

NWT AIR QUALITY

2019 REPORT

QUALITÉ DE L'AIR AUX TNO

REPORT 2019

Government of | Gouvernement des
Northwest Territories
Territoires du Nord-Ouest



Contents

Executive Summary	3
Sommaire	6
Glossary	10
Acronyms	12
Introduction	13
NWT Air Quality Monitoring Network - Operation	13
Canadian Air and Precipitation Monitoring Network (CAPMoN)	16
Developments in 2019	17
Future Plans	17
NWT Air Quality Standards	17
NWT Air Quality in 2019	19
Fine Particulate Matter (PM _{2.5})	19
Coarse Particulate Matter (PM ₁₀)	21
Ground Level Ozone (O ₃)	22
Nitrogen Dioxide (NO ₂)	24
Carbon Monoxide (CO)	26
Sulphur Dioxide (SO ₂)	28
Long-Term Trends	29
National Comparisons	33
CAPMoN Stations	34
NWT 2019 Wildfire Season	35
Health Messaging from Wildfires	37
Summary	41
Appendix A: 2019 Data Capture & Select Statistical Information	42
Appendix B: Potential Air Pollutants	45
Appendix C: Air Quality Monitoring History in the Northwest Territories	48

Executive Summary

The Department of Environment and Natural Resources (ENR) monitors air quality in the Northwest Territories (NWT). ENR maintains and operates the Ambient Air Quality Monitoring Network, which consists of four monitoring stations located in Yellowknife, Inuvik, Fort Smith, and Norman Wells. Each station continuously collects information on a variety of potential air pollutants as well as temperature, wind speed and wind direction. The Yellowknife, Inuvik and Fort Smith stations are operated in partnership with the National Air Pollution Surveillance (NAPS) program – a joint federal/provincial/territorial monitoring network that tracks regional air quality trends across Canada. Rainwater and snow quantities are monitored at Snare Rapids and Wood Buffalo National Park as part of the Canadian Air and Precipitation Monitoring Network (CAPMoN).

What we monitor and why

The air surrounding us on the land and in our communities is called “ambient air.” It contains nitrogen, oxygen, a small amount of carbon dioxide and water vapour. It can also contain amounts of other substances that can be harmful to human health or the environment at certain levels. Naturally occurring levels of these substances when present in the air are called background levels. Human activities and natural events, such as burning fossil fuels and wildfires, can elevate these levels in the ambient air. The NWT Guideline for Ambient Air Quality Standards (AAQS) describes the concentration of these substances over a specific time period that are acceptable in ambient air to protect human health and the environment. By tracking ambient levels of potential pollutants we can assess the impacts of human activities and natural events on air quality.

Particulate Matter (PM_{2.5} and PM₁₀)

Particulate matter comes in different sizes. Fine particulate matter (PM_{2.5}) is about 30 times smaller than the width of a human hair. Coarse particulate matter (PM₁₀) is slightly larger than PM_{2.5}. Both types of particulate matter can be inhaled and can aggravate existing pulmonary and cardiovascular disease. PM_{2.5} is more dangerous because the particles are so small that they pass easily through our nose and throat defenses and can get deep into our lungs.

Particles in the PM_{2.5} range are primarily the result of natural events such as wildfire and human activities such as industrial operations, commercial and residential heating, vehicle emissions. Particles in the PM₁₀ range include road dust and wind-blown soil.

Sulphur Dioxide (SO₂)

SO₂ is a colourless gas which can have negative effects on human and environmental health. Certain types of vegetation (especially lichens) are very sensitive to SO₂. SO₂ also contributes to the formation of other pollutants in the air. Emissions of SO₂ are created during the burning of fossil fuels containing sulphur. Sources of SO₂ in the north include power generating plants, commercial and residential heating, and wildfires.

Nitrogen Dioxide (NO₂)

The sources of NO₂ are the same as SO₂ as well as vehicle exhaust. High levels can cause serious breathing problems that can become chronic. High levels of NO₂ can also lead to formation of other pollutants such as particulate pollution and ground level ozone.

Ground Level Ozone (O₃)

This is the same gas that is found higher up in the atmosphere, 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 and plants. High levels of ozone can be created in the lower atmosphere by sunlight and heat causing gases, usually NO₂ and substances called volatile organic compounds (VOCs) that undergo chemical reactions with each other. High ozone levels can lead to chest tightness, coughing, wheezing and other heart and lung problems. The effect of ozone on plants can be seen as discoloured leaves and general poor vegetation growth.

Carbon Monoxide (CO)

CO comes from a number of sources, including home heating, vehicle exhaust and wildfires. Extremely high levels of CO in our air can be poisonous and can cause headaches, shortness of breath and nausea.

Our network

ENR's monitoring stations are small trailers holding highly specialized instruments that are continuously measuring particulate matter and potential pollutants in the air. All four stations monitor levels of PM_{2.5}, PM₁₀, SO₂, NO₂ and O₃. At the Yellowknife, Inuvik, and Fort Smith stations, we also monitor for CO.

NWT air quality in 2019

Fine Particulate Matter (PM_{2.5})

One of the main sources of PM_{2.5} within the NWT is smoke from wildfires. Generally impacts to air quality from the wildfire season in 2019 across the NWT were below average. The Yellowknife station had moderately elevated levels of PM_{2.5} during the months of May, June, and July due to wildfire smoke drifting up from High Level, Alberta. Norman Wells and Fort Smith stations had moderately elevated levels of PM_{2.5} in the month of July. Fort Smith was impacted by fires burning in Wood Buffalo National Park while Norman Wells experienced smoke from fires burning in the Yukon. Inuvik did not experience any significant wildfire events during the summer of 2019 and as a result PM_{2.5} levels remained fairly consistent throughout the year. There were five episodes in Yellowknife, three episodes in Norman Wells and seven episodes in Fort Smith where PM_{2.5} levels exceeded the 24-hour average AAQS of 28µg/m³ all attributed to wildfire smoke.

Coarse Particulate Matter (PM₁₀)

The greatest source of coarse particulate matter is typically dust from roads, especially in the spring when the snow cover disappears and exposes sand and gravel deposited in winter on roads. Once the sand and gravel is exposed, wind and vehicle activity can cause the dust to become suspended in the air. This is the cause of the elevated PM₁₀ levels observed in March and April at the Yellowknife, Norman Wells, and Inuvik stations.

Norman Wells also experienced elevated PM₁₀ levels in the summer months resulting from fires burning in the Yukon. The Fort Smith PM₁₀ monitor had a malfunction and data could not be collected for the months of

March through to July. There were a total of 44 episodes of PM₁₀ readings that exceeded the AAQS of 50µg/m³. These occurred at Yellowknife, Norman Wells, and Inuvik stations.

Ground Level Ozone (O₃)

Detectable concentrations of ozone exist even in remote areas due to naturally occurring processes. In large urban areas (and areas downwind), ozone concentrations can be much higher due to human activities. Slightly elevated levels of ozone occurred in the months of March, April and May at all stations, which is common at remote monitoring stations in the north. These levels were still well below the AAQS.

Nitrogen Dioxide (NO₂)

Slightly elevated levels of NO₂ at all stations occurred during the winter months but are well below the AAQS. This is likely due to increased emissions from fuel combustion for residential and commercial heating and idling vehicles, as well as short-term “rush hour” traffic influences.

Carbon Monoxide (CO)

CO is monitored at three stations (Yellowknife, Inuvik, and Fort Smith). CO concentrations, like NO₂, are elevated by combustion and therefore there is a strong correlation between them. The highest CO levels occurred during the winter months at the same time that the highest NO₂ levels were recorded. CO concentrations also correlate with high PM_{2.5} caused by wildfire smoke. This was the case at the Fort Smith station which experienced the highest hourly maximum concentration. These levels were still below the AAQS.

Sulphur Dioxide (SO₂)

The 2019 levels of SO₂ continued to be very low at all four monitoring stations. Levels did not exceed the AAQS.

Air quality and your health

The Air Quality Health Index (AQHI) is a health risk communication tool developed by Environment and Climate Change Canada (ECCC) and Health Canada. The AQHI, available in Yellowknife, Inuvik, and Fort Smith, forecasts health risks related to air quality for the current and next day. It translates air quality monitoring data into a health scale from 1 to 10, and provides associated health-based information for the public, such as suggestions to adjust your activity level to protect yourself when the air quality is poor.

Contact Information

If you have questions about ENR's air quality monitoring program or would like more information please contact us or check out ENR's air quality web site at:

<http://www.enr.gov.nt.ca/en/services/air-quality>

Environmental Stewardship and Climate Change Division
Department of Environment and Natural Resources
Government of the Northwest Territories
P.O. BOX 1320
Yellowknife, NT X1A 2L9
Telephone: (867) 767-9236 ext. 53176 Cell: (867) 445-3152 Email: NWTairquality@gov.nt.ca

Sommaire

Le ministère de l'Environnement et des Ressources naturelles (MERN) surveille la qualité de l'air aux Territoires du Nord-Ouest (TNO). Le MERN maintient et gère le Réseau de surveillance de la qualité de l'air, composé de quatre stations de surveillance situées à Yellowknife, à Inuvik, à Fort Smith et à Norman Wells. Chacune de ces stations recueille en continu des données sur les différents polluants atmosphériques présents, la température, ainsi que la vitesse et la direction du vent. Les stations de Yellowknife, d'Inuvik et de Fort Smith sont exploitées en collaboration avec le Réseau national de surveillance de la pollution atmosphérique (Réseau NSPA), un programme fédéral-provincial-territorial visant à observer les tendances régionales de la qualité de l'air au Canada. Les quantités d'eau de pluie et de neige et leur composition chimique sont surveillées à la centrale hydroélectrique Snare Rapids et au parc national Wood Buffalo, dans le cadre du Réseau canadien d'échantillonnage des précipitations et de l'air (RCEPA).

Quels polluants surveillons-nous, et pourquoi?

L'air qui nous entoure sur les terres et dans les collectivités est appelé l'air ambiant. Il contient de l'azote, de l'oxygène, une petite quantité de dioxyde de carbone et de la vapeur d'eau. Il contient également de petites quantités de polluants. Les Normes sur la qualité de l'air ambiant (NQAA) aux TNO établissent la quantité de polluants permise dans l'air ambiant pendant une période donnée. Les concentrations naturelles de polluants dans l'air sont appelées niveaux de fond. Les activités humaines et les événements naturels, comme les feux de forêt, peuvent faire augmenter ces niveaux dans l'air ambiant. Le suivi des niveaux de fonds de polluants nous aide à mieux évaluer les répercussions des activités humaines et des phénomènes naturels sur la qualité de l'air.

Matières particulaires (MP_{2,5} et MP₁₀)

Les matières particulaires sont de tailles différentes. Les matières particulaires fines (MP_{2,5}) sont environ 30 fois plus petites que la largeur d'un cheveu humain. Les particules grossières (MP₁₀) sont un peu plus grosses que les MP_{2,5}. Les deux types peuvent être inhalés et aggraver les maladies pulmonaires ou cardiovasculaires. Les MP_{2,5} sont plus dangereuses, car elles sont si petites qu'elles contournent facilement les moyens de défense du nez et de la gorge et peuvent pénétrer profondément dans les poumons.

Les particules de la catégorie des MP_{2,5} proviennent principalement des activités industrielles, du chauffage commercial et résidentiel, des émissions des véhicules et de la fumée des feux de forêt.

Les MP₁₀ comprennent la poussière des routes et la terre portée par le vent.

Dioxyde de soufre (SO₂)

Le SO₂ est un gaz incolore qui peut avoir des effets négatifs sur la santé humaine et l'environnement. Certains types de végétation (en particulier le lichen) y sont très sensibles. Le SO₂ contribue aussi à la formation d'autres polluants atmosphériques. Les émissions de SO₂ proviennent de l'utilisation de combustibles fossiles qui contiennent du soufre. Les sources de SO₂ dans le Nord comprennent les centrales électriques, le chauffage commercial et résidentiel et les feux de forêt.

Dioxyde d'azote (NO₂)

Les sources de NO₂ sont les mêmes que celles du SO₂, en plus des gaz d'échappement des véhicules. Des concentrations élevées peuvent causer de graves problèmes respiratoires qui peuvent devenir chroniques. Des concentrations élevées de NO₂ peuvent également entraîner la formation d'autres polluants, comme la pollution particulaire et l'ozone troposphérique.

Ozone troposphérique (O₃)

C'est le même gaz que l'on trouve en haute atmosphère, soit l'ozone stratosphérique. En haute atmosphère, l'ozone est une bonne chose – il protège la planète des rayons ultraviolets nocifs du soleil. Par contre, l'ozone qu'on retrouve au niveau du sol peut être nocif pour les êtres humains et la végétation. De fortes concentrations d'ozone peuvent être créées dans la basse atmosphère par la lumière du soleil et la chaleur; elles provoquent des réactions chimiques entre les gaz, généralement du NO₂ et des substances appelées composés organiques volatils (COV). Une forte concentration d'ozone peut causer de la gêne respiratoire ou une toux, rendre la respiration sifflante et entraîner d'autres problèmes cardiaques ou pulmonaires. L'ozone peut aussi décolorer le feuillage et ralentir la croissance des plantes.

Monoxyde de carbone (CO)

Le CO provient de plusieurs sources, dont le chauffage domestique, les gaz d'échappement des véhicules et les feux de forêt. Une concentration très élevée de CO dans l'air peut être toxique et causer des maux de tête, de l'essoufflement et des nausées.

