Prince Edward Island
CANADA

Environment, Water and Climate Change

AIR QUALITY REPORT

2016

Prince Edward Island 2016 Air Quality Report
Covering the Years 2014-2016

PEI Department of Environment,
Water and Climate Change

Published August 2020

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INTRODUCTION

Air Quality Monitoring in PEI

This report provides the status of the air quality in Prince Edward Island for the years 2014-2016. The Department of Environment, Water and Climate Change shares responsibilities regarding air quality and the monitoring of air quality with the federal government. This shared responsibility is attained through a partnership with Environment and Climate Change Canada where the provinces, territories and federal government are signatories to the *Memorandum of Understanding Respecting the National Air Pollution Surveillance Program*.

Through the National Air Pollution Surveillance (NAPS) Program[1], PEI operates an ambient air monitoring network consisting of three stations - Wellington, Southampton and Charlottetown. The stations monitor ambient air parameters such as particulate matter ($PM_{2.5}$), ground level ozone (O_3), sulfur dioxide (SO_2), and nitrous oxides (NO_X) as part of the NAPS program. The data from the NAPS program is available through Environment and Climate Change Canada's data portal[2]. Mercury (Hg) and acid precipitation are also monitored at the Southampton station by the province. At the time of this report, data was not available for download for mercury or acid precipitation. This report focuses on the results of the ozone and particulate matter monitoring.

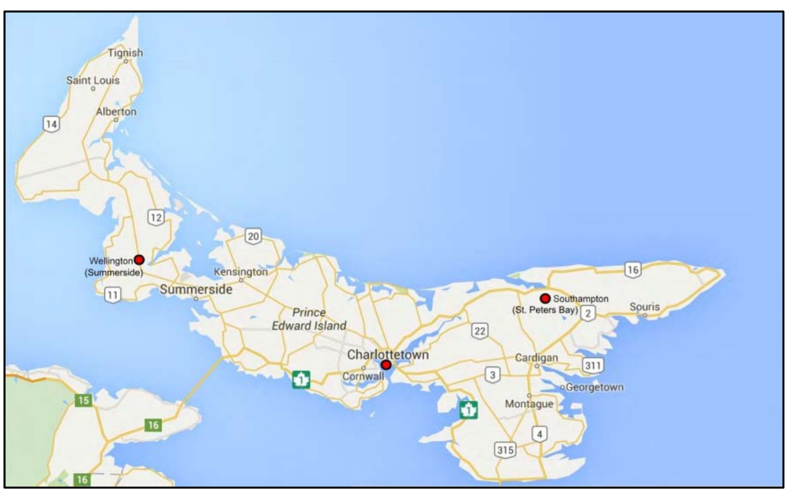


Figure 2 - Map of PEI Air Quality Monitoring Stations

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

[2] http://data.ec.gc.ca/data/air/monitor/national-air-pollution-surveillance-naps-program/

Air Sheds and Air Zones

Airsheds and air zones are geographic areas used to manage air quality. There are six airsheds in Canada, with most of them including portions of multiple provinces/territories. PEI is located in the Southern Atlantic Airshed (Figure 3).

Air zones are smaller areas within air sheds, with most provinces having several air zones within their boundaries. PEI has only one air zone that covers the entire province. Both airsheds and air zones are used to coordinate efforts to manage and report on regional air quality, and to reduce transboundary air pollution flows. Transboundary air pollution flows are those that enter one province or territory from other provinces or territories, or flows that enter Canada from the United States.

