NWT AIR QUALITY

2022 REPORT

Long-Term Trends 2008-2022
Canadian Ambient Air Quality Standards 2020-2022

QUALITÉ DE L'AIR AUX TNO

RAPPORT DE 2022

Tendances à long terme 2007-2022
Normes nationales de qualité de l'air ambiant 2019-2022

Government of
Northwest Territories

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Glossary

Air Quality Management System (AQMS): A comprehensive approach for protecting and improving air quality in Canada.

Air zone: A geographic area used to manage local air quality by the province or territory within its boundaries.

Canadian Air and Precipitation Monitoring Network (CAPMoN): A program operated by Environment and Climate Change Canada (ECCC), designed to study the regional patterns and trends of atmospheric parameters such as acid rain, smog, particulate matter, and mercury, in both air and precipitation.

Canadian Ambient Air Quality Standards (CAAQS): Health and environmental-based air quality objectives to protect human health and the environment.

CAAQS metric value: The measured concentrations of an air parameter calculated in the statistical form of the CAAQS.

Exceedance: The amount by which a parameter exceeds a standard or permissible measurement.

Meteorological: Relating to the science that deals with the phenomena of the atmosphere, especially weather and weather conditions.

Micrograms per cubic meter ($\mu g/m^3$): A measure of parameter concentration. Micrograms of parameter per cubic meter of air.

National Air Pollution Surveillance (NAPS): A joint program of the federal, provincial, and territorial governments to monitor and assess ambient air in Canadian urban centers.

Nitrogen oxides (NO_x): Gases that form when nitrogen and oxygen in the atmosphere are burned with fossil fuels at high temperatures. NO_x contributes to ground-level ozone formation. NO_x consists of nitric oxide (NO) and nitrogen dioxide (NO_2).

Nitrogen dioxide (NO_2): NO_2 is part of the NO_x group of compounds. It forms primarily from emissions from burning fossil fuels, vehicles, power plants and off-road equipment.

Ozone (O_3): An invisible gas occurring naturally in the upper atmosphere but at ground levels it is a major component of smog. It is not emitted directly but formed because of complex chemical reactions when volatile organic compounds and NO_x react in the presence of sunlight.

Fine Particulate matter ($PM_{2.5}$): Airborne particulate matter that is less than or equal to 2.5 micrometers in diameter. These tiny particles can cause or worsen respiratory and cardiovascular problems. Wildfires, industry, heating, and transportation all produce $PM_{2.5}$.

Parts per billion (ppb): A measure of parameter concentration. Parts of parameter per billion parts of air.

Sulfur dioxide (SO_2): A heavy, pungent, colourless gas formed primarily by the combustion of fossil fuels. It is a respiratory irritant, especially for asthmatics.

Acronyms and Abbreviations

AQMS	Air Quality Management System
CAAQS	Canadian Ambient Air Quality Standards
CAPMoN	Canadian Air and Precipitation Monitoring Network
CCME	Canadian Council of Ministers of the Environment
ECC	Department of Environment and Climate Change
ECCC	Environment and Climate Change Canada
GNWT	Government of the Northwest Territories
NAPS	National Air Pollution Surveillance Program
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NWT	Northwest Territories
O_3	Ozone
$PM_{2.5}$	Fine Particulate Matter
ppb	parts per billion (by volume)
SO_2	Sulphur Dioxide
TF/EE	Transboundary Flows / Exceptional Events
$\mu g/m^3$	micrograms per cubic meter

EXECUTIVE SUMMARY

This annual report provides the Northwest Territories' air quality monitoring results spanning over three years from 2020-2022 and includes long-term trends observed over fifteen years from 2008-2022. The report includes a detailed technical explanation of these trends and comparisons to standards. Aggregating data over three years enables comparisons to standards, most of which are based on three-year averages. This approach offers a more stable and reliable assessment of air quality by smoothing out short-term fluctuations and anomalies that could skew annual results.

SOMMAIRE

Ce rapport annuel présente les résultats de la surveillance de la qualité de l'air des Territoires du Nord-Ouest de 2020 à 2022, et inclut les tendances à long terme observées sur quinze ans entre 2008 et 2022. Il inclut une explication technique détaillée de ces tendances et une comparaison avec les normes. En regroupant les données sur trois ans, on peut les comparer aux normes, dont la plupart se basent sur des moyennes sur trois ans. Cette approche offre une évaluation plus stable et plus fiable de la qualité de l'air en atténuant les fluctuations à court terme et les anomalies qui pourraient fausser les résultats.

Who are we?

The Government of the Northwest Territories (GNWT) Department of Environment and Climate Change (ECC, we, us) is responsible for monitoring and managing air quality in the Northwest Territories (NWT). We have been monitoring air quality in the NWT since 1974 and generating annual air quality reports for the public since the mid-1990s.

We work closely with Environment and Climate Change Canada (ECCC) to monitor air quality. ECCC tracks air parameters across Canada. They operate a program to supply us, and other provinces and territories, with the equipment we need to measure and share data. Provinces and territories have also co-developed guidelines with ECCC through the Canadian Council of Ministers of the Environment (CCME) that we use to conduct quality assurance and quality control of our air quality data.

The GNWT, in partnership with ECCC, currently operates five monitoring stations in Yellowknife, Inuvik, Fort Smith, Fort Simpson, and Norman Wells. The Fort Simpson station was established in late 2022 and is not included in this report due to insufficient data.

We manage air quality by providing information to environmental impact assessments, establishing environmental agreements with mine operators, and developing NWT air quality standards, and NWT ambient air quality monitoring guidelines. We work closely with the GNWT's Department of Health and Social Services, which is responsible for issuing air quality advisories on health effects related to wildfire smoke.

What do we measure?

Each of our five stations tracks air quality parameters, including:

- **fine particulate matter ($PM_{2.5}$)**: small solid or liquid particles in the air that are harmful to breathe. Wildfires, industry, heating, and transportation all produce $PM_{2.5}$.
- **ground-level ozone (O_3)**: a gas that is harmful to breathe and can affect vegetation and reduce its productivity when too close to the earth. Ozone is essential in the upper atmosphere where it protects the earth from radiation.
- **nitrogen dioxide (NO_2)**: a gas that is harmful to breathe at certain levels. It is involved in the formation of $PM_{2.5}$ and acid rain. Most NO_2 comes from transportation, industry, and burning fossil fuels for heat and electricity.
- **sulphur dioxide (SO_2)**: a gas that is harmful to breathe and can damage plants at certain levels. It is also involved in the formation of $PM_{2.5}$ and acid rain. Sources of SO_2 include burning of fossil fuels such as in power generation, industrial processes, transportation, and heating.

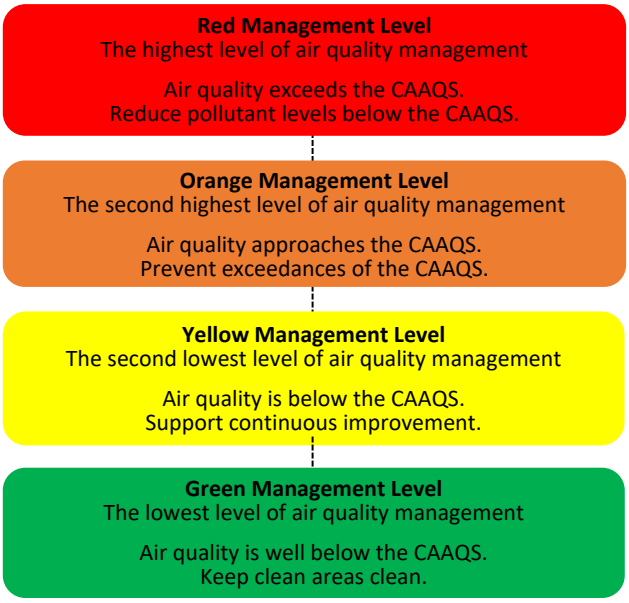
Why do we compare air quality to standards?

This report compares air quality in the territory to national standards – the Canadian Ambient Air Quality Standards (CAAQS) – which are developed by the CCME. While our previous annual reports up to 2019 used territorial air quality standards, we decided to transition our annual air quality reporting from territorial standards to the CAAQS, starting with the 2020 report and for future reports, due to the following reasons:

- Over the past decade, there have been no exceedances of territorial air quality standards, except for particulate matter during active wildfire events and from road dust in spring when the snow cover disappears and exposes sand and gravel deposited in winter on roads;
- CAAQS are more stringent and protective of the environment and human health than the territorial standards, as CAAQS are based on more recent science and health assessment research;
- This transition offers the benefit of harmonization in air quality reporting across the country, promoting data consistency and simplifying comparisons between provinces and territories;
- CAAQS are developed by federal, provincial and territorial governments, Indigenous organizations, and stakeholders under the CCME to guide air zone management; and
- This fulfills GNWT's commitment to monitor and report on air quality as part of Canada's collaborative Air Quality Management System.

CAAQS are integrated into a framework of Air Zone Management Levels that is described below. Each colour represents a management level, which is related to how healthy the air is and how concerned we should be. Air quality in the red management level indicates exceedances of standards, whereas air quality in the green management level indicates air quality levels are well below the standards. We use the data from different air zones to determine which management level applies to a particular zone. The resulting management level sets objectives and actions that should be taken.

Figure 1: Air Zone Management Framework



What did we find?

