Selection Tables
Appendix F – ProUCL Inputs and Outputs
Appendix G – Contaminant Concentrations in Air (CA) Estimates for COPCs
Appendix H – Toxicity Values
Appendix I – IEUBK Model Output for South DeKalb
Appendix J – Risk/Hazard Estimates and RSL Calculator Outputs
Appendix K – Uncertainty Section Supporting Information

Due to file size, Appendices have not been included with this document. Appendices can be obtained by contacting the Air Protection Branch Ambient Air Monitoring Program. For questions concerning this document, please contact the Risk Assessment Program using the contact information on the Land Protection Branch website:

https://epd.georgia.gov/about-us/land-protection-branch

Acronyms

- µg/m^3 – micrograms per cubic meter
- AMDL – Alternate Method Detectable Limit
- MaxAMDL – Maximum Alternate Method Detectable Limit
- AAMP – EPD Air Protection Branch Ambient Air Monitoring Program
- ATSDR – Agency for Toxic Substances and Disease Registry
- AQS – Air Quality System
- CA – Contaminant Concentration in Air
- CalEPA – California Environmental Protection Agency Office of Environmental Health Hazard Assessment
- COPCs – Chemicals of Potential Concern
- EC – Exposure Concentration
- GAEPD, EPD – Georgia Environmental Protection Division
- HEAST - USEPA Superfund Program Health Effects Assessment Summary Table
- HHRA – Human Health Risk Assessment
- HI – Hazard Index
- HQ – Hazard Quotient
- IEUBK – USEPA's Integrated Exposure Uptake Biokinetic Model for Lead
- IUR – Inhalation Unit Risk
- MC – Minimum Detected Concentration
- MDC – Maximum Detected Concentration
- MRL – ATSDR Minimal Risk Levels
- NAAQS – National Ambient Air Quality Standard
- OAQPS – EPA's Office of Air Quality Planning and Standards
- ppb – parts per billion
- PRBSA – Preliminary Risk-Based Screening Analysis
- PPRTV – Provisional Peer-Reviewed Toxicity Value
- RAP – EPD Risk Assessment Program
- RfC – Reference Concentration
- RSL – USEPA November 2020 Resident Air Regional Screening Level
- SVOCs – Semivolatile Organic Compound
- USEPA, EPA – United States Environmental Protection Agency
- UCL – Upper Confidence Limit of the Arithmetic Mean
- VOCs – Volatile Organic Compound

Important Definitions

- Alternate Method Detectable Limit (AMDL): "*method detectable limit (MDL) defined for the sample by the QA agency, which supersedes the EPA-defined method detectable limit for the designated methodology*"[1]. AAMP is considered the QA agency for the purposes of this risk assessment.
- Air Toxics: Defined "*as pollutants that are known or suspected to cause cancer or other serious health effects*" (GAEPD, 2019b, pg. 5).
- Ambient Air: generally defined as that "*portion of the atmosphere, external to buildings, to which the general public has access*" (GAEPD, 2019b, pg. 19)
- Cancer Risk: also referred to as the "incremental risk of cancer" or "risk"; the predicted risk of cancer "*from the exposure being analyzed that is above the risk that the individuals in the population have already (i.e., due to non-air toxics related issues)*" (USEPA, 2004; pg. 13-5)
- Chemicals of Potential Concern (COPCs): All the air toxics that were determined in the PRBSA to potentially pose an unacceptable cancer risk and/or noncancer hazard and which have been further evaluated in the HHRA
- Cumulative Cancer Risk: The total cancer risk which is obtained by summing the cancer risk of individual chemicals
- Contaminant Concentration in Air (CA): For a particular air toxic, estimated as the upper confidence limit of the arithmetic mean (UCL) of all the valid (useable) sample values collected over the year 2019. The CA is an estimate of the chronic (long-term) ambient air concentration of that air toxic within the spatial scale of an air monitoring Site.
- Exposure Concentration (EC): Generally defined as the "*concentration of a chemical in the air at the point where a person breathes the air*" (USEPA, 2004, pg. 6-17). In the context of this Assessment, the EC is a time-weighted contaminant concentration in air (CA) which takes into account the frequency, duration, and time of exposure as well as the time period over which the exposure is averaged (USEPA, 2009, pg. 13 to 17).
- Hazard: Also referred to as "noncancer hazard". Defined as the potential harm from noncarcinogenic air toxics (USEPA, 2004; pg. 13-4)
- Hazard Index (HI): A value which describes the total noncancer hazard which is derived by summing the hazard quotients (HQs) determined for individual air toxics
- Hazard Quotient (HQ): A value obtained by dividing the exposure concentration (EC) by the reference concentration (RfC). An HQ above 1 indicates the potential for an adverse noncancer effect.
- High-End Exposure Estimate: "*plausible estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution*" (USEPA, 2004, glossary).
- Inhalation Unit Risk (IUR): "*the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air*" (USEPA, 2009, pg. 10)

[1] Please see: https://aqs.epa.gov/aqsweb/documents/AQS_Data_Dictionary.html

- Maximum Detected Concentration (MDC): largest concentration out of all a particular air toxic's detected and useable sample values
- Reasonable Maximum Exposure (RME): "*highest exposure that is reasonably expected to occur at a site*" (USEPA, 1989; pg. 6-5).
- Risk Manager: "*persons or groups with the authority to make the decisions about the acceptability of risk and how an unacceptable risk may be mitigated, avoided, or reduced*" (USEPA, 2004, pg. 5-10)
- Reference Concentration (RfC): "*defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer health effects during a lifetime*" (USEPA, 1994; pg. 1-2 to 1-4)
- Resident Air Regional Screening Level (RSL): Conservative air screening levels developed by USEPA. The lower of the Cancer/Carcinogenic RSL derived at a cancer risk of 10^{-6} and Noncancer/Noncarcinogenic RSL derived at a hazard quotient of 0.1 is used to determine the COPCs in the PRBSA.
- Spatial Scale: "*area around the monitoring location (and the types of exposures) the analysts consider the monitoring data to represent*" (USEPA, 2004, pg. 6-14).
- Upper Confidence Limit (UCL): the "*upper boundary (or limit) of a confidence interval of a parameter of interest such as the population mean*" (USEPA, 2015; pg. 22)

Disclaimer

Every effort has been made to use current and technically defensible risk assessment methodologies to prepare the *2019 Air Toxics Risk Assessment* ("Assessment"). However, the methodologies used herein may not necessarily be applicable or relevant when preparing human health or ecological risk assessments required under State or Federal statutes and regulations (e.g. Georgia Hazardous Site Response Act, Resource Conservation and Recovery Act, etc.). Under no circumstances can regulated parties use this Assessment as a template or consider any part of this Assessment as EPD risk assessment policy. The Assessment does not substitute State or Federal statutes and regulations and is not a regulation itself.

2019 Air Toxics Risk Assessment Summary Factsheet

This short factsheet provides a summary to the *2019 Air Toxics Risk Assessment* ("Assessment") in a question-and-answer format.

What is the purpose of this Assessment?

The purpose is to understand whether long-term exposure to specific air toxics in ambient (outdoor) air around 2 air monitoring Sites (South DeKalb and NR-285) in the State of Georgia could be harmful to human health.

Why these locations?

Both the South DeKalb and NR-285 air monitoring Sites have precise instruments that can measure concentrations of air toxics in ambient air, and so monitoring results from these two Sites were available for the Assessment. Federal regulations require that air monitoring Sites follow specific technical criteria so that the measured air toxics concentrations are representative of ambient air concentrations within a defined area around each monitoring Site (known as the spatial scale).

How does this Assessment determine whether air toxics are at levels that could be harmful to human health?

- A determination is made of what the risk assessment will cover. For example, this Assessment only assesses specific air toxics for which data was obtained from South DeKalb and NR-285 in the year 2019.
- The data is screened using conservative screening levels to remove any air toxics from further evaluation that are clearly not of concern to human health. This allows the risk assessment to focus only on those air toxics which may be of concern (chemicals of potential concern, COPCs).
- An exposure concentration, a value that represents "how much" of an air toxic that an individual could be exposed to, is determined for all the COPCs.
- Toxicity values, which indicate how harmful an air toxic is, are obtained from reliable, technically defensible sources. Toxicity values indicate how harmful an air toxic is.
- The exposure concentration and toxicity value for each air toxic are entered into an equation to produce estimates of cancer risk and noncancer hazard. Calculations are also made to determine whether specific air toxics found to be present in ambient air cumulatively pose an unacceptable cancer risk or noncancer hazard.
- All results are explained. Any technical issues and uncertainties that could affect the reliability of the results are also explained.

What are the findings of this Assessment?

The major findings of this Assessment are:

- The cancer risk of specific air toxics and the cumulative risk are within EPA and EPD's acceptable cancer risk range. This indicates that cancer-causing air toxics at the two air monitoring Sites are not present at levels which, for most individuals, would be a cause for concern.
- Exposure to higher levels of these air toxics could, in the long-term, result in harmful health effects other than cancer. The data suggests that the chemical Acrolein found in the ambient air is the major reason for this finding.
- A model accepted by the United States Environmental Protection Agency suggests that Lead at South DeKalb is not expected to be of concern. All Lead concentrations measured in 2019 were below EPA's National Ambient Air Quality Standard of 0.15 $\mu g/m^3$.

Does this risk assessment explain whether harmful health effects are due to ambient air in Georgia?

No. This risk assessment cannot determine if an individual diagnosed with cancer or suffering from other adverse health effects developed illness due to the levels of air toxics in ambient air around each air monitoring Site. It is recommended that people consult with a medical professional about personal health concerns.

Does this risk assessment explain whether a factory near my house is responsible for air pollution?

No. This risk assessment cannot determine the source of the air toxics in ambient air.

How is this risk assessment useful?

The risk assessment follows an in-depth methodology based on technically defensible State and Federal guidance to provide the public with an evaluation of the ambient air quality. This allows for a more informed public. The risk assessment provides information that risk managers (an official in charge of determining whether risk is acceptable and mitigating that risk) can use, along with other pieces of information, in determining best practices for reducing air pollution.

Why does the risk assessment only cover 2019?

The data from air monitoring Sites must be processed and quality checked before it is released for use in the risk assessment. Thus, there is a lag between when data is collected and when the risk assessment is published. Please note that a risk assessment is prepared on a yearly basis as the data becomes available.