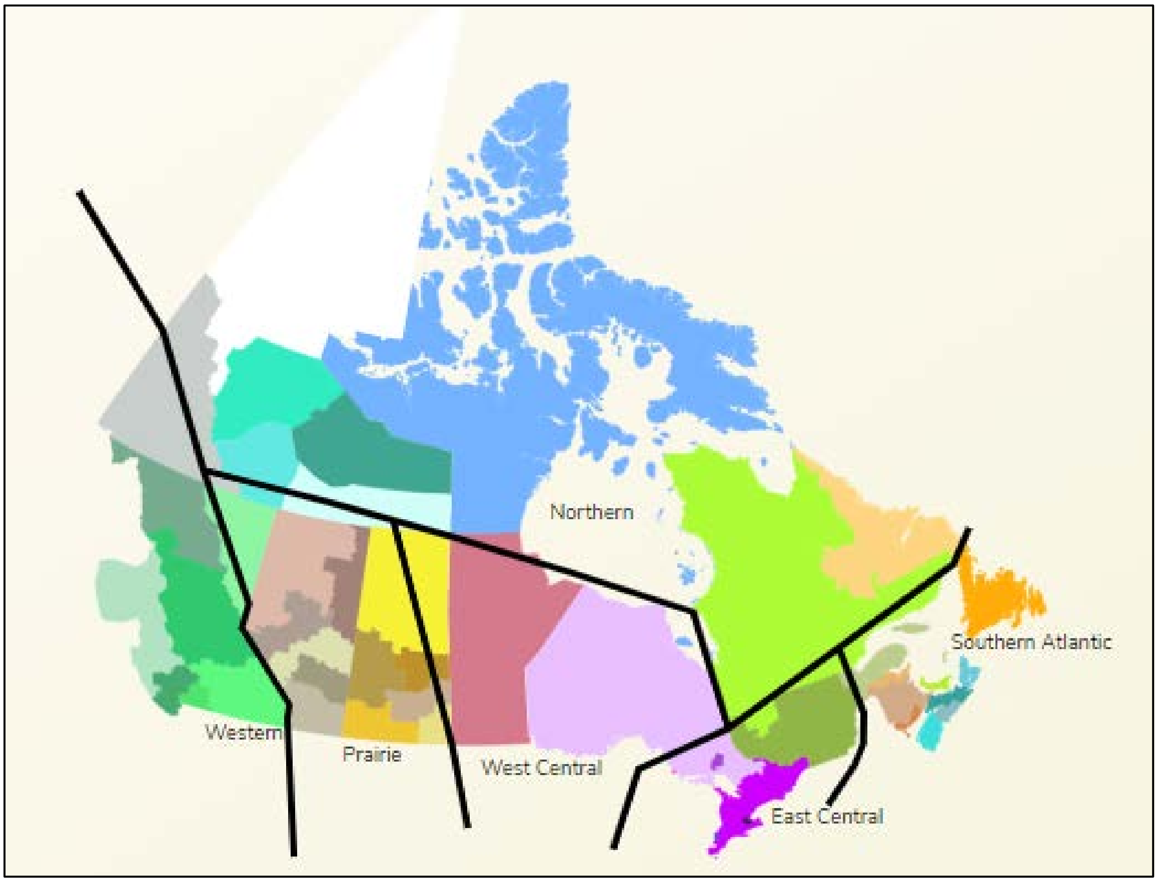


Figure 3 - Airsheds and air zones in Canada. Airsheds are delineated by black lines. Air zones are delineated by colours[3]

An air zone generally exhibits similar air quality issues and trends throughout its area. The Air Zone Management Framework (AZMF)[4] has been developed to ensure proactive measures are taken to protect air quality using the principles of continuous improvement and keeping clean areas clean. Provinces and territories manage air zones within their boundaries with the goal of bringing about improvements in air quality and preventing standards from being exceeded.

[3] http://airquality-qualitedelair.ccme.ca/en/
[4] https://www.ccme.ca/files/Resources/air/aqms/pn_1481_gdazm_e.pdf

Air Quality Management System (AQMS)

The Air Quality Management System (AQMS) was endorsed by the Canadian Council of Ministers of the Environment in October 2012 to improve air quality across Canada, and protect human health and the environment. The system provides a framework for collaborative action across Canada using a consistent approach to air quality management. The AQMS was developed by federal, provincial and territorial governments, in conjunction with a variety of stakeholders, over a number of years. The system consists of several interrelated parts, as depicted in Figure 4.

