Nova Scotia Air Zone Report

2017

NOVA SCOTIA

Nova Scotia Air Zone Report, 2017

Department of Environment

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Acronyms

AQHI	Air Quality Health Index
AQMS	Air Quality Management System
AQU	Nova Scotia Environment's Air Quality Unit
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation
CMA	Canadian Medical Association
ECCC	Environment and Climate Change Canada
GLO	Ground Level Ozone
IA	Industrial Approval
IISD	International Institute for Sustainable Development
NAPS	National Air Pollution Surveillance Program
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides ($NO + NO_2 = NO_x$)
NSE	Nova Scotia Environment
O_3	Ozone
$PM_{2.5}$	Fine particulate matter
ppb	Parts per billion
QA/QC	Quality Assurance/Quality Control
µ/m³	Micrograms per cubic metre
VOCs	Volatile Organic Compounds
WHO	World Health Organization

Introduction

Nova Scotia Environment (NSE) protects, enhances, and promotes the sustainable use of Nova Scotia's ambient air resources by regulating activities that emit air pollutants, monitoring ambient air quality, reporting, and doing public outreach. NSE has a cooperative agreement with Environment and Climate Change Canada (ECCC) to collect ambient data that are essential to the outcomes of NSE's air quality management programs.[1] The terms of the National Air Pollution Surveillance (NAPS) Program agreement are that ECCC provides instruments for monitoring ambient air and maintains the Canada-wide Air Quality Database,[2] while NSE's Air Quality Unit (AQU) sets up and maintains the stations that monitor air pollution and provides monitoring results to the national database.

Average concentrations for continuously monitored pollutants are calculated each hour and the raw data are directly uploaded to NSE's air quality website.[3] Environment and Climate Change Canada uses the hourly measurements of nitrogen dioxide (NO_2),[4] ground-level ozone (GLO) and fine particulate matter ($PM_{2.5}$) to calculate the Air Quality Health Index (AQHI). The AQHI is reported as a number from 1 to 10+, and as a risk category that ranges from "low" to "very-high". Each risk category has a health message to assist individuals in making daily decisions about adjusting their activities to limit exposure to air pollution.[5]

1 https://www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/national-air-pollution-program.html

2 http://www.ec.gc.ca/rnspa-naps/default.asp?lang=En&n=8BA86647-1

3 http://novascotia.ca/nse/airdata/

4 A chemical formula provides a short-hand description of what proportions of atoms are present in a chemical compound. In this example, nitrogen dioxide, or NO_2, consists of one atom of nitrogen and two atoms of oxygen.

5 https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index/understanding-messages.html

The AQU completes quality assurance and quality control (QA/QC) of the ambient air quality data, periodically updates the NSE's website with the validated data, and submits these to the Canada-wide Air Quality Database. The validated data are analysed for trends over time and the results support actions for protecting and improving air quality. For example, the Air Quality Management System (AQMS), put in place across Canada by the Canadian Council of Ministers of the Environment (CCME),[6] is a comprehensive approach with four 'mechanisms' that work together to achieve Canadian Ambient Air Quality Standards (CAAQS) that are designed to protect and improve ambient air quality (Figure 1). The four mechanisms are Base Level Industrial Emissions Requirements (BLIERS), mobile source emissions, airsheds, and air zones. Provinces and territories use air zones as geographic regions for monitoring, managing, and reporting on ambient concentrations of GLO and $PM_{2.5}$ in that area.[7]

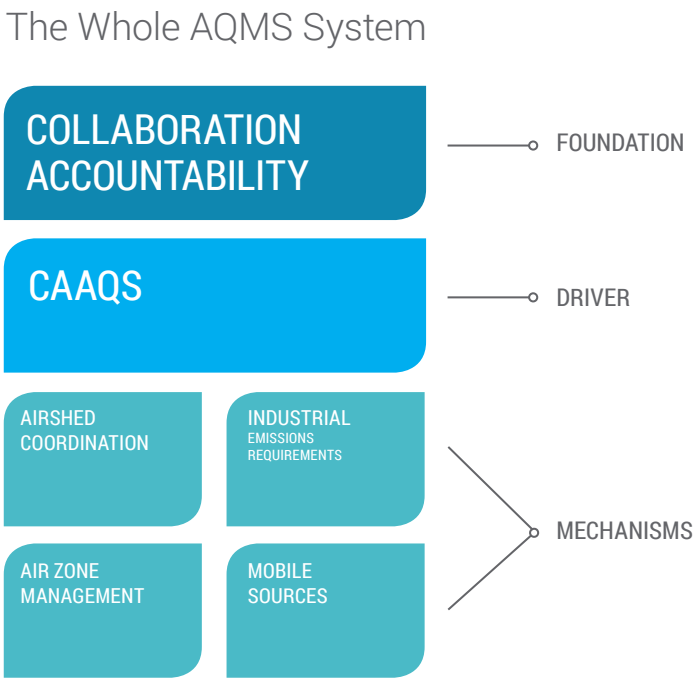

Figure 1. The Air Quality Management Framework.

[6] http://www.ccme.ca/en/resources/air/aqms.html

[7] This report is NSE's fourth annual air zone report. The previous annual report, for 2016 can be accessed at https://novascotia.ca/nse/air/docs/NS-Air-Zone-Report-2016.pdf

Airsheds and Air Zones

Airsheds

Airsheds are large areas that can include many jurisdictions. Emissions from vehicles, residential wood burning, industry, and other activities can remain in the atmosphere for extended periods of time and be carried across borders where they add to local, regional, and global air pollution far from where the emissions occurred. How far the pollution is carried depends on seasonal weather patterns and how long the pollutant is stable in the atmosphere. Air quality management in an airshed requires multiple jurisdictions to work together to minimise emissions that cause transboundary air pollution.

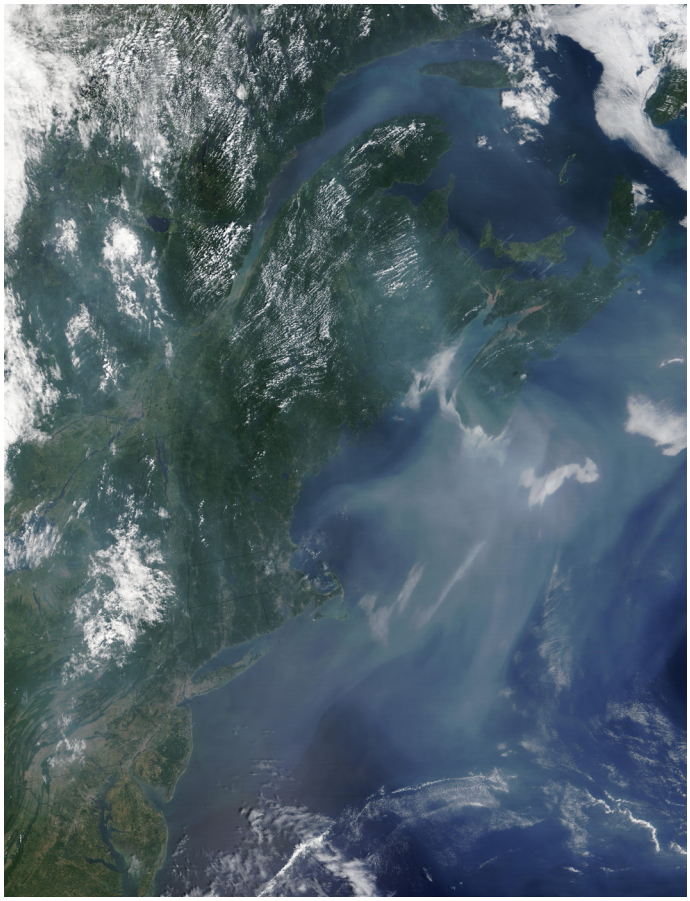

Figure 2. The grey coloured haze in this satellite image[9] is particulate air pollution over the Maritimes that originated in the Eastern United States.