Our air is better than national standards

Overall, the 2020-2022 data shows that our air quality is very good and has achieved the national air quality standards, CAAQS, for the four parameters. Our air quality is very good because our population density is low, and we have limited industrial emission sources. However, wildfires and long-range pollutants can affect our air quality, and it is important that we continue to monitor.

The table below shows territorial air quality, in comparison to CAAQS, for each parameter at each station that represents an air zone. We have only green and yellow levels – the lowest and second lowest levels of air quality management. We have no red or orange, which exceed or approach air quality standards, respectively, and would set the next management steps in motion.

Table 1: Northwest Territories Air Zone Management Level Results 2020-2022

Air Zone	Fine Particulate ($PM_{2.5}$)	Ozone (O_3)	Nitrogen Dioxide (NO_2)	Sulphur Dioxide (SO_2)
North Slave	Yellowknife	Yellowknife	Yellowknife	Yellowknife
South Slave	Fort Smith	Fort Smith	Fort Smith	Fort Smith
Beaufort Delta	Inuvik	Inuvik	Inuvik *(insufficient data)*	Inuvik
Sahtu	Norman Wells	Norman Wells	Norman Wells	Norman Wells

How has air quality changed over the last 15 years?

Air quality has remained stable between 2008 and 2022.

- $PM_{2.5}$ levels remained fairly stable, with annual changes driven by the occurrence of wildfire smoke.
- NO_2 levels have remained stable, which is likely because of the absence of any major changes to emissions from residential and commercial heating.
- SO_2 levels have remained consistently low, which can be related to lower emissions from combustion and mobile sources. This is a cross-country trend that is likely because of lower sulphur levels in fuel.
- O_3 levels have stayed relatively consistent, which can be linked to background O_3.

It is important to continue monitoring

We have clean air in the Northwest Territories, but we need to keep monitoring. Due to the changing climate, we can expect more wildfire events within and outside the territory which could cause pollutants to travel long distances and impact our air quality. We must continue to measure air quality across the territory to understand current conditions, identify potential issues early, and respond proactively. Monitoring air quality is important for protecting the environment and public health, issuing air quality advisories, informing policy decisions, ensuring compliance, supporting research and development, and raising public awareness about the significance of clean air.

1.0 INTRODUCTION

1.1 Air Quality Monitoring in the Northwest Territories

The Government of the Northwest Territories (GNWT) Department of Environment and Climate Change (ECC) monitors outdoor air quality in the Northwest Territories (NWT).

Air quality monitoring in the NWT began with a single particulate matter monitor in Yellowknife in 1974. Since the 1990s, the NWT Air Quality Monitoring Network has expanded to a network of five monitoring stations located in Yellowknife, Inuvik, Fort Smith, Norman Wells and Fort Simpson. Each station monitors a variety of air quality parameters and meteorological conditions. Data from the Fort Simpson station, established in late 2022, is not included in this report due to insufficient data.

Since 2019 reports used territorial air quality standards. In 2020 the decision was made to transition annual air quality reporting from territorial standards to the Canadian Ambient Air Quality Standards (CAAQS). This decision was made because:

- Over the past decade, there have been no exceedances of territorial air quality standards, except for particulate matter during active wildfire events and from road dust in the spring when the snow cover disappears and exposes sand and gravel deposited in winter on roads;
- CAAQS are more stringent and protective of the environment and human health than the territorial standards, as CAAQS are based on recent science and health assessment research;
- This transition offers the benefit of harmonization in air quality reporting across the country, promoting data consistency and simplifying comparisons between provinces and territories;
- CAAQS were developed by federal, provincial, and territorial governments, Indigenous organizations, and stakeholders under the Canadian Council of Ministers of the Environment (CCME) to guide air zone management; and
- This fulfills GNWT's commitment to monitor and report on air quality as part of Canada's collaborative Air Quality Management System.

The purpose of this report
This annual report presents long-term trends in air quality over fifteen years from 2008 to 2022 and monitoring results spanning over three years from 2020 to 2022 compared to CAAQS. This report is also ECC's annual air zone report.

You can find additional information, including 'near real-time' air quality parameter readings, on the NWT Air Quality Monitoring Network website at http://aqm.enr.gov.nt.ca/.

For information on health effects related to air quality, see Environmental Health website at https://www.hss.gov.nt.ca/en/services/environmental-health/air-quality.

Measuring air quality is coordinated across Canada
ECC works closely with other jurisdictions and are also involved with various programs to share data and knowledge. We participate in:

- the National Air Pollution Surveillance (NAPS) program—a joint federal, provincial and territorial monitoring network run by Environment and Climate Change Canada (ECCC). The goal of the NAPS program is to provide accurate and long-term air quality data in a uniform standard across Canada. We have five monitoring stations in the NWT - Yellowknife, Inuvik, Fort Smith, Norman Wells and Fort Simpson - as part of the NAPS program.
- the Canadian Air and Precipitation Monitoring Network (CAPMoN) program—a program that monitors rainwater and snow quantities for deposition and ozone levels at two stations in the NWT at the Wood Buffalo National Park and the Snare Rapids hydro facility (**Figure 2**).
- the CCME's Air Quality Management System (AQMS).

1.2 National Air Quality Management System

The CCME worked closely with federal, provincial, and territorial governments; Indigenous Organizations; industry; and environmental and health non-governmental organizations to establish the Canadian AQMS that launched in 2012. The AQMS is the country's comprehensive approach to air quality management and is built on a foundation of collaboration, accountability, and transparency. The CCME continues to monitor and improve how the AQMS is being implemented. You can find additional details regarding the AQMS on ccme.ca.

1.2.1 Canadian Ambient Air Quality Standards (CAAQS)

The CAAQS are the national standards to assess air quality under the AQMS. They are designed to protect human health and the environment from air pollution. The CAAQS cover four parameters: $PM_{2.5}$, O_3, NO_2, and SO_2. The table below shows the current and future CAAQS. We used the 2020 CAAQS in this report to compare our monitoring results to. The 2025 CAAQS were announced in advance of their achievement date, allowing jurisdictions and industries sufficient time to make necessary adjustments and take appropriate actions to address emissions, if needed.

Table 2: Canadian Ambient Air Quality Standards

Parameter	Averaging Time	Standard		Statistical Form
		2020	2025	
Fine Particulate ($PM_{2.5}$)	24-hour	27 µg/m^3	-	The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
	Annual	8.8 µg/m^3	-	The 3-year average of the annual average of the daily 24-hour average concentrations
Ozone (O_3)	8-hour	62 ppb	60 ppb	The 3-year average of the annual 4th highest daily maximum 8-hour average 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
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

- Future CAAQS for $PM_{2.5}$ are under review. (Source: ccme.ca)
µg/m^3 - micrograms per cubic metres.
ppb - parts per billion.

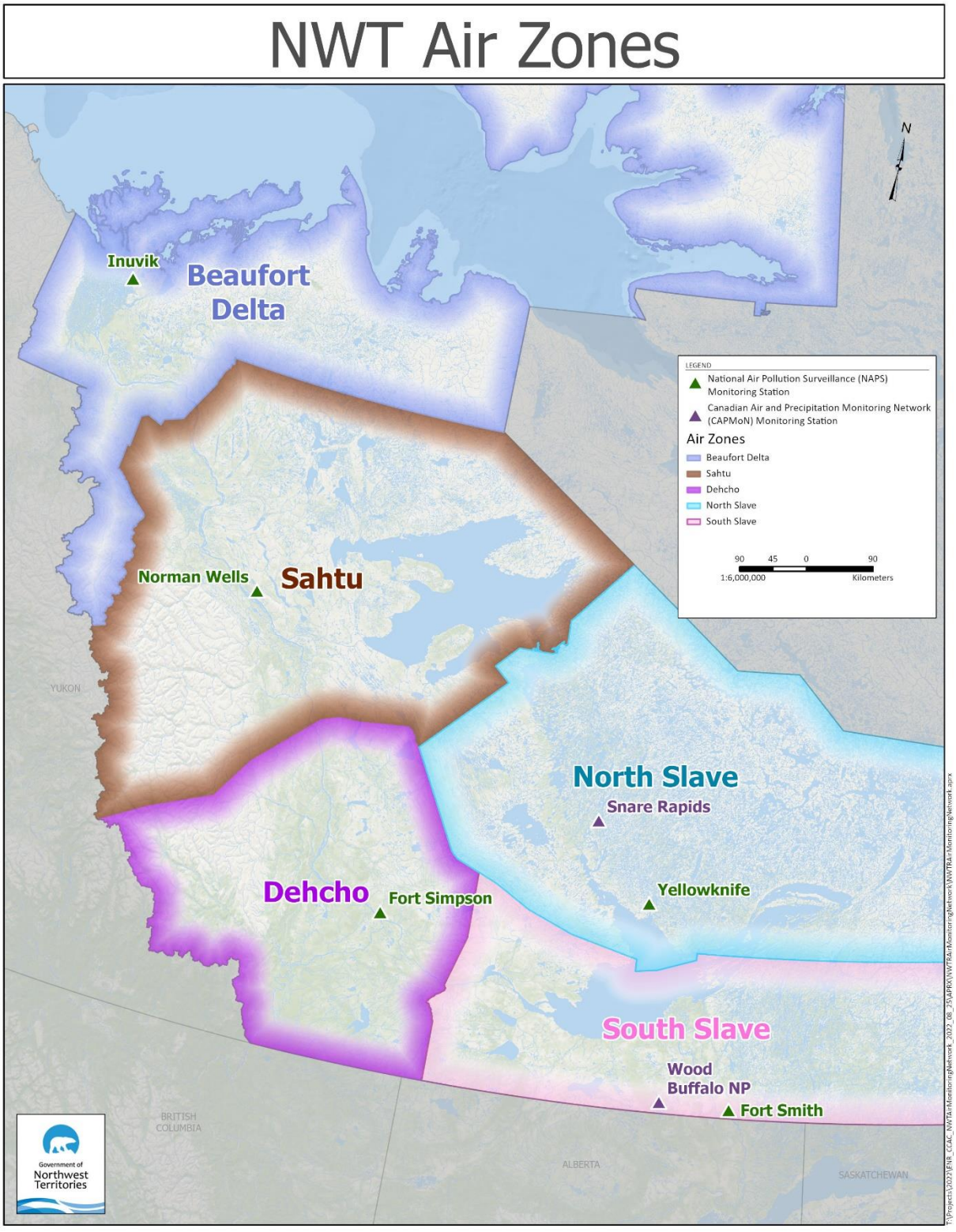
Note that when concentrations of air quality parameters measured at a monitoring station are converted into the statistical form of the CAAQS as shown in **Table 2** to enable comparison with the CAAQS, these concentrations are referred to as 'CAAQS metric values' or 'CAAQS metrics' or simply 'metric values'.