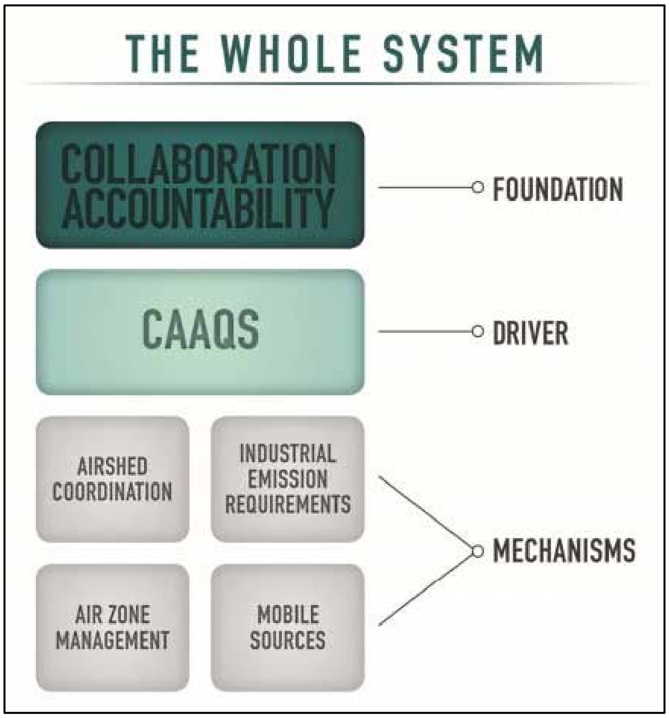


Figure 4 - The Air Quality Management System[5]

The driver for this system is the Canadian Ambient Air Quality Standards (CAAQS)[6]. Standards have been developed for fine particulate matter ($PM_{2.5}$) and ground-level ozone (O_3). Standards for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) will be available and utilized starting with the 2020 report.

There are two standards for fine particulate matter, a 24 hour standard (28 µg/m^3) and an annual standard (10 µg/m^3). Ground level ozone has one standard, an 8 hour standard (63 ppb). The goal is to ensure the CAAQS are not exceeded while managing emissions using the mechanisms listed in the table above (Airshed Coordination, Industrial Emission Requirements, Air Zone Management and Mobile

[5] Image source and additional information regarding the AQMS is available at: https://www.ccme.ca/en/resources/air/aqms.html
[6] https://www.ccme.ca/en/resources/air/aqms.html

Sources). These standards, however, are not “pollute up to” standards, and have graduated zones to help guide provinces with their air quality management.

In addition to standards, there are colour coded management levels that signify the relative amount of air pollutants in the air during the reporting time period. The management levels range from green to red, and each category has its own objectives. For example, an area that falls within the red level will prompt a province to institute air management actions to achieve air zone CAAQS. The *Guidance Document on Air Zone Management*[7] is available as a reference tool for jurisdictions and the public, providing details of the Air Zone Management Framework under the AQMS .

It is important to note the difference between the Canadian Ambient Air Quality **Standards** and **management levels** under the Air Zone Management Framework. The standards are hard values for a parameter that the province either meets or doesn’t. The management levels fit a provincial calculated value into a coloured range, with each range having management techniques that the jurisdiction should introduce. Table 1 provides an example of the difference between a standard and a management level.

Table 1 – Standards versus Management Levels using example data

	Example provincial monitoring value for 0_3 (ppb)	Air Quality Standard and Management Levels for 0_3 (ppb)	Explanation	Example Result
Air Quality Standard	52	62	*If data value is under standard, the standard is achieved. If value is over standard, the standard is not achieved.*	*Standard achieved*
Management Levels	52	>62 >56 and ≤ 62 >50 and ≤ 56 ≤ 50	*Data value is placed into one of the management levels and assigned that colour (green/yellow/orange/red).*	Data value is assigned a *yellow management level.*

Health and Environmental Effects

Although we may not consider air pollution as a major health issue, Health Canada estimates that 14,600 premature deaths per year in Canada can be linked to air pollution from fine particulate matter, nitrogen dioxide and ozone. In addition, the total Canadian economic valuation of the health impacts that can be attributed to air pollution is $114 billion per year[8].

