Manitoba
Sustainable Development

2015 Provincial Summary Report

Achievement Status on the Canadian Ambient Air Quality Standards (CAAQS) for Fine Particulate Matter ($PM_{2.5}$) and Ozone

January 2016

Overview

This is the first annual provincial report on the achievement of the Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter ($PM_{2.5}$) and ground-level ozone (ozone). This report is a commitment under the national Air Quality Management System (AQMS) of the Canadian Council of Ministers of the Environment (CCME) to annually report on the achievement of the Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter ($PM_{2.5}$) and ground-level ozone (ozone).

Fine particulate matter ($PM_{2.5}$) and ground-level ozone (ozone) are two of the most important outdoor air pollutants from a public health perspective. Both pollutants are key components of urban smog and associated with short-term and long-term impacts on human health and the environment.

For the current reporting period of 2012 to 2014, all air quality reporting areas were below the CAAQS 24-hour and annual standards for $PM_{2.5}$. $PM_{2.5}$ levels ranged from 18 to 21μg/m^3 (24-hour) and 4.0 to 6.5μg/m^3 (annual) and the respective CAAQS values are 28 and 10μg/m^3. The $PM_{2.5}$ levels in Manitoba were influenced by forest fire smoke during the reporting period.

In the case of ozone, all air quality reporting areas were below the CAAQS ozone standard. Ozone levels ranged from 47 to 58 ppb and the CAAQS value is 63 ppb. The ozone level in southern Manitoba was influenced by transboundary flow from the United States and other Canadian provinces.

The Air Quality Management System (AQMS) defines color-coded management levels associated with air quality. Based on this, Winnipeg and Brandon areas have been assigned a management level of “yellow” for both $PM_{2.5}$ and ozone level. Flin Flon area is also assigned a “yellow” level for $PM_{2.5}$ but “green” for ozone. Thompson area is assigned with “yellow” for $PM_{2.5}$. The “yellow” management level indicated that actions should focus on preventing air quality deterioration. To prevent the deterioration of air quality and provide for long-term sustainability, major programs and strategies are being implemented as part of the provincial air quality management strategy.

1.0 INTRODUCTION

In 2012, the Canadian Council of Ministers of the Environment (CCME) committed to implement a new comprehensive Air Quality Management System (AQMS) to better protect human health and the environment. One of the key elements of the new system is the Canadian Ambient Air Quality Standards (CAAQS) for selected air pollutants beginning with fine particulate matter ($PM_{2.5}$) and ground-level ozone (ozone). The CAAQS for $PM_{2.5}$ and ozone (**Table 1**) were established to replace the Canada-wide Standards (CWS) for $PM_{2.5}$ and ozone established in 2000.

This is the first provincial report under the new standard and presents the achievement status of Manitoba with the Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ and ozone based on the ambient concentrations measured over the years 2012, 2013 and 2014.

Table 1: CAAQS value for $PM_{2.5}$ and Ozone

Pollutant	Averaging Time	Standards (concentration)		Metric
		2015	2020	
$PM_{2.5}$	24-hour (calendar day)	28 µg/m^3	27 µg/m^3	The 3-year average of the annual 98th percentile of the daily 24-hr average concentrations.
$PM_{2.5}$	Annual (calendar year)	10.0 µg/m^3	8.8 µg/m^3	The 3-year average of the annual average concentrations.
Ozone	8-hour	63 ppb	62 ppb	The 3-year average of the annual 4th highest daily maximum 8-hr average concentrations.

1.1 Air Management Levels and Threshold Values

Under the AQMS, each province and territory is committed to establish a number of air zones covering the entire jurisdiction. An air zone is a specific geographic region which exhibits similar emission characteristics, air quality issues and trends.

Provincial governments will be taking management actions in order to improve air quality and achieve the CAAQS for each air zone considering its emissions and air quality trends. **Table 2** illustrates the air zone management levels and corresponding threshold values. The color coding represents the required management level separated by a threshold value which is a specific concentration level for a specified air pollutant. The establishment of air zones in Manitoba is now underway. Pending the air zone designation, the CAAQS values and management levels presented in this report will reflect four reporting areas within the province where ambient air monitoring is being performed namely Winnipeg, Brandon, Flin Flon, and Thompson.

Table 2. Air Zone management level and threshold values

Management Level	Management Actions	Air Management Threshold Values					
		Ozone 8-hr (ppb)		$PM_{2.5}$ Annual ($\mu g/m^3$)		$PM_{2.5}$ 24-hr ($\mu g/m^3$)	
		2015	2020	2015	2020	2015	2020
RED	Actions for Achieving Air Zone CAAQS						
Threshold		63	62	10.0	8.8	28	27
ORANGE	Actions for Preventing CAAQS Exceedance						
Threshold		56		6.4		19	
YELLOW	Actions for Preventing Air Quality Deterioration						
Threshold		50		4.0		10	
GREEN	Actions for Keeping Clean Areas Clean						

2.0 AMBIENT AIR QUALITY MONITORING IN MANITOBA

The ambient air quality monitoring network in Manitoba includes five monitoring stations distributed across the province. **Figure 1** shows the location of the ambient air monitoring stations.