Section 1: Introduction

The *2019 Air Toxics Risk Assessment* ("Assessment") was prepared on behalf of the Georgia Environmental Protection Division (GAEPD) Air Protection Branch Ambient Air Monitoring Program (AAMP) by the GAEPD Land Protection Branch Risk Assessment Program (RAP). The goal of this Assessment is to assess cancer risk and noncancer hazard resulting from chronic (long-term) exposure to ambient air toxics within the defined spatial scale of the following ambient air monitoring Sites:

- National Air Toxics Trends Station (NATTS): 2390-B Wildcat Road, Decatur, GA, 30034 ["South DeKalb"]
- Near Road Monitoring Network Site: 3073 Panthersville Road, Decatur, GA, 30034 ["NR-285"]

Air toxics samples collected from each monitoring Site in the year 2019 have been used to prepare this Assessment. Section 2 provides a brief explanation about the dataset used to prepare the risk assessment. Section 3 contains the preliminary risk-based screening analysis (PRBSA) on all air toxics analyzed at each of the Sites. The goal of the PRBSA is to create a short-list of chemicals of potential concern (COPCs) by comparing maximum detected concentrations (MDCs) with conservative air screening levels. COPCs are air toxics that can *potentially* present a risk/hazard to human health and are further evaluated in the Human Health Risk Assessment (HHRA) in Section 4. Guidance from Version 2 of USEPA Region 4's *A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Data Sets* (USEPA, 2010) was considered when preparing the PRBSA while the HHRA was primarily prepared in accordance with USEPA's *Air Toxics Risk Assessment Reference Library: Volume 1 Technical Resource Manual* (USEPA, 2004). However, other risk assessment guidance documents have been consulted as necessary to ensure that the Assessment reflects current risk assessment technical recommendations and best practices. Supporting information necessary to understand the conclusions of the PRBSA and HHRA have been referenced or included in the Appendices.

It is important to emphasize that the risks/hazards determined in Section 4 are representative of a high-end exposure estimate and that there are uncertainties in these estimates due to several reasons. The Uncertainty Section in Section 5 describes the uncertainties inherent to the *2019 Air Toxics Risk Assessment*.

Section 2: Data Collection and Evaluation

Section 2.1 – Collection and Validation of Ambient Air Monitoring Data

Ambient air samples were collected from "*midnight to midnight for a 24-hour sample"* (GAEPD, 2019b, pg. 23) every 6 days at South DeKalb and every 12 days at NR-285 over the year 2019. Samples were analyzed by EPD Laboratory and all results have been validated by the AAMP Quality Assurance Unit. Further information on sample collection, analysis, and data validation can be found in the *Standard Operating Procedure for Data Validation of Integrated Data* (GAEPD, 2018a), *Quality Assurance Project Plan for the Georgia Ambient Air Monitoring Program National Air Toxics Trends Station (NATTS)* (GAEPD, 2019), and the *2019 Ambient Air Monitoring Plan* (GAEPD, 2019b). Table 1 lists the number of air toxics that have been evaluated in this Assessment.

Table 1: Number of Air Toxics Assessed in the 2019 Air Toxics Risk Assessment. The following Table lists the number of metals, semivolatiles, volatile organic compounds, and carbonyls that have been assessed in the 2019 Air Toxics Risk Assessment.

Monitoring Site	Number of Air Toxics
South DeKalb	Metals (10 analyzed) Semivolatiles (18 analyzed) Volatile Organic Compounds (43 analyzed) Carbonyls (6 analyzed) Total: 77 air toxics
NR-285	Volatile Organic Compounds (43 analyzed)

As of December 31, 2018, "*the GA AAMP closed the Air Toxics Network monitors at the Macon-Forestry site (13-021-0012), the Savannah-E. President's Street site (13-051-0021), and the General Coffee site (13-069-0002)*" (GAEPD, 2019b, pg. 5). Though these monitoring Sites were assessed in the 2018 Ambient Air Risk Assessment, they have not been assessed in the *2019 Air Toxics Risk Assessment*.

Section 2.2 – Organization of Ambient Air Monitoring Results

Validated monitoring results were organized by monitoring Site and air toxic so that the Assessment could be prepared. Since the monitoring results were coded using EPA's Air Quality System (AQS) codes, the AQS Code List[2] was consulted during the organization process. Unusable sample values, which are qualified with a Null data qualifier, (a list of all data qualifiers can be found in Appendix C) were removed from the dataset and have not been considered when preparing this Assessment. Sample values were assigned as either a detect or non-detect (see Section 2.3). VOC sample values and corresponding Alternate Method Detectable Limits (AMDLs) were provided in units of parts per billion (ppb) and were converted to units of micrograms per cubic meter ($\mu g/m^3$) using the following formula:

[2] https://www.epa.gov/aqs/aqs-code-list

$$\frac{\text{MW x ppb}}{24.45}$$

Where:

- MW = Molecular weight of air toxic
- ppb = Air toxic concentration, in parts per billion
- 24.45 = Constant (see USEPA, 2004, pg. 9-8)

Organized data files have been included in Appendix A, while the original data files used to prepare the organized data files have been included in Appendix B.

Section 2.3 – Detects and Non-detects

To determine the chemical concentration in air (CA) using ProUCL (see Section 4.2.1), it was necessary to assign a sample value as either a detect or non-detect. Detection status was determined based on the data qualifiers listed in Appendix C. The only datapoints that have been considered non-detects are those qualified with an ND ("No Value Detected, Zero Reported") or MD ("Value less than the MDL").

Please note that sample values were MD-qualified by the analytical laboratory (EPD Laboratory). However, the AMDL is defined by AAMP and is taken into consideration when determining chemicals of potential concern (COPCs) in the PRBSA. There are some instances in the dataset where an MD-qualified sample value exceeds the AMDL corresponding to that sample value. However, since the analytical laboratory considers MD-qualified data to be non-detect, MD-qualified sample values have been considered non-detect for the purposes of determining a CA. Detection status has not been assigned based on the AMDL.

Section 3: Preliminary Risk-Based Screening Analysis (PRBSA)

Section 3.1 – Purpose

The purpose of Section 3 is to present a preliminary risk-based screening analysis (PRBSA) on the 2019 ambient air monitoring data. The "*basic concept behind this risk-based initial screening level methodology is to evaluate air monitoring data sets using a framework that is, by design, relatively simple to perform yet conservative (i.e., health protective) in nature*" (USEPA, 2010, pg. 2). A PRBSA allows the HHRA to focus on those air toxics, the COPCs, which could potentially pose an unacceptable risk/hazard.

For each chemical analyzed at each Site, the greater of the maximum detected concentration (MDC) or Maximum Alternate Method Detectable Limit (MaxAMDL) is compared with conservative air screening levels. Any chemical which exceeds the screening level is considered a chemical of potential concern (COPC) that "*at a minimum, will commonly require a more in-depth analysis (e.g., a more detailed risk assessment) to clarify the potential risks associated with the monitored concentrations*" (USEPA, 2010, pg. 4). All COPCs were further evaluated in the Human Health Risk Assessment (HHRA) in Section 4.

Section 3.2 – Maximum Detected Concentration (MDC)

The maximum detected concentration (MDC) is the highest concentration out of all a particular air toxic's useable and detected sample values. The MDC is used for screening in accordance with USEPA (2010) since it "*is expected to result in a lessened chance that chemicals posing exposures of potential public health concern will be removed from further consideration*" in the HHRA (USEPA, 2010, pg. 7).

Section 3.3. – Maximum Alternate Method Detectable Limit (MaxAMDL)

The Alternate Method Detectable Limit (AMDL) is defined as the "*method detectable limit (MDL) defined for the sample by the QA agency, which supersedes the EPA-defined method detectable limit for the designated methodology*"[3]. For a particular air toxic analyzed at either South DeKalb or NR-285, the Maximum Alternate Method Detectable Limit (MaxAMDL) is the largest AMDL out of all of the AMDLs corresponding to the useable sample values.

Section 3.4: Resident Air Regional Screening Level (RSL)

Chemicals of Potential Concern (COPCs) were determined by comparing the greater of the MDC or MaxAMDL of an air toxic with the lower of that air toxic's cancer (carcinogenic) or noncancer (noncarcinogenic) November 2020 USEPA Resident Air Regional Screening Level (RSL) (USEPA, 2020). RSLs are derived from risk equations that have been modified to obtain an ambient air concentration. Cancer RSLs are derived at a cancer risk level of $1x10^{-6}$ (1 in 1 million) while noncancer RSLs are derived at a hazard quotient (HQ) of 0.1[4] and both RSLs are based on

[3] Please see: https://aqs.epa.gov/aqsweb/documents/AQS_Data_Dictionary.html

[4] As stated in Frequent Question #6 in USEPA (2020), the justification for deriving noncancer RSLs at a HQ of 0.1 is "*that when multiple contaminants of concern are present at a site or one or more are present in multiple exposure media, the total hazard index could exceed 1.0 if each were screened at the HQ of 1.0*". Thus, deriving the noncancer RSL at a HQ of 0.1 allows for a more health protective RSL and avoids the

residential "*default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures*" (USEPA, 2020)[5]. The November 2020 Resident Air RSLs have been included in Appendix D. For more information regarding how RSLs are derived, please see the RSL User's Guide (USEPA, 2020).

The use of RSLs is a deviation from the recommended Chronic Screening Values provided in USEPA (2010). However, USEPA (2010) provides for using alternative screening levels like RSLs if it is documented why these values are used and how these values are in accordance with the concept behind a screening analysis (USEPA, 2010, pg. 6). The Chronic Screening Values in USEPA (2010) are based off toxicity values that were acceptable to EPA's Office of Air Quality Planning and Standards (OAQPS) when USEPA (2010) was published. Using RSLs, which are updated semi-annually with the most current recommended toxicity values, ensures that the PRBSA is prepared based on the most current, technically defensible information and allows for more chemicals to be screened since the RSLs are derived using toxicity values that are not considered by OAOPS (for example, USEPA's Provisional Peer-Reviewed Toxicity Values (PPRTVs); see Section 4.3.2). Since RSLs are derived using exposure parameters and factors representing Reasonable Maximum Exposure (RME) conditions, while cancer RSLs are derived at the lower end of EPA's acceptable cancer risk range (which is $1x10^{-4}$ to $1x10^{-6}$; see Section 4.4.2) and noncancer RSLs at a noncancer hazard of 0.1, the use of the lower of the cancer and noncancer RSL for screening will ensure that only those air toxics which are not expected to be of concern to human health will be eliminated and that the HHRA can focus on evaluating only those air toxics which may present an unacceptable risk/hazard.

Section 3.5 – Procedure for Selection of Chemicals of Potential Concern (COPCs)

An air toxic was selected as a COPC if the larger of the MDC or MaxAMDL exceeds the lower of the cancer and noncancer RSL for that air toxic. The exceedance of the MaxAMDL of an air toxic over the RSL indicates that the air toxic may have had the possibility to be present in the ambient air within the spatial scale of the monitoring Site at a concentration above the RSL. To ensure that the HHRA will not underestimate risk/hazard, air toxics where this is the case have been conservatively assumed to be COPCs and evaluated in the HHRA.