[7] https://www.ccme.ca/files/Resources/air/aqms/pn_1481_gdazm_e.pdf
[8] https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html

More specific to this report, both $PM_{2.5}$ and ozone can affect human health and the environment. Table 2 provides a summary of health and environmental effects of fine particulate matter and ozone.

Table 2 – Summary of ground level ozone and particulate matter effects

Overview of O_3 and $PM_{2.5}$		
Air Pollutant	**Description**	**Health/Environmental Effects**
Ground Level Ozone (O_3)	Ground-level ozone is a colorless and highly irritating gas that forms just above the earth's surface. Ozone occurs naturally in the upper atmosphere where it filters ultraviolet radiation, but at ground level, O_3 is an important ingredient of smog. It is called a "secondary" pollutant because it is produced when two primary pollutants react in sunlight and stagnant air (often hot, sunny weather). These two primary pollutants are nitrogen oxides (NO_x) and volatile organic compounds (VOCs). NO_x and VOCs come from natural sources as well as human activities. About 95 per cent of NO_x from human activity come from the burning of coal, gasoline and oil in motor vehicles, homes, industries and power plants. VOCs from human activity come mainly from gasoline combustion and marketing, upstream oil and gas production, residential wood combustion, and from the evaporation of liquid fuels and solvents. Significant quantities of VOCs also originate from natural (biogenic) sources such as coniferous forests.	Ozone is known to have significant effects on human health, mainly in the form of breathing issues. Ozone can also significantly impact vegetation and decrease the productivity of some crops, damage synthetic materials, cause cracks in rubber and speed the deterioration of some paints and coatings.
Particulate Matter ($PM_{2.5}$)	Particulate matter (PM) consists of airborne particles in solid or liquid form (e.g. dust, smoke, sand, pollen, mist, and fly ash). PM may be classified as primary or secondary, depending on the compounds and processes involved during its formation. Primary PM is emitted at the emissions source in particle form, for example, the smokestack of an electrical power plant or a recently tilled field subject to wind erosion. Secondary PM formation results from a series of chemical and physical reactions involving different precursor gases, such as sulphur oxides and nitrogen oxides, and ammonia reacting to form sulphate, nitrate and ammonium particulate matter. This report deals with $PM_{2.5}$, airborne particulate matter with a mass median diameter less than 2.5 µm. Air pollutants at this size are small enough to float in air and can be transported over long distances.	Numerous studies have linked PM to aggravated cardiac and respiratory diseases such as asthma, bronchitis and emphysema and to various forms of heart disease. PM can also have adverse effects on vegetation and structures, and contributes to visibility deterioration and regional haze.

Adapted from:
https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants.html
https://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/naaqo-ongaa/ground_level-ozone-tropospherique/summary-sommaire/ozone-summary-sommaire-eng.pdf

PEI RESULTS

Canadian Ambient Air Quality Standards (CAAQS)

The two parameters measured for the CAAQS are ground level ozone and $PM_{2.5}$. As previously mentioned, there is one standard for ground level ozone and two for $PM_{2.5}$. When applying data results to standards, the data are an average of three years, 2014-2016 in the case of this report.

The protocols for comparing monitoring data to the CAAQS are detailed in the *Guidance Document on the Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone*[9]. The protocol details criteria for determining the values for comparison, including data completeness requirements. Table 3 below provides a summary of the CAAQS. As the table shows, the standard values decrease and become more stringent over time (2015, 2020 and 2025). Standards for SO_2 and NO_2 will be employed and reported in the 2020 report.

Table 3 - Canadian Ambient Air Quality Standards[10]

Pollutant	Averaging Time	Numerical Value			Statistical Form
		2015	2020	2025	
Fine Particulate Matter ($PM_{2.5}$)	24-hour	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
	Annual	10.0 $\mu g/m^3$	8.8 $\mu g/m^3$		The 3-year average of the annual average of all 1-hour concentrations
Ozone (O_3)	8-hour	63 ppb	62 ppb	60 ppb	The 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations
Sulphur Dioxide (SO_2)	1-hour	-	70 ppb	65 ppb	The 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations
	Annual	-	5.0 ppb	4.0 ppb	The average over a single calendar year of all 1-hour average SO_2 concentrations
Nitrogen Dioxide (NO_2)	1-hour	-	60 ppb	42 ppb	The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
	Annual	-	17.0 ppb	12.0 ppb	The average over a single calendar year of all 1-hour average concentrations