Winnipeg Census Metropolitan Area

Winnipeg is the only Census Metropolitan Area (CMA) in Manitoba and almost 60% of the provincial population resides in the region. Air quality data are being collected from two ambient air monitoring stations, one in the downtown Winnipeg area (65 Ellen Street) and one in a residential neighborhood (299 Scotia Street).

Winnipeg has generally good air quality and air quality issues tend to relate to localized concerns. The emission sources are more or less similar in the entire Winnipeg region, mainly from transportation, residential heating, agricultural and industrial activities. Transportation, agriculture and industrial combustion are the primary sources of $PM_{2.5}$ emissions in Winnipeg. Forest and wildfires within and outside the province occasionally contribute to the $PM_{2.5}$ concentrations in Winnipeg. Emissions of ground level ozone precursors such as nitrogen oxides (NO_X) and volatile organic compounds (VOC's) generally come from transportation sources and industrial activities. Also, transboundary flow of air pollutants from northern United States and other Canadian provinces influence the concentrations of ground-level ozone in Winnipeg.

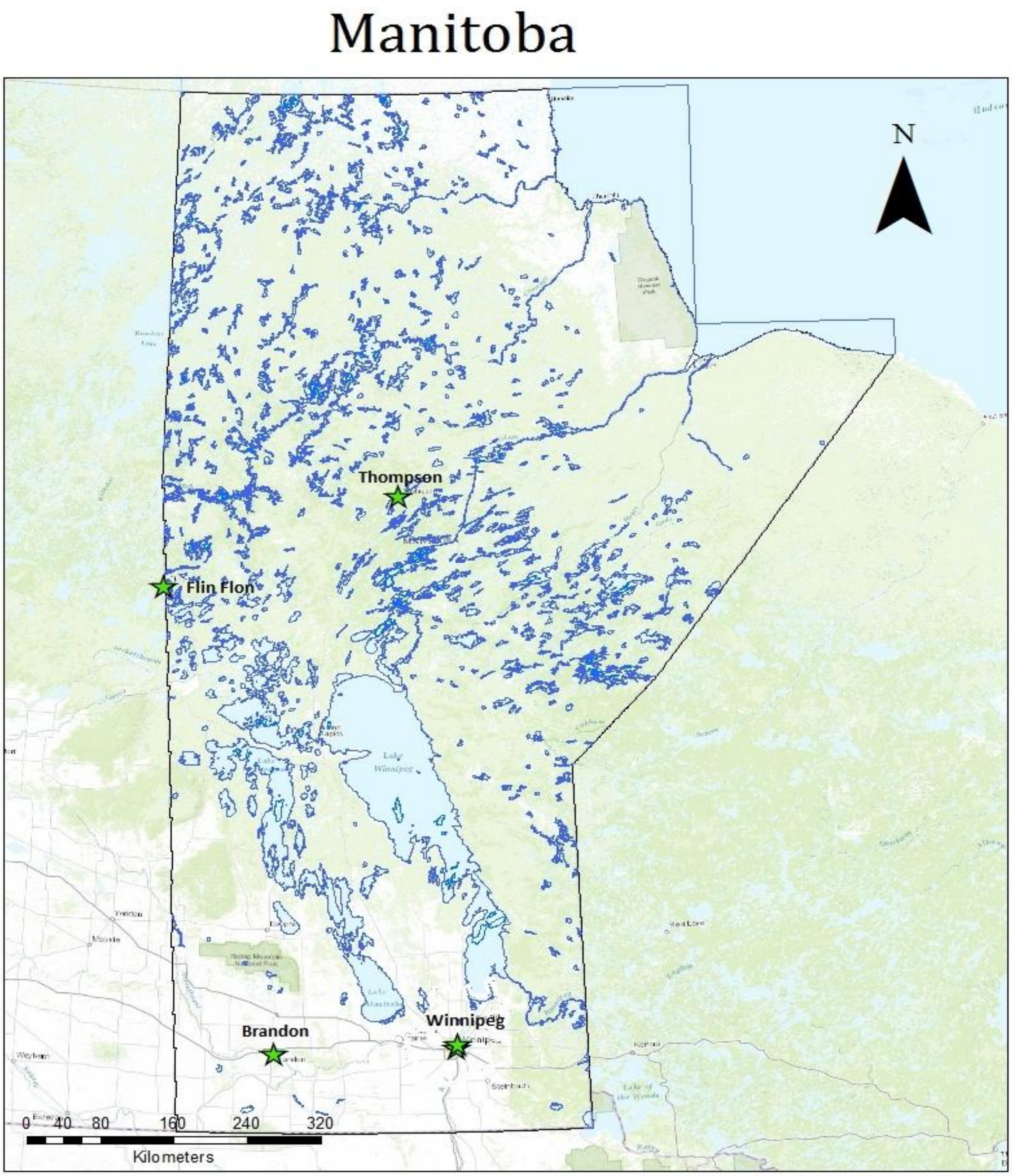

Figure 1: Air Quality Monitoring in Manitoba.