Notre réseau

Les stations de surveillance du MERN sont des petites remorques contenant des instruments hautement spécialisés qui mesurent en continu la quantité de particules et de substances chimiques dans l'air. Les quatre stations surveillent les concentrations de MP_{2,5}, de MP₁₀, de SO₂, de NO₂ et d'O₃. Les stations de Yellowknife, d'Inuvik et de Fort Smith surveillent aussi le CO.

La qualité de l'air des TNO en 2019

Particules fines (MP_{2,5})

L'une des principales sources de MP_{2,5} aux TNO est la fumée des feux de forêt. Dans l'ensemble, la saison des feux de forêt aux TNO a été tranquille. La station de Yellowknife a enregistré des niveaux modérément élevés pendant les mois de mai, juin et juillet en raison de la fumée de feu de forêt dérivant de High Level, en Alberta. Les stations de Norman Wells et de Fort Smith ont enregistré des niveaux modérément élevés de MP_{2,5} pendant le mois de juillet. La région de Fort Smith a été touchée par des feux dans le Parc national du Canada Wood Buffalo, tandis que Norman Wells a reçu de la fumée de feux au Yukon. Inuvik n'a pas été touchée par d'importants feux de forêt au cours de l'été 2019 et, par conséquent, les niveaux de MP_{2,5} sont demeurés relativement constants tout au long de l'année. Il y a eu cinq épisodes à Yellowknife, trois épisodes à Norman Wells et sept épisodes à Fort Smith où les niveaux de MP_{2,5} ont dépassé la moyenne des NQAA de 28 µg/m³ en 24 heures. Ces épisodes sont tous dus à la fumée des feux de forêt.

Grosses particules (MP₁₀)

La plus importante source de grosses particules est habituellement la poussière des routes, particulièrement au printemps, quand la neige fond et expose le sable et le gravier déposés sur la route pendant l'hiver. Le vent et les véhicules soulèvent ensuite ces particules, qui restent suspendues dans l'air. C'est ce qui explique les concentrations élevées de MP₁₀ observées en mars et en avril à Yellowknife, Norman Wells et Inuvik. Norman Wells a également enregistré des niveaux élevés de MP₁₀ pendant les mois d'été en raison des feux au Yukon. Le capteur de MP₁₀ de Fort Smith a connu une défaillance et les données n'ont pas pu être recueillies de mars à juillet. Au total, des concentrations de MP₁₀ supérieures aux NQAA de 50 µg/m³ ont été observées à 44 occasions à Yellowknife, Norman Wells, et Inuvik.

Ozone troposphérique (O₃)

En raison de processus naturels, des concentrations détectables d'ozone existent même dans les régions éloignées. Dans les grands centres urbains (et dans les régions sous le vent environnantes), les activités humaines peuvent faire augmenter considérablement la concentration d'ozone. Les concentrations d'ozone ont été légèrement élevées en mars, en avril et en mai à toutes les stations, ce qui est courant dans les stations de surveillance dans les régions éloignées du Nord. Ces concentrations étaient encore bien inférieures aux NQAA.

Dioxyde d'azote (NO₂)

Des concentrations légèrement élevées de NO₂ ont été observées à toutes les stations pendant les mois d'hiver, mais ces concentrations étaient encore bien inférieures aux NQAA. Cela est probablement attribuable à l'augmentation des émissions provenant de l'utilisation de combustible pour le chauffage résidentiel et commercial et des véhicules tournant au ralenti, ainsi qu'aux influences à court terme de la circulation aux heures de pointe.

Monoxyde de carbone (CO)

Le CO est surveillé à trois stations (Yellowknife, Inuvik et Fort Smith). Les concentrations de CO, comme celles de NO₂, augmentent avec la combustion et il existe une forte corrélation entre les deux. Les concentrations les plus élevées de CO ont été observées pendant les mois d'hiver, soit au même moment que les concentrations les plus élevées de NO₂. Il existe également une corrélation entre les concentrations de CO et un niveau élevé de MP_{2,5} causé par la fumée des feux de forêt. Ce fut le cas à la station de Fort Smith qui a enregistré la concentration horaire maximale la plus élevée. Ces concentrations étaient encore bien inférieures aux NQAA.

Dioxyde de soufre (SO₂)

Les concentrations de SO₂ observées en 2019 sont demeurées très faibles aux quatre stations de surveillance. Les niveaux n'ont pas dépassé les NQAA.

La qualité de l'air et votre santé

La cote air santé (CAS) est un outil de communication des risques pour la santé mis au point par Environnement et Changement climatique Canada (ECCC) et Santé Canada. La CAS, appliquée à Yellowknife, Inuvik et Fort Smith, prévoit les risques pour la santé liés à la qualité de l'air pour la journée en cours et le lendemain. Elle convertit les données de surveillance de la qualité de l'air en une échelle de santé de 1 à 10 et

fournit au public des renseignements connexes axés sur la santé, comme des suggestions pour ajuster le niveau d'activité pour se protéger lorsque la qualité de l'air est mauvaise.

Coordinnées

Si vous avez des questions au sujet du programme de surveillance de la qualité de l'air du MERN ou si vous souhaitez obtenir de plus amples renseignements, veuillez communiquer avec nous ou visiter le site Web du MERN consacré à la qualité de l'air : <https://www.enr.gov.nt.ca/fr/services/qualite-de-lair>.

Division de la gérance environnementale et du changement climatique

Ministère de l'Environnement et des Ressources naturelles

Gouvernement des Territoires du Nord-Ouest

C. P. 1320

Yellowknife NT X1A 2L9

Téléphone : 867-767-9236, poste 53176

Cellulaire : 867-445-3152

Courriel : nwtairquality@gov.nt.ca

Glossary

Ambient air: Atmospheric air in its natural state. It is what we breathe in when the atmosphere is not contaminated by air-borne pollutants.

Anthropogenic: Emissions resulting from human activities, such as those from vehicles or manufacturing.

Black carbon (BC): A fine particulate that is produced both naturally and by human activities as a result of the incomplete combustion of fossil fuels, biofuels, and biomass. Primary sources include emissions from diesel engines, cook stoves, wood burning and wildfires.

Carbon monoxide (CO): A gas formed from the incomplete combustion of substances that contain carbon (such as gasoline and wood).

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 pollutants such as acid rain, smog, particulate matter and mercury, in both air and precipitation.

Chemiluminescence: The emission of light during a chemical reaction that does not produce significant quantities of heat.

Exceedance: The amount by which something, especially a pollutant, exceeds a standard or permissible measurement.

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

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

National Air Pollution Surveillance (NAPS): The NAPS network was established in 1969 as a joint program of the federal, provincial, and territorial governments to monitor and assess ambient air in Canadian urban centers.

Oxides of nitrogen (NO_x): Gases that form when nitrogen and oxygen in the atmosphere are burned with fossil fuels at high temperatures. NO_x is a precursor to ozone formation.

Nitrogen dioxide (NO_2): NO_2 is one of the two most significantly toxicologically significant compounds found in NO_x . It forms primarily from emissions from vehicles, power plants and off-road equipment. High concentrations can irritate airways in the human respiratory system.

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 as a result of complex chemical reactions when VOCs and NO_x react in the presence of sunlight.

Particulate matter (PM): PM_{10} (Coarse Particulate Matter) - airborne particulate matter with a mass median diameter less than 10 μm (micron)

PM_{2.5} (Fine Particulate Matter) - airborne particulate matter with a mass median diameter less than 2.5 μm (micron)

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

Parts per million (ppm): A measure of pollutant concentration. Parts of pollutant per million parts of air.

Precursor: a compound that participates in a chemical reaction that produces another compound.

Sulfur dioxide (SO₂): A heavy, pungent, colorless gas formed primarily by the combustion of fossil fuels. It is a respiratory irritant, especially for asthmatics.

Transboundary pollution: Pollution that originates in one province or country but, by crossing the border through pathways of water or air, can impact the environment and human health in another province or country.

Volatile organic compounds (VOCs): Compounds that contain carbon, oxygen, hydrogen, chlorine and other atoms that can evaporate easily into the atmosphere. They are found in nature as well as in some glues, solvents and paints. They combine with NO_x to form O₃ near the ground.

Acronyms

AAQS	Ambient Air Quality Standards
API	Advanced Pollution Instrumentation
AQHI	Air Quality Health Index
ARI	Aurora Research Institute
BAM	Beta Attenuation Monitor
CAAQS	Canadian Ambient Air Quality Standards
CAPMoN	Canadian Air and Precipitation Monitoring Network
ECCC	Environment and Climate Change Canada
ENR	Department of Environment and Natural Resources
FS	Fort Smith
IN	Inuvik
NAPS	National Air Pollution Surveillance Program
NTPC	Northwest Territories Power Corporation
NW	Norman Wells
NWT	Northwest Territories
PM	Particulate Matter
PM _{2.5}	Fine Particulate Matter
PM ₁₀	Course Particulate Matter
ppb	Parts Per Billion
ppb _v	Parts Per Billion by Volume
ppm	Parts Per Million
UV	Ultraviolet Light
VOCs	Volatile Organic Compounds
YK	Yellowknife
µg/m ³	Micrograms Per Cubic Meter

Introduction

The Government of the Northwest Territories (GNWT) Department of Environment and Natural Resources (ENR) monitors air quality in the Northwest Territories (NWT). ENR maintains and operates the Ambient Air Quality Monitoring Network, consisting of four monitoring stations located in Yellowknife, Inuvik, Fort Smith and Norman Wells. Each station is capable of continuously monitoring a variety of air pollutants and meteorological conditions. The Yellowknife, Inuvik, and Fort Smith stations are operated in partnership with the National Air Pollution Surveillance (NAPS) program – a joint federal/provincial/territorial monitoring network. The goal of the NAPS program is to provide accurate and long-term air quality data of a uniform standard across Canada. ENR uses data collected from the stations to establish baseline levels of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and particulate matter ($\text{PM}_{2.5}$ and PM_{10}) ahead of development as well as to track the trends and cumulative impacts from source emissions should they occur.

Deposition monitoring of rainwater and snow quantities is also conducted in the NWT, in cooperation with the Canadian Air and Precipitation Monitoring Network (CAPMoN). Precipitation samples are collected daily and sent to a lab for analyses. The results provide information about regional patterns and trends of atmospheric pollutants such as acid rain. One station is located in Wood Buffalo National Park and the other at the Snare Rapids Hydro Facility. The latter is operated in partnership with the Northwest Territories Power Corporation (NTPC).

This Annual Air Quality Report summarizes the air quality information collected in 2019, along with some discussion of trends. Data capture and select statistical information can be found in **Appendix A**. The report provides information on network operations, the potential air pollutants that were monitored and the air quality standards used in assessing the monitoring results. Additional information, including ‘near real-time’ potential air pollutant readings, can be found on the NWT Air Quality Monitoring Network website at <http://aqm.enr.gov.nt.ca/>.

NWT Air Quality Monitoring Network - Operation

The NWT Air Quality Monitoring Network consists of four permanent monitoring stations located in Yellowknife, Inuvik, Fort Smith and Norman Wells. The stations are climate controlled structures and include state of the art monitoring equipment capable of continuously sampling and analyzing a variety of potential air pollutants and meteorological conditions. Potential pollutants monitored vary by station but include sulphur dioxide (SO_2), fine particulate matter ($\text{PM}_{2.5}$), coarse particulate matter (PM_{10}), ground level ozone (O_3), carbon monoxide (CO), and nitrogen dioxide (NO_2). Wind speed, wind direction and temperature are also monitored. For additional information on potential air pollutants, see **Appendix B**.

Figure 1: Map of the NWT Air Quality Monitoring Network



Table 1: Parameters Monitored by Station

Stations	Particulate Matter	Gaseous			Precipitation	Meteorological Monitoring
	PM _{2.5} – Fine Particulate	PM ₁₀ – Coarse Particulate	SO ₂ – Sulphur Dioxide	NO ₂ – Nitrogen Dioxide	O ₃ – Ground Level Ozone	CO – Carbon Monoxide
Yellowknife	✓	✓	✓	✓	✓	✓
Inuvik	✓	✓	✓	✓	✓	✓
Norman Wells	✓	✓	✓	✓	✓	✓
Fort Smith	✓	✓	✓	✓	✓	✓
Snare Rapids				✓	✓	
Wood Buffalo				✓	✓	

Table 1 shows the breakdown of the NWT Air Quality Monitoring Network by substances and meteorological parameters monitored at each station.

Data from each station is automatically transmitted every hour to ENR headquarters in Yellowknife using a sophisticated data acquisition system (DAS) and communications software. This allows for review of community air quality on a near real-time basis. The data also undergoes a series of real time validity checks before being archived by the data management, analysis and reporting system.

The Yellowknife, Inuvik, and Fort Smith stations are part of National Air Pollution Surveillance (NAPS) program, a larger national network monitoring sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), fine particulate matter (PM_{2.5}) and carbon monoxide (CO) in communities across Canada¹. The NAPS program is a joint federal/provincial/territorial initiative, incorporating 300 stations in 200 communities across the country. ENR operates the Inuvik station in partnership with the Aurora Research Institute (ARI), which provides on-the-ground technical operations of the station. Data from the 3 stations, along with data from other cities, is summarized and assessed, with results published in the NAPS annual data reports. More information on the NAPS program along with links to the data can be found at:

¹ NAPS 2017 Monitoring and Quality Assurance / Quality Control Guidelines

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

The NAPS program has a stringent quality assurance/quality control (QA/QC) component; ensuring Canada-wide data is comparable. ENR follows these QA/QC procedures at all four stations. The intent is for the Norman Wells station to become part of the NAPS program as well in the coming years.