1.2.2 Air Zones

The AQMS requires territories and provinces to divide their jurisdictions into air zones—areas that show similar air quality characteristics, issues, and trends. These characteristics may include factors like pollutant sources, topography, meteorological patterns, population density, and other characteristics that influence air. Each jurisdiction must then measure, manage, and report on their air zones to show how air quality compares to the CAAQS.

We divided the NWT into five air zones which are aligned with the GNWT's five administrative regions—Beaufort Delta, Sahtu, Dehcho, North Slave, and South Slave (**Figure 2**). The NWT consists of vast expanses of land, with relatively few intermittent and small populated areas, and few widely distributed industrial emission sources. The reason for using administrative regions as the basis for air zone delineation is that currently there are no specific air quality issues or trends that require us to delineate the territory differently and factors that typically affect air quality are not unique to any particular area. Also, this alignment provides administrative convenience for air monitoring and reporting. Additionally, each air zone has one NAPS air quality monitoring station. We used data from the monitoring stations to calculate how each air zone scored on the CAAQS air zone management levels.

Figure 2: Air Zones and Monitoring Stations in the Northwest Territories



Note: Data from CAPMoN stations was not used in this report

1.2.3 Air Zone Management Levels

A framework[1] of air zone management levels helps to easily communicate air quality in an air zone and helps territories and provinces to set management objectives and take action, if needed. The CAAQS are supported by four management levels, each colour-coded (refer to **Figure 1** in the executive summary and **Table 3** below). Levels are separated by threshold values—if the concentration of a parameter exceeds a threshold value, then that air zone is assigned a new, stricter management level. A red management level means that air pollution exceeds the CAAQS. The green, yellow and orange management levels mean that air pollution achieves the CAAQS.

Air zones are assigned management levels that correspond to their air quality. For a given year, we:

1. average parameter levels in the air zone over the previous three years, except for annual NO_2 and SO_2 levels that are averaged over a single year as shown in **Table 2**;
2. compare the average to the threshold numbers in **Table 2**; and
3. assign the air zone the corresponding management level from **Table 3**.

This report is dated 2022 and uses data collected over three years from 2020 to 2022, as most CAAQS are based on a 3-year average, to assign management levels.

Table 3: CAAQS Management Levels

Management Levels	$PM_{2.5}$		O_3	NO_2		SO_2	
	24-hour (µg/m³)	**Annual** (µg/m³)	**8-hour** (ppb)	**1-hour** (ppb)	**Annual** (ppb)	**1-hour** (ppb)	**Annual** (ppb)
Red	>27	>8.8	>62	>60	>17.0	>70	>5.0
Orange	20 to 27	6.5 to 8.8	57 to 62	32 to 60	7.1 to 17.0	51 to 70	3.1 to 5.0
Yellow	11 to 19	4.1 to 6.4	51 to 56	21 to 31	2.1 to 7.0	31 to 50	2.1 to 3.0
Green	≤10	≤4.0	≤50	≤20	≤2.0	≤30	≤2.0

(Source: ccme.ca)

1.2.4 Transboundary Flows and Exceptional Events

Air quality can be influenced by emissions that are uncontrollable or originate outside of the NWT boundaries:

- **transboundary flows (TF)**—when air pollutants originate in one province, territory, or country and are transported to another location through air flows.
- **exceptional events (EE)**— unusual or naturally occurring events that can affect air quality but are not reasonably controllable using techniques that provincial, territorial or local air agencies may implement to maintain the CAAQS.

How we handle data caused by transboundary flows and exceptional events

Jurisdictions have little to no control over TF or EE, such as wildfires. The AQMS allows provinces and territories to distinguish between pollution data caused by controllable (e.g. anthropogenic sources like industrial emissions) and uncontrollable sources when determining the management levels in the air zones. The *Guidance Document on Transboundary Flows and Exceptional Events for Air Zone Management* provides procedures on how to account for the influences of TF and EE.

[1] CCME's Guidance Document on Air Zone Management, 2019

In this report, we use adjusted metric values (measured concentration) to determine management levels for air zones. These adjusted values (**Table 4**) include $PM_{2.5}$ data influenced by smoke during the wildfire season (May 1 to October 31) that would put an air zone into the orange management level (over 19 µg/m^3).

1.2.5 Achievement Assessment

The *Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards* defines how to calculate levels of $PM_{2.5}$, O_3, NO_2, and SO_2, so they can be compared to the CAAQS levels shown in **Table 2**. We check data for completeness before using it in calculations.

An air zone achieves the CAAQS if the metric value is equal to or less than the standard. Otherwise, the air zone exceeds the CAAQS and is assigned the red management level. The achievement status is determined based on all measured values including those influenced by TF or EE (wildfire smoke).

2.0 RESULTS

2.1 Long-Term Air Quality Trends

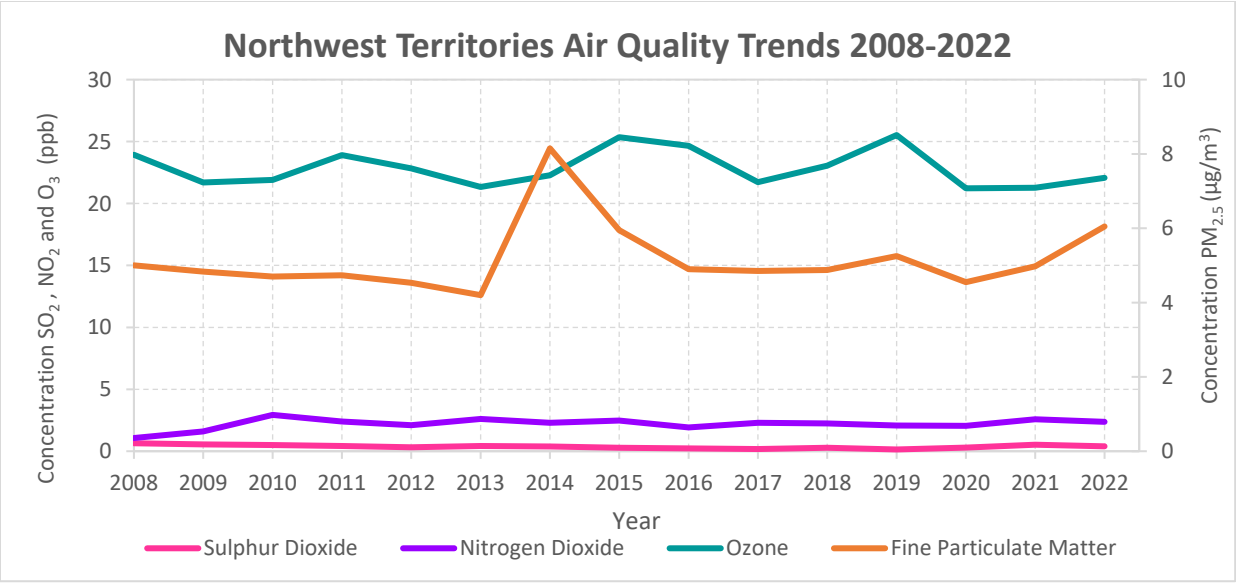
The NWT Ambient Air Quality Monitoring Network has been in operation for many years, providing enough data to analyze trends over a longer period. **Figures 3 to 7** show levels of $PM_{2.5}$, O_3, NO_2, and SO_2 from 2008 to 2022 for each station and parameter. Note that the long-term trends analyses presented below are based on all values including those influenced by wildfire smoke. **Appendix A** shows annual average concentrations since 2008 for the entire network.