Brandon

Brandon is the second largest community in Manitoba with a population of 51,282 (2014) and is located in the southwestern part of the province. Brandon has one ambient air monitoring station located at the parking area of Assiniboine Community College. The main sources of emissions are transportation, agricultural and industrial activities. Major industrial activities include electric power generation and fertilizer production.

Northern Manitoba

In northern Manitoba, there are two air quality monitoring stations, one located in the City of Flin Flon (143 Main Street) and the other in the City of Thompson (Westwood School).

Flin Flon with a population of 5,840 (2014), is a mining city and is located on the border of Manitoba with Saskatchewan. Copper and zinc mining by Hudson Bay Mining and Smelting (HBM&S) is the major source of industrial air emissions in Flin Flon. However, the copper smelter in Flin Flon shut down in June 2010, significantly reducing air emissions to the region. Transportation is also a major source of emissions.

Thompson is a city in northern Manitoba with a population of 14,459 (2014). Vale's smelting and mining operations is the main source of industrial emissions in Thompson. Transportation is also a major source of emissions.

3.0 ACHIEVEMENT STATUS

This section gives details on Manitoba's achievement status with the CAAQS for $PM_{2.5}$ (24-hour, annual $PM_{2.5}$) and ozone based on concentrations measured over 2012, 2013 and 2014[1].

3.1 $PM_{2.5}$ Levels

> $PM_{2.5}$ is referred to as "fine" particulates and is believed to pose the greatest health risk among particulate matter. Because of their small size (~1/30th of the average human hair width), $PM_{2.5}$ can lodge deeply into the lungs.

$PM_{2.5}$ measurements are reported for all five ambient air monitoring stations in Manitoba. The measurements were performed using federal equivalent methods (FEM) monitoring equipment.

The 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ concentrations at all stations indicated that all provincial air quality reporting areas are in achievement of the CAAQS $PM_{2.5}$ standard. Winnipeg's 24 hour-$PM_{2.5}$ (98th percentile) concentrations ranged from 18µg/m^3 (65

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[1] The requirements and procedures to determine the achievement status of an air zone with the CAAQS are presented in the *Guidance Document on Achievement Determination* which is available at: http://www.ccme.ca/assets/pdf/pn_1483_gdad_eng.pdf

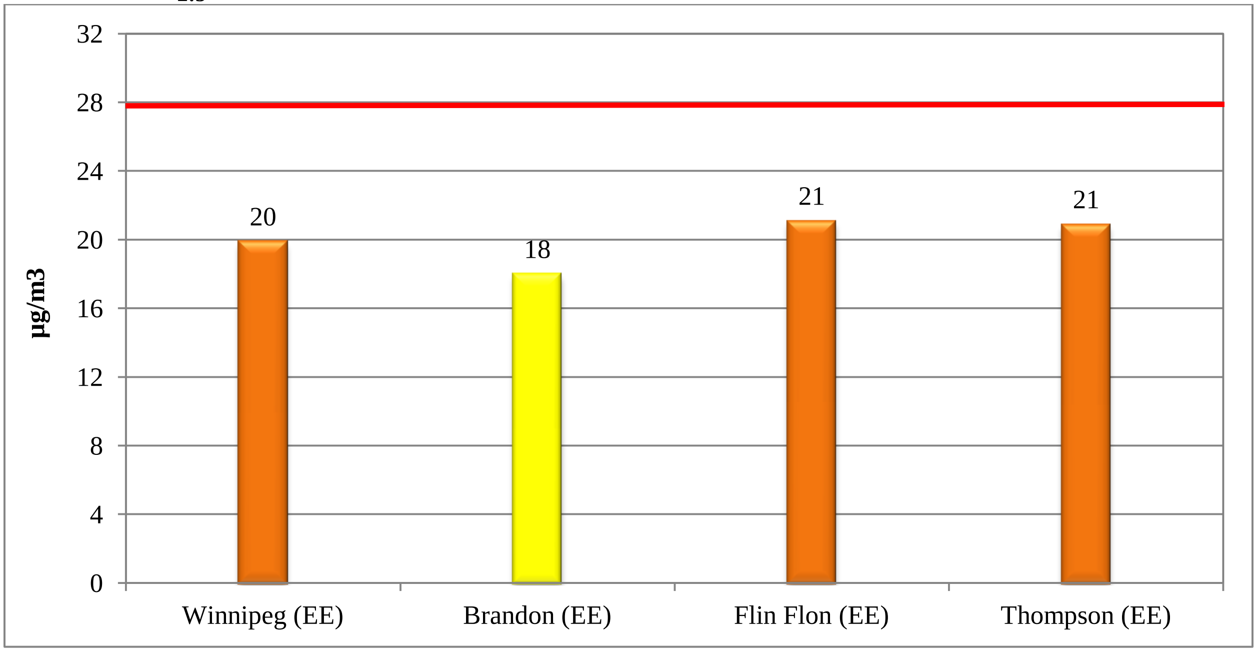
Ellen Street) to 20µg/m^3 (299 Scotia Street). Outside Winnipeg, the 24-hour $PM_{2.5}$ metric ranged from 18 µg/m^3 (Brandon) to 21µg/m^3 (Thompson and Flin Flon).