[9] *Guidance Document on the Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone*

[10] Image source: http://airquality-qualitedelair.ccme.ca/en/

$PM_{2.5}$ 24-hour Standard Calculations for PEI

To calculate the 24-hour standard for PEI, the following steps were taken:

1. The daily 24-hour average $PM_{2.5}$ concentrations for 2014, 2015, and 2016 were determined for each of the three monitoring stations;
2. The 98th percentile value of the daily 24hr $PM_{2.5}$ for the given year was calculated for each year and site;
3. The values for the three years were averaged for each site.
4. The highest of the averages from the three stations was used as the value for the Air Zone and to determine CAAQS achievement. Results are shown in Table 4 below.

Table 4 – 2016 $PM_{2.5}$ 24-hour Standard Results for PEI

2016 $PM_{2.5}$ 24-hour Standard Results				
Station/Year	2014	2015	2016	Average
Wellington	*	11.8	10.2	**
Charlottetown	12.1	11.4	10.0	**
Southampton	9.9	7.7	10.6	9

Units – µg/m^3
Green values meet data completeness criteria
Red values do not meet data completeness criteria, and therefore not used to calculate average
* No data are available for 2014
** Cannot calculate as there are not enough years that meet data completeness criteria (2 required)

Of the three stations, the average for the three years can only be calculated for Southampton. Therefore the PEI 2016 $PM_{2.5}$ 24-hour standard is **9 µg/m^3**.

Information regarding data completeness criteria is found in Appendix 1.

The value of 9 µg/m^3 is below the CAAQS of 28 µg/m^3, therefore PEI achieved the $PM_{2.5}$ 24-hour standard for 2016.

$PM_{2.5}$ Annual Standard Calculations for PEI

To calculate the annual standard, the following steps were taken:

1. The daily 24-hour average $PM_{2.5}$ concentrations over 2014, 2015, and 2016 were determined for each day for the three monitoring stations;
2. The annual averages of the daily 24hr $PM_{2.5}$ for the given year were calculated for each year and site;
3. The values for the three years were averaged for each site.
4. The highest of the averages from the three stations was used as the value for the Air Zone and to determine CAAQS achievement. Results are shown in Table 5 below.

Table 5 – 2016 $PM_{2.5}$ Annual Standard Results for PEI

2016 $PM_{2.5}$ Annual Standard Results				
Station/Year	2014	2015	2016	Average
Wellington	**	5.2	5.7	*
Charlottetown	6.0	4.3	3.9	*
Southampton	3.9	3.3	6.4	4.5

Units – $\mu g/m^3$
Green values meet data completeness criteria
Red values do not meet data completeness criteria, and therefore not used to calculate average
* No data are available for 2014
** Cannot calculate as there are not enough years that meet data completeness criteria (2 required)

Of the three stations, the average for the three years can only be calculated for Southampton. Therefore the PEI 2016 $PM_{2.5}$ annual standard is **4.5 $\mu g/m^3$**.

Information regarding data completeness criteria is found in Appendix 1.

The value of 4.5 $\mu g/m^3$ is below the CAAQS of 10 $\mu g/m^3$, therefore PEI achieved the $PM_{2.5}$ annual standard for 2016.

Ozone Standard Calculations for PEI

To calculate the ozone standard, the following steps were taken:

1. The 8-hour average ozone concentration was calculated for each hour of the day, for each of the three sites;
2. The maximum 8-hour average ozone concentration was calculated for each day;
3. The annual 4th highest maximum daily 8-hour ozone concentration was determined for each year and each station. Results are shown in Table 6 below.