For example, there are large cities, dense networks of roadways, and numerous industries upwind of Nova Scotia, in the Ohio River Valley, Eastern seaboard of the U.S., and the Québec/Ontario corridor. Emissions from these areas contribute to the formation of Ground-level ozone (GLO) and fine particulate matter ($PM_{2.5}$) that affect Nova Scotia's air quality (Figure 2). Canada and the United States have an agreement to reduce emissions in the airshed, and this has led significant improvements in transboundary pollution.[8]

[8] https://www.canada.ca/en/environment-climate-change/services/air-pollution/issues/transboundary/canada-united-states-air-quality-agreement-overview.html

[9] https://visibleearth.nasa.gov/view.php?id=61010

Air Zones

Air zones are geographically smaller than airsheds and are used to manage local air quality inside provincial and territorial borders. Nova Scotia is divided into four air zones (Figure 3). Each air zone has common terrain, meteorology, and other factors that interact with air pollutant emissions to influence ambient air quality in the air zone. The AQU collects data from ambient air monitoring stations in each air zone that are used to calculate air quality compared to the CAAQS and help determine what management actions may be best suited to each air zone.

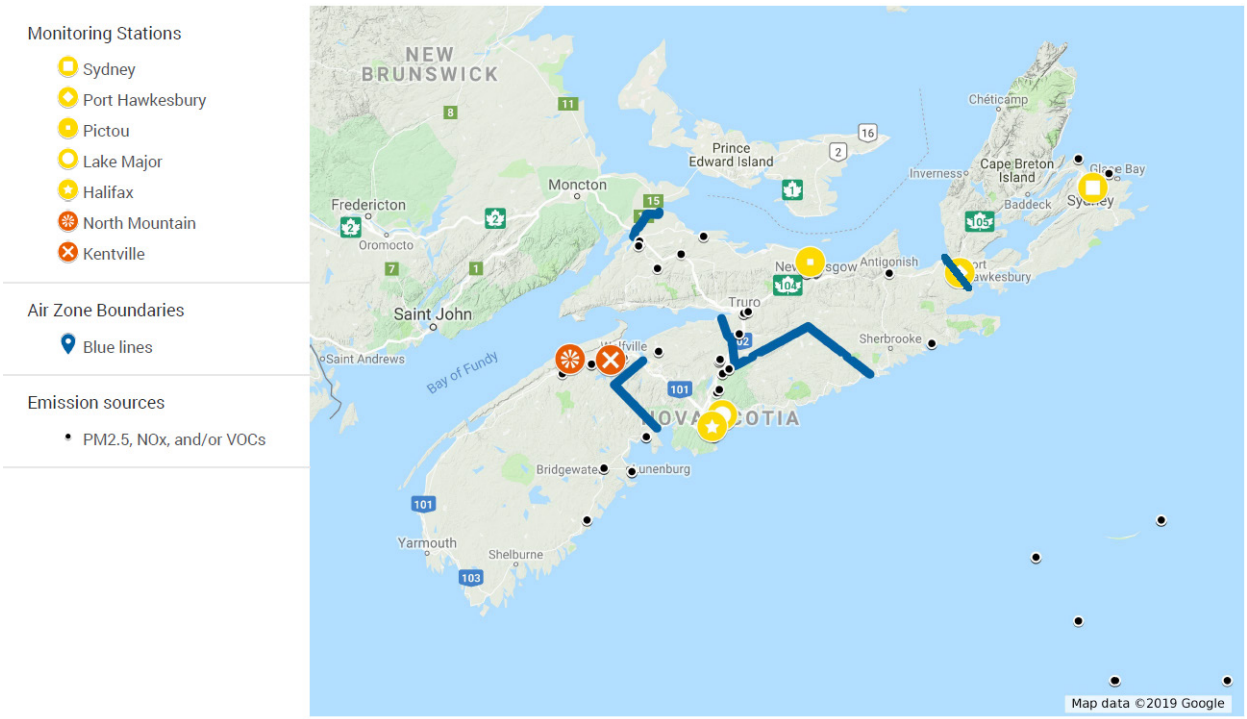

Figure 3. Nova Scotia's four air zones, with the locations of ambient air monitoring stations indicated by large circles with a colour that corresponds to the management level achieved in 2017. The black dots are locations of operations that report emissions of fine particulate matter and/or precursors to the formation of ground level ozone, nitrogen oxides and/or volatile organic compounds, to the National Pollutant Release Inventory (NPRI).

Canadian Ambient Air Quality Standards (CAAQS)

Ground level ozone and $PM_{2.5}$ are two of the most common elements of ambient air pollution, and CAAQS for these two pollutants are the current drivers for action in the AQMS.[10]

Ground Level Ozone

Ozone higher up in the atmosphere is formed through natural processes and makes up a region in the stratosphere called the 'ozone layer.' The ozone layer is beneficial to human health and the environment by preventing harmful ultraviolet rays from reaching the Earth's surface. On the other hand, ground level ozone (GLO) is harmful to human health and the environment. For example, inhalation of ozone can cause airway inflammation, reduced breathing capacity, and increased cardiovascular mortality.[11] Ozone also causes damage to plants, affecting crop yields[12] and forest productivity.

Ninety percent of the atmosphere's ozone is found in the stratosphere and the rest is found in the lower atmosphere — the troposphere.[13] Unlike stratospheric ozone, GLO is mostly the result of sunlight reacting with nitrogen oxides (NO_x) and volatile organic compounds (VOCs) that are emitted from activities such as electric power generation, the natural gas industry, wood burning, manufacturing and transportation.[14] There is some ozone in the troposphere that is the result of "natural events, such as wildfires or stratospheric intrusions, or from man-made pollution from [transboundary] sources".[15] It is estimated that Canada's average annual baseline concentrations of GLO range from 23 and 34 ppb.[16] It has also been modelled that if all of North America's emissions of pollutants that participate in GLO formation were turned off, the fourth highest 8-hour value in Nova Scotia between March 1 and August 31 would be about 50 ppb.[17,18] The 2017 CAAQS results for GLO, which is the 3-year average of the annual 4th-highest daily maximum 8-hour average concentrations, ranges between 43 and 61 ppb in Nova Scotia's air zones. The current CAAQS threshold for 8-hour GLO, used for air zone management, is 63 ppb (Table 1).

In addition to the 8-hour CAAQS, the *Nova Scotia Air Quality Regulations* contain a maximum permissible 1-hour concentration for GLO of 82 ppb. Ground level ozone is also a key pollutant for determining the AQHI and providing near real-time advice on reducing exposure.

[10] As part of the continuous improvement and implementation of the AQMS, new CAAQS for sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) have been developed and will take effect in 2020.