Canadian Air and Precipitation Monitoring Network (CAPMoN)

ENR also participates in the CAPMoN program. CAPMoN is a non-urban monitoring network with measurement sites in Canada and in the United States designed to study the regional patterns and trends of atmospheric pollutants such as acid rain, smog, particulate matter and mercury, in both air and precipitation. Unlike NAPS, CAPMoN locates sites to limit the effect of anthropogenic sources. Most sites are remote and data is considered representative of background values.

Two CAPMoN stations are operated in the NWT, one at the Wood Buffalo National Park approximately 80 kilometres northwest of Fort Smith and the other at the Snare Rapids Hydro Facility approximately 150 kilometres northwest of Yellowknife. ENR, with assistance from the NTPC staff, operate the Snare Rapids station which consists of an acid precipitation collector and an ozone analyzer. The Wood Buffalo station uses an automated precipitation collector and monitors continuous ozone. Daily rain and snow samples from both stations are collected and forwarded to the CAPMoN laboratory for analysis. The data from these sites is available through Environment and Climate Change Canada (ECCC).

Table 2: NWT Air Quality Monitoring Network

Government of the Northwest Territories	Partnership/Contact	Stations	Network
		Yellowknife and Fort Smith	 Environment and Climate Change Canada National Air Pollution Surveillance
	 Aurora Research Institute	Inuvik	 Environment and Climate Change Canada National Air Pollution Surveillance
		Norman Wells	Northwest Territories Station
	 NWT Power Corporation	Snare Rapids	 Environment and Climate Change Canada Canadian Air and Precipitation Monitoring
		Wood Buffalo	

Developments in 2019

Air quality monitoring began with a single particulate monitor in Yellowknife in 1974. The NWT Air Quality Monitoring Network has been in operation since the 1990s, progressing through various monitoring locations and equipment to reach the current stage of development. **Appendix C** outlines the history of air quality monitoring in the NWT.

To ensure the NWT Air Quality Monitoring Network is current with technological advancements and serving the needs of the NWT, continuous improvement of the monitoring network is required. Improvements conducted in 2019 included:

- The installation of a number of trace level instruments continued throughout the network to replace aging and in some cases outdated gas analyzers.
- New Advanced Pollution Instrumentation API T-640 particulate monitors were deployed to measure PM2.5 and PM10 across the network replacing all of the old Beta Attenuation Monitors (BAM).

Future Plans

- ENR will participate in work being undertaken by ECCC investigating the feasibility of using small portable PM2.5 sensors to better delineate the extent of wildfire smoke.
- A new air quality monitoring station will be situated in the Dehcho region of NWT in the town of Fort Simpson. With the addition of this fifth station, there will be a monitoring station located in each GNWT administrative region of the NWT.

NWT Air Quality Standards

The GNWT has adopted a number of concentration limits for the protection of ambient (outdoor) air quality in the NWT. These standards apply to select potential pollutants and are documented in the “Guideline for Ambient Air Quality Standards in the Northwest Territories”, established under the NWT Environmental Protection Act. They are summarized in **Table 3** below.

These NWT Ambient Air Quality Standards (AAQS) are used in the assessment of air quality monitoring data as well as in determining the acceptability of emissions from proposed and existing developments. Where NWT standards are not available for a particular potential pollutant, the Canadian National Ambient Air Quality Objectives (national standards) or standards established in other jurisdictions are used for comparison purposes.

Table 3: NWT Ambient Air Quality Standards (NWT AAQS)

Parameter and Standard	Concentration
Sulphur Dioxide (SO ₂) 1-hour average 24-hour average	172 ppb 57 ppb
Ground Level Ozone (O ₃) 8-hour running average	63 ppb
Fine Particulate Matter (PM _{2.5}) 24-hour average	28 µg/m ³
Nitrogen Dioxide (NO ₂) 1-hour average 24-hour average	213 ppb 106 ppb
Carbon Monoxide (CO) 1-hour average 8-hour average	13 ppm 5 ppm

The “Guideline for Ambient Air Quality Standards in the Northwest Territories” provides additional information on the application of the NWT standards and the pollutants of concern.

Additional criteria from other jurisdictions used in this report are presented in **Table 4**.

Table 4: Additional Ambient Air Quality Standards (AAQS)

Parameter and Standard	Concentration	Source
Coarse Particulate Matter (PM ₁₀) 24-hour average	50 µg/m ³	Ontario Ambient Air Quality Criteria, 2012 B.C. Ambient Air Quality Objectives, 2014

NWT Air Quality in 2019

Fine Particulate Matter (PM_{2.5})

Fine Particulate Matter (PM_{2.5}) is monitored at all four stations with specialized particulate monitors. These monitors measure fine particles in the range of 0.1 to 2.5 μm in diameter providing continuous analysis of particulate concentrations. Non-continuous particulate monitoring is also conducted at the Yellowknife station using a Partisol 2000i-D filter-based sampler. These smaller particles include combustion particles, organic compounds, and metals. One of the main sources of PM_{2.5} within the NWT is smoke from wildfires. Note that wildfire events are observed and documented by regional ENR staff as they occur (i.e. visible smoke and olfactory indications of smoke), and this qualitative data serves as a validation to the conclusions drawn from measured PM_{2.5} readings. In addition, smoke forecasts can be monitored with the use of modeling programs developed by ECCC.

Figure 2: 2019 Fine Particulate Matter (PM_{2.5}) Monthly Averages

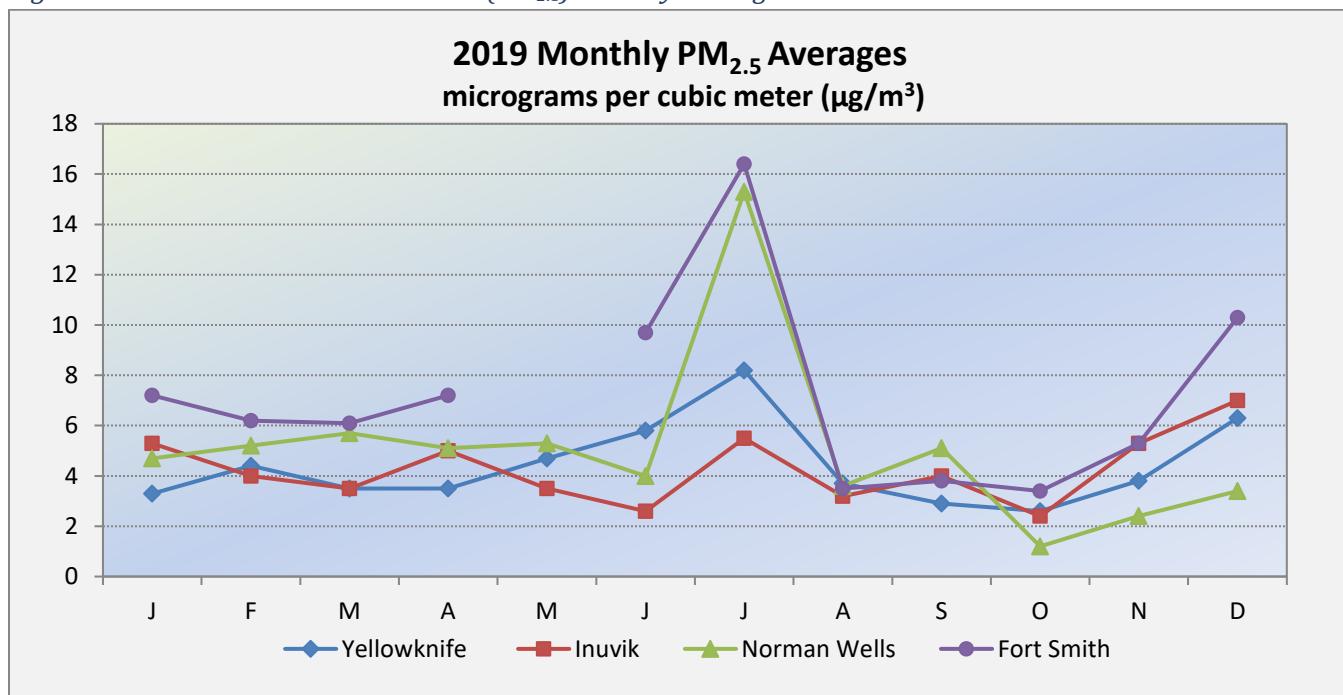


Figure 2 shows the monthly averages measured at the four air monitoring stations in 2019. The Yellowknife, Fort Smith, and Norman Wells stations saw elevated levels mainly in the month of July. This was directly attributed to regional wildfire smoke. The Inuvik region did not experience any significant wildfire events during the summer of 2019 and as a result PM_{2.5} levels remained fairly consistent throughout the year. The Fort Smith PM_{2.5} particulate monitor did not operate during the month of May due to an instrument malfunction.

Figure 3: 2019 Fine Particulate Matter (PM_{2.5}) Maximum Daily Average Per Month

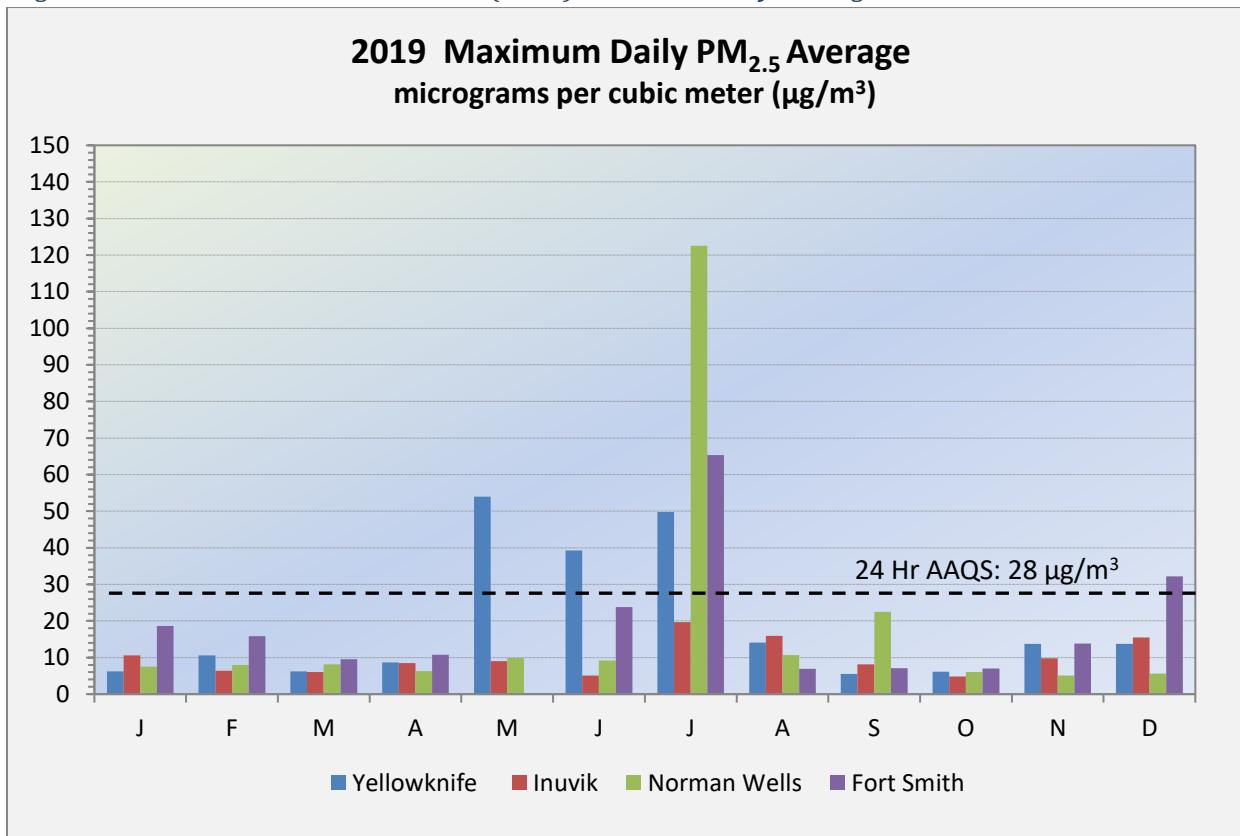


Figure 3 shows the maximum daily average for each month at each station. As presented in Table 5, there were fifteen episodes where PM_{2.5} levels exceeded the 24-hour average AAQS of 28 µg/m³.

Fort Smith had the most with seven, followed by Yellowknife with five, and Norman Wells with three. All of these PM_{2.5} exceedances were attributed to both regional and transboundary wildfire smoke.

Table 5: PM_{2.5} Averages and AAQS - 2019

Station	Max 24 Hour Avg. (µg/m ³)	24 Hour Avg. AAQS (µg/m ³)	# Exceedances Days >28 µg/m ³
Yellowknife	54.0	28	5
Inuvik	19.7		0
Norman Wells	122.5		3
Fort Smith	65.3		7

Coarse Particulate Matter (PM₁₀)

Coarse Particulate Matter (PM₁₀) is monitored at all four stations with specialized particulate monitors (BAM and T640 Particulate Matter Mass Monitor). The PM₁₀ monitor measures coarse particles in the range of 2.5 to 10 μm in diameter. The greatest source of coarse particulate matter is dust from roads, especially in the spring when the snow cover disappears and exposes sand and gravel deposited in winter on roads. Once the sand and gravel is exposed, wind and vehicle activity can cause the dust to become suspended in the air. This is the cause of the peak PM₁₀ levels we see in April in Yellowknife. The other three stations also experience springtime peaks and are susceptible to elevated levels during late spring and into the summer months. This is due to the fact that these three regions have more gravel roads where wind-blown dust is present during the spring and summer months. PM₁₀ concentrations can also be elevated due to wildfire smoke especially in cases where a wildfire is nearby resulting in larger ash particles falling out near the location of the station.