Table 6 – 2016 Ozone Standard Results for PEI

2016 Ozone Standard Results				
Station/Year	2014	2015	2016	Average
Wellington	**51.3**	**50.9**	**57.3**	**53**
Charlottetown	**53.0**	**62.2**	**46.8**	**54**
Southampton	**51.3**	**50.8**	**46.8**	**50**

Units – ppb *(parts per billion)*
Green values meet data completeness criteria

All three stations met the data completeness criteria. To choose the ozone standard value for PEI in this case, the highest of the three averages is selected. Charlottetown had the highest average ozone standard value at 54 ppb, therefore the PEI 2016 ozone standard value is **54 ppb**.

The value of 54 ppb is below the CAAQS ozone standard of 63 ppb, therefore PEI achieved the ozone standard for 2016.

CAAQS Summary Values for PEI

Table 7 below is a summary of the $PM_{2.5}$ and Ozone values (calculated above) for PEI compared to the CAAQS. The table lists the CAAQS value for each of the three parameters, with the respective PEI values for 2016 compared to them. If the PEI value is lower than the CAAQS, the respective standard is achieved. All three standards are achieved for the 2016 reporting year.

Table 7 – Achievement of Canadian Ambient Air Quality Standards

Parameter	Standard (CAAQS)	PEI 2016 Value	Achieved/Not Achieved
$PM_{2.5}$ 24-hour standard	28 $\mu g/m^3$	9 $\mu g/m^3$	**Achieved**
$PM_{2.5}$ Annual Standard	10 $\mu g/m^3$	4.5 $\mu g/m^3$	**Achieved**
Ozone	63 ppb	54 ppb	**Achieved**

Management Levels and Final Air Zone Results for PEI

Under the Air Zone Management Framework (AZMF), progressively more rigorous actions are to be implemented in an air zone as air quality approaches or exceeds the CAAQS. Four Management Levels, covering $PM_{2.5}$ and ground-level ozone concentrations, provide general guidance on the nature of the management, monitoring and reporting actions to be implemented in air zones, see Table 8.

Table 8 - Air Zone Management Framework[11]

Air quality management levels	Management Levels for the Ozone CAAQS (ppb)		Management Levels for the Annual $PM_{2.5}$ CAAQS ($\mu g/m^3$)		Management Levels for the 24-hour $PM_{2.5}$ CAAQS ($\mu g/m^3$)		Management Objective (if value is in this coloured category)
	2020	2025	2015	2020	2015	2020	
Red	>62	>60	>10.0	>8.8	>28	>27	To Achieve Air Zone CAAQS through Advanced Air Management Actions
Orange	>56 and ≤ 62	>56 and ≤ 60	>6.4 and ≤ 10.0	>6.4 and ≤ 8.8	>19 and ≤ 28	>19 and ≤ 27	To Improve Air Quality through Active Air Management and Prevent a CAAQS Exceedance
Yellow	>50 and ≤ 56		>4.0 and ≤ 6.4		>10 and ≤ 19		To Improve Air Quality using Early and Ongoing Actions for Continuous Improvement
Green	≤ 50		≤ 4.0		≤ 10		To Maintain Good Air Quality through Proactive Air Management Measures to Keep Clean Areas Clean

The values calculated earlier in the report for $PM_{2.5}$ and ozone (summarized in Table 7) were fed into the AZMF to determine the management level of each parameter. The three parameter levels are compared to each other to determine the final management level for the PEI Air Zone. The highest level of the three parameters is used as the final management level for the Air Zone. Table 9 summarizes these results.

[11] Adapted from - http://airquality-qualitedelair.ccme.ca/en/

Table 9 – 2016 PEI Air Zone Results

Air Zone	Final Management Level	Management Actions	2016 Results		
			Ozone 8-hour (ppb)	PM2.5 24-hour (µg/m^3)	PM2.5 Annual (µg/m^3)
PEI	**YELLOW**	Actions for Preventing Air Quality Deterioration	**54**	**9**	**4.5**

Both the ozone and $PM_{2.5}$ annual values fall within the yellow management for the specific parameter, while the $PM_{2.5}$ 24-hour value falls in the green management level. The higher management level of the three is used to determine the final management level, therefore the **PEI Air Zone falls within the YELLOW management level for 2016**.

For 2016 the Prince Edward Island Air Zone falls within the YELLOW management level.