[11] See, for example, Day, Drew B. et. al. (2017). Association of ozone exposure with cardiorespiratory pathophysiologic mechanisms in healthy adults. *Journal of the American Medical Association (JAMA) Internal Medicine*. Pp. E1–E10. DOI:10.1001/jamainternmed.2017.2842.

[12] https://earthobservatory.nasa.gov/features/OzoneWeBreathe/ozone_we_breathe3.php

[13] Jet Propulsion Laboratory (2015). *NASA: Background ozone a major issue in U.S. West*. https://www.jpl.nasa.gov/news/news.php?feature=4723

[14] http://www.ec.gc.ca/inrp-npri/donnees-data/ap/index.cfm?lang=En

[15] U.S. EPA (2015). *Tools for addressing background ozone*. https://www.epa.gov/sites/production/files/2015-10/documents/20151001_background_ozone.pdf

[16] Vingarzan, R. (2004). A review of surface ozone background levels and trends. *Atmospheric Environment*, 38, p. 3439.

[17] Chan, E. and Vet, R.J. (2010). Baseline levels and trends of ground level ozone in Canada and the United States. *Atmospheric Chemistry and Physics*, (10), pp. 8629-8647. Doi: 10.5194/acp-10-8629-2010.

[18] Fiore, A.M. et. al. (2014). Estimating North American background ozone in U.S. surface air with two independent global models: Variability, uncertainties, and recommendations. *Atmospheric Environment*, 96, p. 297.

Fine Particulate Matter

Fine particulate matter are solid and liquid particles in the atmosphere that are less than or equal to 2.5 micrometres in diameter (a micrometre is 1/1,000,000 of a metre). Fine particulate matter is made up of many different chemicals that are emitted from natural sources such as forest fires, windblown dust, sea salt and marine algae, and from human activities such as wood burning, transportation, agriculture, power plants and factories.[19]

Globally, $PM_{2.5}$ affects more people than any other air pollutant[20] and exposure to $PM_{2.5}$ leads to increased public health issues. Heath outcomes are correlated to the mass of $PM_{2.5}$ in a volume of air, and instruments in each Nova Scotia's air zones measure 1-hour average mass concentrations (in micrograms per cubic metre of air, or $\mu g/m^3$).

Real-time $PM_{2.5}$ data are used to help calculate the AQHI that provides near real-time advice on reducing exposure and risk. The 1-hour data that have passed QA/QC are used to analyse daily, seasonal and yearly trends. The 24-hour average and annual mass concentration per volume are used to determine CAAQS for air zone management, determined by the 3-year average of the annual 98th percentile of the daily 24-hour average and 3-year average of the annual average, respectively (Table 1).

		Standards (numerical values)		
Pollutant	**Averaging time**	**2015**	**2020**	**Metric**
$PM_{2.5}$	24-hour (calendar day)	28 $\mu g/m^3$	27 $\mu g/m^3$	The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
$PM_{2.5}$	Annual (calendar year)	10.0 $\mu g/m^3$	8.8 $\mu g/m^3$	The 3-year average of the annual average concentrations.
Ground-level Ozone	8-hour	63 ppb	62 ppb	The 3-year average of the annual 4th-highest daily maximum 8-hour average concentrations.

Table 1. The Canadian Ambient Air Quality Standards (CAAQS).

[19] http://www.ec.gc.ca/inrp-npri/donnees-data/ap/index.cfm?lang=En

[20] World Health Organization. http://www.who.int/mediacentre/factsheets/fs313/en/

Air Zone Management Framework

The CAAQS are achieved in all Nova Scotia's air zones, but an air zone management framework is used to work towards continuous improvement because the health for some portion of the population continues to be affected when ambient concentrations of GLO and $PM_{2.5}$ are very low.[21,22] For example, in 2008 the World Health Organization (WHO) ranked Canada to have the third best air quality in the world,[23] but the Canadian Medical Association (CMA) estimated that in 2008 there were 2,682 premature deaths in Canada from air pollution (69 in Nova Scotia) and total economic damages of about $8 billion ($200 million in Nova Scotia).[24] More recently, the International Institute for Sustainable Development (IISD) estimated that "7,712 deaths were attributable to $PM_{2.5}$ and ground-level ozone in Canada in 2015"[25] and "direct welfare cost of [GLO and $PM_{2.5}$] is estimated to have been $36 billion in 2015".[26] The majority of these cumulative effects occur on days that are normally regraded as having good air quality.[27]

The air zone management framework has four air management levels, represented by four colours, and provides guidance on management actions for each level (Table 2). Numerical values of GLO and $PM_{2.5}$ in the form of the CAAQS are calculated from the data measured at each monitoring station. The values are compared to management level threshold values, and the highest CAAQS value in an air zone sets the air zone's management level. Management levels have continuous improvement as a priority and require more stringent management actions as the numerical form of the air pollutant measurements approach the CAAQS limits. There is one management level (Red) that requires actions to be implemented for achieving CAAQS if the CAAQS are exceeded. There are three management levels (green, yellow and orange) that require action to 'keep clean areas clean' or prevent degradation of air quality when the CAAQS are achieved.

[21] For example, see: Bell, M. L., Peng, R. D., and Dominici, F. (2006). The Exposure-Response Curve for Ozone and Risk of Mortality and the Adequacy of Current Ozone Regulations. *Environmental Health Perspectives.* http://dx.doi.org/10.1289/ehp.8816

[22] Government of Canada (2012). *Canadian smog assessment – Highlights and key messages.* Environment Canada. Retrieved from http://publications.gc.ca/site/eng/9.694820/publication.html. Page 4.

[23] World Heath Organization (2011). Urban outdoor air pollution database. http://www.who.int/phe/health_topics/outdoorair/databases/OAP_database_8_2011.xls Accessed from CBC News. *Canada's air quality 3rd best in world*, http://www.cbc.ca/news/health/canada-s-air-quality-3rd-best-in-world-1.980695

[24] Canadian Medical Association (2008). No breathing room: National illness costs of air pollution.

[25] International Institute for Sustainable Development (2017). *Costs of pollution in Canada: Measuring the impacts on families, businesses and governments.* Page 26.

[26] Ibid. Page viii.

[27] Government of Canada (2012). http://publications.gc.ca/site/eng/9.694820/publication.html, pp. 4-5.

		Air Management Threshold Values		
Management Level	**Management Actions**	**Ozone 8-hour (ppb)**	**$PM_{2.5}$ 24-hour ($\mu g/m^3$)**	**$PM_{2.5}$ Annual ($\mu g/m^3$)**
Red††	Actions for **Achieving** Air Zone CAAQS	63	28	10
Orange	Actions for **Preventing** CAAQS **Exceedance**	56	19	6.4
Yellow*	Actions for **Preventing** air quality **Deterioration**	50	10	4
Green	Actions for **Keeping Clean Areas Clean**	0	0	0

Table 2. The Air Quality Management Framework and associated threshold values.

†† The threshold values for the "red" management level are equal to the numerical values of the Canadian Ambient Air Quality Standards (CAAQS).

* The CAAQS thresholds between the green and yellow management levels are based on estimated baseline concentrations in ambient air.[28]

Air Zone Results, 2017

In 2017, the CAAQS were achieved in all four of Nova Scotia's air zones. The management level in the central, eastern, and northern air zones is 'yellow' and the management level for the western air zone is 'orange' (Table 3).