Several analyzed air toxics do not have RSLs. There is uncertainty as to whether these air toxics could be of potential concern at the Site. A conservative approach was taken in this Assessment where these air toxics were assumed to be COPCs to be further evaluated in the HHRA.

A list of all South DeKalb COPCs can be found on Table 2, while a list of all NR-285 COPCs can be found on Table 3. Detailed COPC Selection Tables can be found in Appendix E.

elimination of chemicals from further evaluation in the HHRA that could potentially present an unacceptable hazard if taken into consideration with other noncancer air toxics.

[5] Reasonable maximum exposure (RME) is defined as the "*highest exposure that is reasonably expected to occur at a site*" (USEPA, 1989; pg. 6-5). Though USEPA (2004) does not use the term RME, exposure parameters and factors that represent RME conditions are high-end exposure estimates, meaning that they represent a "*plausible estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution*" (USEPA, 2004, glossary). Use of residential exposure parameters and factors that represent RME conditions ensure that the RSLs are protective of individuals who might be exposed to ambient air within the spatial scale of a monitoring Site for a lower frequency, time, and duration.

Section 3.6 – Lead

Even though Appendix D lists a RSL for Lead of 0.15 µg/m^3, which is USEPA's National Ambient Air Quality Standard (NAAQS), this value was not considered in the PRBSA so that Lead could be selected as a COPC to be further evaluated in the HHRA.

Lead is evaluated differently from other air toxics in that EPA does not recommend using toxicity values to evaluate Lead (as would be done for other air toxics in a risk assessment) but recommends evaluating Lead using EPA-provided Lead models[6]. To ensure Lead is evaluated in accordance with EPA guidance, Section 4.4.1 discusses the result of the evaluation of Lead at South DeKalb using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (USEPA, 2004; pg. 11-10).

Section 3.7 – Elimination of m/p-Xylene and o-Xylene as COPCs

In Appendix D, a noncancer RSL of 10 µg/m^3 is assigned for Xylenes (CAS Number: 1330-20-7) and for the individual m-, p-, and o- congeners. As stated in Frequent Question #55 (USEPA, 2020), this is because USEPA (2020) considers the Xylenes reference concentration (RfC) from USEPA's Integrated Risk Information System (IRIS) to represent the toxicity for individual m-, p-, and o- congeners. Please see Section 4.3 for more information on toxicity values.

At both South DeKalb and NR-285, Xylenes were reported as m/p-Xylenes (represents a mixture of m- and p- congeners) and o-Xylenes. Using the Noncancer RSL of 10 µg/m^3, m/p-Xylene (since the RSL assigned for the individual m- and p- congeners are the same, using this RSL to screen m/p-Xylene is considered acceptable since the toxicity of the individual congeners which comprise m/p-Xylene is considered the same) and o-Xylene were eliminated as COPCs since their respective MDCs are below the RSL. Please see Appendix E for more information.

[6] https://www.epa.gov/superfund/lead-superfund-sites-risk-assessment

Table 2: List of South DeKalb COPCs. These chemicals have been further evaluated in the HHRA. Please see Appendix E for more detailed COPC Selection Tables.

Chemical (Air Toxic)	Air Quality System (AQS) Parameter Code	CAS Number	Rationale for Selection as a Chemical of Potential Concern (COPC)
Volatile Organic Compounds			
Freon 114	**43208**	**76-14-2**	**No Screening Level**
Butadiene, 1,3-	**43218**	**106-99-0**	**MDC above Screening Level**
Acrolein	**43505**	**107-02-8**	**MDC above Screening Level**
Chloroform	**43803**	**67-66-3**	**MDC above Screening Level**
Carbon Tetrachloride	**43804**	**56-23-5**	**MDC above Screening Level**
Trichlorofluoromethane	**43811**	**75-69-4**	**MDC above Screening Level**
Dichloroethane, 1,2-	**43815**	**107-06-2**	**MDC above Screening Level**
Tetrachloroethane, 1,1,2,2-	**43818**	**79-34-5**	**MDC and MaxAMDL above Screening Level**
Trichloroethane, 1,1,2-	**43820**	**79-00-5**	**MDC and MaxAMDL above Screening Level**
Trichloroethylene	**43824**	**79-01-6**	**MDC above Screening Level**
Dichloropropene, Trans-1,3-	**43830**	**10061-02-6**	**No Screening Level**
Dichloropropene, Cis-1,3-	**43831**	**10061-01-5**	**No Screening Level**
Dichloroethene, Cis-1,2-	**43839**	**156-59-2**	**No Screening Level**
Dibromoethane, 1,2-	**43843**	**106-93-4**	**MDC exceeds Screening Level**
Hexachlorobutadiene	**43844**	**87-68-3**	**MDC and MaxAMDL above Screening Level**
Benzene	**45201**	**71-43-2**	**MDC above Screening Level**
Benzene, 1-Ethenyl-4-Methyl	**45228**	**622-97-9**	**MDC and MaxAMDL above Screening Level**
Dichlorobenzene, 1,3-	**45806**	**541-73-1**	**No Screening Level**
Dichlorobenzene, 1,4-	**45807**	**106-46-7**	**MDC above Screening Level**
Benzyl Chloride	**45809**	**100-44-7**	**MaxAMDL above Screening Level**
Trichlorobenzene, 1,2,4-	**45810**	**120-82-1**	**MaxAMDL above Screening Level**
Metals			
Arsenic	**82103**	**7440-38-2**	**MDC above Screening Level**
Cadmium	**82110**	**7440-43-9**	**MDC above Screening Level**
Chromium	**82112**	**7440-47-3**	**No Screening Level**
Cobalt	**82113**	**7440-48-4**	**MDC above Screening Level**
Lead	**82128**	**7439-92-1**	**No Screening Level**
Manganese	**82132**	**7439-96-5**	**MDC above Screening Level**

Carbonyls			
Formaldehyde	**43502**	**50-00-0**	**MDC Exceeds Screening Level**
Acetaldehyde	**43503**	**75-07-0**	**MDC Exceeds Screening Level**
Butyraldehyde	**43510**	**123-72-8**	**No Screening Level**
Benzaldehyde	**45501**	**100-52-7**	**No Screening Level**
Semivolatiles			
Acenaphthene	**17147**	**83-32-9**	**No Screening Level**
Acenaphthylene	**17148**	**208-96-8**	**No Screening Level**
Anthracene	**17151**	**120-12-7**	**No Screening Level**
Benzo(A)Pyrene	**17242**	**50-32-8**	**MaxAMDL above Screening Level**
Benzo(E)Pyrene	**17224**	**192-97-2**	**No Screening Level**
Benzo[G,H,I]Perylene	**17237**	**191-24-2**	**No Screening Level**
Dibenz[A,H]Anthracene	**17231**	**53-70-3**	**MaxAMDL above Screening Level**
Fluoranthene	**17201**	**206-44-0**	**No Screening Level**
Fluorene	**17149**	**86-73-7**	**No Screening Level**
Naphthalene	**17141**	**91-20-3**	**MDC above Screening Level**
Phenanthrene	**17150**	**85-01-8**	**No Screening Level**
Pyrene	**17204**	**129-00-0**	**No Screening Level**
Perylene	**17212**	**198-55-0**	**No Screening Level**

Screening Level: Lower of the Cancer and Noncancer November 2020 USEPA Resident Air Regional Screening Level (RSL). Cancer RSLs are derived at a cancer risk level of $1x10^{-6}$ while noncancer RSLs are derived at a hazard quotient (HQ) of 0.1.

Table 3: List of NR-285 COPCs. These chemicals have been further evaluated in the HHRA. Please see Appendix E for more detailed COPC Selection Tables.

Chemical (Air Toxic)	Air Quality System (AQS) Parameter Code	CAS Number	Rationale for Selection as a COPC
Volatile Organic Compounds			
Freon 114	**43208**	**76-14-2**	**No Screening Level**
Butadiene, 1,3-	**43218**	**106-99-0**	**MDC Above Screening Level**
Acrolein	**43505**	**107-02-8**	**MDC Above Screening Level**
Chloroform	**43803**	**67-66-3**	**MDC Above Screening Level**
Trichlorofluoromethane	**43811**	**75-69-4**	**No Screening Level**
Tetrachloroethane, 1,1,2,2-	**43818**	**79-34-5**	**MaxAMDL Above Screening Level**
Trichloroethane, 1,1,2-	**43820**	**79-00-5**	**MDC and MaxAMDL Above Screening Level**
Dichloropropene, Trans-1,3-	**43830**	**10061-02-6**	**No Screening Level**
Dichloropropene, Cis-1,3-	**43831**	**10061-01-5**	**No Screening Level**
Dichloroethene, Cis-1,2-	**43839**	**156-59-2**	**No Screening Level**
Dibromoethane, 1,2-	**43843**	**106-93-4**	**MDC Above Screening Level**
Hexachlorobutadiene	**43844**	**87-68-3**	**MaxAMDL Above Screening Level**
Benzene	**45201**	**71-43-2**	**MDC Above Screening Level**
Benzene, 1-Ethenyl-4-Methyl	**45228**	**622-97-9**	**No Screening Level**
Dichlorobenzene, 1,3-	**45806**	**541-73-1**	**No Screening Level**
Dichlorobenzene, 1,4-	**45807**	**106-46-7**	**MDC Above Screening Level**
Benzyl Chloride	**45809**	**100-44-7**	**MaxAMDL Above Screening Level**
Trichlorobenzene, 1,2,4-	**45810**	**120-82-1**	**MaxAMDL Above Screening Level**

Screening Level: Lower of the Cancer and Noncancer November 2020 USEPA Resident Air Regional Screening Level (RSL). Cancer RSLs are derived using a cancer risk level of $1x10^{-6}$ while noncancer RSLs are derived using a hazard quotient (HQ) of 0.1.

Section 4: Human Health Risk Assessment (HHRA)

Section 4.1 - Conceptual Model

The conceptual model "*explicitly identifies the sources, receptors, exposure pathways, and potential adverse human health effects that the risk assessment will evaluate*" (USEPA, 2004, pg. 6-1). This allows risk managers and the public to understand exactly what is being evaluated in this Assessment. USEPA (2004) recommends specific elements that should be included in a conceptual model, which has been graphically displayed in Figure 1 and further explained below.