A jurisdiction with a yellow management level should be implementing actions for preventing air quality deterioration.

PEI MANAGEMENT ACTIONS

The quality of the air in PEI is influenced by two sources; the emissions we generate within the province and those that come to us from provinces to the west and from the northeastern United States. Although we can make efforts at home to improve air quality, we don't have control over what happens elsewhere. However, as the AQMS is a national effort, improvement efforts in other provinces are continually occurring. As well, the Canada-United States Air Quality Agreement, signed in 1991 to address transboundary air pollution leading to acid rain, has led to benefits for Atlantic Canada. In 2000, the Ozone Annex was added to address ground-level ozone, a major component of smog.

With respect to $PM_{2.5}$ and ground-level ozone, the concentrations measured in PEI are all below their respective standards. Although the quality of the air in our province is good, there is always work to be done to ensure that continual improvements are made.

This report, covering the years 2014-2016, was published in 2020 and therefore recent management actions may not be relevant to what occurred during the 2014-2016 time period. For that reason, recent management actions will not be listed in this report, however they can be found in both the 2018 and 2019 Air Quality Reports. Past Air Quality Reports can be accessed online at: https://www.princeedwardisland.ca/en/information/environment-water-and-climate-change/air-quality-reports

APPENDIX 1 – Data Completeness Criteria

The flowing table details the requirements for data completeness for the calculation of the CAAQS values. The contents of the table were extracted from the *Guidance Document on the Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone.*

Standard	Data Requirements

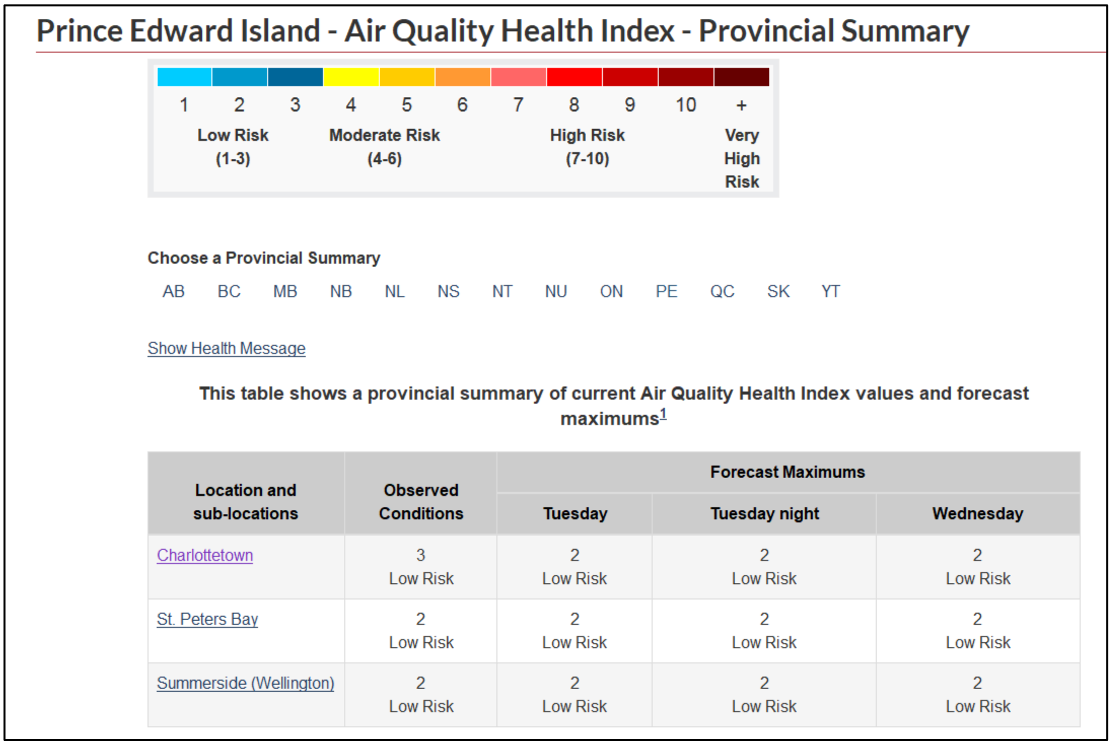
$PM_{2.5}$ 24hr Standard	• a daily 24hr-$PM_{2.5}$ is to be considered valid if at least 75% (18 hours) of the 1-hour concentrations are available on the given day
	• For any given year, the annual 98P will be considered valid if the following two criteria are satisfied:
	   o at least 75% valid daily-24hr-$PM_{2.5}$ in the year
	   o at least 60% valid daily-24hr-$PM_{2.5}$ in each calendar quarter
	• A $PM_{2.5}$ 24-hour metric value will be calculated and considered valid if an annual 98P value is available for at least two of the required three years