			2017 CAAQS Results		
Air Zone	**Management Level**	**Management Actions**	**Ozone 8-hour (ppb)**	**$PM_{2.5}$ 24-hour ($\mu g/m^3$)**	**$PM_{2.5}$ Annual ($\mu g/m^3$)**
Central	**Yellow**	Actions for Preventing AQ Deterioration	**52**	**12**	**5.2**
Eastern	**Yellow**	Actions for Preventing CAAQS Exceedance	**48**	**12**	**5.8**
Northern	**Yellow**	Actions for Preventing CAAQS Exceedance	**46**	**14**	**5.7**
Western	**Orange**	Actions for Preventing CAAQS Exceedance	**61**	**12**	**6.2**

Table 3. CAAQS achievement and management level results for air zone monitoring in Nova Scotia for the 2017 reporting year.

[28] CCME (2012). *Guidance document on air zone management*, pages 12–14. http://www.ccme.ca/files/Resources/air/aqms/pn_1481_gdazm_e.pdf

	Air Zone Management Levels			
	Central	Eastern	Northern	Western
2013	Yellow	Yellow	Orange	Orange
2014	Yellow	Yellow†	Orange	Orange
2015	Yellow	Yellow	Orange	Orange
2016	Yellow	Yellow	Orange	Orange
2017	Yellow	Yellow	Yellow	Orange

Table 4. Year-to-year comparison of the air zones' management levels.

† The management level for the Eastern Air Zone was reported as "Orange" in the 2014 Air Zone Report. It was later discovered that an instrument used for measuring $PM_{2.5}$ had a technical issue to cause the readings to be incorrect. The data have been adjusted to account for the issue and the air zone management level has been revised to "Yellow."

Central Air Zone

The central air zone has the greatest population density of Nova Scotia's four air zones, and population density tends to be correlated with air emissions because transportation, housing, and commercial activities that support population also generate emissions. There are two ambient air monitoring stations in the central air zone. One is located in Downtown Halifax and the other is located at Lake Major, which is downwind[29] from Downtown Halifax, in an area with less population, traffic, and commercial density (Figure 4). The $PM_{2.5}$ measurements in the central air zone in 2017, as in previous years, fall in the 'yellow' management level. GLO in downtown Halifax is 'green,' and 'yellow' in Lake Major (Table 5).

CENTRAL AIR ZONE MONITORING STATIONS AND EMISSION SOURCES

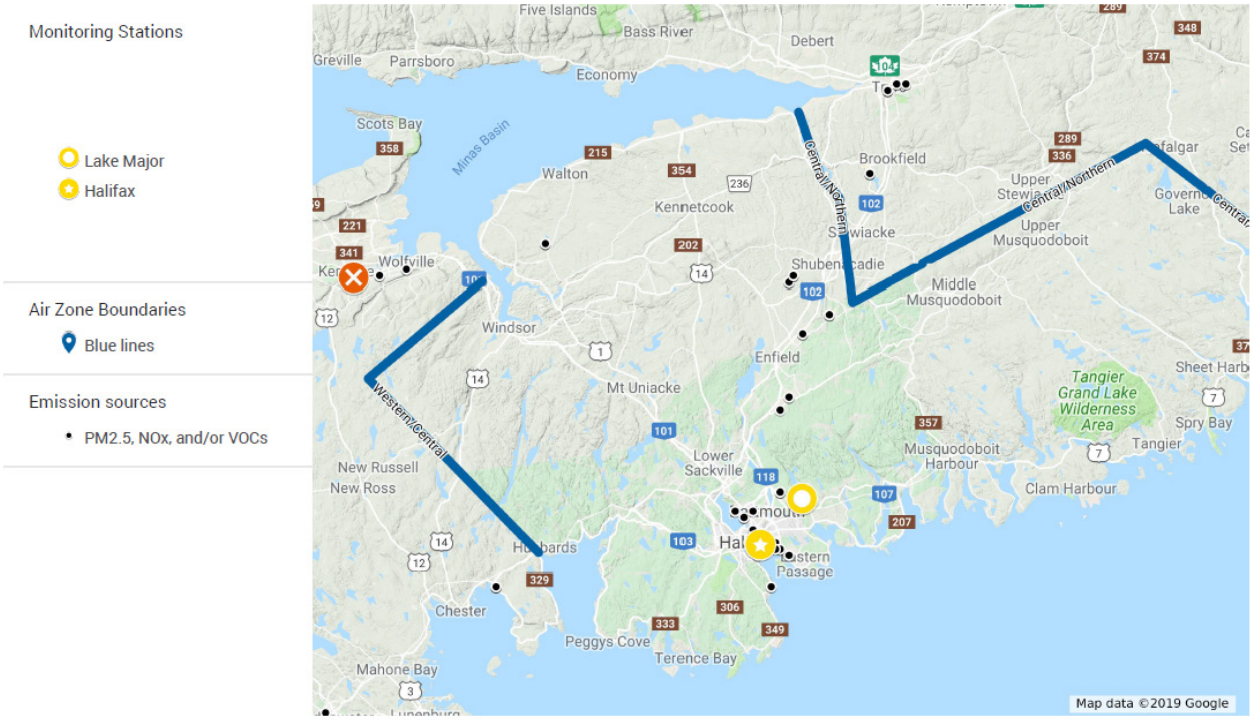

Figure 4. The location of ambient air monitoring stations in the central air zone. The black dots are locations of operations that report emissions of fine particulate matter and/or precursors to the formation of ground level ozone, nitrogen oxides and/or volatile organic compounds, to the National Pollutant Release Inventory (NPRI).

[29] Based on the most frequent annual wind direction.

CENTRAL AIR ZONE CAAQS ACHIEVEMENT AND MANAGEMENT LEVELS

Reporting Year	Ozone 8-hour (ppb)		$PM_{2.5}$ 24-hour (µg/m³)		$PM_{2.5}$ Annual (µg/m³)	
	Lake Major	Downtown Halifax	Lake Major	Downtown Halifax	Lake Major	Downtown Halifax
2013	52	42	15	*	6.0	*
2014	52	41	14	*	6.0	*
2015	51	42	15	11	6.3	4.6
2016	51	41	*	11	*	4.6
2017	52	43	*	12	*	5.2

Table 5. Year-to-year comparison of the central air zone's management levels and CAAQS measured at each monitoring station.

* Station data did not pass quality assurance tests and are not used to calculate the CAAQS. More information on QA/QC testing for CAAQS can be found at http://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf.

Transportation is the main source of NO_x pollution that contributes to the formation of GLO. When fuel is burned with air at high temperature, nitrogen (N_2) and oxygen (O_2) gases in the air are split and recombine to form nitrogen oxide (NO) and nitrogen dioxide (NO_2). These undergo chemical reactions when exposed to sunlight to form N_2 and ozone (O_3) molecules. First however, NO can combine with O_3 molecules already present in the atmosphere near the emission source to reduce the ambient concentration of GLO. Then, as the air moves away from the emission source, the pollutants continue to react in the presence of sunlight and result in an excess of GLO.