2.1.1 Network-Wide Long-Term Trend

Generally, air quality in the NWT is very good. Since 2008, network-wide (**Figure 3**) concentrations of:

- **$PM_{2.5}$ remained fairly stable**—this can be attributed to the absence of any major changes to anthropogenic emission sources. Slightly higher levels were observed in 2014 and 2022 due to major wildfire seasons in the region.
- **NO_2 remained stable**—this is likely due to the absence of any major changes to emissions from fuel combustion sources for residential and commercial heating and idling vehicles.
- **SO_2 remained low**—this can be related to lower emissions from combustion and mobile sources that is likely because of lower sulphur levels in fuel.
- **O_3 stayed consistent**—this may be linked to average background O_3 levels. Natural sources contribute to background O_3, and the formation of O_3 is a complicated process that depends on a chemical reaction involving nitrogen oxides (NO_x) and hydrocarbons in the presence of sunlight. When there is more NO_x in the air, it can result in lower O_3 levels.

Figure 3: Network-wide Annual Concentrations



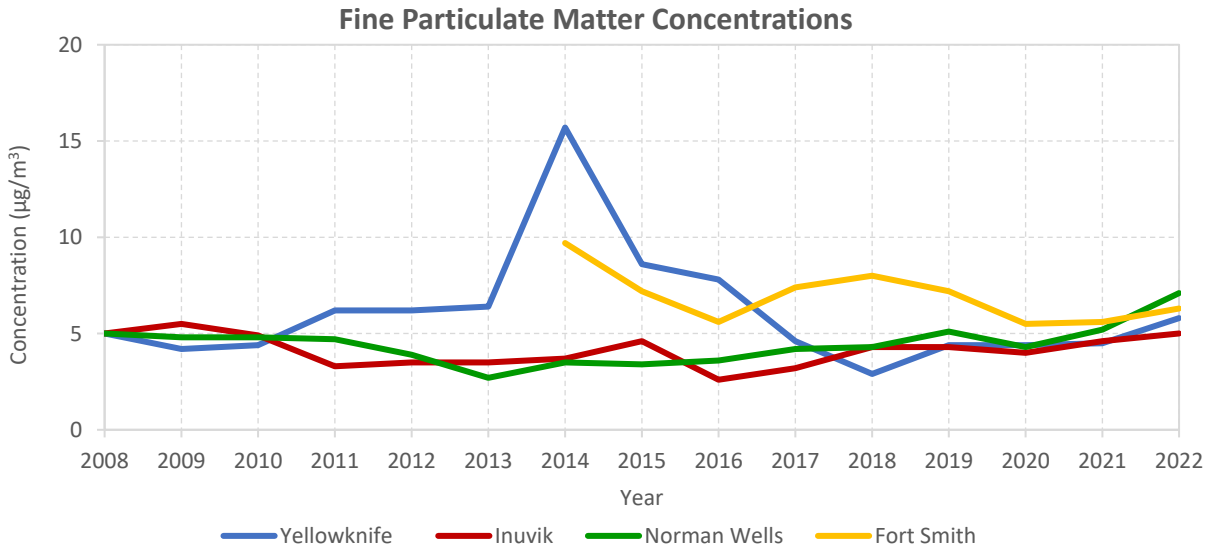
2.1.2 Fine Particulate Long-Term Trend

$PM_{2.5}$ refers to solid particles and liquid droplets suspended in air that are smaller than or equal to 2.5 micrometres (µm) in diameter. $PM_{2.5}$ is about 30 times smaller than the width of a human hair. $PM_{2.5}$ emissions come from natural events such as wildfires and human activities such as burning of fossil fuels, industry, mining, oil and gas operations, commercial and residential heating, and vehicle emissions. $PM_{2.5}$, depending on its chemical composition, can change the chemistry of soil and water, leading to negative consequences for vegetation and organisms. $PM_{2.5}$ contributes to reduced visibility and is a major component of smog. These tiny particles, when inhaled, travel deep into the lungs and bloodstream where they can cause adverse health effects. $PM_{2.5}$ is considered a non-threshold pollutant, meaning there are no safe limits for exposure.

$PM_{2.5}$ levels in the NWT change annually

This is likely due to the significant influence of seasonal wildfires, which also change in amount and severity year-to-year. The noticeable peak in $PM_{2.5}$ levels recorded in Yellowknife in 2014 was a direct result of one of the most severe wildfire seasons experienced in the NWT. The wildfire smoke that year caused the highest $PM_{2.5}$ levels ever recorded at the Yellowknife monitoring station during 2008-2022. Note that data started to be collected at the Fort Smith station in 2014.

Figure 4: $PM_{2.5}$ Annual Average Concentrations



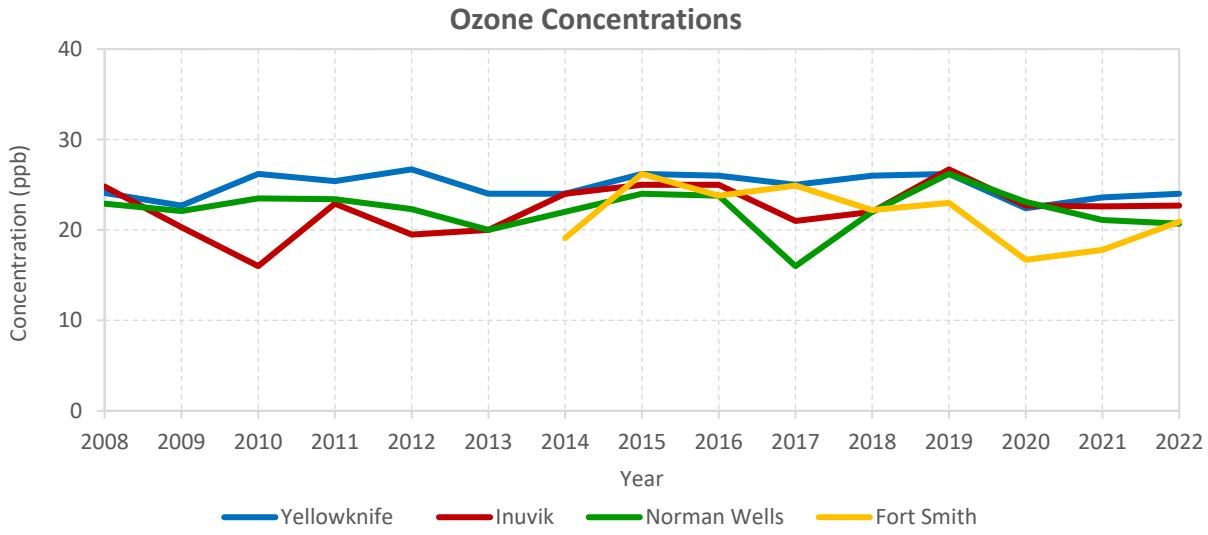
2.1.3 Ozone Long-Term Trend

O_3 is a colourless, odourless and irritating gaseous parameter. It is the same gas that is found higher up in the atmosphere, about 10 to 40 kilometers above the Earth's surface, where it is called stratospheric ozone. High in the atmosphere, ozone is a good thing—it protects the planet from the sun's harmful ultraviolet rays. However, at ground level, ozone can be harmful to humans, animals, and plants. High levels of ozone can be created in the lower atmosphere by sunlight and heat-causing gases, usually NO_x and substances called volatile organic compounds that undergo chemical reactions with each other. O_3 is also a greenhouse gas that contributes to climate change and is a major component of smog.

O_3 levels have stayed relatively consistent from year-to-year

No significant trends were observed over the period of analysis. This indicates that O_3 levels in the NWT are largely influenced by regional factors, such as atmospheric transport. Overall, the O_3 levels in the NWT are within the range of natural levels of O_3 in other areas of Canada. Note that data started to be collected at the Fort Smith station in 2014.

Figure 5: O_3 Annual Average Concentrations



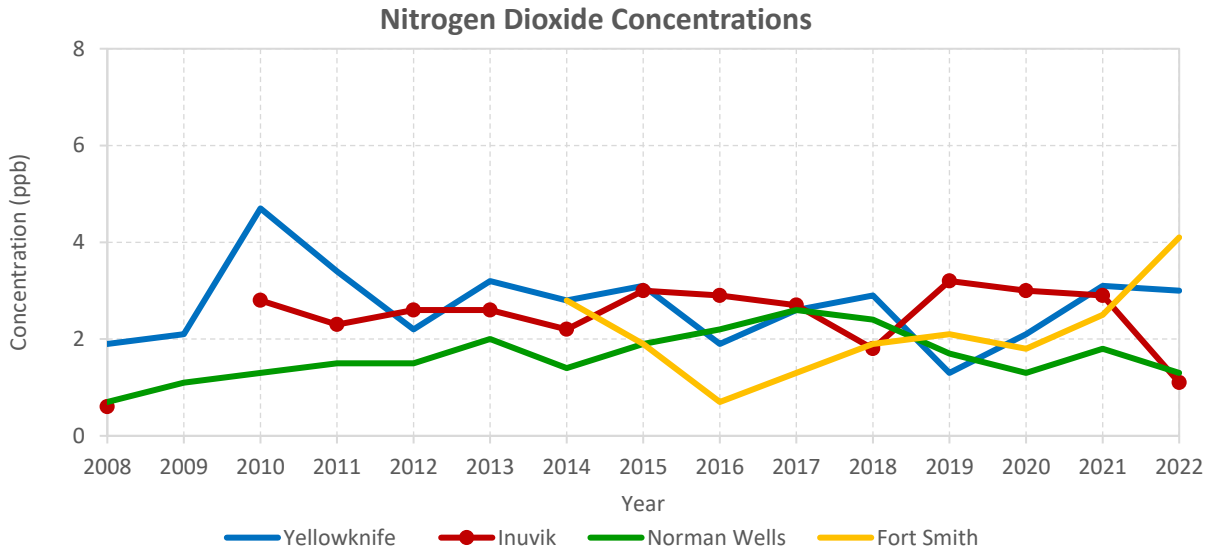
2.1.4 Nitrogen Dioxide Long-Term Trend

NO_2 is a gaseous parameter formed along with other nitrogen oxides (NO_x) during the high-temperature combustion of fossil fuels. NO_2 at higher levels has a strong and harsh odour and can be seen as a brownish haze. The sources of NO_2 are the same as for SO_2 as well as vehicle exhaust being one of the main contributors. High levels can cause serious breathing problems that can become chronic. NO_2 can affect the ecosystem and contribute to form $PM_{2.5}$, O_3, and acid rain.