The NWT does not have an AAQS for PM₁₀. Instead, it adopts a 24-hour average standard of 50 $\mu\text{g}/\text{m}^3$. This level is used in several Canadian jurisdictions, including British Columbia and Ontario.

Figure 4: 2019 Coarse Particulate Matter (PM₁₀) Monthly Averages

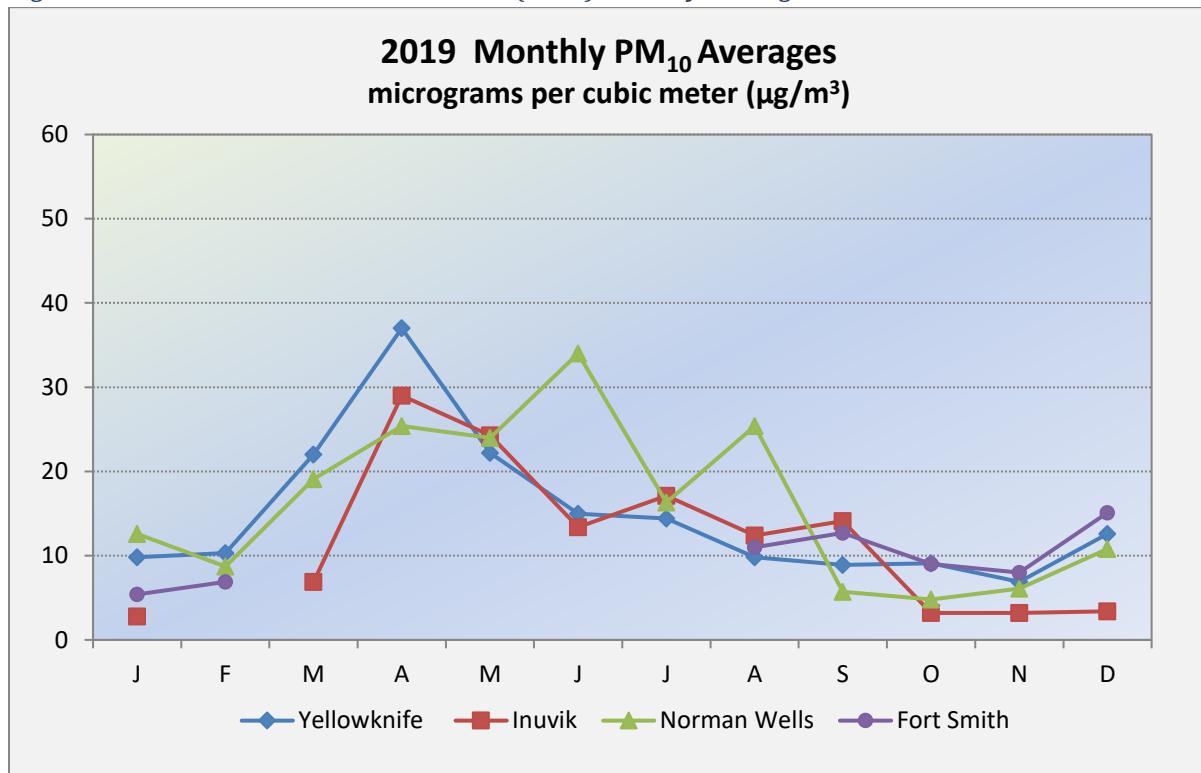


Figure 4 shows the monthly averages measured at the four air monitoring stations in 2019. The Yellowknife and Inuvik stations had their highest concentrations in April which can be attributed to spring melt and road dust. Norman Wells experienced its spring melt peak in April. Norman Wells also experienced peak concentrations throughout the summer months as a result of larger size ash coming from forest fires burning in the Yukon. Unfortunately, a major instrument malfunction at the Fort Smith station greatly limited the number of valid months of PM₁₀ data including the spring melt months and most of the summer. A PM₁₀ instrument malfunction also occurred at the Inuvik station in February causing data loss for that month.

Figure 5: 2019 Coarse Particulate Matter (PM₁₀) Maximum Daily Averages Per Month

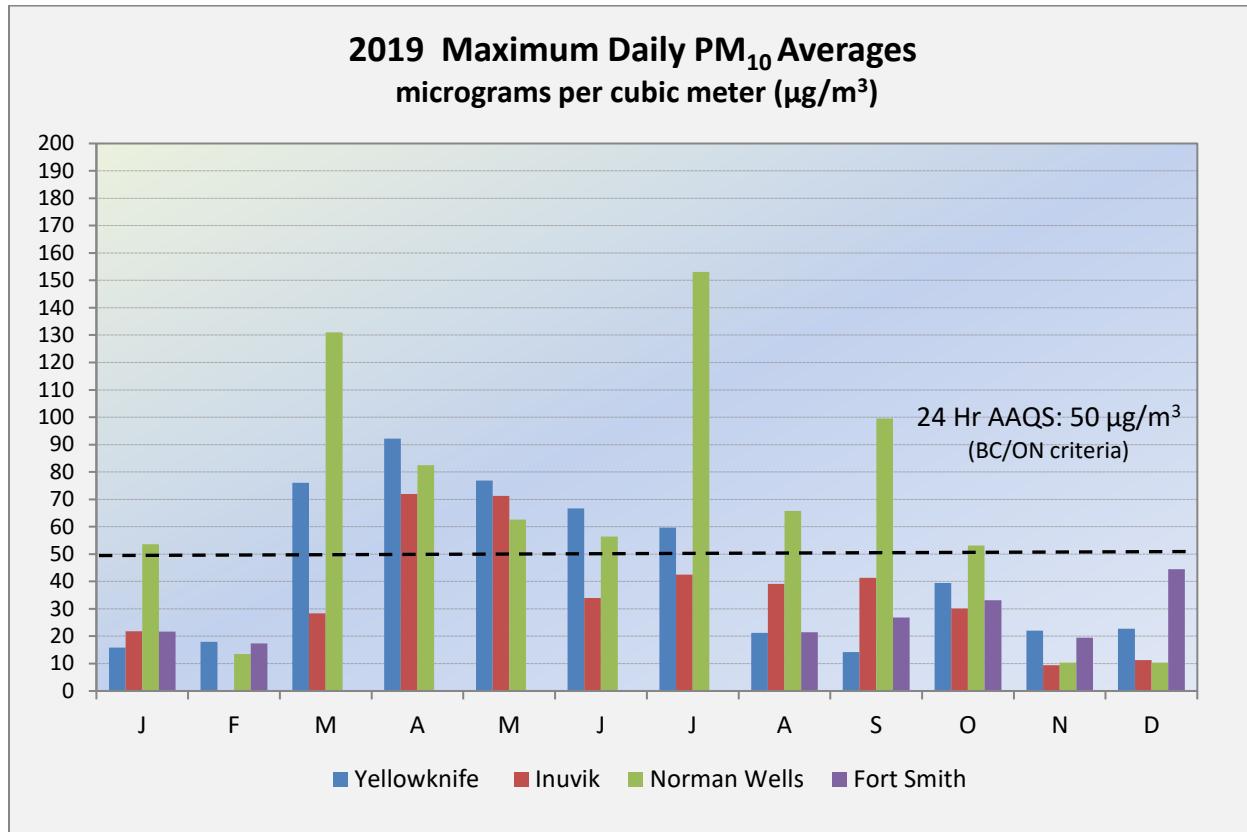


Figure 5 shows the maximum daily average for each month at each station. In 2019, there were a total of 44 episodes of PM₁₀ readings that exceeded the adopted standard of 50 µg/m³ (see Table 6). Norman Wells had the most exceedances with 18; they occurred mostly in the spring and summer months due to the spring melt and due to large particulate from nearby wildfires in the summer. Yellowknife had 17 exceedances most of which occurred in the spring as a result of the melt exposing dust. Inuvik had 9 exceedances all resulting from the spring melt in the months of April and May. Due to a major instrument malfunction, the Fort Smith PM₁₀ monitor was not operational for 5 months. A new instrument was installed in August. Unfortunately the data capture fell below the necessary criteria for which to analyze the data.

Table 6: PM₁₀ Averages and AAQS (BC/ON Criteria) - 2019

Station	Max 24 Hour Avg. (µg/m ³)	24 Hour Avg. Adopted Std (µg/m ³)	# Exceedances Days >50 µg/m ³
Yellowknife	92.2	50	17
Inuvik	72.0		9
Norman Wells	153.1		18
Fort Smith	N/A		N/A

Ground Level Ozone (O₃)

Ozone is monitored at all four stations with API 400 series UV absorption analyzers. Detectable concentrations of ozone exist even in remote areas due to naturally occurring sources of the precursor gases, such as VOC emissions from trees, and the introduction of stratospheric ozone to lower elevations that can occur due to

atmospheric mixing processes. These background concentrations typically are in the range of 20 to 40 ppb. In large urban areas (and areas downwind), ozone concentrations can be much higher due to the additional emissions of precursor gases that form as a result of human activities.

Figure 6: 2019 Monthly Ozone (O_3) Averages

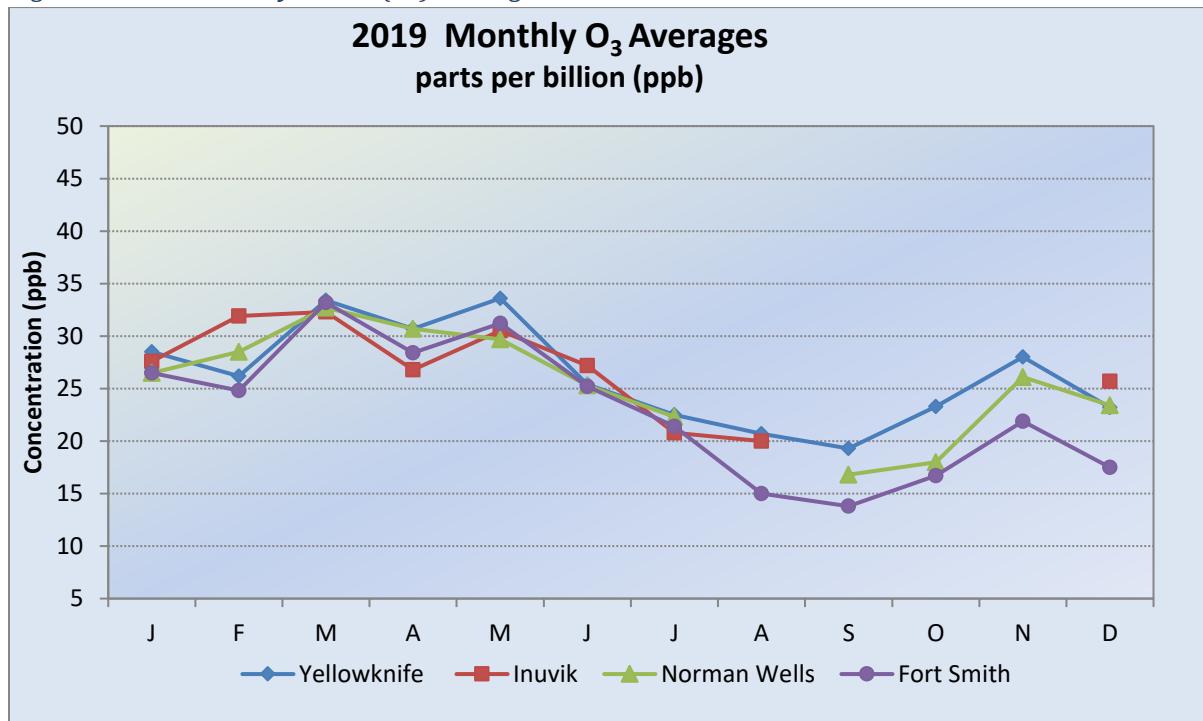


Figure 6 shows the monthly averages recorded in 2019. Unfortunately analyzer malfunctions occurred at both the Norman Wells and Inuvik stations. Inuvik lost 3 months of data while Norman Wells lost 1 month of data. Ozone levels were highest in the springtime which coincides with the increased sunlight, and natural and anthropogenic sources of precursor compounds. Generally, the most elevated monthly averages at all stations occurred within the spring months (March to May) which is common at remote monitoring stations located in mid to high latitudes in the northern hemisphere. Typical monthly ozone concentrations at remote sites in Canada range between 20 and 45 ppb². The recorded ozone concentrations were within this range.

² Vingarza, R. "A review of surface ozone background levels and trends". Atmospheric Environment, Vol 38, Issue 21, pp 3431-3442 (2004).