The effect of NO reacting with GLO and reducing concentrations near the emission source is evident in measurements taken at downtown Halifax. Average 1-hour NO measured at Downtown Halifax is represented in Figure 5. The ambient concentrations of NO are greatest at two times during the day, and these times correspond with morning and afternoon 'rush hours' when traffic density is at its highest. Further illustrating the traffic effect is that concentrations are lower during the weekend when fewer cars are on the streets. Figure 6 shows a similar pattern for GLO, but ambient concentrations are lowest at those times of day when NO concentrations are at their highest.

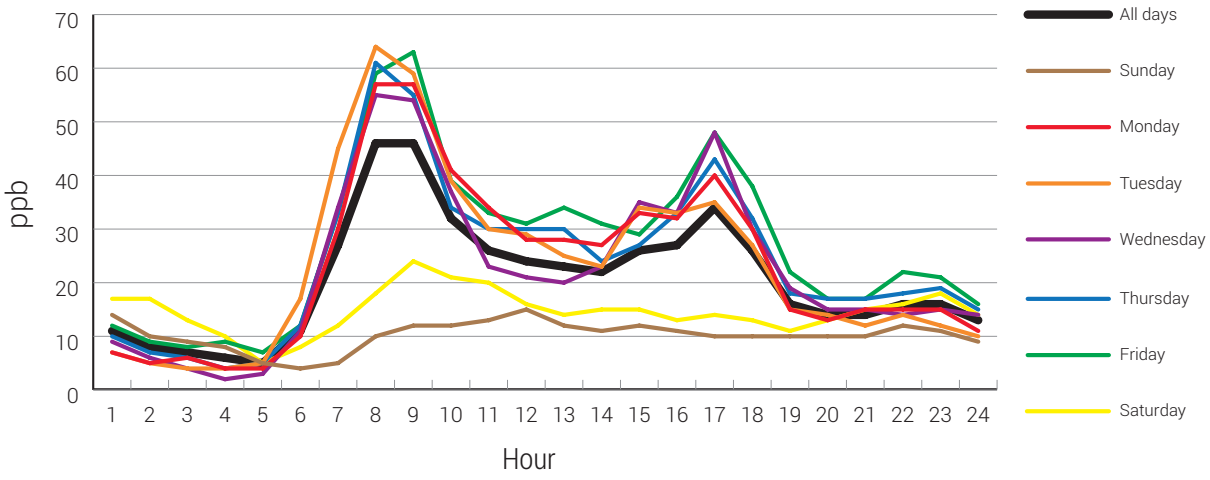

Figure 5. Daily patterns of ambient concentrations of nitrogen oxide (NO) at Downtown Halifax.

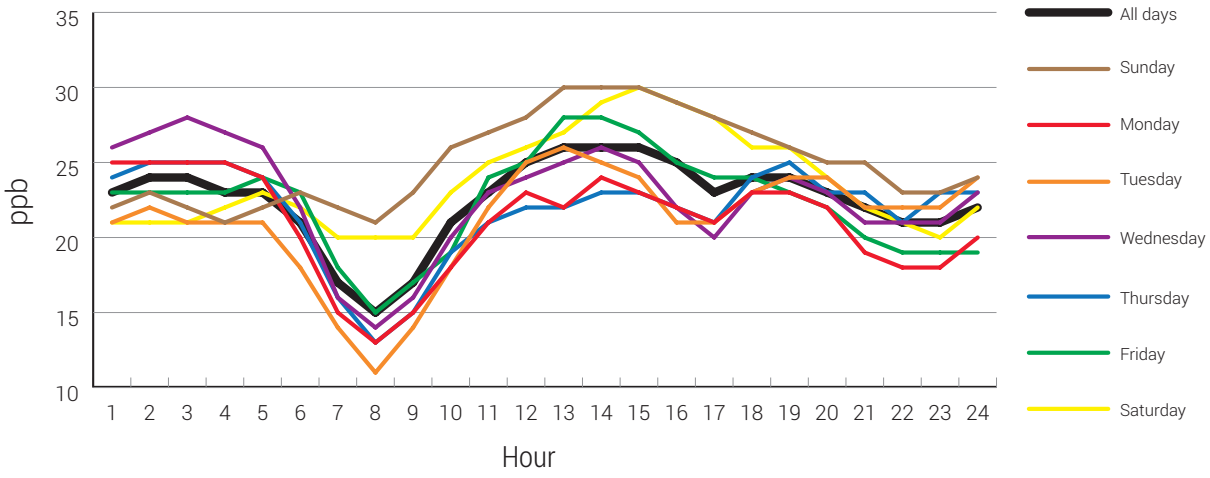

Figure 6. Daily patterns of ambient concentrations of ground-level ozone (GLO) at Downtown Halifax.

The GLO, in the form of the CAAQS measured at Downtown Halifax in 2017, is 43 ppb. The GLO, in the form of the CAAQS measured downwind of Halifax, at Lake Major, is 52 ppb. The difference between the two stations is statistically significant. It is thought that as the air moves away from Downtown Halifax, chemical reactions continue to take place and excess ozone is formed. The highest measurement from the two stations (52 ppb) is used to report on CAAQS achievement for 2017 in the central air zone.

Eastern Air Zone

The eastern air zone has Nova Scotia's second largest population centre, but the population density of the air zone is only about one quarter of the central air zone's population density. There are two monitoring stations in the air zone, located in the areas with the highest concentrations of population and industry (Figure 7). There are three coal-fired power plants, a biomass-fired power plant, a thermal mechanical pulping paper mill, and several commercial facilities and other smaller activities that report CAAQS-relevant air emissions to the National Pollutant Release Inventory (NPRI).