Yellowknife and Inuvik generally have slightly higher NO_2 levels than other communities

This is expected considering their larger population sizes and higher number of combustion sources. Each stations' trend has remained relatively stable. This is also expected as there have been no major changes to emission sources or population growth in these communities. Note that data started to be collected at the Fort Smith station in 2014 and no data was available for Inuvik in 2019 because NO_2 analyzer malfunctioned.

Figure 6: NO_2 Annual Average Concentrations



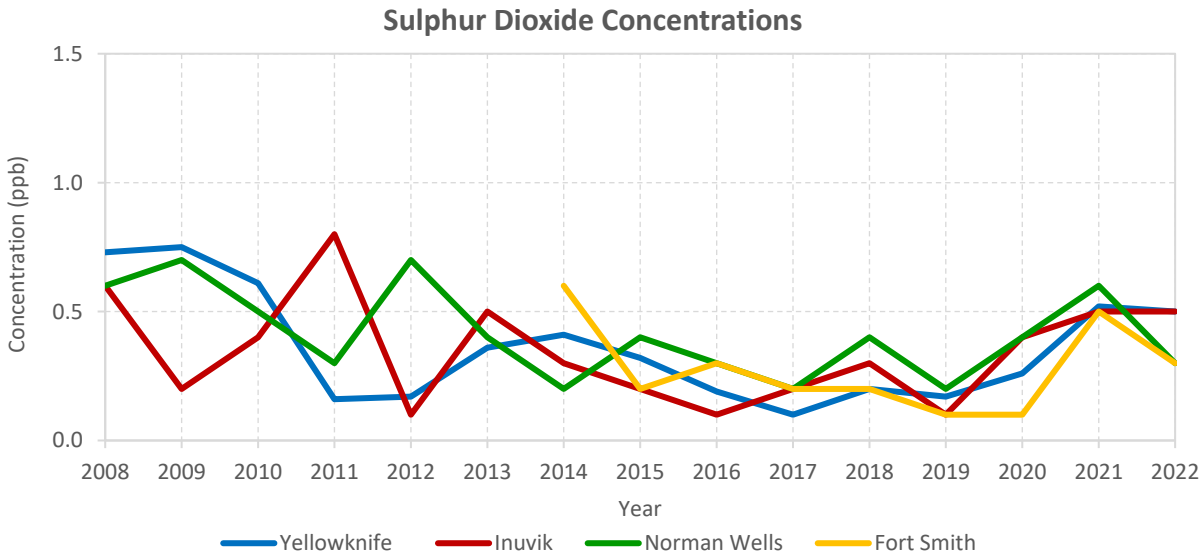
2.1.5 Sulphur Dioxide Long-Term Trend

SO_2 is a colourless gas that smells like burnt matches. Sources of SO_2 include burning of fossil fuels such as in power generation, industrial processes, transportation, and commercial and residential heating. SO_2 can have negative effects on human and ecosystem health. Certain types of vegetation (for example, lichens) are sensitive to SO_2. It also contributes to the formation of acid rain and smog.

SO_2 levels in the NWT have remained consistently low

Levels remain below 1 µg/m^3 across all four monitoring stations. Low SO_2 levels indicate good air quality and absence of any major sources of SO_2 emissions. Note that data started to be collected at the Fort Smith station in 2014.

Figure 7: SO_2 Annual Average Concentrations



2.2 Canadian Ambient Air Quality Standards Achievement Status

The CAAQS metric values for the years 2020, 2021 and 2022 are in **Appendix A**. The $PM_{2.5}$ data influenced by TF/EE (wildfire smoke) is in **Appendix B**.

2.2.1 Fine Particulate CAAQS Metric

$PM_{2.5}$ was measured at four air monitoring stations in the NWT during 2020-2022. Three stations achieved the $PM_{2.5}$ CAAQS for both the 24-hour standard and the annual standard. The Fort Smith station exceeded the $PM_{2.5}$ 24-hour standard. However, after removing data influenced by wildfire smoke, the adjusted metric value of Fort Smith achieved the $PM_{2.5}$ 24-hour standard.

Wildfire smoke was the largest contributor to $PM_{2.5}$ in the 2020-2022 reporting period. **Figure 8** compares $PM_{2.5}$ levels with and without wildfire smoke (that is, before and after removing the data influenced by TF and EE) and illustrates the CAAQS achievement status by station. Wildfire smoke events are considered exceptional events and as such, $PM_{2.5}$ 24-hour values that were influenced by wildfire

smoke between May 1 and October 31 and had values greater than 19 $\mu g/m^3$ (the orange management level threshold) were removed.

Figure 8: Fine Particulate Matter Concentrations during 2020-2022

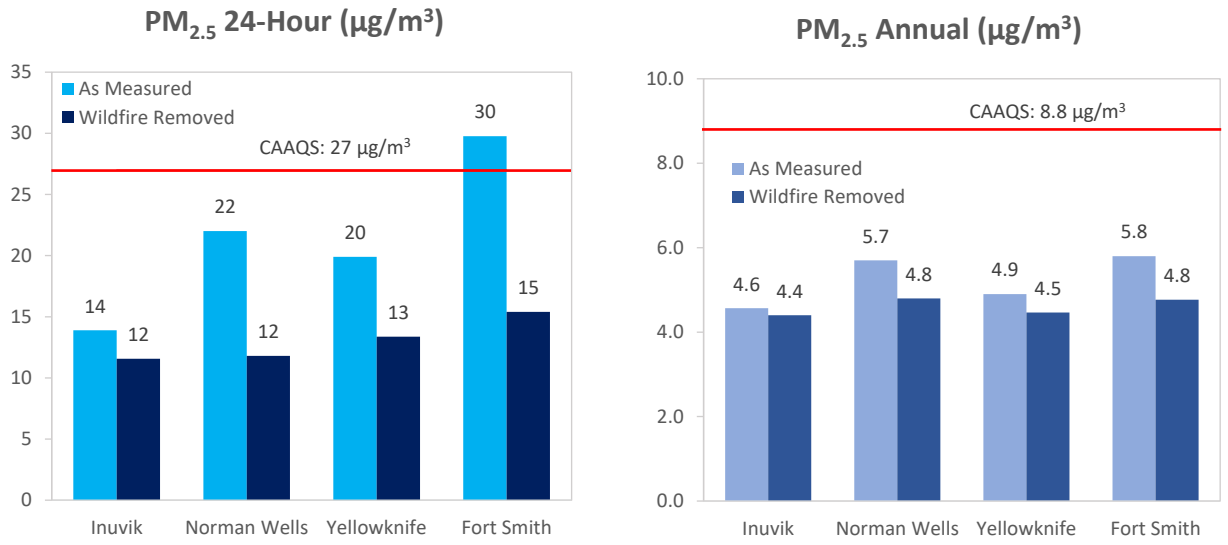


Table 4 shows each air zone's 2020-2022:

- actual $PM_{2.5}$ metric values
- adjusted metric values (excluding TF- and EE-influenced data)
- CAAQS achievement status
- $PM_{2.5}$ management level

Since there are two CAAQS averaging periods for $PM_{2.5}$ (24-hour and annual), the final management level is based on the stricter of the two adjusted management levels.

Table 4: Fine Particulate Matter CAAQS Results for 2020-2022

Air Zone	Station	$PM_{2.5}$ 24-hour			$PM_{2.5}$ Annual			$PM_{2.5}$ Air Zone Management Level
		Actual Metric Value[1] (µg/m³)	Adjusted Metric Value[2] (µg/m³)	CAAQS Achievement Status	Actual Metric Value[1] (µg/m³)	Adjusted Metric Value[2] (µg/m³)	CCAQS Achievement Status	
Beaufort Delta	Inuvik	14	12	Achieved	4.6	4.4	Achieved	Yellow
Sahtu	Norman Wells	22[3]	12[3]	Achieved	5.7[3]	4.8[3]	Achieved	Yellow
North Slave	Yellowknife	20	13	Achieved	4.9	4.5	Achieved	Yellow
South Slave	Fort Smith	30	15	Exceeded	5.8	4.8	Achieved	Yellow
Dehcho[4]	Fort Simpson	-	-	-	-	-	-	-
CAAQS		**27**			**8.8**			

1. Actual CAAQS metric values are those calculated based on all measured concentrations.
2. Adjusted CAAQS metric values are those calculated after excluding concentrations influenced by TF/EE between May 1 and October 31.
3. The metric value is based on two years of data. One of the three years of the reporting period did not meet data completeness criteria.
4. No assessment is possible as no air monitoring station or data was available in the air zone for the reporting period.