The annual average $PM_{2.5}$ ranged from 3.7µg/m^3 (Thompson) to 6.5µg/m^3 (65 Ellen St., Winnipeg). In the Winnipeg CMA, the annual average $PM_{2.5}$ concentrations were higher in the downtown station (65 Ellen Street) at 6.5µg/m^3 compared with the residential station (299 Scotia Street) at 5.5µg/m^3. However, only two years of data (2013 and 2014) were available for the 299 Scotia Street station as data completeness criteria (at least 60% valid data in each calendar quarter) were not met in 2012. In the city of Brandon, 6.2µg/m^3 is the annual average for $PM_{2.5}$. In northern Manitoba, Flin Flon and Thompson monitoring stations had annual averages of 5.6µg/m^3 and 3.7µg/m^3 $PM_{2.5}$, respectively.

There is evidence that 24-hour average $PM_{2.5}$ levels in all air quality monitoring stations in Manitoba were affected by exceptional events (EE) like forest or wildfire smoke during the years 2012-2014. Thompson and Flin Flon stations were the most affected by forest fire smoke when compared to southern Manitoba. There is a separate report on the weight of evidence analysis to determine the influence of exceptional events on the monitoring data.

Figure 2 presents the $PM_{2.5}$ concentrations based on the measurements conducted for the period 2012-2014 at all stations.

24-hour $PM_{2.5}$



Annual $PM_{2.5}$

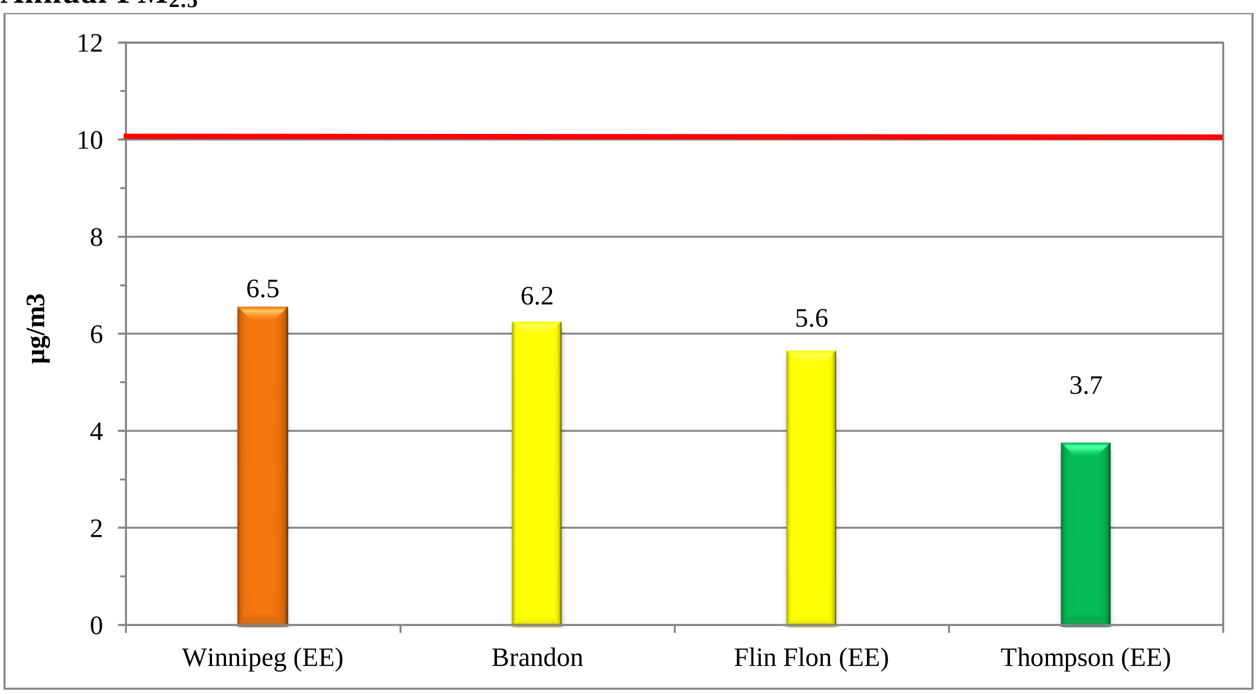


Figure 2: $PM_{2.5}$ concentrations in Manitoba (2012 to 2014). Upper graph based on 24-hour concentration (annual 98th percentile, averaged over 3 years). Lower graph based on annual mean concentration (averaged over 3 years). Red line on graph indicates CAAQS standards of 28 µg/m^3 (upper graph) and 10µg/m^3 (lower graph). The color of each vertical bar indicates the appropriate CAAQS's management level. (EE) indicates that concentrations were influenced by Exceptional Event (EE).