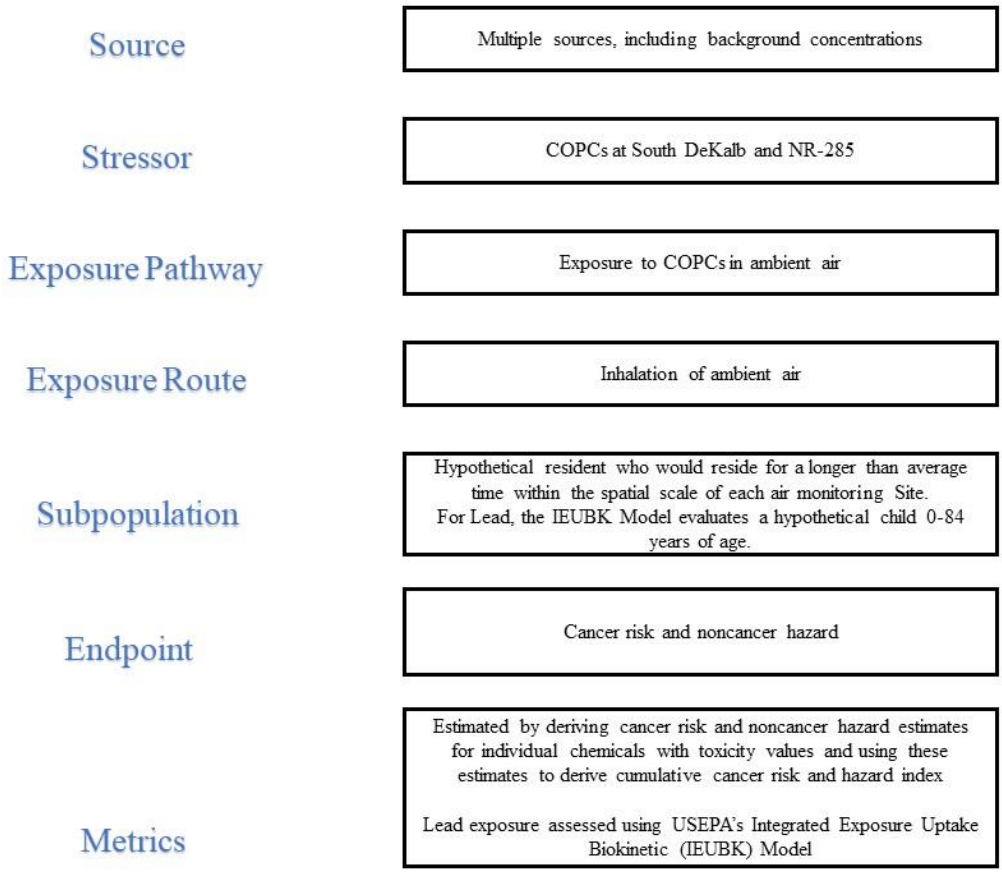


Figure 1: Conceptual Model, Applies to All Monitoring Sites. This conceptual model was made similar to the conceptual model in Exhibit 6-1 of USEPA (2004).

Section 4.1.1 – Sources of Air Toxics

The air toxics present in ambient air are a "*combination of background concentrations and the same chemical released from possibly multiple sources*" (USEPA, 2004, pg. 10-37). However, the exact sources of these air toxics cannot be pinpointed from the air monitoring data used in the HHRA.

Section 4.1.2 – Stressors

The stressors are the specific air toxics that will be evaluated in the HHRA, which are the COPCs determined for each of the monitoring Sites in the PRBSA. Only COPCs with available toxicity values contribute to the risk/hazard estimates discussed in Section 4.4.2.

Section 4.1.3 – Exposure Pathway/Exposure Route

The HHRA only evaluates exposure to COPCs resulting from inhalation of ambient (outdoor) air, defined "*as that portion of the atmosphere, external to buildings, to which the general public has access*" (GAEPD, 2019b, pg. 19), since only validated air monitoring data is available. Air toxics present in indoor air has not been evaluated in the HHRA, "*but indoor air concentrations of air toxics are expected to be the same or lower than the outdoor concentrations*" (USEPA, 2004, pg. 11-2). An individual could possibly be exposed to air toxics that have deposited out of the air onto water bodies, plants, soil, and/or other surfaces (USEPA, 2004, pg. 6-2), but other exposure pathways and routes have not been evaluated since atmospheric deposition data is not available.

Section 4.1.4 – Subpopulation

The scale (or "spatial scale") is defined as the "*area around the monitoring location (and the types of exposures) the analysts consider the monitoring data to represent*" (USEPA, 2004, pg. 6-14). AAMP has estimated the spatial scale of each monitoring Site and considers pollutant concentrations to be uniform within the spatial scale of an air monitoring Site (GAEPD, 2019b, pg. 19). Please see Figure 2 for the spatial scale of South DeKalb and Figure 3 for the spatial scale of NR-285.

The risk/hazard estimates discussed in Section 4.4.2 of the HHRA are representative of a hypothetical individual who lives within the spatial scale of either air monitor for a longer than average length of time where that hypothetical resident could be exposed to concentrations of stressors present at the higher end of a range of plausible stressor concentrations. Deriving risk/hazard estimates in such a conservative manner ensures that any risk management decisions based on these estimates would be protective of individuals who might be exposed to stressors within the spatial scale of either air monitor for a shorter length of time.

Lead exposure has been evaluated using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model. A risk or hazard as defined in this HHRA is not derived for Lead. Instead, the IEUBK Model determines the probability that the blood Lead concentration in a hypothetical child aged 0-84 years exceeds a target blood Lead level. Please refer to Section 4.4.1 for more detail.

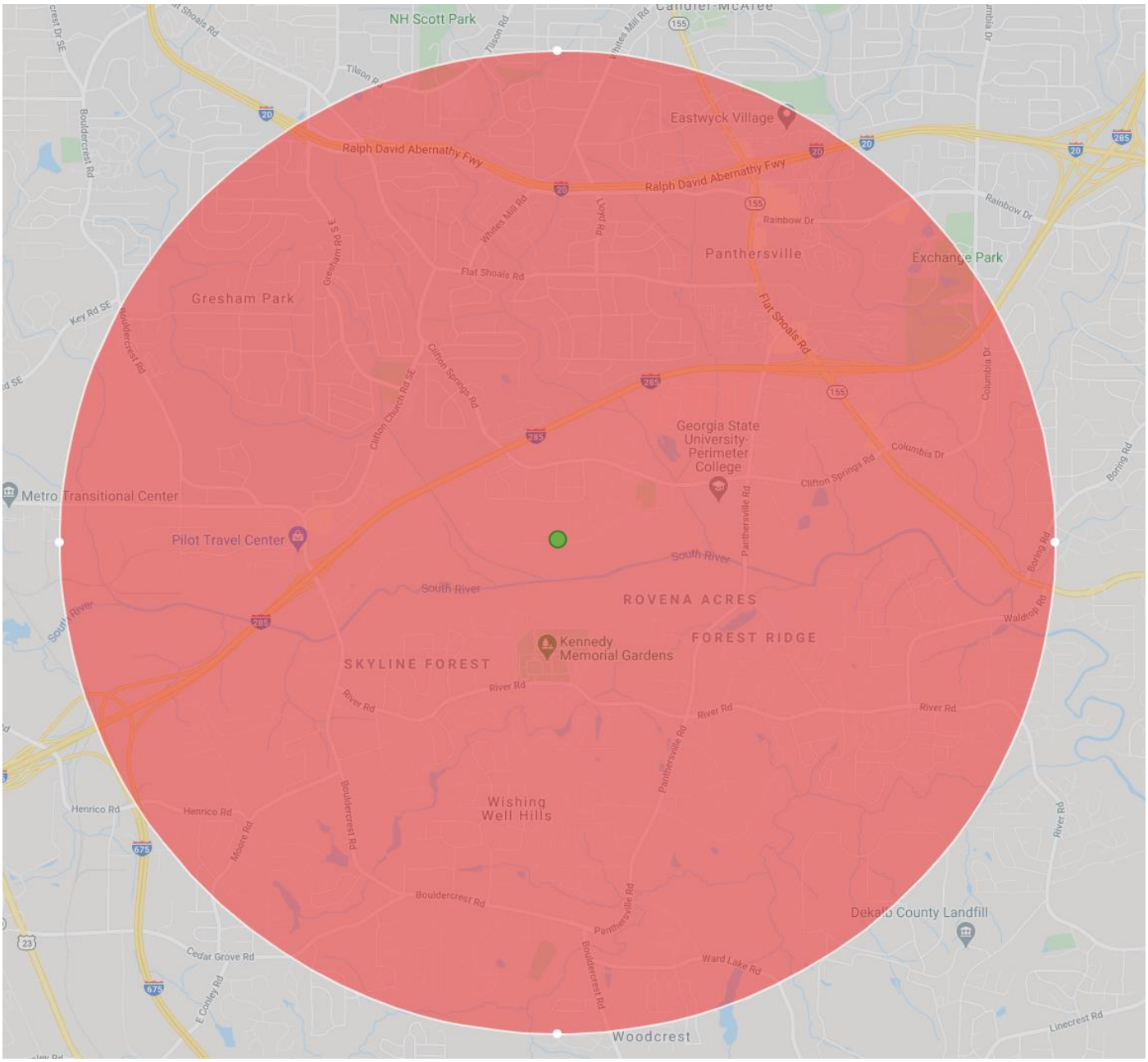


Figure 2: Spatial Scale for the South DeKalb Air Monitoring Site. According to GAEPD (2019b), South DeKalb has a Neighborhood spatial scale (an area with dimensions up to 4 kilometers from the monitoring Site), which means that air toxics concentrations measured at South DeKalb represent ambient air concentrations within a 4-kilometer radius (area in red) from the South DeKalb monitoring Site (middle green dot)