2.2.2 Ozone CAAQS Metric

Ozone was measured at four air monitoring stations in the NWT during 2020-2022. **Figure 9** shows how all measured ozone concentrations were well below the CAAQS and typical of remote site concentrations.

Figure 9: Ozone Concentrations during 2020-2022

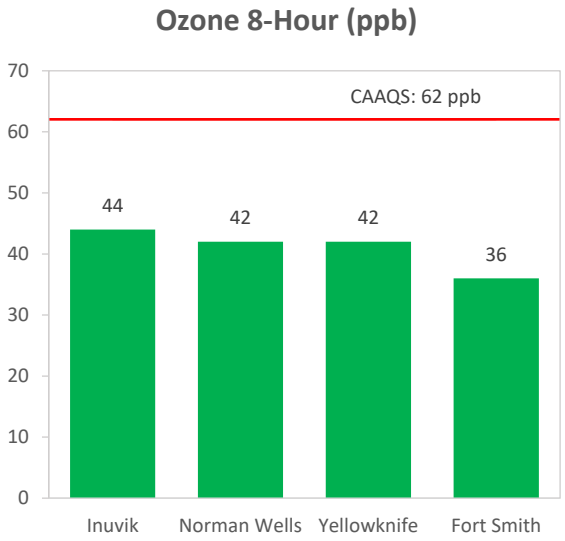


Table 5 shows each air zone's 2020-2022:

- O_3 levels
- CAAQS achievement status
- O_3 management level

Table 5: Ozone CAAQS Results for 2020-2022

Air Zone	Station	O_3 8-hour		O_3 Air Zone Management Level
		CAAQS Metric Value (ppb)	CAAQS Achievement Status	
Beaufort Delta	Inuvik	44[1]	Achieved	Green
Sahtu	Norman Wells	42[1]	Achieved	Green
North Slave	Yellowknife	42	Achieved	Green
South Slave	Fort Smith	36[1]	Achieved	Green
Dehcho[2]	Fort Simpson	-	-	-
CAAQS		**62**		

1. The metric value is based on two years of data. One of the three years of the reporting period did not meet data completeness criteria.
2. No assessment is possible as no air monitoring station or data was available in the air zone for the reporting period.

2.2.3 Nitrogen Dioxide CAAQS Metric

NO_2 was measured at four air monitoring stations in the NWT during the 2020-2022 reporting period. All measured concentrations were well below the CAAQS (see **Figure 10**). There was insufficient data for Inuvik to calculate the NO_2 1-hour metric value; likewise, there was insufficient data for Inuvik, Norman Wells and Fort Smith to calculate the annual metric values for the reporting period.

Figure 10: Nitrogen Dioxide Concentrations during 2020-2022

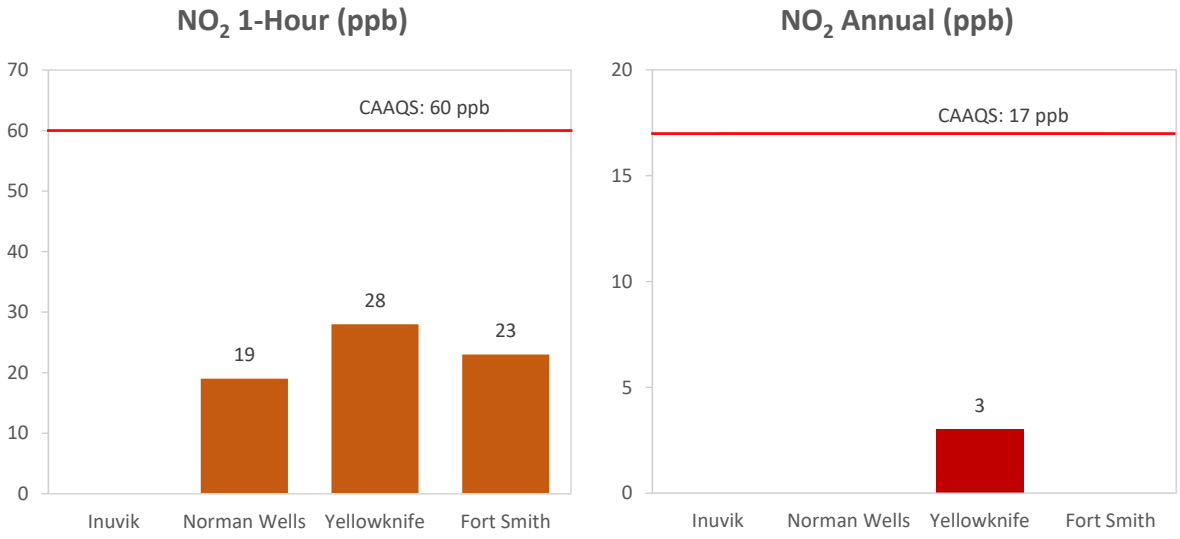


Table 6 shows each air zone's 2020-2022:

- NO_2 levels
- CAAQS achievement status
- NO_2 management level

Since there are two CAAQS averaging periods for NO_2 (1-hour and annual), the final management level is based on the stricter of the two management levels.

Table 6: Nitrogen Dioxide CAAQS Results for 2020-2022

Air Zone	Station	NO_2 1-hour		NO_2 Annual		NO_2 Air Zone Management Level
		CAAQS Metric Value (ppb)	CAAQS Achievement Status	CAAQS Metric Value (ppb)	CAAQS Achievement Status	
Beaufort Delta	Inuvik	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]
Sahtu	Norman Wells	19	Achieved	NA[1]	NA[1]	Green
North Slave	Yellowknife	28	Achieved	3.0	Achieved	Yellow
South Slave	Fort Smith	23	Achieved	NA[1]	NA[1]	Yellow
Dehcho[2]	Fort Simpson	-	-	-	-	-
CAAQS		**60**		**17.0**		

1. Not available - insufficient data to calculate the metric value and determine achievement status for this parameter.
2. No assessment is possible as no air monitoring station or data was available in the air zone for the reporting period.

2.2.4 Sulphur Dioxide CAAQS Metric

SO_2 was measured at four air monitoring stations in the NWT during the 2020-2022 reporting period. All four stations achieved the SO_2 CAAQS for both the 1-hour standard and the annual standard (**Figure 11**).

Figure 11: Sulphur Dioxide Concentrations during 2020-2022

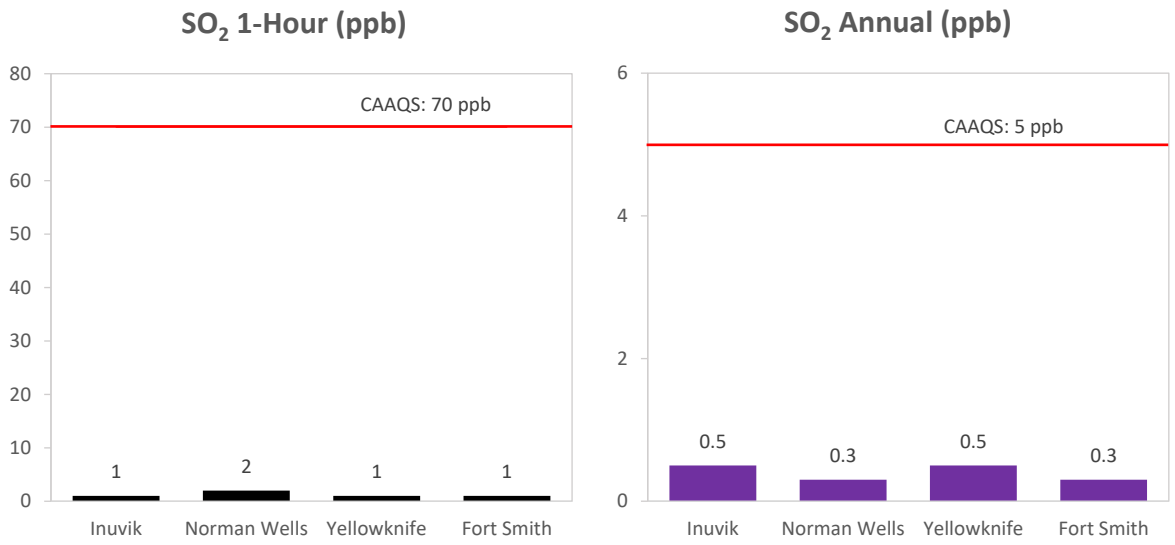


Table 7 shows each air zone's 2020-2022:

- SO_2 levels
- CAAQS achievement status
- SO_2 management level

Since there are two CAAQS averaging periods for SO_2 (1-hour and annual), the final management level is based on the stricter of the two management levels.

Table 7: Sulphur Dioxide CAAQS Results for 2020-2022

Air Zone	Station	SO_2 1-hour		SO_2 Annual		SO_2 Air Zone Management Level
		CAAQS Metric Value (ppb)	CCAQS Achievement Status	CAAQS Metric Value (ppb)	CCAQS Achievement Status	
Beaufort Delta	Inuvik	1	Achieved	0.5	Achieved	Green
Sahtu	Norman Wells	2	Achieved	0.3	Achieved	Green
North Slave	Yellowknife	1	Achieved	0.5	Achieved	Green
South Slave	Fort Smith	1	Achieved	0.3	Achieved	Green
Dehcho[1]	Fort Simpson	-	-	-	-	-
CAAQS		**70**		**5.0**		

1. No assessment is possible as no air monitoring station or data was available in the air zone for the reporting period.