A ten year trend (2005-2014) in $PM_{2.5}$ concentrations (24-hour 98th percentile) is shown in **Figure 3**. No trend[2] in this $PM_{2.5}$ metric (increasing or decreasing) was observed during this time for either Flin Flon or Brandon. An increasing trend in the $PM_{2.5}$ metric was observed for both Thompson and Winnipeg. The trend for Thompson is largely the result of the influence from a highly active wildfire season in 2013. The trend for Winnipeg is likely due to a variety of factors, including a potential increase in mobile sources of PM, and the influence of smoke from wildfires moving into the city in recent years.

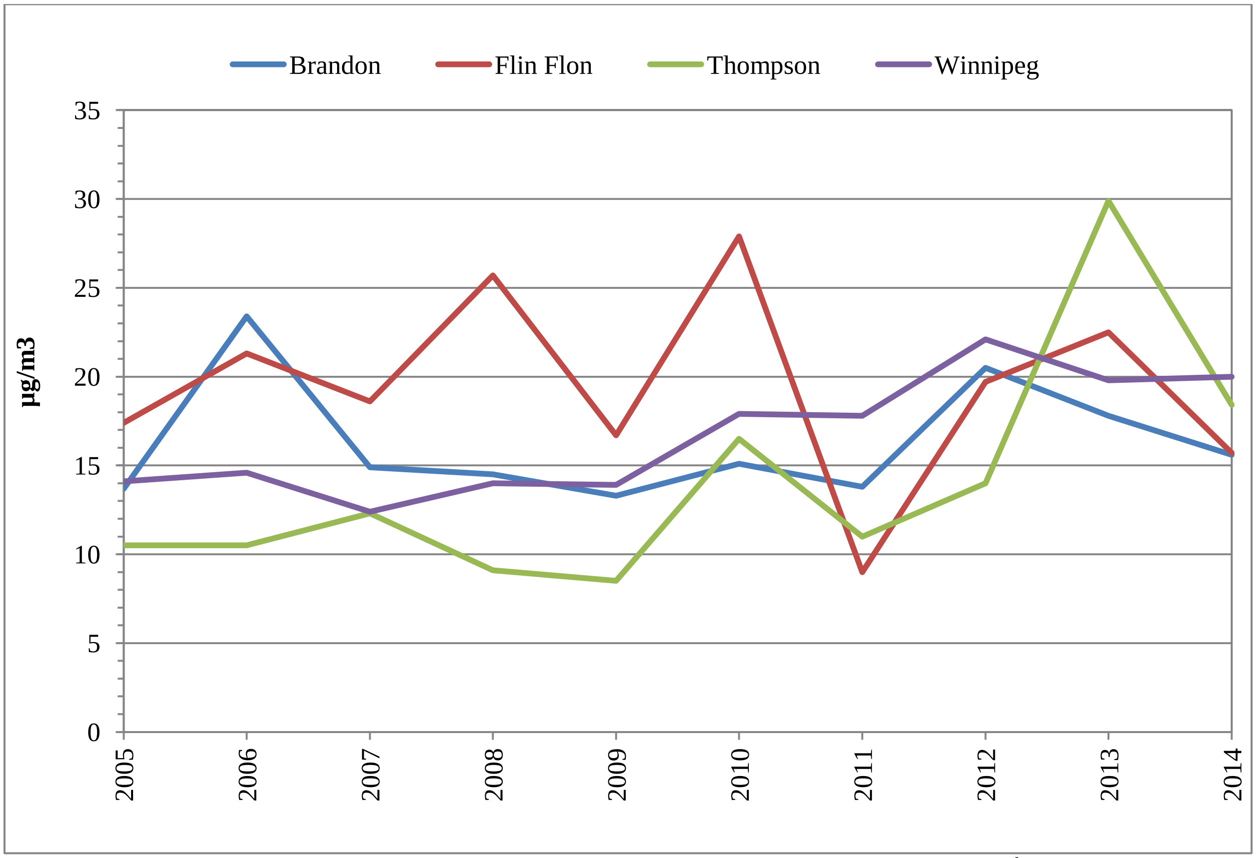


Figure 3: Annual Trend in $PM_{2.5}$ concentrations (2005-2014), based on the 98th percentile of 24-hour average concentrations. This data is not corrected for the influence of exceptional events (i.e. wildfires).

Note: $PM_{2.5}$ data for Flin Flon in 2014 do not meet data completeness criteria.

[2] Statistical significance was determined based on a least-squares linear regression at 95% confidence.

3.2 Ground Level Ozone (O3)

Ground level ozone is a secondary pollutant from reactions involving nitrogen oxides and hydrocarbons in the presence of sunlight.

Ozone in the air we breathe can harm our health—typically on hot, sunny days when ozone has the potential to reach unhealthy levels. Children, people with lung disease, older adults, and people who are active outdoors, including outdoor workers, may be particularly sensitive to ozone.

Measurement of ground level ozone was conducted in all Manitoba stations but Thompson's data are not included in the report as they did not meet the data completeness criteria. The criteria requires that there must be valid data for at least 75% of the spring and summer months (April 1^{st} to September 30^{th}). **Figure 4** shows the ozone concentrations over the years 2012, 2013 and 2014.