EASTERN AIR ZONE MONITORING STATIONS AND EMISSION SOURCES

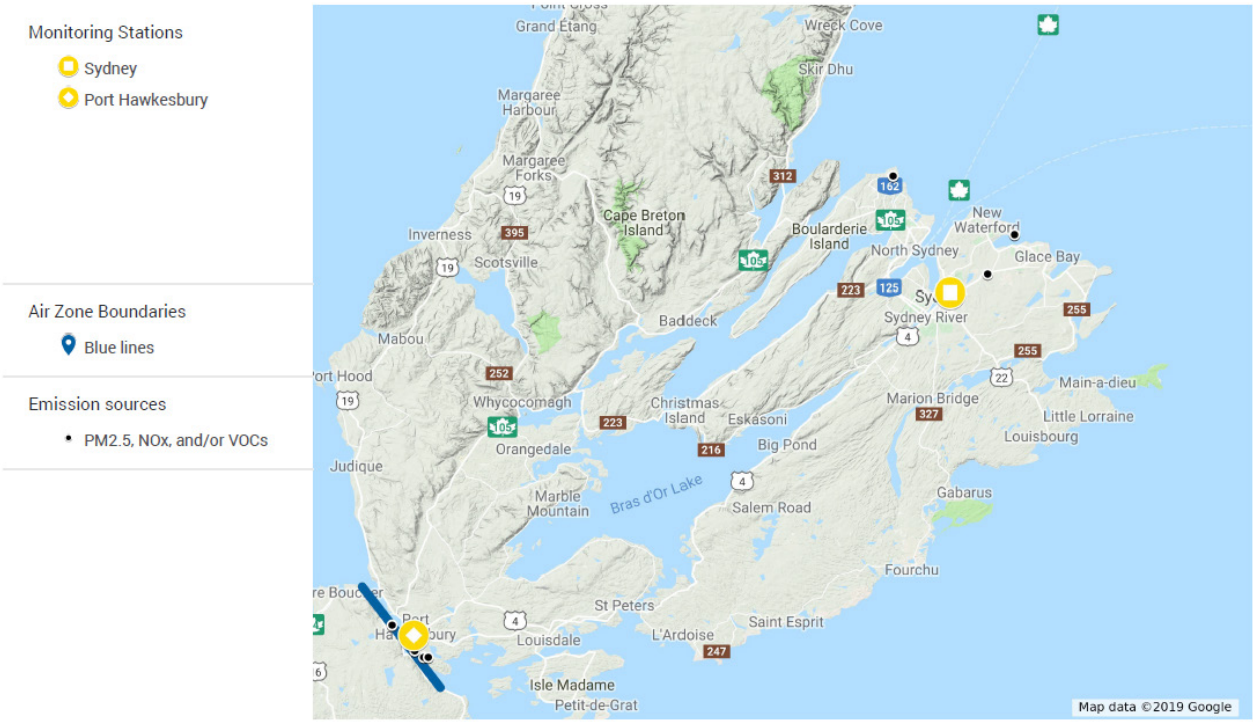

Figure 7. The location of ambient air monitoring stations in the eastern air zone. The black dots are locations of operations that report emissions of fine particulate matter and/or precursors to the formation of ground level ozone, nitrogen oxides and/or volatile organic compounds, to the National Pollutant Release Inventory (NPRI).

Measurements of GLO at both monitoring stations in the eastern air zone in 2017, as in previous years, are within the 'green' management level. Measurements of $PM_{2.5}$ are within the 'yellow' management level (Table 6). Both the 24-hour and annual $PM_{2.5}$ CAAQS measured at the Port Hawkesbury monitoring station show a decreasing trend. This may be because the Port Hawkesbury station is located very near to the northern air zone boundary and may be influenced by emission reductions in that air zone.

EASTERN AIR ZONE CAAQS ACHIEVEMENT AND MANAGEMENT LEVELS

	Ozone 8-hour (ppb)		$PM_{2.5}$ 24-hour (µg/m³)		$PM_{2.5}$ Annual (µg/m³)	
Reporting Year	**Port Hawkesbury**	**Sydney**	**Port Hawkesbury**	**Sydney**	**Port Hawkesbury**	**Sydney**
2013	47	49	16	13	6.3	5.0
2014	47	50	15	14	6.1	5.4
2015	46	49	15	14	6.1	5.9
2016	48	48	13	13	5.7	6.0
2017	48	48	11	12	5.5	5.8

Table 6. Year-to-year comparison of the eastern air zone's management levels and CAAQS measurements.

Western Air Zone

The western air zone is Nova Scotia's largest air zone and is mostly rural. The climate is "marked by warm summers and mild winters strongly influenced by the Atlantic Ocean and is one of the most humid parts of the Maritime provinces."[30] Key geographic features include the North and South Mountains that border the Annapolis Valley. The Valley contains a high concentration of agricultural activity and some industrial air emissions sources that report to the NPRI, including an airport, food processing facilities, manufacturing plants, and other institutions (Figure 8).

There are two monitoring stations in the western air zone used for calculating CAAQS. One is located on the North Mountain near Aylesford, and the second in the town of Kentville. The station in Kentville was put into service in 2016, and this is the first year with enough data for reporting from the new station.

[30] Webb and Marshall (1999). *Ecoregions and ecodistricts of Nova Scotia.* Agriculture and Agri-Food Canada & Environment Canada. Accessed at http://sis.agr.gc.ca/cansis/publications/surveys/ns/nsee/nsee_report.pdf

WESTERN AIR ZONE MONITORING STATIONS AND EMISSION SOURCES

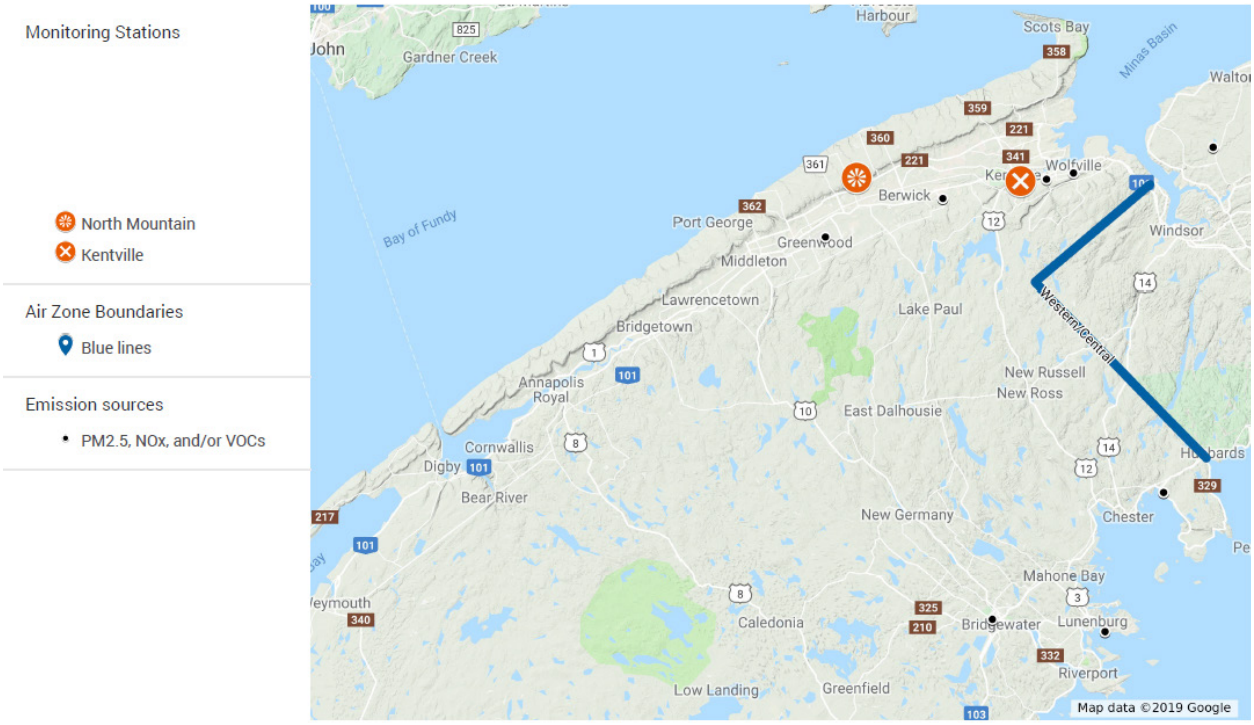

Figure 8. The location of ambient air monitoring stations in the western air zone. The black dots are locations of operations that report emissions of fine particulate matter and/or precursors to the formation of ground level ozone, nitrogen oxides and/or volatile organic compounds, to the National Pollutant Release Inventory (NPRI).

The $PM_{2.5}$ measurements in the western air zone in 2017, as in previous years, fall in the yellow management level. The western air zone's ground level ozone measurements fall in the 'orange' management level (Table 7) and are the highest in Nova Scotia. In addition, the GLO CAAQS metric in 2017 increased significantly from the previous year. Various factors for this result are being investigated (including increased emissions of precursors from forest fires, and/or shifting meteorological conditions that contribute to transboundary flows), but the cause of the increase is not yet fully explained.