2.2.5 Summary of CAAQS Achievement

Table 8 summarizes the achievement status of the national air quality standards, CAAQS, in the NWT. The achievement status is based on all measured values including those influenced by wildfire smoke. Overall, the NWT air zones have achieved the CAAQS for the listed parameters, except for the $PM_{2.5}$ 24-hour standard for the South Slave air zone due to wildfire smoke.

Note that an air monitoring station was not established in the Dehcho air zone until late 2022 and there was insufficient data, so this air zone was not assessed for this report. The Beaufort Delta air zone did not have enough data to assess the achievement status for NO_2. Similarly, Sahtu and North Slave did not have enough data to calculate the achievement status for the NO_2 annual standard.

Table 8: CAAQS Achievement Status in the Northwest Territories for 2020-2022

Air Zone	$PM_{2.5}$ 24-hr	$PM_{2.5}$ Annual	O_3 8-hr	NO_2 1-hr	NO_2 Annual	SO_2 1-hr	SO_2 Annual
Beaufort Delta	Achieved	Achieved	Achieved			Achieved	Achieved
Sahtu	Achieved	Achieved	Achieved	Achieved		Achieved	Achieved
North Slave	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
South Slave	Exceeded	Achieved	Achieved	Achieved		Achieved	Achieved

Legend

Achieved	Ambient concentrations of air parameters are less than or equal to the corresponding standard.
Exceeded	Ambient concentrations of air parameters are greater than the corresponding standard.
	Not Available. Insufficient data to calculate the CAAQS achievement status.

3.0 AIR ZONE MANAGEMENT

Table 9 shows the air zone management levels for each parameter during the 2020-2022 reporting period. All air zones are green or yellow, meaning that the NWT's air quality is very good.

Note that the Fort Simpson station was not established until November 2022, and the data collected was insufficient, so the Dehcho air zone was not assessed for this report. The Beaufort Delta air zone did not have enough data to be assigned an NO_2 management level.

Table 9: Air Zone Management Levels in the Northwest Territories for 2020-2022

Air Zone	Fine Particulate ($PM_{2.5}$)	Ozone (O_3)	Nitrogen Dioxide (NO_2)	Sulphur Dioxide (SO_2)
North Slave	Yellowknife	Yellowknife	Yellowknife	Yellowknife
South Slave	Fort Smith	Fort Smith	Fort Smith	Fort Smith
Beaufort Delta	Inuvik	Inuvik	Inuvik	Inuvik
Sahtu	Norman Wells	Norman Wells	Norman Wells	Norman Wells

Legend

Green	The lowest level of air quality management. Air quality is well below the standards. Keep clean areas clean.
Yellow	The second lowest level of air quality management. Air quality is below the standards. Support continuous improvement.
Orange	The second highest level of air quality management. Air quality approaches the standards. Prevent exceedances of the standards.
Red	The highest level of air quality management. Air quality exceeds the standards. Reduce pollutant levels below the standards.
	Not available. Insufficient data to assign an air zone management level.

4.0 CONCLUSION

The data in this report indicates the overall air quality of the NWT is very good
Overall, the 2020-2022 data shows our air quality achieves the national air quality standards, CAAQS, for the four parameters, except for the $PM_{2.5}$ 24-hour standard in the South Slave air zone, which was impacted by wildfire smoke. Major industries causing air pollution are extremely limited compared to larger Canadian centres.

Air quality trends over the last 15 years
Air quality has remained stable between 2008 and 2022.

- $PM_{2.5}$ levels have remained fairly stable mostly because of the absence of any major changes to anthropogenic emission sources.
- NO_2 levels have remained stable, due to the absence of any major changes to emissions from residential and commercial heating.
- SO_2 levels have remained consistently low, because of lower emissions from combustion and mobile sources. This is a cross-country trend that is likely because of lower sulphur levels in fuel.
- O_3 levels have stayed relatively consistent, potentially linked to average background O_3.

It is very important to continue monitoring
We have clean air in the NWT, but we need to keep monitoring. Given the shifting climate, more wildfire events are likely to occur within and outside the territory, which could cause pollutants to travel long distances and impact our air quality. We must continue to measure air quality across the territory to understand current conditions, identify potential issues early, and respond proactively to future changes rather than reactively. Monitoring air quality is important for protecting the environment and public health, issuing air quality advisories, informing policy decisions, ensuring compliance, supporting research and development, and raising public awareness about the significance of clean air.

If you have questions regarding ECC's air quality monitoring program or require further information, please contact us at this address:

Environmental Protection and Waste Management Division
Department of Environment and Climate Change
Government of the Northwest Territories
P.O. BOX 1320
Yellowknife NT X1A 2L9
Telephone: (867) 767-9236 ext. 53176
Email: nwtairquality@gov.nt.ca

This report is also available on the Internet at:
www.ecc.gov.nt.ca/en/services/air-quality

Appendix A: Air Quality Data Summary

Table A-1: NWT Network-wide Annual Average Concentrations of $PM_{2.5}$, O_3, NO_2 and SO_2

Year	$PM_{2.5}$ ($\mu g/m^3$)	O_3 (ppb)	NO_2 (ppb)	SO_2 (ppb)
2008	5.0	24	1.1	0.6
2009	4.8	22	1.6	0.6
2010	4.7	22	2.9	0.5
2011	4.7	24	2.4	0.4
2012	4.5	23	2.1	0.3
2013	4.2	21	2.6	0.4
2014	8.2	22	2.3	0.4
2015	6.0	25	2.5	0.3
2016	4.9	25	1.9	0.2
2017	4.9	22	2.3	0.2
2018	4.9	23	2.3	0.3
2019	5.3	26	2.1	0.1
2020	4.6	21	2.1	0.3
2021	5.0	21	2.6	0.5
2022	6.1	22	2.4	0.4

Annual Average: the average over a calendar year of all 1-hour average concentrations

Table A-2: $PM_{2.5}$ CAAQS metric values ($\mu g/m^3$)

Station	2020		2021		2022		3-Year Average	
	Annual	24-hour	Annual	24-hour	Annual	24-hour	Annual	24-hour
Inuvik	4.0	10.5	4.6	11.8	5.1	19.4	4.6	14
Norman Wells	4.3	9.0	-	-	7.1	35.0	5.7	22
Yellowknife	4.4	11.8	4.5	18.2	5.8	29.7	4.9	20
Fort Smith	5.5	16.0	5.6	24.7	6.3	48.6	5.8	30

Annual: the annual average of the daily 24-hour average concentrations
24-hour: the 98th percentile of the daily 24-hour average concentrations
-: insufficient data

Table A-3: O_3 CAAQS metric values (ppb)

Station	2020	2021	2022	3-Year Average
	8-hour	8-hour	8-hour	8-hour
Inuvik	-	45.9	42.5	44
Norman Wells	-	43.1	40.4	42
Yellowknife	41.8	41.1	44.0	42
Fort Smith	-	33.8	38.0	36

8-hour: the 4th highest daily maximum 8-hour average concentrations
-: insufficient data

Table A-4: NO_2 CAAQS metric values (ppb)

Station	2020		2021		2022		3-Year Average
	Annual	1-hour	Annual	1-hour	Annual	1-hour	1-hour
Inuvik	2.8	26.6	-	-	-	-	-
Norman Wells	1.1	16.1	1.8	16.6	-	-	19
Yellowknife	2.1	26.1	3.1	31.4	3.0	27.7	28
Fort Smith	1.7	23.0	2.5	23.1	-	-	23

Annual: the average over a single calendar year of all 1-hour average concentrations
1-hour: the 98th percentile of the daily maximum 1-hour average concentrations
-: insufficient data

Table A-5: SO_2 CAAQS metric values (ppb)

Station	2020		2021		2022		3-Year Average
	Annual	1-hour	Annual	1-hour	Annual	1-hour	1-hour
Inuvik	0.4	0.9	0.5	0.9	0.5	1.6	1
Norman Wells	0.4	0.9	0.6	2.1	0.3	2.3	2
Yellowknife	0.3	1.1	0.5	0.9	0.5	2.4	1
Fort Smith	0.1	0.9	0.5	1.8	0.3	0.9	1

Annual: the average over a single calendar year of all 1-hour average concentrations
1-hour: the 99th percentile of the daily maximum 1-hour average concentrations
-: insufficient data

Appendix B: Data Influenced by Wildfire Smoke

Wildfire smoke events are considered exceptional events and as such $PM_{2.5}$ 24-hour values that were influenced by wildfire smoke between May 1 and October 31 and had values greater than 19 µg/m^3 (the orange management level threshold) were removed.

The following dates were influenced by exceptional events and were excluded from the dataset for the purpose of determining air zone management levels.