Ozone concentrations from all stations indicated that all reporting areas in Manitoba were in achievement of the CAAQS ozone standard. The three-year average of the fourth highest daily maximum 8-hour ozone concentrations ranged from a low of 47 ppb at Flin Flon to a high of 58 ppb at Winnipeg (299 Scotia Street). Ozone metric values in Winnipeg (65 Ellen Street) and Brandon stations were both 54 ppb during the period 2012-2014. It is noteworthy that southern Manitoba experienced higher ozone levels when compared to northern Manitoba. While there are local sources of ozone and its precursors in the Winnipeg area, there is evidence that transboundary flow may have contributed to the higher ozone levels in southern Manitoba. The transboundary flow (TF) is predicted to be from the Midwestern United States and other Canadian provinces. There is a separate report on the weight of evidence analysis to determine the influence of transboundary flows on the monitoring data.

A ten year trend (2005-20014) in the annual 4^{th} highest daily maximum 8-hour averaged ozone concentrations is shown in **Figure 5**. No trend[3] (increasing or decreasing) was observed during this time for either Winnipeg or Brandon. The start of ozone measurement in Flin Flon and Thompson (2012) was too recent to determine any trends in ozone concentrations at this time.

[3] Statistical significance was determined based on a least-squares linear regression at 95% confidence.

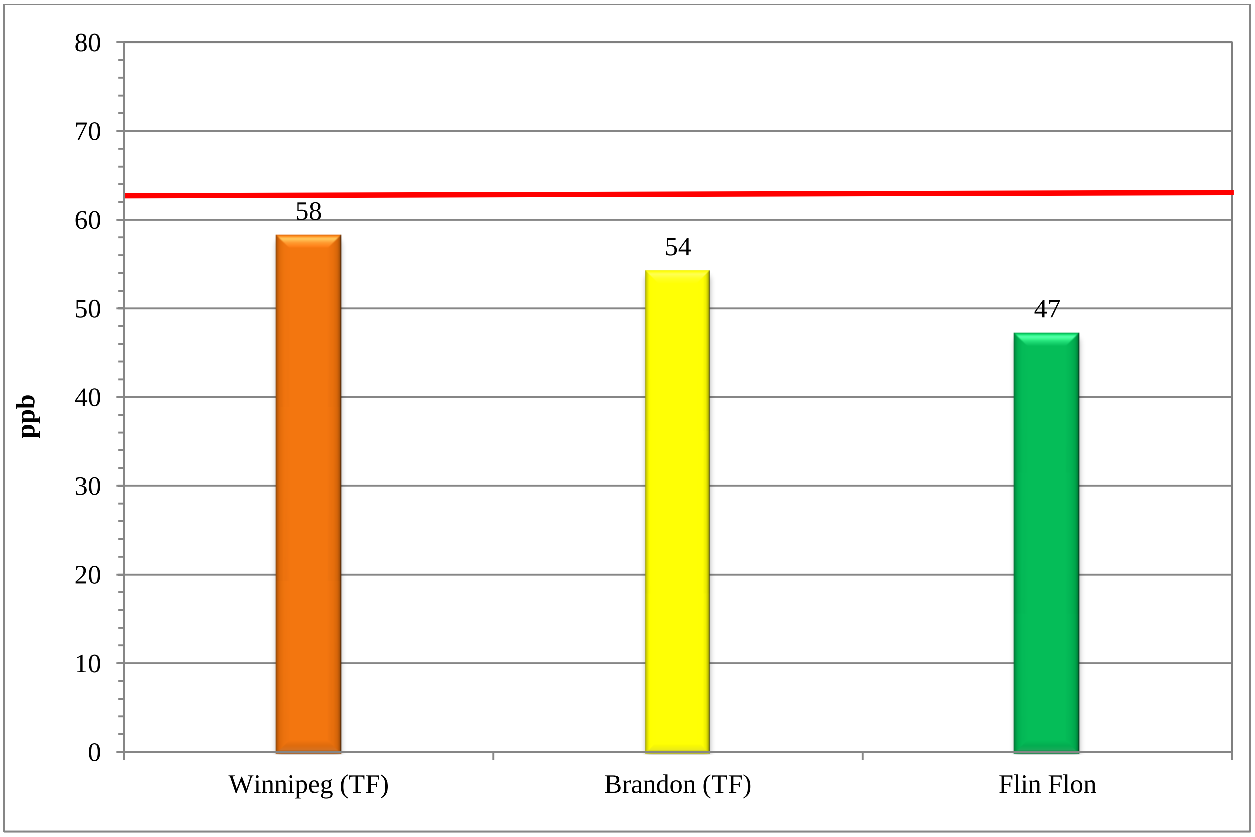


Figure 4: Ozone concentration in Manitoba (2012-2014), based on the CAAQS metric (i.e. the year's 4th highest daily maximum 8-hour ozone concentrations averaged over 3 consecutive years). The color of each vertical bar indicates the appropriate CAAQS's management level. (TF) indicates that concentrations were influenced by Transboundary Flows (TF) of air pollutants. The red line is the CAAQs value of 63 ppb.