Figure 7: 2019 Maximum 8-Hour Ozone (O_3) Averages

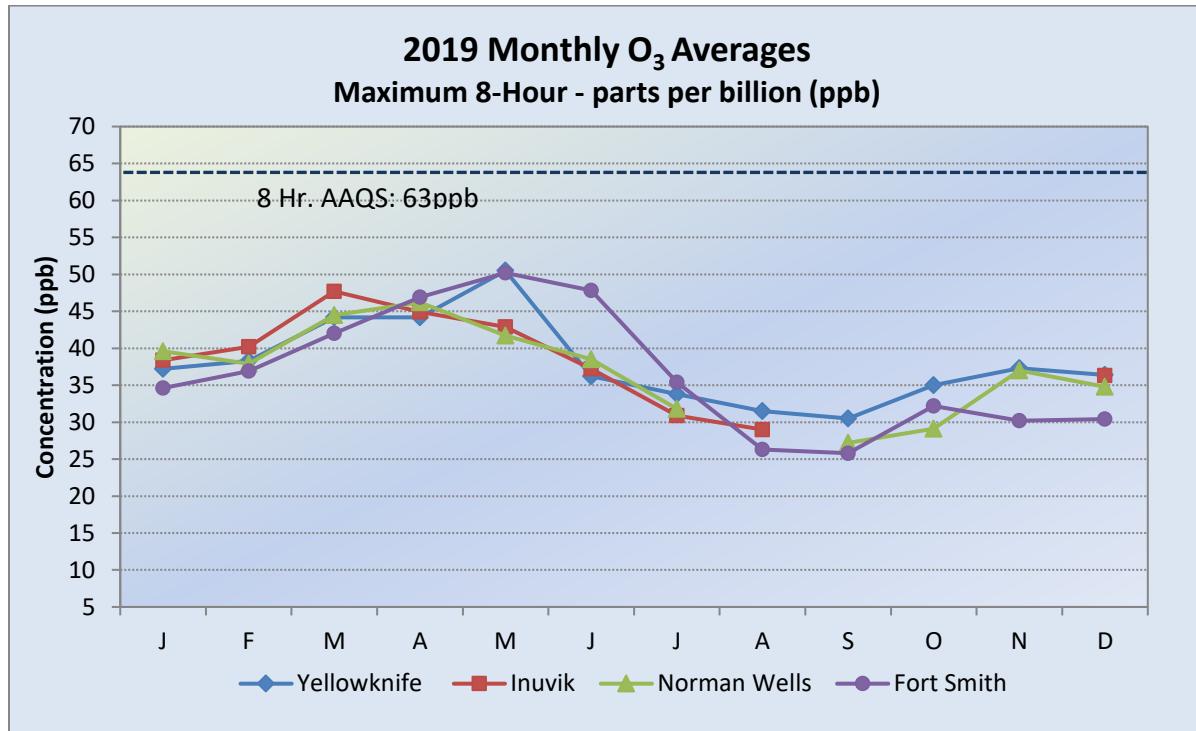


Figure 7 and **Table 7** show the maximum 8-hour averages per month recorded in 2019. The concentrations for all of the stations were well below the 8-hour NWT AAQS of 63 ppb and within typical remote site concentrations.

Table 7: Ozone (O_3) Averages and AAQS - 2019

Station	Max 8 Hour Avg.(ppb)	8 Hour Avg. AAQS (ppb)
Yellowknife	50.8	63
Inuvik	47.9	
Norman Wells	46.7	
Fort Smith	54.7	

Nitrogen Dioxide (NO_2)

NO_2 is monitored at all four stations with API 200 series chemiluminescence NO_x analyzers. The NO_x gas analyzers provide continuous information on oxides of nitrogen (NO , NO_2 and NO_x). However, the focus is on NO_2 due to the health concerns associated with this pollutant and the availability of national air quality standards for comparison. Exposure to elevated levels of NO_2 increases the likelihood of respiratory problems. It has the ability to inflame the lining of the lungs which can increase the risk of lung infections.

Figure 8: 2019 Nitrogen Dioxide (NO_2) Monthly Averages

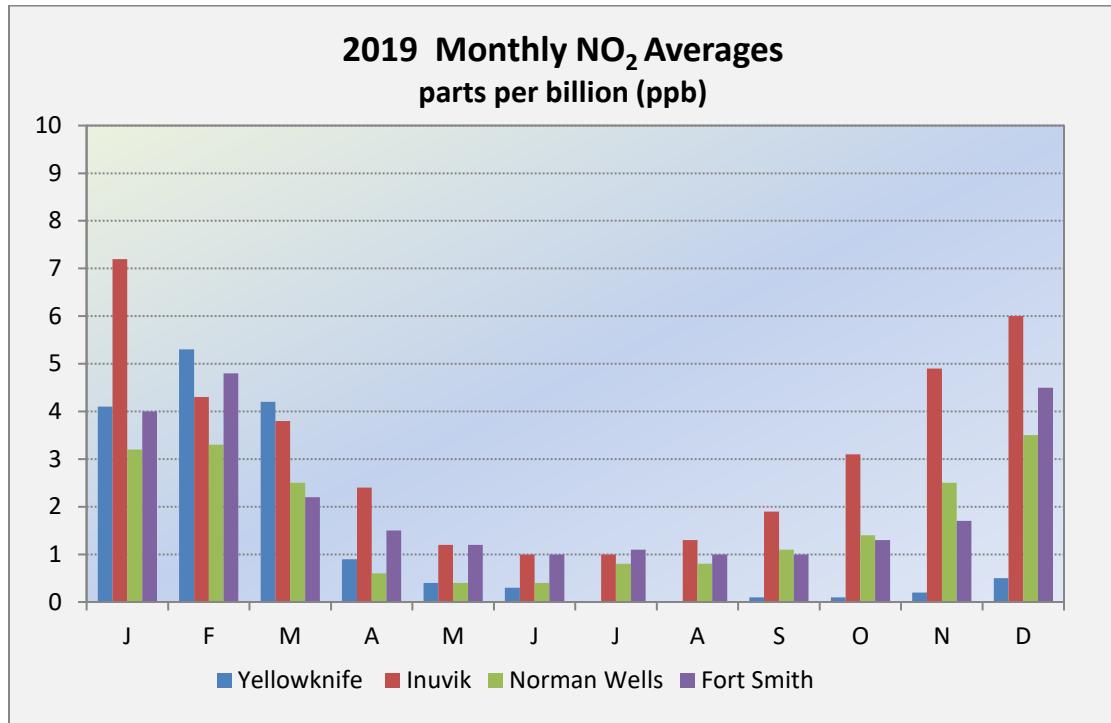


Figure 9: 2019 Nitrogen Dioxide (NO_2) 1-Hour Maximums

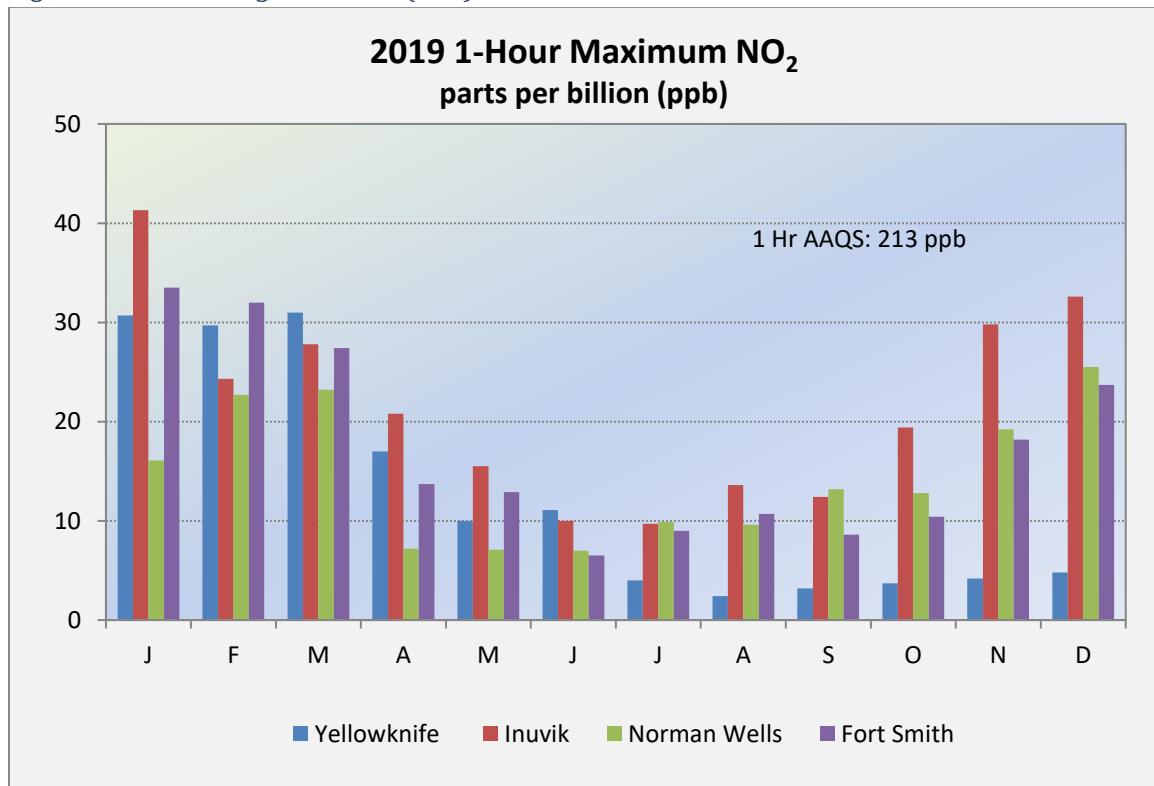
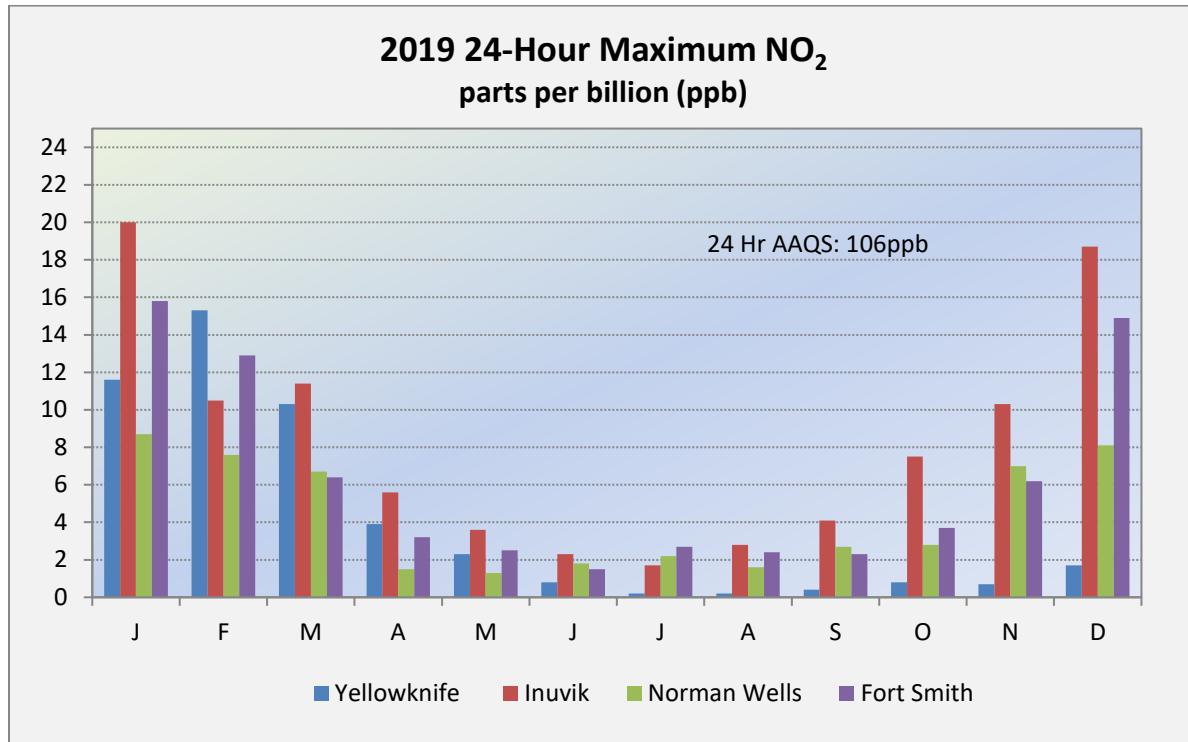


Figure 10: 2019 Nitrogen Dioxide (NO_2) 24-Hour Maximums



Figures 8 to 10 and Table 8 show the monthly average, 1-hour maximum, and the 24-hour maximum concentrations of NO_2 at each station. Generally, the highest monthly averages and the highest hourly concentrations occurred during the winter months but were well below AAQS standards. This is likely due to increased emissions from fuel combustion for residential and commercial heating and idling vehicles, as well as short-term “rush hour” traffic influences. The effects of these combustion emissions on wintertime air quality can increase when combined with stagnant meteorological conditions. Cold, calm days can result in an atmospheric situation where the normal decrease in air temperature with elevation is reversed and a zone of colder air is present at ground level. This zone of colder air and the lack of wind act to restrict dispersion and trap pollutants close to the ground. This is also known as an inversion. Neither the 1-hour (213 ppb) nor the 24-hour (106 ppb) AAQS for NO_2 were exceeded.

Table 8: Nitrogen Dioxide (NO_2) Averages and AAQS - 2019

Station	Max 1 Hour Avg. (ppb)	1 Hour Avg. AAQS (ppb)	Max 24 Hour Avg. (ppb)	24 Hour Avg. AAQS (ppb)
Yellowknife	31.0	213	15.3	106
Inuvik	41.3		20.0	
Norman Wells	25.5		8.7	
Fort Smith	33.5		15.8	

Carbon Monoxide (CO)

Carbon Monoxide (CO) is monitored at three stations (Yellowknife, Inuvik, and Fort Smith), using API 300 series gas filter correlation analyzers. Analyzer issues caused 3 months of data loss at the Fort Smith station and 1 month at the Inuvik station. The 2019 data continued the pattern of low CO readings measured in 2018, with

some exceptions. There were elevated concentrations that occurred during the winter months at all three stations; these levels were associated with high NO_x emissions from combustion sources in close proximity to the stations. In addition there were a couple of elevated concentrations that occurred at the Yellowknife and Fort Smith stations in the months of June and July. These were associated with wildfire smoke.