WESTERN AIR ZONE CAAQS AND MANAGEMENT LEVELS

	Ozone 8-hour (ppb)		$PM_{2.5}$ 24-hour (µg/m³)		$PM_{2.5}$ Annual (µg/m³)	
Reporting Year	**North Mountain**	**Kentville**	**North Mountain**	**Kentville**	**North Mountain**	**Kentville**
2014	59	n/a	12	n/a	4.8	n/a
2015	59	n/a	14	n/a	5.3	n/a
2016	57	n/a	12	n/a	5.7	n/a
2017 †	61	60	12	11	6.2	5.5

Table 7. Year-to-year comparison of the western air zone's management levels and CAAQS measurements at the North Mountain monitoring station. † Results for Kentville are based on two-years of data.

Ground level ozone is formed when sunlight reacts with 'precursor' pollutants, such as NO_x and VOCs. The potential for ozone formation depends on if the environment is saturated or limited in NO_x. Rural environments, like that of the western air zone, tend to be limited in NO_x, and further reductions of NO_x tend to result in reduced concentrations of GLO. Environments that are saturated with NO_x, like downtown Halifax, will experience an increase in GLO concentrations when NO_x is decreased (Figures 5 and 6).

Air pollution that is created in one jurisdiction and travels across borders to another jurisdiction is called transboundary pollution. Weather patterns in eastern North America generally carry air pollution from the south-west to the north-east and, because of its location, the western air zone it is generally the first region of Nova Scotia to receive long-range air pollutants that originate in the Eastern United States. Coal-fired power plants and transportation are important sources of NOx, and there are many coal-fired power plants upwind of Nova Scotia (Figure 9).

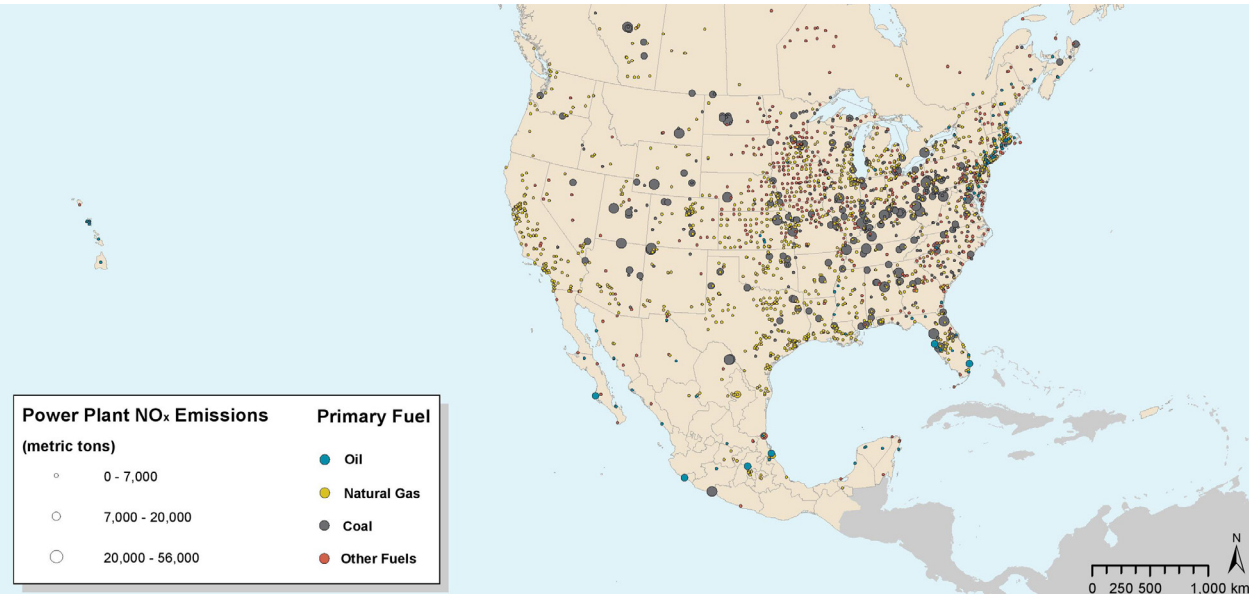

Figure 9. This map identifies the locations of North American coal-fired power plants and the relative size of their NO_x emissions.[31] Emissions from sources Southwest of Nova Scotia can affect the province's ambient air quality.[32]

Analysis of the long-term GLO monitoring data from the western air zone show that NO_2 emission reductions from coal-fired power plants in the Ohio River Valley, beginning in 1999, are correlated with reduced summertime GLO concentrations in Nova Scotia's western air zone.[33] The GLO CAAQS is achieved in the western air zone, but the results are in the "orange" management level. It is important for the Government of Canada to continue working with the United States Government to manage transboundary pollution.

[31] Data are taken from the Commission for Environmental Cooperation of North America (CEC) power plant emissions project http://www.cec.org/sites/default/napp/en/north-american-emissions/north-american-emissions.php

[32] For more information, see *Case study of a trans-boundary air pollution event in Nova Scotia* https://novascotia.ca/nse/air/docs/NovaScotiaTransboundaryEvent2004.pdf

[33] For a detailed explanation, see *Nova Scotia's 2016 Air Zone Report*, accessible at https://novascotia.ca/nse/air/docs/NS-Air-Zone-Report-2016.pdf

Northern Air Zone

The Cobequid Mountain Range is a prominent geographical feature that runs west to east through the northern air zone, and the Maritime Lowlands ecoregion, to the north of the Cobequid Mountains, is characterised by having "the lowest precipitation levels in the Maritime provinces."[34] A coal-fired power plant, tire manufacturing plant, and pulp and paper plant are in this region, near the Town of Pictou (Figure 10).