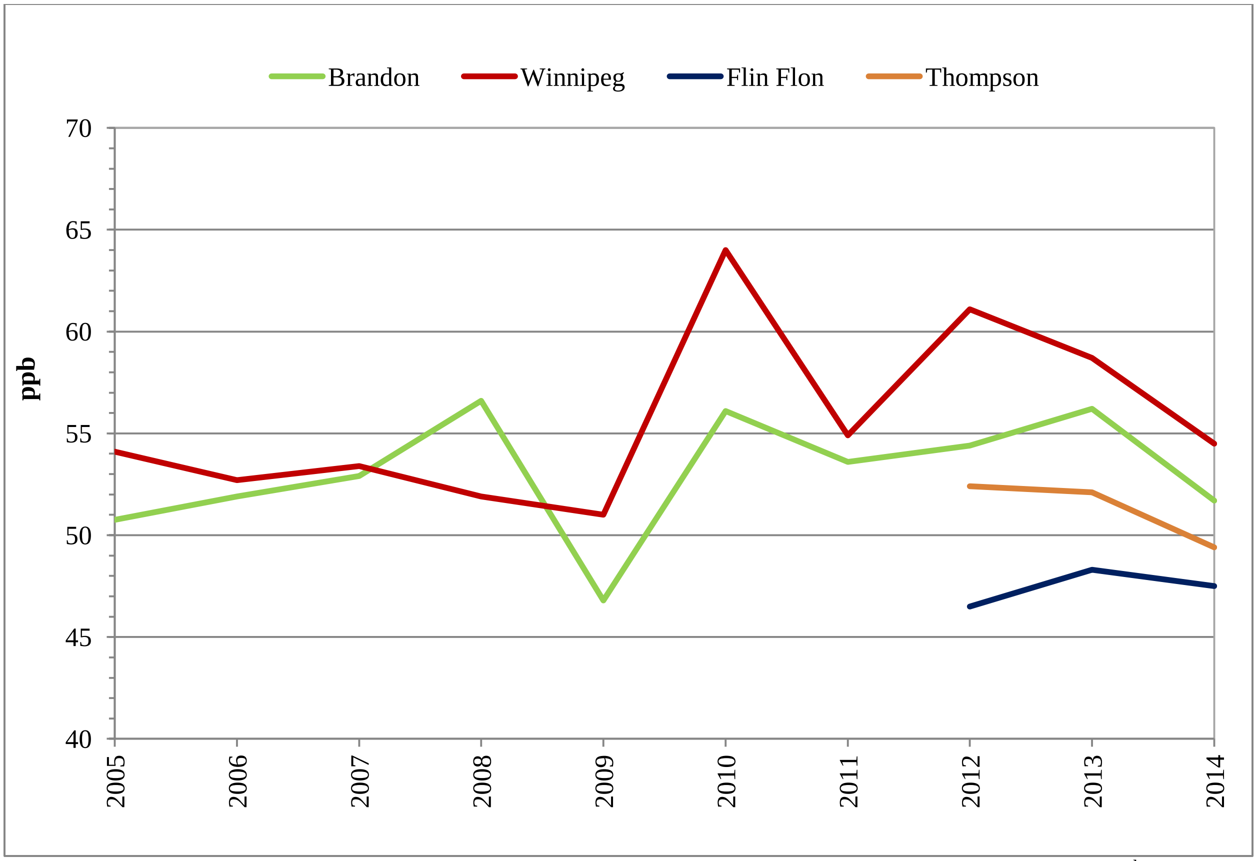


Figure 5: Annual trend in ozone concentrations (2005-2015), based on the annual 4th highest daily 8-hour maximum concentration. These data are not corrected for the influence of transboundary flow of ozone from beyond Manitoba.

Note: 2013 and 2014 data for Thompson and 2013 data for Flin Flon do not meet data completeness criteria.

4.0 INFLUENCE OF TRANSBOUNDARY FLOWS AND EXCEPTIONAL EVENTS (TF/EE)

There are instances that ambient $PM_{2.5}$ and ground level ozone concentrations may be higher because of exceptional events (i.e. smoke from forest fire) or external influences (i.e. transboundary flow).Where such influences can be demonstrated using a weight-of-evidence approach, the contribution of such events to air quality measurements can be removed. This is done so that long-term management strategies are not developed on the basis of events that are beyond local or provincial control. For the reporting period 2012-2014, there are several instances that $PM_{2.5}$ and ground level ozone concentrations are influenced by exceptional events and external influences.

$PM_{2.5}$ data for the years 2012-2014 from the five ambient air monitoring stations in Manitoba were considered in the determination of potential influences from forest or wildfire fire smoke. A threshold value 28 $\mu g/m^3$ for 24-hour average $PM_{2.5}$ was selected and $PM_{2.5}$ concentrations equal to or higher were reviewed. Using the weight-of-evidence analysis approach, it was determined that 14 days were potentially influenced by forest fire smoke for the period 2012-2014.