Figure 11: 2019 Carbon Monoxide (CO) Monthly Averages

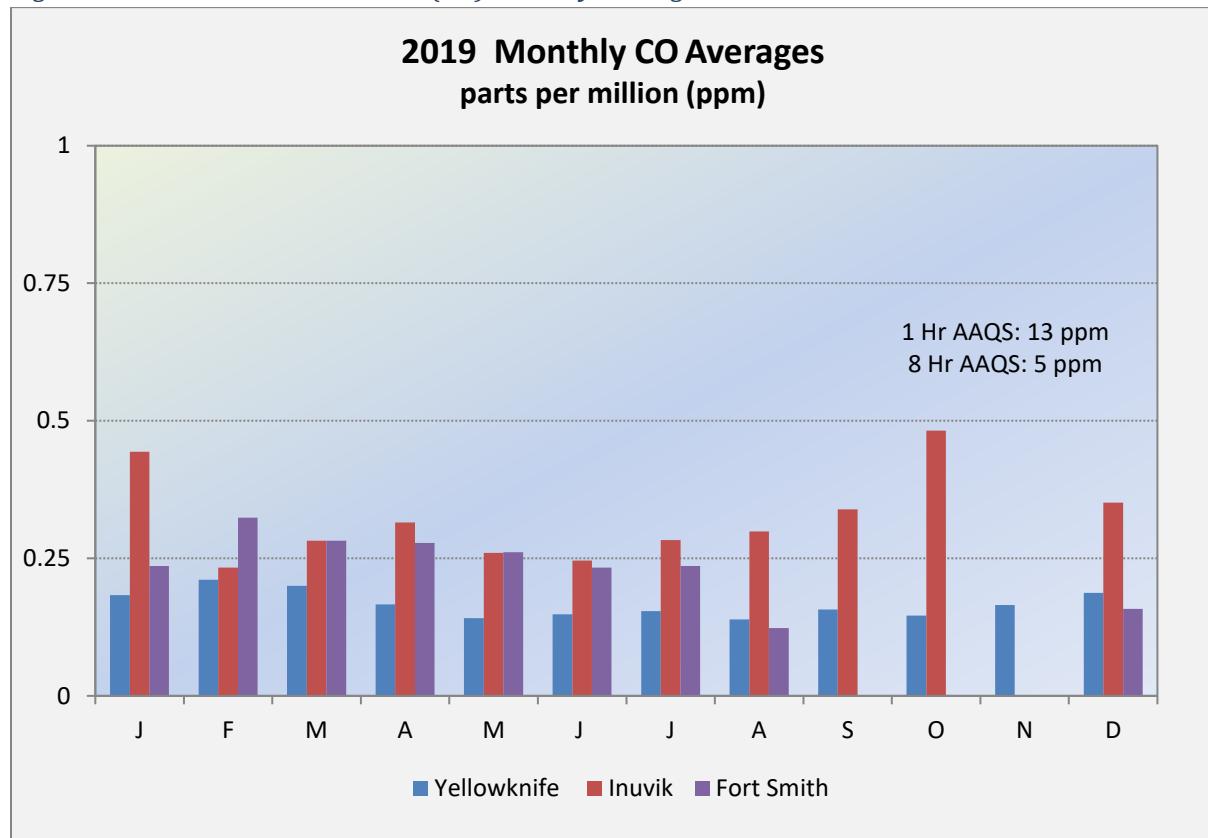


Figure 11 shows that the overall concentrations at all three stations were well below the NWT 1-hr and 8-hr average AAQS of 13ppm and 5ppm, respectively.

Figure 12: 2019 Carbon Monoxide (CO) 1-Hour Maximum and Maximum 8-Hour Averages

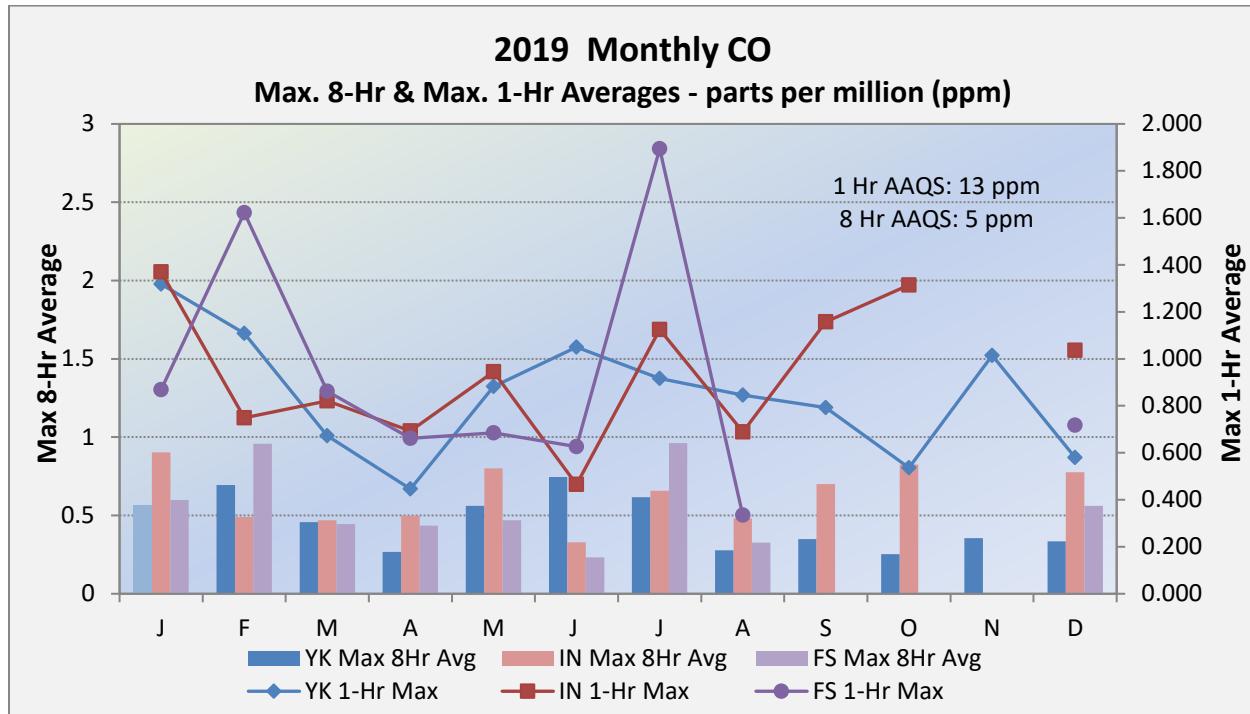


Figure 12 and Table 9 show that even the 1-hour maximum and maximum 8-hour averages concentrations were below the AAQS standards

Table 9: Carbon Monoxide (CO) Averages and AAQS - 2019

Station	Max 1 Hour Avg. (ppm)	1 Hour Avg. AAQS (ppm)	Max 8 Hour Avg. (ppm)	8 Hour Avg. AAQS (ppm)
Yellowknife	1.3	13	0.7	5
Inuvik	1.4		0.9	
Fort Smith	1.9		1.0	

Sulphur Dioxide (SO₂)

Sulphur Dioxide (SO₂) is monitored at all four stations with API 100 series UV fluorescence analyzers. The 2019 levels continued to be extremely low at all four monitoring stations. Levels did not exceed the 24-hour average AAQS of 57 ppb or the annual average AAQS of 11 ppb.

Figure 13 : 2019 Sulphur Dioxide (SO₂) Monthly Averages

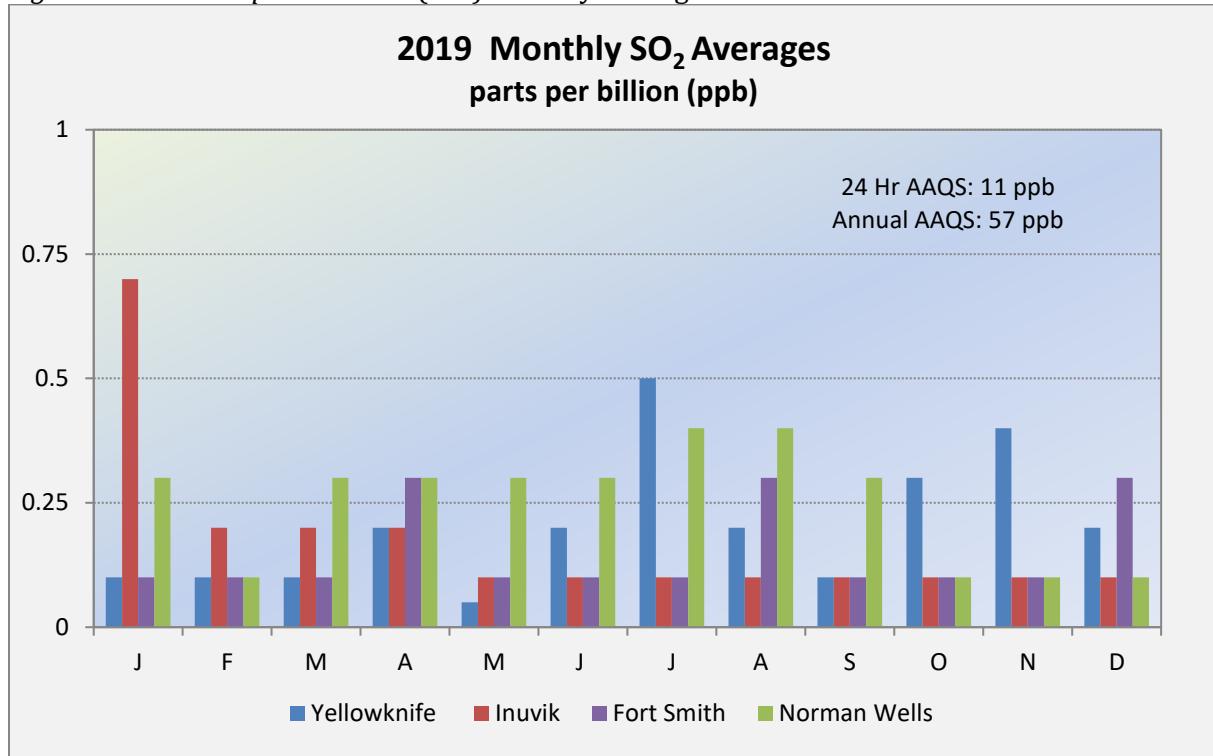


Figure 13 shows the average concentration for each month at each station

Table 10: Sulphur Dioxide (SO₂) Averages and AAQS - 2019

Station	Annual Average (ppb)	Annual Average AAQS (ppb)	Max 24 Hour Avg. (ppb)	24 Hour Average AAQS (ppb)
Yellowknife	0.2	11	0.7	57
Inuvik	0.1		0.9	
Norman Wells	0.2		0.6	
Fort Smith	0.2		0.7	

Long-Term Trends

The NWT Ambient Air Quality Monitoring Network has been in operation for over a decade, and there is sufficient data to conduct longer term trend analyses. Comparisons of the annual averages of select potential pollutants are presented below. In cases where no NWT AAQS exists, standards from other jurisdictions have been adopted for reference.

Figure 14: 2007 to 2019 PM_{2.5} Trends

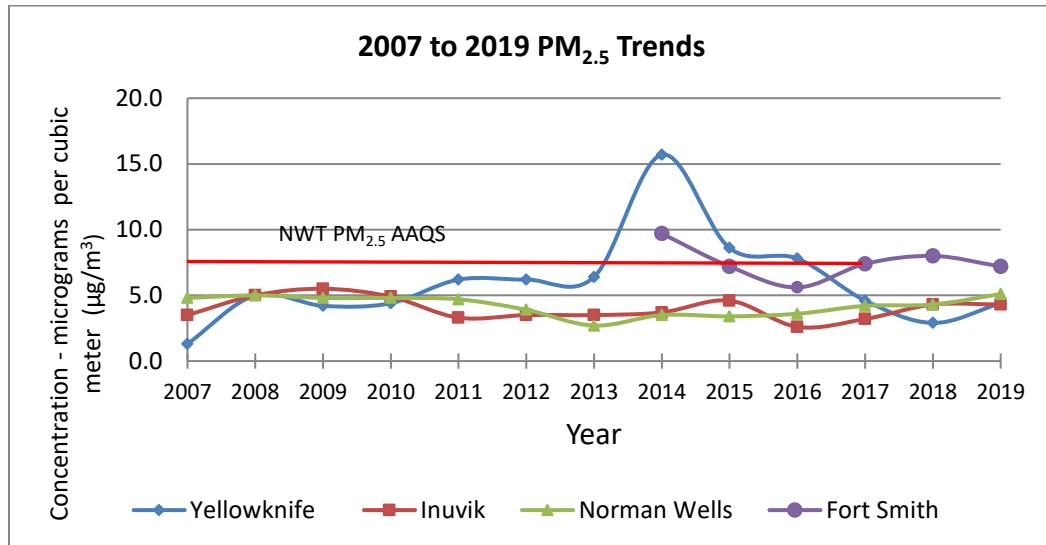


Figure 14 compares the annual PM_{2.5} average concentrations from the Yellowknife, Norman Wells and Inuvik stations from 2007 to 2019. Fort Smith has six years of data. The results demonstrate that the PM_{2.5} levels in the NWT fluctuate annually, which is likely due to the major influence of seasonal wildfires whose effects vary annually. The noticeable 2014 Yellowknife peak was directly caused by one of the worst wildfire seasons in the NWT. The wildfire smoke which surrounded Yellowknife in 2014 caused the highest PM_{2.5} readings ever recorded at the Yellowknife station to date, exceeding the NWT annual PM_{2.5} AAQS. To assess the data without the natural and variable/fluctuating influences from fires, the following figure presents the PM_{2.5} averages for the years 2007 to 2019, excluding the May to August time frames.