NORTHERN AIR ZONE MONITORING STATION AND EMISSION SOURCES

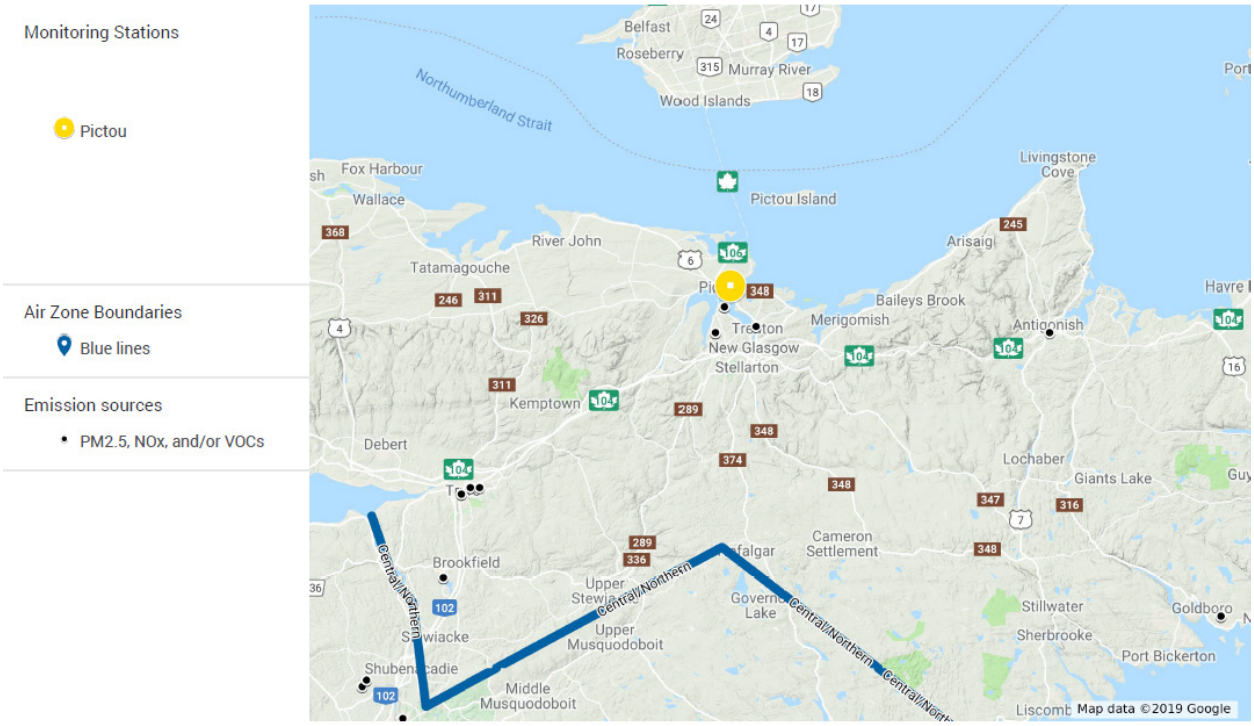

Figure 10. The location of the ambient air monitoring station in the northern air zone. The black dots are locations of operations that report emissions of fine particulate matter and/or precursors to the formation of ground level ozone, nitrogen oxides and/or volatile organic compounds, to the National Pollutant Release Inventory (NPRI).

Long-term $PM_{2.5}$ data collected at an air monitoring station in Pictou exhibit patterns of local, distant, natural and human-caused sources of $PM_{2.5}$ pollution and analysis of the ambient data revealed significant influence from emissions by a local pulp and paper mill.[35] In previous years, ambient $PM_{2.5}$ concentrations placed the northern air zone's management level in the orange category. Remedial actions were taken to reduce PM emissions from this source, and a corresponding improvement in ambient concentrations of $PM_{2.5}$ was observed beginning in mid-2015 (Figure 11). Because the ambient $PM_{2.5}$ CAAQS are based on a 3-year average of the annual 98th percentile of 24-hour average concentrations, the air zone's management level remained in at the orange management level for a delayed period following the emission reductions, but in 2017 it is yellow (Table 8).

[34] Webb and Marshall (1999). *Ecoregions and ecodistricts of Nova Scotia.* Agriculture and Agri-Food Canada & Environment Canada. Accessed at http://sis.agr.gc.ca/cansis/publications/surveys/ns/nsee/nsee_report.pdf

[35] Go to http://www.ec.gc.ca/inrp-npri/donnees-data/index.cfm?lang=En and enter NPRI ID, "815".

NORTHERN AIR ZONE CAAQS AND MANAGEMENT LEVELS

Reporting Year	Ozone 8-hour (ppb)	$PM_{2.5}$ 24-hour (µg/m³)	$PM_{2.5}$ Annual (µg/m³)
2013	46	18	6.9
2014	45	21	7.5
2015	45	23	7.6
2016	45	18	6.6
2017	46	14	5.7

Table 8. Year-to-year comparison of the northern air zone's management levels and CAAQS measurements at the Pictou monitoring station.

NORTHERN AIR ZONE, 24-HOUR AVERAGE $PM_{2.5}$, 2015 TO 2017

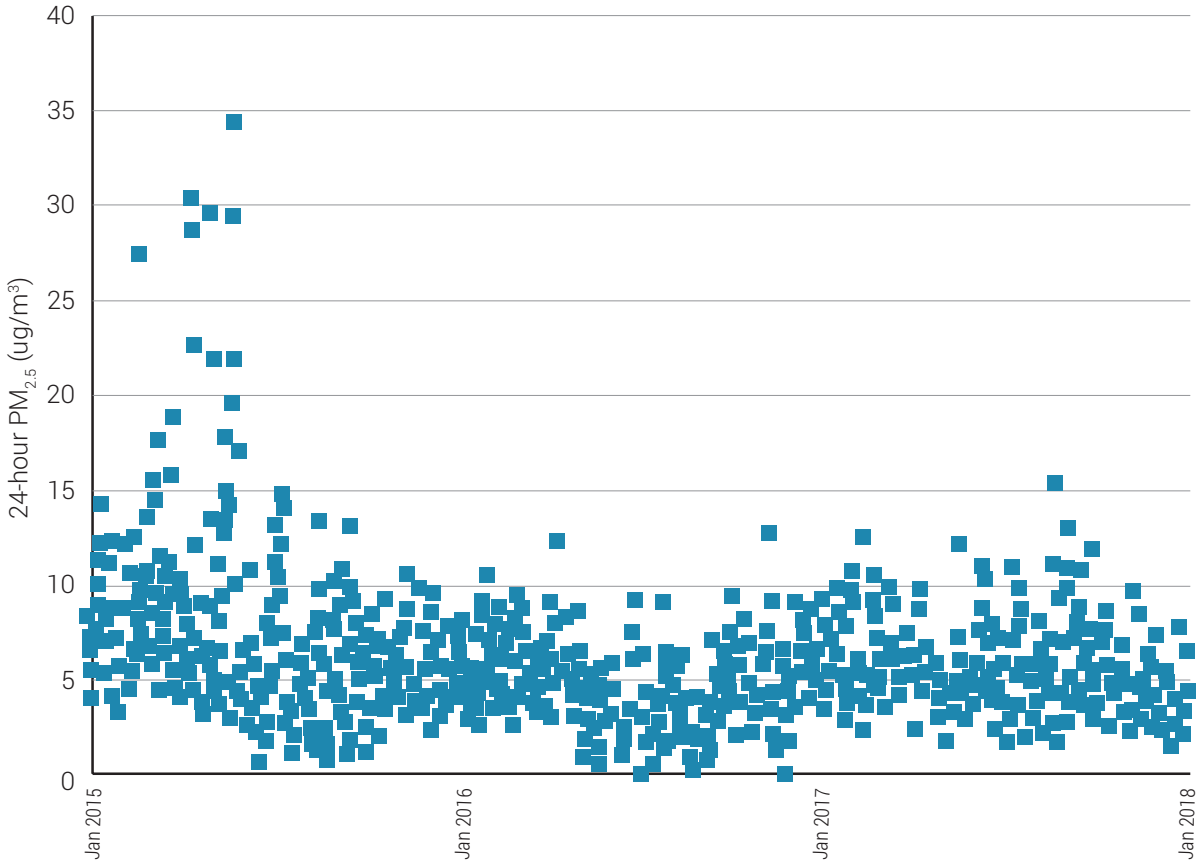

Figure 11. Maximum 24-hour average values of ambient $PM_{2.5}$ in the northern air zone decreased in May 2015, during the period during which a pulp and paper mill in the air zone shutdown for repairs and continues to have reduced ambient values following the resumption of operations with new pollution control equipment to reduce $PM_{2.5}$ emissions.

Contact Us

For more information on ambient air quality monitoring, the AQMS, ambient air quality data or related products visit **novascotia.ca/nse/air/** or contact us at **902-424-3600**.