Table B-1: NWT $PM_{2.5}$ Data Influenced by Wildfire Smoke for the 2020-2022 Reporting Period

Beaufort Delta Air Zone	
Inuvik Air Station	
Date (yyyy-mm-dd)	**$PM_{2.5}$ 24-hour (µg/m^3)**
2021-08-01	25.0
2022-06-27	22.4
2022-07-04	25.0
2022-07-05	19.3
2022-07-06	19.9
2022-07-07	27.1
2022-07-08	27.1
2022-07-11	21.7

Sahtu Air Zone	
Norman Wells Air Station	
Date (yyyy-mm-dd)	**$PM_{2.5}$ 24-hour (µg/m^3)**
2020-08-01	21.2
2021-08-01	43.0
2021-08-02	49.1
2021-08-03	34.0
2022-06-28	29.7
2022-06-29	28.7
2022-06-30	24.3
2022-07-01	19.7
2022-07-03	20.0
2022-07-04	21.3
2022-07-05	35.0
2022-07-06	43.6
2022-07-07	39.8
2022-07-08	65.9

2022-07-09	156.5
2022-07-10	69.6
2022-07-11	52.2
2022-08-19	39.1
2022-08-24	20.5
2022-08-25	19.4
2022-09-30	19.3
2022-10-16	23.9
2022-10-17	24.5

Dehcho Air Zone	
Fort Simpson Air Station	
Date (yyyy-mm-dd)	**$PM_{2.5}$ 24-hour ($\mu g/m^3$)**
	N/A*

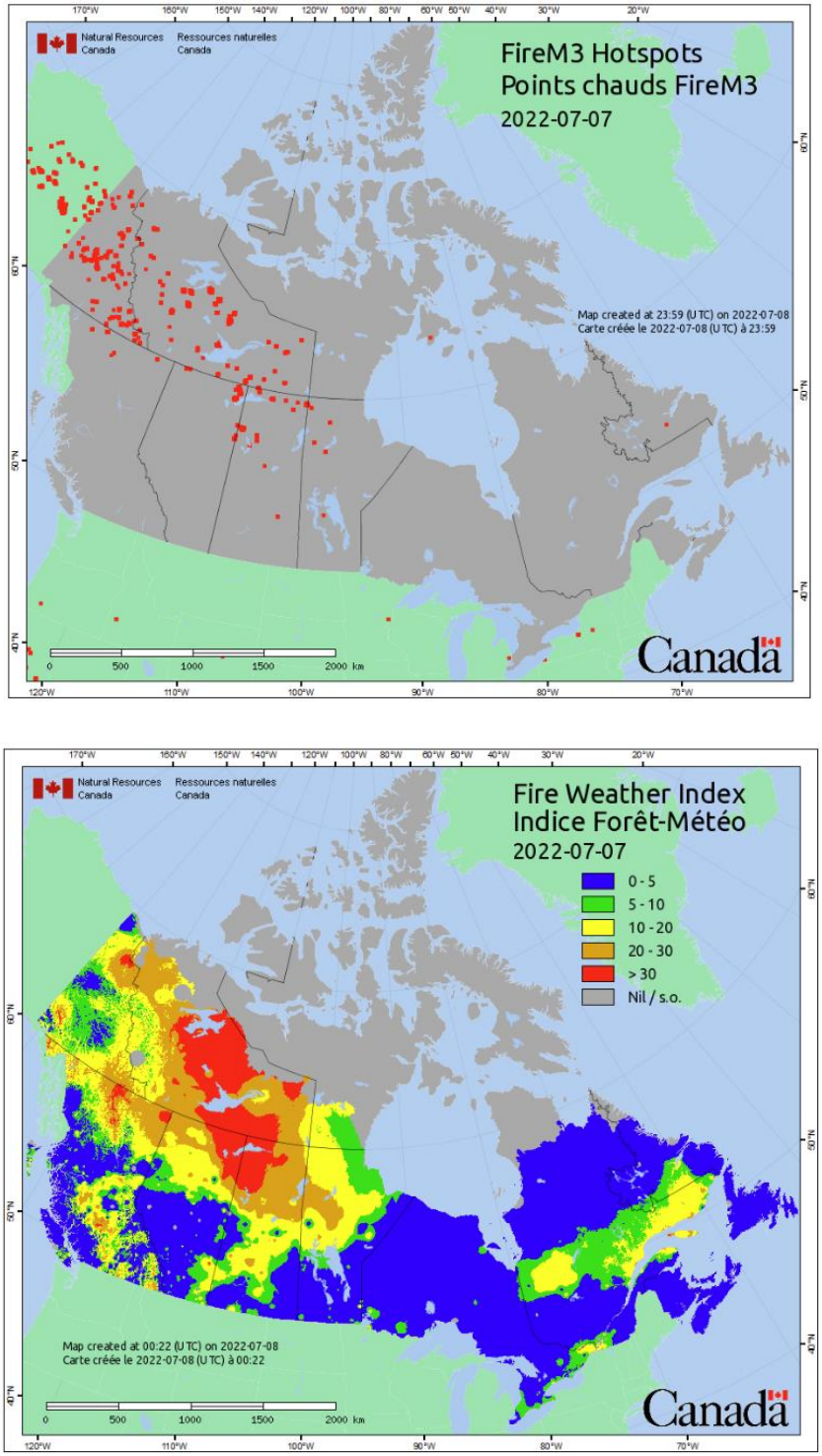
* No data available for the 2020-2022 period.

North Slave Air Zone	
Yellowknife Air Station	
Date (yyyy-mm-dd)	**$PM_{2.5}$ 24-hour ($\mu g/m^3$)**
2021-07-21	30.2
2021-08-02	24.0
2021-08-05	20.3
2021-08-06	24.3
2022-06-23	37.7
2022-07-05	37.5
2022-07-06	29.6
2022-07-07	35.4
2022-07-08	50.6
2022-07-09	38.0
2022-08-19	52.1
2022-08-24	56.8
2022-08-25	23.3
2022-09-16	19.8
2022-10-09	21.7

South Slave Air Zone	
Fort Smith Air Station	
Date (yyyy-mm-dd)	**$PM_{2.5}$ 24-hour ($\mu g/m^3$)**
2020-07-01	22.5
2021-07-11	20.3
2021-07-18	21.9
2021-07-19	22.3
2021-07-20	79.4
2021-07-21	54.6
2021-07-22	24.9
2021-08-02	24.7
2021-08-03	28.2
2021-08-06	40.7
2021-08-07	25.3
2022-07-02	19.4
2022-07-05	32.1
2022-07-06	65.9
2022-07-07	82.8
2022-07-08	126.6
2022-08-20	44.5
2022-08-23	100.7
2022-08-24	33.6
2022-08-25	61.1
2022-08-26	25.3
2022-09-04	25.4
2022-09-16	25.1
2022-09-29	20.8
2022-10-04	42.6
2022-10-05	20.3
2022-10-09	60.3
2022-10-10	48.6

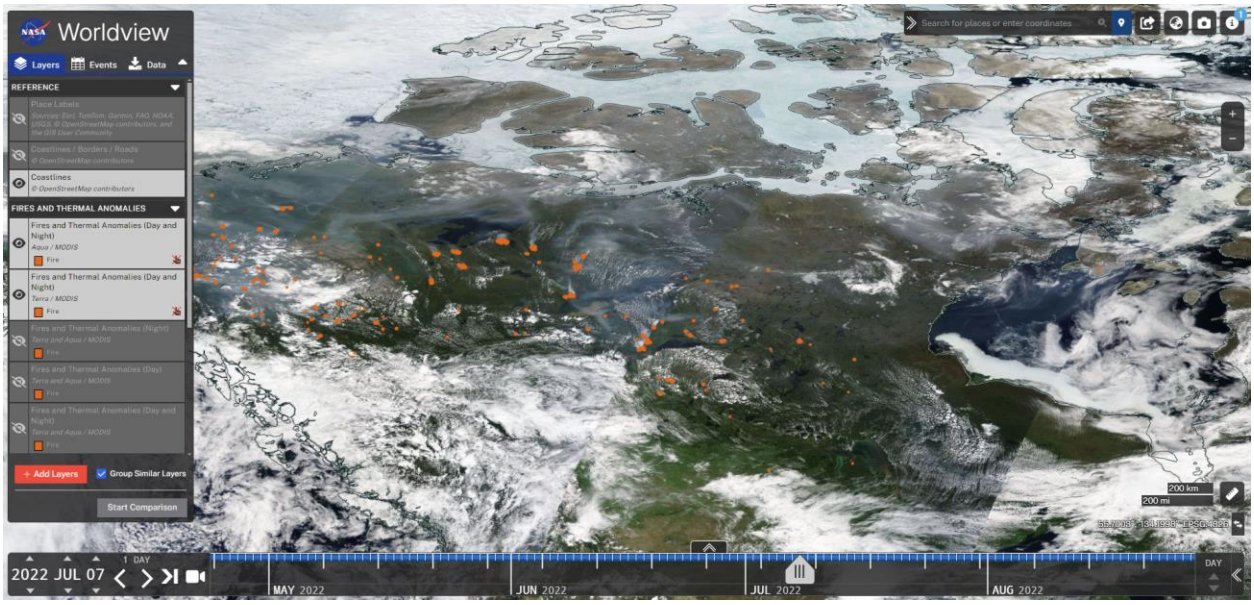
The evidence of wildfires is shown in images below as an example for July 7, 2022 when multiple monitoring stations in the Northwest Territories reported elevated levels of $PM_{2.5}$.

Figure B-1: Fire hot spots and fire weather index maps on July 7, 2022



(Source: https://cwfis.cfs.nrcan.gc.ca)

Figure B-2: Wildfire smoke (gray plume) and fire/thermal anomalies (red dots) over the NWT on July 7, 2022



(Source: https://worldview.earthdata.nasa.gov)