Figure 15: 2007 to 2019 – PM_{2.5} Trends, Excluding May to August

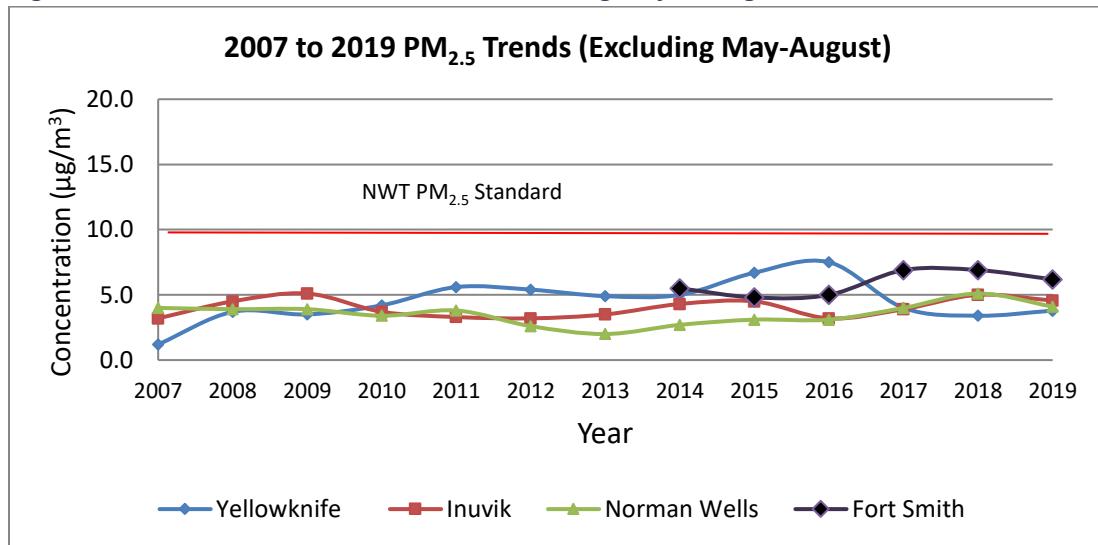


Figure 15 demonstrates that when the seasonal influences from wildfire smoke are eliminated, the PM_{2.5} levels in each of the NWT communities are generally consistent from year to year and below the AAQS.

Figure 16: 2007 to 2019 – Annual NO₂ Averages

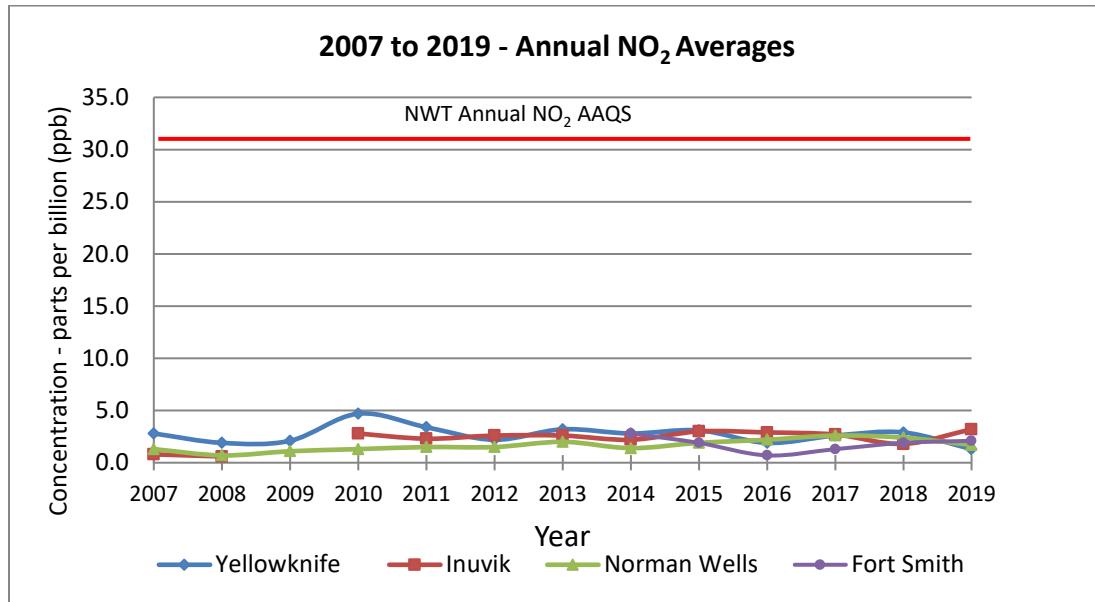


Figure 16 compares the annual NO₂ average concentrations from the Yellowknife, Norman Wells and Inuvik stations from 2007 to 2019. The Fort Smith data includes six years. Results indicate that generally Yellowknife has slightly higher NO₂ levels than the other communities, which is to be expected given the larger population size and resulting combustion sources. All results are below the AAQS of 32 ppb. The trend over this time period for each monitoring station is relatively stable, which is to be expected given the absence of any major changes to emission sources or population growth in these communities.

Figure 17: 2007 to 2019 – 8-hr Ozone (O_3)

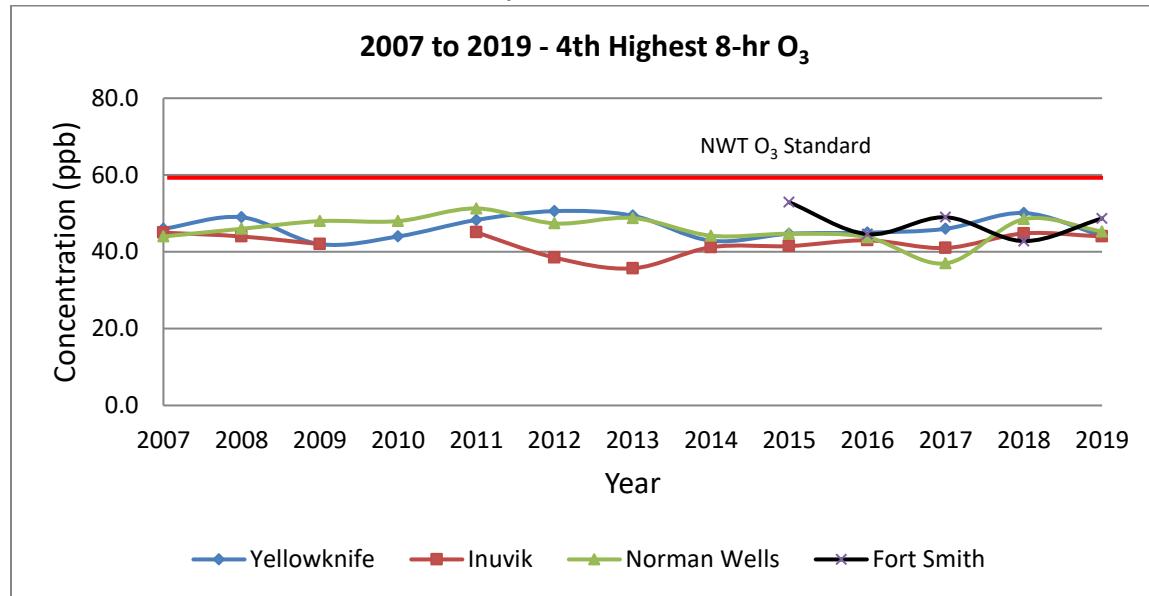


Figure 17 shows the O₃ 8-hour average concentrations from the Yellowknife, Norman Wells and Inuvik stations from 2007 to 2019. The Fort Smith data includes five years. The concentrations are consistently below the AAQS of 63 ppb. The results indicate that O₃ levels are fairly consistent from year to year and between the communities. The Canadian Ambient Air Quality Standard for Ozone is based on the 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations.

National Comparisons

In addition to comparing our air quality data within the NWT, this report compares NWT air quality with other cities in Canada. When looking at ambient air data from other locations, it is important to note that there are many influences to local air quality, including geographic considerations, population size and density, local industrial sources, transboundary considerations, and others. For comparison purposes, ENR has presented Yellowknife air quality against select jurisdictional capitals (Figure 17), followed by a comparison to cities of similar population (Figure 18), regardless of the types and sources of their air emissions.

Figure 18: 2019 National Comparisons – Jurisdictional Capitals

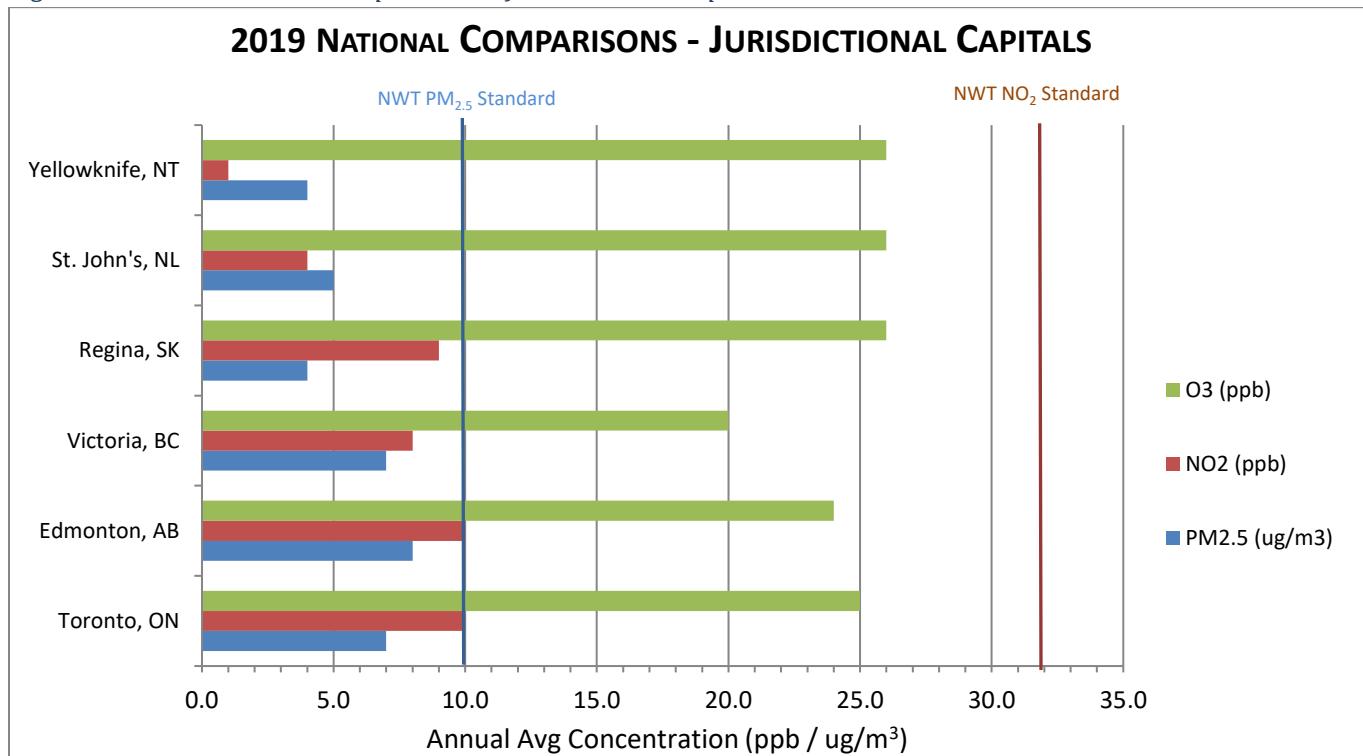


Figure 18 above compares the 2019 annual average concentrations of O₃, NO₂ and PM_{2.5} between select capital cities across Canada. The values are measured against the AAQS for PM_{2.5} and NO₂; no standards are available for annual O₃.

The data shows that Yellowknife O₃ levels in 2019 were the same as St. John's and Regina. Yellowknife NO₂ levels were significantly lower than all the comparison cities, presumably as a result of a much smaller size city with fewer combustion emission sources. The reverse relationship between Yellowknife's O₃ and NO₂ concentrations is generally to be expected, in part because localized NO_x levels contribute to ozone reduction through a chemical process known as scavenging. Therefore, higher O₃ levels may be expected in areas with lower NO₂ concentrations. NO₂ levels for all cities that were compared were below the AAQS. The PM_{2.5} levels in Yellowknife were the lowest in the group of cities that were compared and fell well below the AAQS.