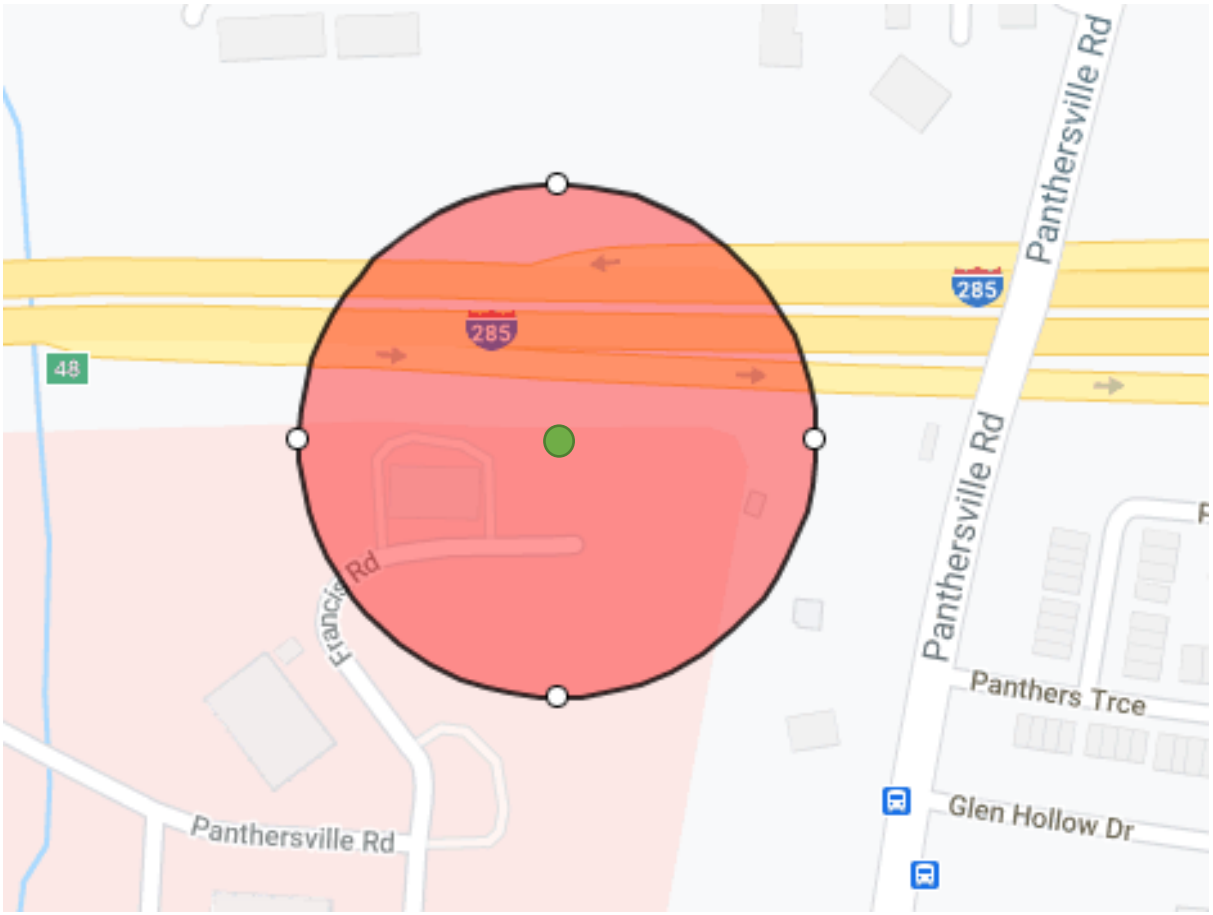


Figure 3: Spatial Scale for the NR-285 Air Monitoring Site. According to GAEPD (2019b), NR-285 has a Micro spatial scale (an area with dimensions up to 100 meters from the monitoring Site), which means that air toxics concentrations measured at NR-285 represent ambient air concentrations within a 100-meter radius (area in red) from the NR-285 monitoring Site (middle green dot)

Section 4.1.5 – Endpoints and Metrics

Endpoints are specific harmful effects that could occur because of being exposed to air toxics in ambient air. This risk assessment will not evaluate specific endpoints but will provide quantitative estimates of the cancer risk and noncancer hazard from exposure to COPCs. Cancer risk and noncancer hazard for COPCs with toxicity values have been estimated using the RSL Calculator, and the cancer risk estimates and hazard quotients are summed to obtain the cumulative cancer risk and hazard index (HI), respectively. As explained in Section 4.4.1, Lead exposure has been evaluated using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model.

Section 4.2 – Exposure Assessment

To assess exposure to ambient air within the spatial scale of each air monitor, an exposure concentration (EC) is defined. The EC generally can be defined as the "*concentration of a chemical in the air at the point where a person breathes the air*" (USEPA, 2004, pg. 6-17)[7]. However, in the context of this HHRA, the EC is a time-weighted contaminant concentration in air (CA) which considers the frequency, duration, and time of exposure as well as the time over which the exposure is averaged (USEPA, 2009, pg. 13 to 17).

Section 4.2.1 – Estimating the Contaminant Concentration in Air (CA) for a COPC

The CA is a high-end estimate (i.e. a concentration at the higher end of a range of plausible concentrations of an air toxic that could reasonably exist in ambient air) of the chronic (long-term) ambient air concentration of an air toxic within the spatial scale of an air monitoring Site. The CA is time-weighted to develop the EC. The EC does not represent the actual concentration of an air toxic that a particular individual might breathe (which could vary amongst individuals) but could be thought of as a highly conservative estimate of the amount of an air toxic an individual *has the potential* to breathe if that individual were to reside within the spatial scale of an air monitoring Site over a long period of time (see Section 4.2.3).

USEPA (2004) specifically recommends the 95% upper confidence limit of the arithmetic mean (UCL) to estimate the CA (USEPA, 2004, pg. I-4 and I-5). ProUCL statistical software has been developed under the direction of USEPA's Technical Support Center (TSC) to calculate technically defensible UCLs for risk assessment purposes[8] and has been recommended in Region 4 air toxics risk assessment guidance (USEPA, 2010, pg. 13). Thus, the most current version of ProUCL (Version 5.1.002) was used to derive an estimate of the CA for all air toxics (see exceptions below).

The useable sample values for each air toxic, coded either as non-detect or detect (see Section 2.3) were inputted into ProUCL. Based on the size, distribution, and skewness of the dataset for each air toxic, ProUCL automatically recommended an appropriate UCL, which in some cases was not the 95% UCL (USEPA, 2015, pg. 7). ProUCL's recommended UCL was used to estimate the CA of an air toxic with some exceptions below

- If the dataset for a particular air toxic had less than 4 detects, 4 distinct detects, or fewer than 10 useable sample values, the MDC (or the MaxAMDL, if it was greater than the MDC) was used to estimate the CA.
- If the recommended UCL was based on Land's H-statistic, the greater of the MDC or MaxAMDL was used to estimate the CA since *ProUCL Version 5.1 User Guide* does not recommend the use of the H-statistic (USEPA, 2015, pg. 57).
- If the ProUCL recommended UCL exceeds the MDC, the MDC (or MaxAMDL if greater than the MDC) was used to estimate the CA. Though USEPA (2015) does not recommend this procedure, other EPA guidance has recommended this procedure to ensure that the CA estimate is representative of the actual dataset (USEPA, 2015, pg. 57).

[7] It is important to clarify that the term exposure concentration (EC) is used more generally in USEPA (2004) to refer to what would be termed the contaminant concentration in air (CA) in this Assessment. Based on USEPA (2009), the EC is technically a time-weighted CA.
[8] https://www.epa.gov/land-research/proucl-software

Please consult USEPA (2015) for further information and recommendations on deriving technically defensible UCLs. All ProUCL inputs and outputs have been provided in Appendix F, and a list of the CAs estimated for each COPC has been provided in Appendix G.

Section 4.2.2 – Estimating the Contaminant Concentration in Air (CA) for Lead

Lead exposure has been evaluated in the HHRA using version 1.1 (build 11) of USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model as explained in Section 4.4.1. Though EPA has implied that a UCL could be entered into the IEUBK Model (USEPA, 2007), EPA's *Guidance Manual For The IEUBK Model For Lead In Children* implies that average concentrations are entered into the Model (USEPA, 1994b, pg. 1-18) and a more recent EPA guidance document explicitly mentions that the EPA Technical Review Working Group for Lead recommends using average concentrations for assessing Lead exposures (USEPA, 2002, pg. 2). To ensure that Lead is assessed in the IEUBK Model in accordance with EPA standard practice, the annual average Lead air concentration (arithmetic mean of all useable detected Lead sample values) has been used to estimate the CA for Lead in this HHRA.

Section 4.2.3 – How the Exposure Concentration (EC) is Determined from the CA

As previously mentioned, the EC is a time-weighted CA which takes into account the frequency, duration, and time of exposure as well as the time period over which the exposure is averaged (USEPA, 2009, pg. 13 to 17). However, the EC has not been calculated in the HHRA since the risk/hazard estimates discussed in Section 4.4.2 were derived using USEPA's Regional Screening Level (RSL) calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) in accordance with the following equations discussed in Section 2.6.1 of the RSL *User's Guide*, which only requires the contaminant concentration in air (CA) as the input.

$$\textbf{Cancer Risk} = (\textbf{C} \times \textbf{TR}) / \textbf{CancerRSL}$$

$$\textbf{Noncancer Hazard Quotient} = (\textbf{C} \times \textbf{THQ}) / \textbf{NoncancerRSL}$$

Where:

- C = contaminant concentration in air (CA)
- TR = $1x10^{-6}$
- THQ = 0.1
- CancerRSL = November 2020 USEPA Cancer Resident Air Regional Screening Level (RSL) derived using a cancer risk level of $1x10^{-6}$. Please see Appendix D.
- NoncancerRSL: November 2020 USEPA Noncancer Resident Air Regional Screening Level (RSL) derived using a hazard quotient (HQ) of 0.1. Please see Appendix D.

The RSLs referred to in the Section 2.6.1 RSL Calculator equations were already derived using the default residential parameters in Table 4. Dividing by the RSL automatically time-weights the CA so that the final risk or hazard estimate is based off an EC that accounts for the residential parameters in Table 4. These residential exposure parameters are recommended in EPA guidance and represent RME conditions that "*account for daily exposure over the long term and generally result in the highest potential exposures and risk*" (USEPA, 1991, pg. 3). In other words, the risk/hazard estimates discussed in Section 4.4.2 of the HHRA are representative of a hypothetical resident who lives within the spatial scale of either air monitoring Site for a longer than average length of time where that hypothetical resident could be exposed to concentrations of stressors that are at the higher end of a range of plausible stressor concentrations. Deriving risk/hazard estimates based on a residential scenario ensures that risk management decisions based on these estimates would be protective of individuals who might be exposed to air toxics within the spatial scale of either air monitoring Site for a shorter length of time.

Table 4: Default Residential Parameters used in the RSL Calculator to Determine the Exposure Concentration (EC)

ED	Exposure duration	26 years	26 years is a default exposure duration value used in the residential exposure scenario. The value is obtained from Table 16-108; 90th percentile for current residence time in USEPA (2011). 26 years is a conservative assumption for the total length of time an individual resident could inhale ambient air chemicals within the spatial scale of an air monitoring Site.
EF	Exposure frequency	350 days/year	This value is from page 15 of USEPA (1991) and is a residential exposure frequency. Though 365 days/year (every day per year) is a more conservative exposure frequency, USEPA believes that "*the common assumption that workers take two weeks of vacation per year can be used to support a value of 15 days per year spent away from home (i.e., 350 days/year spent at home)*" (USEPA, 1991, pg. 5). 350 days/year is still an upper-bound residential assumption and is used to be in line with recommended USEPA values. Thus, this value denotes that an individual resident inhaling ambient air chemicals within the spatial scale of an air monitoring Site for 350 days out of the year. This is considered a conservative assumption.
ET	Exposure time	24 hours/day	A resident is assumed to be able to be exposed to environmental chemicals for a maximum of 24 hours a day (USEPA, 1989a, pg. 6-6). 24 hours/day as the ET ensures is maximum amount of time per day that an individual could inhale an air toxic within the spatial scale of an air monitoring Site. Thus, this exposure parameter is conservative.