Hourly ozone data for the years 2012-2014 from five ambient air monitoring stations in Manitoba were considered in the determination of potential influences from transboundary flow from the United States or other Canadian jurisdictions. A threshold value of 55 ppb for 8-hour rolling average ozone was selected and data equal or higher than the threshold were reviewed. Using the weight of evidence approach, a total of 18 days were identified as influenced by transboundary flow on the years 2012-2014. In 2012, a total of 10 days were potentially influenced by transboundary flows which is the highest during the reporting three-year period. It is worthy to note that ozone concentrations impacted by transboundary flow are all in southern Manitoba (Winnipeg and Brandon areas).

There is a separate report on the weight of evidence analysis to determine the influence of exceptional events and transboundary flows on the monitoring data.

Tables 3 and **4** show the CAAQS values for annual 98^{th} percentile of $PM_{2.5}$ and annual average of $PM_{2.5}$ at all air quality reporting areas in Manitoba during the period 2012-2014, respectively. Both tables contain the CAAQS values for $PM_{2.5}$ after removing the forest fire smoke influence.

Table 3: CAAQS reporting values for $PM_{2.5}$ after removing the wildfires influence (Annual 98th percentile of 24-hr average)

Air Quality Reporting Area	$PM_{2.5}$ Annual 98th percentile of 24-hr average (µg/m^3) (Standard Value: 28 µg/m^3)			
	2012	2013	2014	3-year average
Winnipeg	18.1	18.8	20.0	19
Brandon	19.6	17.8	15.6	18
Flin Flon	14.7	22.1	N/A	18
Thompson	14.0	19.9	18.4	18

Table 4: CAAQS reporting values for $PM_{2.5}$ after removing the wildfires influence (Annual average)

Air Quality Reporting Area	$PM_{2.5}$ Annual average (µg/m^3) (Standard Value: 10 µg/m^3)			
	2012	2013	2014	3-year average
Winnipeg	6.5	6.5	6.2	6.4
Brandon	6.6	6.4	5.7	6.2
Flin Flon	5.1	5.3	N/A	5.2
Thompson	3.6	3.7	3.3	3.5

Table 5 show the CAAQS values for the annual average of 4th highest daily maximum 8-hour ozone after removing the influence from transboundary flows. The color of the 3-year average column indicates the corresponding management action level.

Table 5: CAAQS values for the 4th highest daily max. 8-hour ozone after removing the transboundary influence

Air Quality Reporting Area	4th Highest Daily Maximum 8-hour O_3 (Standard Value: 63 ppb)			
	2012	2013	2014	3-year average
Winnipeg	57.5	58.7	51.6	56
Brandon	54.4	55.6	51.6	54
Flin Flon	46.5	N/A	47.5	47

5.0 DETERMINATION OF MANAGEMENT LEVEL

Management levels are assigned on the basis of the highest concentration within each reporting area excluding the contributions from exceptional events such as wildfire and external influences such as transboundary flow of ozone. As a result, the management levels for the reporting areas are shown on **Table 6**.

Table 6: Management levels for $PM_{2.5}$ and Ozone for the Manitoba reporting areas

Reporting Area	Management Level PM2.5	Management Level Ozone
Winnipeg	Yellow	Yellow
Brandon	Yellow	Yellow
Flin Flon	Yellow	Green
Thompson	Yellow	N/A

6.0 ACTIONS TO PROTECT AIR QUALITY

As part of the provincial air quality management strategy to prevent the deterioration of air quality and provide for long-term sustainability, the following are the major programs and strategies being implemented in Manitoba:

- **Environmental Licensing:** Industries and other developments where there is a potential impact to air quality will continue to be assessed and managed for the longer term. The Province will ensure that new facilities are built to meet the highest level of environmental quality with respect to air emissions.

- **Compliance Monitoring and Enforcement:** Licensed facilities and developments are being monitored and assessed and when necessary air sampling and monitoring at the facility and its area of influence will be conducted using Environment Canada or US EPA approved sampling methodologies.

- **Setting Air Quality Objectives and Guidelines:** Manitoba will continue to participate collaboratively in the development of national air quality criteria and will develop provincial air quality criteria/standards.

- **Ambient Air Quality Monitoring:** In cooperation with Environment Canada, ambient air monitoring is being conducted on selected urban areas within the province as well as in targeted areas (special projects) where specific air quality concerns have been raised. Additional monitoring stations are being considered to improve area of coverage and to enhance decision making.

- **Action on Climate Change:** Many actions related to reducing greenhouse gas emissions in Manitoba are anticipated to have co-benefits related to improved air quality.

- **National Activities:** Manitoba will continue to participate in work being undertaken collaboratively with federal, provincial and territorial governments on air quality issues of regional, national or international interest.

- **Providing Air Quality Information:** A website providing the monitoring data in near real time is available and publicly accessible. Also, the Province is an active partner in the Canada Air Quality Health Index forecasting (AQHI) program. The AQHI is designed to help Manitobans make informed decisions about protecting themselves and their family from the effects of air pollution. The AQHI is currently available for Winnipeg and Brandon and is being considered for Flin Flon and Thompson.
  www.manitobaairquality.ca
  http://www.ec.gc.ca/cas-aqhi/default.asp?lang=En&n=CB0ADB16-1