$PM_{2.5}$ Annual Standard	• a daily 24hr-$PM_{2.5}$ is to be considered valid if at least 75% (18 hours) of the 1-hour concentrations are available on the given day
	• For any given year, the annual average $PM_{2.5}$ concentration will be will be considered valid if the following two criteria are satisfied:
	   o at least 75% valid daily-24hr-$PM_{2.5}$ in the year
	   o at least 60% valid daily-24hr-$PM_{2.5}$ in each calendar quarter
	• A $PM_{2.5}$ annual metric value will be calculated and considered valid if annual averages are available for at least two of the required three years

Ozone Standard	• A rolling 8-hour average will be calculated and considered valid if there are at least six 1-hour • For any given day, the daily 8hr-O_3-max will be considered valid if there are at least 75% (18) valid 8-hour rolling averages in the day • For any given year, the annual 4th highest daily 8hr-O_3-max will be considered valid if there are at least 75% valid daily 8hr-O_3-max in the combined 2nd and 3rd quarters (April 1 to September 30) • For a given CAAQS reporting station, the ozone metric value will be calculated and considered valid if the annual 4th highest daily 8hr-O_3-max are available in at least two of the required three years
CAAQS Achievement	• Stations must have metric values for all three years to be included in the Air Zone Management Level determination

APPENDIX 2 – Air Quality Health Index

The Air Quality Health Index (AQHI) is a public information tool that helps Canadians protect their health on a daily basis from the negative effects of air pollution. This tool was developed by Health Canada and Environment and Climate Change Canada, in collaboration with the provinces and key health and environment stakeholders. It measures the air quality in relation to your health on a scale from 1 to 10 (Figure 5) and provides related health messages. The higher the number, the greater the health risk associated with the air quality. The AQHI is calculated based on the relative risks of a combination of common air pollutants that is known to harm human health. These pollutants are ground-level ozone, particulate matter and nitrogen dioxide.



Prince Edward Island - Air Quality Health Index - Provincial Summary

1	2	3	4	5	6	7	8	9	10	+
Low Risk (1-3)			Moderate Risk (4-6)			High Risk (7-10)				Very High Risk

Choose a Provincial Summary

AB BC MB NB NL NS NT NU ON PE QC SK YT

Show Health Message

This table shows a provincial summary of current Air Quality Health Index values and forecast maximums[1]

Location and sub-locations	Observed Conditions	Forecast Maximums		
		Tuesday	Tuesday night	Wednesday
Charlottetown	3 Low Risk	2 Low Risk	2 Low Risk	2 Low Risk
St. Peters Bay	2 Low Risk	2 Low Risk	2 Low Risk	2 Low Risk
Summerside (Wellington)	2 Low Risk	2 Low Risk	2 Low Risk	2 Low Risk

Figure 5 - Air Quality Health Index (https://weather.gc.ca/airquality/pages/provincial_summary/pe_e.html)

The AQHI has been available in Prince Edward Island since May 1, 2009, for each of the three areas in which the Department of Environment, Water and Climate Change has a monitoring site; Charlottetown, St. Peters Bay (Southampton) and Summerside (Wellington). Real time data is continuously provided to Environment and Climate Change Canada, who then calculate and provide the Index to the public continuously on their weather forecast website. Most of the time, the AQHI across the province is 2. It will often dip to 1 or occasionally rise to 3. In unusual circumstances, such as a forest fire in a neighbouring province, it may increase beyond 3.