LT	Lifetime	70 years	70 years is standard assumption used by USEPA (USEPA, 1989a, pg. 6-22) to represent a hypothetical individual's lifetime and is assumed to be the length of time over which exposure to a carcinogenic air toxic can be averaged. Even if the actual exposure duration of a carcinogenic air toxic is less than 70 years (e.g. 26 years), EPA assumes that exposure to a higher amount of carcinogen over a short time period is equivalent to exposure to a smaller amount of carcinogen over a lifetime (USEPA, 2005a, pg. 3-26).

Section 4.3 – Toxicity Assessment

The purpose of the toxicity assessment is to identify the cancer and noncancer effects of a chemical [hazard identification] and to quantify its toxicity [dose-response assessment] (USEPA, 2004, pg. 12-1). For many of the chemicals, toxicity assessments have already been conducted by toxicologists either at USEPA or another Federal/State agency. Thus, the focus of this section is to briefly explain the toxicity values that are used to derive risk/hazard estimates.

Section 4.3.1 – Toxicity Values

During the toxicity assessment, the information from the hazard identification and dose-response assessment are translated into specific toxicity values that are used to prepare the HHRA. Two kinds of inhalation toxicity values are used in the risk assessment to evaluate inhalation: the reference concentration (RfC) and the inhalation unit risk (IUR).

The RfC "*is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncarcinogenic health effects during a lifetime*" (USEPA, 1994, pg. 1-2 to 1-4). Readers should consult USEPA (1994) and a chemical's noncancer toxicity assessment for more information on how a RfC is derived.

The IUR is defined as "*the upper-bound excess lifetime carcinogenic risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air*" (USEPA, 2009, pg. 10). Readers should consult USEPA (2005a) and a chemical's cancer toxicity assessment for more information on how an IUR is derived.

Appendix H lists the toxicity values for all air toxics (that have available toxicity values) that were either used to derive the RSLs used in the PRBSA or, for the COPCs, used to derive risk/hazard estimates. Since the purpose of this risk assessment is to assess long-term (chronic) exposure to ambient air, only chronic toxicity values have been used.

Section 4.3.2 – USEPA Human Health Toxicity Values Hierarchy

Many different State and Federal organizations publish toxicity values. For some air toxics, one organization may have published an IUR while another organization may have published an RfC, and it is necessary to organize the sources from which toxicity values are selected so that the toxicity values used to assess a particular air toxic are determined using a consistent procedure.

EPA's OAOPS has a published list of chronic toxicity values that it recommends for use in air risk assessment[9] which prioritizes using EPA Integrated Risk Information System (IRIS) toxicity values whenever they are available[10]. However, OAOPS does not consider USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), which are derived for USEPA's Superfund program and are not considered USEPA consensus values. Not considering PPRTVs, which are derived by EPA scientists and both internally and externally peer-reviewed[11], would make it impossible to provide risk/hazard estimates for several air toxics assessed in the HHRA and potentially underestimate risk/hazard. To ensure that all technically defensible toxicity values available for air toxics are being considered, this HHRA deviates from the OAOPS hierarchy and has selected the toxicity values in Appendix H following USEPA's Human Health Toxicity Values Hierarchy recommended for Superfund risk assessments, summarized below (USEPA, 2003):

- Tier 1 toxicity values: USEPA's Integrated Risk Information System (IRIS), found at: https://www.epa.gov/iris, is consulted first. USEPA considers IRIS to be its preferred source for toxicity information on chemicals and "*IRIS health assessments contain [USEPA] consensus toxicity values*" (USEPA, 2003, pg. 2).

- Tier 2 toxicity values: If a chemical does not have a toxicity value listed in IRIS, USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) are consulted next. USEPA PPRTVs are developed by USEPA's Office of Research and Development Center for Public Health and Environmental Assessment and USEPA's Human Health Risk Assessment (HHRA) National Research Program. These values are peer-reviewed but are developed primarily for the Superfund program and not necessarily considered a consensus toxicity value within USEPA. For more information on PPRTVs, please refer to: https://www.epa.gov/pprtv/basic-information-about-provisional-peer-reviewed-toxicity-values-pprtvs.

[9] https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants
[10] https://www.epa.gov/fera/prioritization-data-sources-chronic-exposure
[11] https://www.epa.gov/pprtv/basic-information-about-provisional-peer-reviewed-toxicity-values-pprtvs#basicinfo

- Tier 3 toxicity values: If a chemical doesn't have a PPRTV (or an IRIS toxicity value), then toxicity values from other sources may be used. Though USEPA's Toxicity Values Hierarchy does not have clear criteria to prioritize which Tier 3 toxicity values should be considered first, USEPA generally recommends that Tier 3 values be obtained from "*sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed*" (USEPA, 2003, pg. 3). The RSL Calculator, used to derive risk/hazard in this HHRA, defines a hierarchy for Tier 3 toxicity values in Section 2.3 of USEPA (2020). The hierarchy, described below, was used to select the toxicity values in Appendix H and derive the risk/hazard estimates using the RSL calculator:

    - EPA's Office of Pesticide Programs (OPP) Human Health Benchmarks for Pesticides were considered if a Tier 1 or Tier 2 toxicity value is not available.

    - If an OPP benchmark was not available, then chronic inhalation minimal risk levels (MRLs) from the Agency for Toxic Substances and Disease Registry (ATSDR), found at https://www.atsdr.cdc.gov/mrls/mrllist.asp[12], are selected. For the purposes of the HHRA, MRLs are considered equivalent to RfCs.

    - If an MRL is not available, chronic RfCs published by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (CalEPA) were used. If an IUR was not available from a Tier 1 or 2 source, then the IUR published by CalEPA was used. CalEPA toxicity values can be found here: https://oehha.ca.gov/chemicals.

    - For some chemicals, the toxicity assessments used to obtain a PPRTV ("PPRTV Assessments") also contain screening toxicity values which although published are considered to have more uncertainty in their derivation than a PPRTV. These are used for chemicals when an MRL or CalEPA toxicity value is not available.

    - If a chemical does not have a toxicity value in the aforementioned Tier 3 sources, then toxicity values listed in the USEPA Superfund program's Health Effects Assessment Summary Table (HEAST), found at https://epa-heast.ornl.gov/ were used.

Section 4.3.3 – Toxicity Values Unavailable

Several COPCs do not have toxicity values in either a Tier 1, Tier 2, or Tier 3 source. Thus, it is not possible to derive risk/hazard estimates for these air toxics.

[12] Only the chronic inhalation MRLs from this table is listed on Appendix H.

Section 4.3.4 – Using RPFs to Determine IUR for Select PAHs

The IUR for several polycyclic aromatic hydrocarbons (PAHs) listed in Appendix H were derived by adjusting the IUR of Benzo(a)pyrene with chemical-specific relative potency factors (RPF). Frequent Question #46 in USEPA (2020) provides a detailed justification and reasoning behind why this is done.

Section 4.3.5 – Chromium Toxicity

Chromium is known to exist in two major valence states, hexavalent chromium (Cr^{+6}) and trivalent chromium (Cr^{+3}). AAMP indicated that the total chromium analyzed at South DeKalb is assumed to be 100% trivalent chromium. Thus, a risk/hazard estimate for chromium could not be determined because trivalent chromium does not have air toxicity values from a Tier 1-3 source.

Section 4.3.6 – Mutagenic Air Toxics

The RSL Calculator follows recommendations outlined in USEPA (2005b) for air toxics that have a mutagenic mode of action and derived the cancer RSLs differently for these air toxics. Please see Sections 5.17 and 5.18 of USEPA (2020) for more information. Since the RSL Calculator uses the cancer RSL to derive cancer risk estimates for mutagenic air toxics, the risk estimates presented in Section 4.4.2 reflect the mutagenicity of COPCs that are considered to have a mutagenic mode of action.

Section 4.4 – Risk Characterization

In the risk characterization step, the information from the exposure assessment and the toxicity assessment are integrated to obtain a cancer risk and/or hazard quotient (HQ) for COPCs with toxicity values as well as a cumulative cancer risk and hazard index (HI) of all the COPCs with toxicity values. USEPA's RSL calculator was used to obtain these estimates by inputting the CA (the toxicity values in Appendix H are automatically populated in the RSL Calculator). The equations that the RSL Calculator uses to obtain risk/hazard estimates have been discussed in Section 4.2.3. For more information on how the RSL Calculator was used to obtain risk/hazard estimates, please refer to USEPA (2020).

Section 4.4.1 – USEPA Integrated Exposure Biokinetic (IEUBK) Model for Lead

Though Lead has an IUR from CalEPA[13], Lead has not been evaluated in the HHRA using toxicity values in line with EPA recommendations (USEPA, 2004, pg. 11-10). Thus, a cancer risk or noncancer HQ has not been derived. Instead, Lead exposure is evaluated using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model which at its core relates environmental Lead exposure to plausible blood-Lead concentrations that could be expected in a hypothetical child (defined as a child between 0-84 months of age) as a result of Lead exposure (USEPA, 1994b, pg. 1-1 to 1-4). The IEUBK Model also determines the probability that these blood-Lead concentrations will exceed a level of concern. The level of concern is set by default in the IEUBK Model to 10 µg/dL as currently recommended in USEPA guidance (USEPA, 1994b, pg. 1-2).

Lead was evaluated at South DeKalb using Version 1.1 Build 11, the most current version of the Model. Since the IEUBK Model considers all Lead exposures (i.e. from soil, water, dietary, and not only ambient air), the default values for other exposure pathways as currently entered in the Model were used. The annual average ambient air concentration of Lead determined at South DeKalb was inputted into the IEUBK Model as a Constant Value to represent the Outdoor Air Lead Concentration. USEPA (1994b) and other IEUBK Model guidance[14] can provide more information on how the default values in the IEUBK Model were derived.

Both the text file output and the distribution probability percent curve from the IEUBK Model have been included in Appendix I. At South DeKalb, the IEUBK Model suggests that the probability that the blood-Lead concentration of a hypothetical child aged 0-84 months (assumed to reside within the spatial scale of the South DeKalb air monitor) would be greater than 10 µg/dL is **approximately 0.24%**. Though USEPA (2004) does not explain how the IEUBK Model should be interpreted for an air toxics risk assessment, EPA has previously indicated that risk management actions should be taken to limit Lead exposure so that there is no more than a 5% probability of exceeding a 10 µg/dL blood lead level (USEPA, 1998, pg. 3). Since the probability is below 5%, it can be concluded based on the IEUBK Model that ambient air exposure to Lead is not expected to present a public health concern within the spatial scale of the South DeKalb air monitoring station. It is also important to indicate that every Lead sample value collected at South DeKalb in

[13] Please see: https://oehha.ca.gov/chemicals/Lead-and-Lead-compounds
[14] Please see: https://www.epa.gov/superfund/Lead-superfund-sites-frequent-questions-risk-assessors-integrated-exposure-uptake

the year 2019 is below EPA's NAAQS of 0.15 $\mu g/m^3$, so even the 3-month average concentration would not exceed the NAAQS[15].

Section 4.4.2 – Risk/Hazard Estimates

For each COPC that has available toxicity values, an estimate of the cancer risk and hazard quotient (HQ) has been provided in Table 5 (South DeKalb) and Table 6 (NR-285). Cancer risk for individual air toxics was reported to 1 significant figure, while HQs were reported to 3 or more significant figures so that enough digits can be seen.

The cumulative cancer risk and hazard index (HI) was determined by summing the cancer risk of individual COPCs and summing the hazard quotients, respectively. This assumes that the risk/hazard of individual air toxics can be added together to represent the cumulative cancer risk/hazard index of the mixture of those air toxics in ambient air (USEPA, 2004, pg. 13-6 to 13-10). As recommended by USEPA, the cumulative cancer risks and hazard indices that have been determined in the HHRA have been reported to 1 significant figure (USEPA, 2004, pg. 13-7).

Monitoring Site	Cumulative Cancer Risk	Hazard Index (HI)
South DeKalb	4E-05	30
NR-285 VOCs	2E-05	30

Detailed Risk/Hazard Tables as well as supporting RSL Calculator outputs can be found in Appendix J.

The cancer risks for individual COPCs as well as the cumulative cancer risks are within USEPA's and EPD Air Protection Branch acceptable cancer risk range of 10^{-4} to 10^{-6} (USEPA, 1989b).

The hazard index determined at each air monitoring Site exceeds 1, indicating the potential for adverse noncancer effects. However, the hazard indices at both monitoring Sites are driven by the chemical Acrolein. If the Acrolein HQ is not considered when deriving the hazard index, the HI (reported to 1 significant figure) at both monitoring Sites is 1.

Since the monitoring Sites do not necessarily have the same COPCs, the cumulative cancer risk or HI determined at one monitoring Site should not be compared with those determined at other monitoring Sites. It is also important that the risk/hazard estimates provided in this Section be interpreted in light of all of the uncertainties as described in Section 5.

[15] Please see: https://www.epa.gov/lead-air-pollution/national-ambient-air-quality-standards-naaqs-lead-pb-fact-sheets-and-additional

Table 5: Cancer Risk and Noncancer Hazard Quotients for South DeKalb. For more detailed risk/hazard tables, please see Appendix J.

Chemical of Potential Concern (COPC) with Available Toxicity Values	CAS Number	Cancer Risk Estimate	Noncancer Hazard Quotient
Acetaldehyde	75-07-0	1E-06	0.149
Formaldehyde	50-00-0	1E-05	0.270
Acrolein	107-02-8	-	26.6
Benzene	71-43-2	2E-06	0.026
Benzyl Chloride	100-44-7	3E-06	0.14
Butadiene, 1,3-	106-99-0	3E-06	0.13
Carbon Tetrachloride	56-23-5	8E-07	0.004
Chloroform	67-66-3	1E-06	0.002
Dibromoethane, 1,2-	106-93-4	9E-06	0.004
Dichlorobenzene, 1,4-	106-46-7	7E-07	0.0002
Dichloroethane, 1,2-	107-06-2	7E-07	0.011
Hexachlorobutadiene	87-68-3	1E-06	-
Tetrachloroethane, 1,1,2,2-	79-34-5	4E-07	-
Trichlorobenzene, 1,2,4-	120-82-1	-	0.021
Trichloroethane, 1,1,2-	79-00-5	1E-07	0.122
Trichloroethylene	79-01-6	1E-07	0.03
Benzo[a]pyrene	50-32-8	4E-08	0.03
Dibenz[a,h]anthracene	53-70-3	1E-08	-
Naphthalene	91-20-3	7E-07	0.02
Arsenic	7440-38-2	2E-06	0.097
Cadmium	7440-43-9	9E-08	0.014
Cobalt	7440-48-4	7E-07	0.034
Manganese	7439-96-5	-	0.178
	Cumulative Cancer Risk	**4E-05**	
		Hazard Index	**30**

Table 6: Cancer Risk and Noncancer Hazard Quotients for NR-285 VOCs. For more detailed risk/hazard tables, please see Appendix J.

Chemical of Potential Concern (COPC) with Available Toxicity Values	CAS Number	Cancer Risk Estimate	Noncancer Hazard Quotient
Acrolein	107-02-8	-	28.1
Benzene	71-43-2	2E-06	0.027
Benzyl Chloride	100-44-7	3E-06	0.142
Butadiene, 1,3-	106-99-0	5E-06	0.210
Chloroform	67-66-3	2E-06	0.002
Dibromoethane, 1,2-	106-93-4	7E-06	0.004
Dichlorobenzene, 1,4-	106-46-7	7E-07	0.000
Hexachlorobutadiene	87-68-3	6E-07	-
Tetrachloroethane, 1,1,2,2-	79-34-5	4E-06	-
Trichlorobenzene, 1,2,4-	120-82-1	-	0.260
Trichloroethane, 1,1,2-	79-00-5	2E-07	0.126
	Cumulative Cancer Risk	**2E-05**	
		Hazard Index	**30**

Section 4.5 – Limitations of the HHRA

Due to the process of risk assessment, there are limitations as to the information that can be obtained from the risk/hazard estimates that have been provided. It is important to understand that these risk/hazard estimates:

- Only estimate risk/hazard for COPCs with toxicity values, meaning that any air toxic that was considered to be a COPC but which does not have toxicity values cannot be assessed quantitatively.
- The estimates are high-end estimates that are representative of risk/hazard to a hypothetical individual residing for a longer than average period within the spatial scale of each air monitoring Site and inhaling a greater than average concentration of air toxics (please see Section 4.4.1 concerning Lead). Calculating high-end estimates ensures that a risk management decision would be protective of individuals who may be exposed to ambient air for less time.
- The estimates do not include potential risks/hazards from inhaling chemicals that were not analyzed. The risk/hazard estimates at NR-285 are only for VOCs.
- The estimates do not necessarily represent the risk/hazard to a specific individual; this point will be further explained in Section 5.
- The estimates **cannot** determine if an individual diagnosed with cancer or a noncarcinogenic disorder developed illness due to inhaling ambient air within the spatial scale of any of the monitoring Sites.
- The estimates cannot be used to estimate potential risks/hazards at any other location (e.g. the risk/hazard estimates developed for South DeKalb cannot estimate risks/hazards to residents in Augusta, GA who may inhale ambient air chemicals).

- The estimates do not represent risks/hazards from generally inhaling ambient air chemicals.
- The estimates cannot pinpoint the sources of the chemicals present in ambient air, which are "*a combination of background concentrations and the same chemical released from possibly multiple sources*" (USEPA, 2004, pg. 10-37).

Section 5 – Uncertainty Section

An integral part of any risk assessment is the uncertainty section, where "*major uncertainties associated with determining the nature and extent of the risk are identified and discussed*" (USEPA, 2004, pg. 13-1). Uncertainties are inherent to all risk assessments due to the procedures used to obtain risk/hazard estimates. The purpose of this section is to discuss specific uncertainties so that the results of the risk assessment can be properly understood and utilized.

Section 5.1 – Dataset Gaps

Since the Assessment is based on the useable sample values for 77 air toxics at South DeKalb and 43 VOCs at NR-285, it is unknown how the cumulative cancer risk or hazard index determined at each monitoring Site would be affected if there was available monitoring data for additional air toxics and if more sample values were useable.

Section 5.2 – COPC Selection Uncertainty

Though the process for determining COPCs in the PRBSA is highly conservative, there could be questions that the process is not conservative enough and that the risk assessment could have underestimated risks/hazards. Thus, a separate analysis was undertaken for each monitoring Site where cumulative cancer risk and hazard index were derived assuming that all 77 air toxics at South DeKalb and 43 VOCs at NR-285 are COPCs. The same methodology outlined in the HHRA was used to derive CA, obtain toxicity values, and derive risk/hazard estimates. There was no appreciable change to the cumulative cancer risk estimates and hazard indices determined for each air monitoring Site and at 1 significant figure, the risk/hazard estimates are the same as the values provided in Section 4.4.2. Thus, the COPC selection process in the PRBSA does not affect the conclusions of the HHRA. Please see Appendix K for the RSL Calculator results of these analyses.

Section 5.4 – What an Air Monitoring Site Represents

Though GAEPD (2019b) has estimated the spatial scale of each air monitoring Site, ambient air monitoring really "*only provides estimates of concentrations at the point at which samples are taken, and it is often difficult to clearly define the spatial coverage that those measured concentrations represent"* (USEPA, 2004, pg. 10-7). Though ambient air concentrations are assumed to be uniform within the spatial scale of an air monitoring Site, realistically the ambient air concentration of a chemical can vary even within the spatial scale of an air monitor due to various factors, including:

- meteorological factors, such as wind speed and direction and ambient air temperature
- physical factors, such as buildings/structures or variability in terrain elevation
- chemical transformation of chemicals which may attenuate or increase the concentrations of toxic air pollutants

Since ambient air monitoring data cannot adequately capture the variability of ambient air concentrations within the spatial scale of the air monitor, the CA (and thus the EC) is estimated to be a higher-end concentration of ambient air that an individual could be exposed to. Realistically, an individual would likely be exposed to ambient air concentrations at levels far less than the EC but could be exposed to ambient air concentrations above the EC.

Section 5.5 – Deriving High-End ECs Using Conservative Upper-Bound Estimates

ECs (except for Lead) are derived by using upper-bound estimates of default residential exposure parameters and ambient air concentrations and represent a high-end exposure estimate. The toxicity values that are used in this risk assessment are derived in a conservative way and are also considered upper-bound estimates. Thus, the actual risk or hazard could be less.

Section 5.6 – Only Inhalation Exposure Route is Assessed

Since only ambient air monitoring data is available, only the inhalation exposure route has been assessed in the HHRA. As previously mentioned, it is possible for air toxics to deposit onto soil, water bodies, and other surfaces and for individuals to encounter these chemicals. There could be risks/hazards associated with other routes of exposure that are not quantifiable in this risk assessment.

Section 5.7 – COPCs without Toxicity Values

At each monitoring Site, there were several air toxics that were selected as COPCs but which do not have toxicity values from a Tier 1-3 source. Some examples are Benzene 1-ethenyl-4-methyl, Freon 114, and many of the Polycyclic Aromatic Hydrocarbons. Since a cancer risk estimate or hazard quotient cannot be determined for these COPCs, there is no way to quantify whether the presence of these COPCs could present an unacceptable human health risk/hazard. It is possible that the cumulative cancer risks and hazard indices could be underestimated.

AAMP has previously stated that the "*Ambient Monitoring Program's ability to measure lower concentrations of air toxics is currently exceeding its ability to understand and explain the potential health consequences of the concentrations measured*" (GAEPD, 2019b, pg. 6). This is an uncertainty that is already well-understood in the regulatory community and for which a long-term solution is not clear since the regulatory process for deriving toxicity values is cumbersome and since many air toxics have not been well-studied enough to be able to derive a scientifically defensible toxicity value.

EPA guidance recommends that if a toxicity value is not available for an air toxic, the risk assessor "s*hould describe the effects of the chemical qualitatively and discuss the implications of the absence of the chemical from the risk estimate in the uncertainty section of the risk assessment*" (USEPA, 2004, pg. 12-31). The general implication for not including air toxics without toxicity values have been discussed above, while qualitative descriptions of the health effects of COPCs without toxicity values have been provided in Appendix H.

Section 5.8 – Lead at South DeKalb

The HHRA determined that Lead in ambient air within the spatial scale of South DeKalb is not a concern since there is less than 5% probability that a hypothetical child aged 0-84 years would have a blood Lead concentration greater than 10 µg/dL if the ambient air concentration of Lead at South DeKalb is assumed to be the annual average Lead concentration as determined in the HHRA.

However, it should be noted that a USEPA *Integrated Science Assessment* for Lead determined that there is "*evidence of cognitive function decrements (as measured by Full Scale IQ, academic performance, and executive function) in young children (4 to 11 years old) with mean or group blood [Lead] levels measured at various lifestages and time periods between 2 and 8 µg/dL*"

(USEPA, 2013, pg. 1-15). EPA has concurred with the recommendations from the Centers for Disease Control and Prevention (CDC) that "*no safe blood lead level in children has been identified*" along with CDC's current reference level of 5 µg/dL (USEPA, 2019, pg. 4).

Even though some EPA documents acknowledge that a blood Lead level below 10 µg/dL could be of concern, the IEUBK Model was run using a default blood Lead level of concern of 10 µg/dL based on EPA's currently promulgated recommendations, which are also on EPA's website[16] . However, Some EPA Region 4 risk assessors currently prefer that the level of concern in the IEUBK Model be set to 5 µg/dL. If this recommendation is followed, the IEUBK Model shows that there is an approximately 9% probability that a hypothetical child aged 0-84 years would have a blood Lead concentration greater than 10 µg/dL, which is greater than 5% and would suggest that Lead is a concern. Please see Appendix K for supporting information.

Even though the risk assessment did not find Lead to be a concern at South DeKalb and all Lead sample values are below EPA's NAAQS, it is recommended that risk managers take an abundance of caution when it comes to Lead exposure and do whatever it takes to minimize Lead emissions so that ambient air Lead concentrations can also be minimized.

Section 5.9 – Risk/Hazard Additivity

The assumption of risk/hazard additivity used to determine the cumulative cancer risk/hazard index implies that COPCs exhibit their adverse effects independently of one another and that there are no chemical interactions between the COPCs that could intensify or attenuate adverse health effects (USEPA, 1989a, pg. 8-12). Thus, exposure to multiple chemicals within the spatial scale of a monitoring Site could potentially present less/greater risk/hazard than the risk estimates would suggest.

[16] Please see: https://www.epa.gov/superfund/lead-superfund-sites-risk-assessment#Tox

Section 6 – Conclusion

This risk assessment was prepared and is consistent with relevant, publicly available USEPA risk assessment guidance and has strived to faithfully represent the validated air monitoring results from each monitoring Site while providing risk/hazard estimates that are derived in a public health conservative manner. The risk/hazard estimates derived in the HHRA represent a hypothetical individual residing within the spatial scale of each air monitoring Site for a longer than average length of time and who would be exposed to air toxics concentrations at the upper range of plausible air toxics concentrations (except for Lead, as previously mentioned). In other words, these risk/hazard estimates are theoretical and do not necessarily represent a typical individual. The purpose behind deriving risk/hazard estimates in this manner is to be consistent with EPA guidance and to ensure that any risk management decision made based on these estimates would be protective of individuals who may be exposed to lower concentrations of air toxics within the spatial scale of each air monitoring Site.

The cumulative cancer risk estimates at all monitoring Sites fall within the USEPA and EPD Air Protection Branch acceptable carcinogenic risk range of 10^{-4} to 10^{-6} (USEPA, 1989b). The HIs at all monitoring Sites exceed 1, but the chemical Acrolein is the primary driver of hazard; and, if Acrolein is not considered, the HI determined for both monitoring Sites would be 1. Based on the results of the IEUBK Model, Lead is not expected to be of concern at South DeKalb.

There are a lot of uncertainties involving the dataset and the parameters selected to prepare the Assessment and those uncertainties should be kept in mind when interpreting the findings. The major uncertainties have been transparently discussed in Section 5, and a public health conservative approach was taken to prepare this Assessment. Even then, this Assessment is best suited for determining which air toxics are not expected to be a concern (acceptable risk/hazard) and for identifying where further information may need to be collected to make an appropriate risk management decision (USEPA, 2004, pg. 13-4). Additionally, this Assessment will need to be evaluated in context with other pieces of information (regulatory policies, social values, economics, etc.) when making a risk management decision(s) and should not be the sole driver for making decisions on how to reduce concentrations of air toxics to health protective levels.

References

Georgia Environmental Protection Division (GAEPD). 2018. *Standard Operating Procedure for Data Validation of Integrated Data* (Revision 2). Atlanta, GA.: Georgia Environmental Protection Division, Air Protection Branch Ambient Air Monitoring Program

Georgia Environmental Protection Division (GAEPD). 2019a. *Quality Assurance Project Plan for the Georgia Ambient Air Monitoring Program National Air Toxics Trends Station (NATTS)* (Revision 1). Atlanta, GA.: Georgia Environmental Protection Division, Air Protection Branch Ambient Air Monitoring Program

Georgia Environmental Protection Division (GAEPD). 2019b. *2019 Ambient Air Monitoring Plan*. Atlanta, GA.: Georgia Environmental Protection Division, Air Protection Branch Ambient Air Monitoring Program

United States Environmental Protection Agency (USEPA). 1989a. *Risk Assessment Guidance for Superfund (RAGS), (Part A) Volume I, Human Health Evaluation Manual*. EPA/540/1-89/002. Washington, D.C.: United States Environmental Protection Agency, Office of Emergency and Remedial Response.

United States Environmental Protection Agency (USEPA). 1989b. *National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration (Part II)*. EPA-400-Z-89-100. Washington, D.C.: National Archives and Records Administration, Office of the Federal Register

United States Environmental Protection Agency (USEPA). 1991. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors" Interim Final.* OSWER 9285.6-03. Washington, DC.: United States Environmental Protection Agency, Office of Emergency and Remedial Response Toxics Integration Branch

United States Environmental Protection Agency (USEPA). 1994. *Methods For Derivation Of Inhalation Reference Concentrations And Application Of Inhalation Dosimetry.* EPA-600-8-90-066F. Research Triangle Park, NC: United States Environmental Protection Agency, Environmental Criteria and Assessment Office

United States Environmental Protection Agency (USEPA). 1994b. *Guidance Manual For The IEUBK Model For Lead In Children*. EPA 540-R-93-081. Washington D.C.: United States Environmental Protection Agency, Office of Solid Waste and Emergency Response

United States Environmental Protection Agency (USEPA). 1998. *Memorandum: OSWER Directive: Clarification To The 1994 Revised Interim Soil Lead (Pb) Guidance For CERCLA Sites And RCRA Corrective Action Facilities.* EPA/540/F-98/030. Washington D.C.: United States Environmental Protection Agency, Office of Solid Waste and Emergency Response

United States Environmental Protection Agency (USEPA). 2002. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. OSWER 9285.6-10. Washington D.C.: United States Environmental Protection Agency, Office of Emergency and Remedial Response

United States Environmental Protection Agency (USEPA). 2003. *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER 9285.7-53. Washington D.C.: United States Environmental Protection Agency, Office of Solid Waste and Emergency Response

United States Environmental Protection Agency (USEPA). 2004. *Air Toxics Risk Assessment Reference Library: Volume 1 Technical Resource Manual*. EPA-453-K-04-001A. Research Triangle Park, NC.: United States Environmental Protection Agency, Office of Air Quality Planning and Standards

United States Environmental Protection Agency (USEPA). 2005a. *Guidelines for Carcinogen Risk Assessment*. EPA-630-P-03-001F. Washington D.C.: United States Environmental Protection Agency, Risk Assessment Forum

United States Environmental Protection Agency (USEPA). 2005b. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. EPA-630-R-03-003F. Washington D.C.: United States Environmental Protection Agency, Risk Assessment Forum

United States, Environmental Protection Agency (USEPA). 2007. *SHORT SHEET: Estimating the Soil Lead Concentration Term for the Integrated Exposure Uptake Biokinetic (IEUBK) Model.* OSWER 9200.1-78. Washington, D.C.: United States Environmental Protection Agency, Office of Solid Waste and Emergency Response

United States, Environmental Protection Agency (USEPA). 2009. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).* EPA-540-R-070-002. Washington, D.C.: United States Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation

United States Environmental Protection Agency (USEPA). 2010. *A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Data Sets* (Version 2). EPA-904-B-06-001. Atlanta, GA.: United States Environmental Protection Agency, Air, Pesticides, and Toxics Management Division

United States Environmental Protection Agency (USEPA). 2011. *Exposure Factors Handbook 2011 Edition (Final Report)*. EPA-600-R-09-052F. Washington D.C.: United States Environmental Protection Agency, Office of Research and Development's National Center for Environmental Assessments (NCEA)

United States Environmental Protection Agency (USEPA). 2013. *Integrated Science Assessment for Lead*. EPA-600-R-10-075F. Research Triangle Park, NC.: United States Environmental Protection Agency, Office of Research and Development's National Center for Environmental Assessments (NCEA)-RTP Division

United States Environmental Protection Agency (USEPA). 2015. *ProUCL Version 5.1 User Guide.* EPA-600-R-07-041. Atlanta, GA.: United States Environmental Protection Agency, Office of Research and Development Site Characterization and Monitoring Technical Support Center

United States Environmental Protection Agency (USEPA). 2018. *Region 4 Human Health Risk Assessment Supplemental Guidance*. Atlanta, GA.: United States Environmental Protection Agency, Scientific Support Section Superfund Division

United States Environmental Protection Agency (USEPA). 2019. *Implementation Status Report for EPA Actions under the December 2018 Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts*. EPA 100-R-19-003. https://www.epa.gov/sites/production/files/2019-04/documents/leadimplementationbooklet_april2019.pdf

United States Environmental Protection Agency (USEPA). 2020. *Regional Screening Levels (RSLs) - User's Guide and Frequently Asked Questions.* https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide and https://www.epa.gov/risk/regional-screening-levels-frequent-questions