Figure 19: 2019 National Comparisons – Similar Population Size

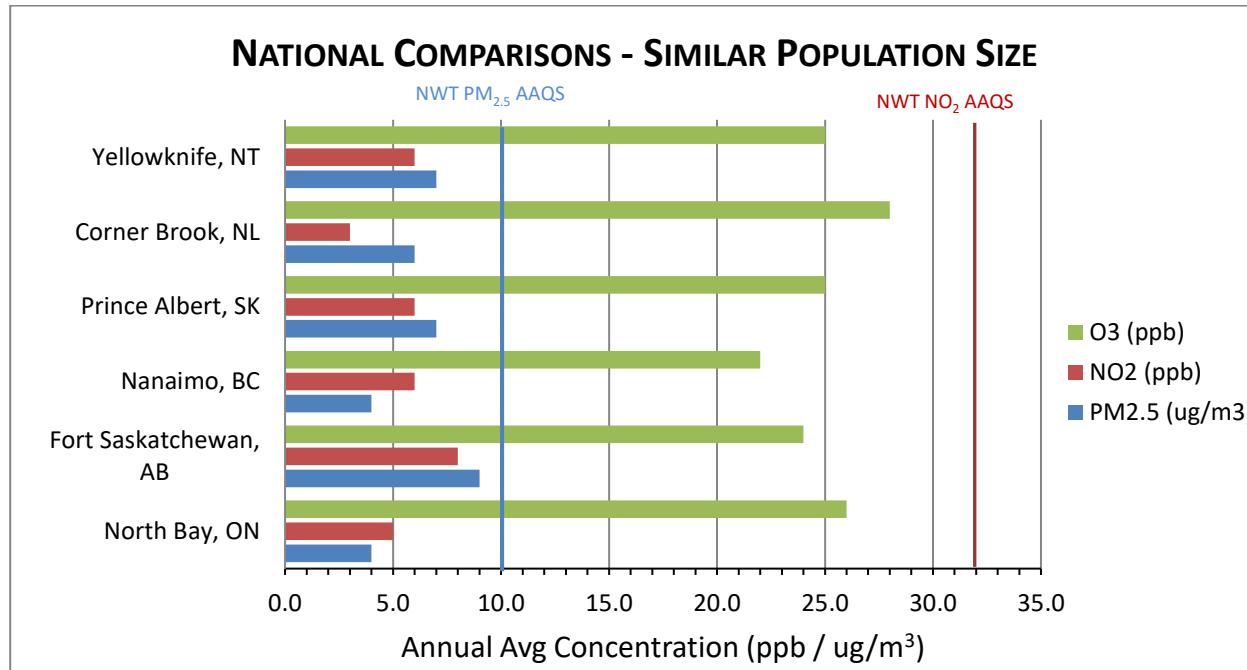


Figure 19 compares Yellowknife's annual average concentrations of O_3 , NO_2 , and $\text{PM}_{2.5}$ to select cities across Canada of a similar population size (<100,000). The results show that Yellowknife O_3 and NO_2 levels were similar to other cities. All the NO_2 levels were below the AAQS. The Yellowknife O_3 levels are typical of rural cities. Yellowknife $\text{PM}_{2.5}$ levels were average within the group in 2019. All of the $\text{PM}_{2.5}$ levels measured at all of the cities compared were below the AAQS.

CAPMoN Stations

Since 1989, ENR has supported a Canadian Air and Precipitation Monitoring Network (CAPMoN) station at the Northwest Territories Power Corporation's Snare Rapids hydro-electric generating site. The CAPMoN Network, federally operated by ECCC, is designed to assess the regional patterns and trends of atmospheric pollutants such as acid rain, smog, particulate matter and mercury, in both air and precipitation. This site is located approximately 150 kilometres northwest of Yellowknife. Rain and snow samples are collected on a daily basis and sent to ECCC CAPMoN laboratory in Toronto for analysis of precipitation chemistry. Select results are presented below.

In 2014, a second CAPMoN station was established in the NWT, in the Wood Buffalo National Park, approximately 80 kilometres northwest of Fort Smith. The area was of interest to CAPMoN due to the remote nature of the park and its location relative to the oil sands operations in Alberta. The site uses a state-of-the-art, automated daily collection sampler for precipitation chemistry and a continuous ambient analyzer for ozone monitoring.

Figure 20: Snare Rapids Acid Deposition

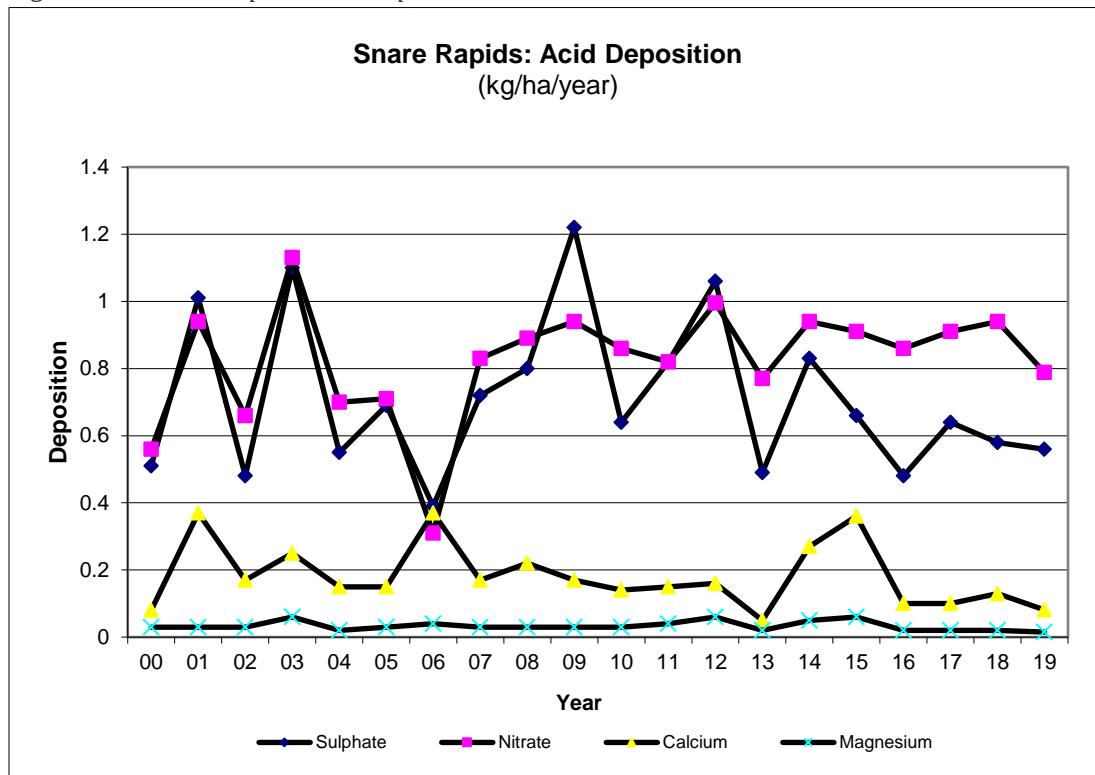


Figure 20 shows the deposition rates for sulphate, calcium, nitrate, and magnesium from 2000 to 2019.

The geology of the NWT is mostly characterized by non-carbonate bedrock resistant to weathering, and/or shallow, coarse-textured soils with low cation exchange capacity, low sulphate adsorption capacity, and low pH. The sulphate level of deposition that is considered to be protective of sensitive ecosystems in the NWT is 7 kg/ha/yr. In areas of eastern Canada where acid rain is a more serious environmental problem, sulphate deposition has been measured by CAPMoN in excess of 20 kg/ha/yr. Nitrate deposition at Snare Rapids is also low relative to eastern Canada.

Sulphate and nitrate deposition rates measured at Snare Rapids remain below levels expected to cause a significant environmental effect in sensitive ecosystems.

NWT 2019 Wildfire Season

The 2019 wildfire season was moderate. Yellowknife experienced some prolonged smoky conditions throughout the months of May, June, and July from fires burning in High Level, Alberta. The Fort Smith and Norman Wells regions experienced some smoky conditions in the months of July and August that were short lived. Inuvik experienced the least impacts from wildfire smoke, but did experience some intermittent impacts from wildfires burning in the Yukon. These occurred during the months of July and August.

Figure 21: Summer 2019 - 24-Hour Average $PM_{2.5}$ Concentrations for Yellowknife, Fort Smith, Norman Wells, and Inuvik

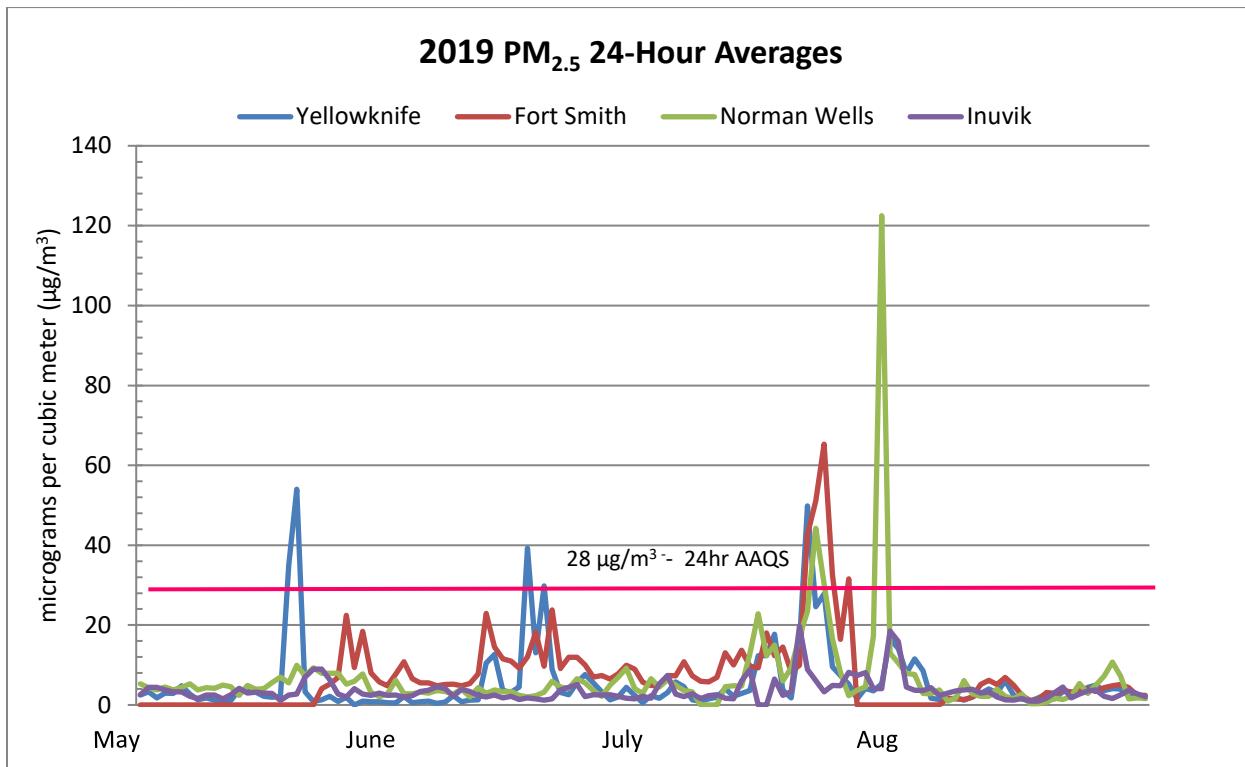
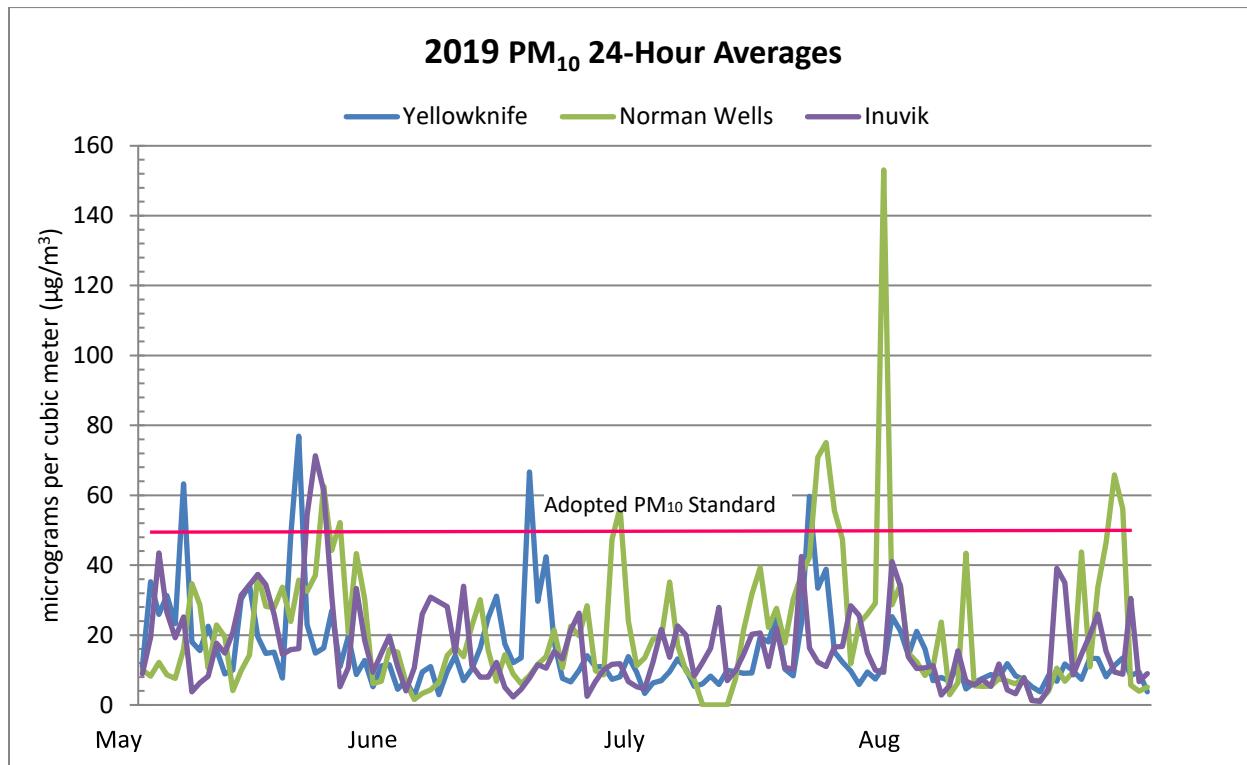


Figure 22: Summer 2019 - 24-Hour Average PM_{10} Concentrations for Yellowknife, Fort Smith, Norman Wells, and Inuvik



Figures 21 and 22 illustrate the moderately elevated levels of particulate ($PM_{2.5}$ and PM_{10}) concentrations from May through to August. The elevated Norman Wells PM_{10} levels recorded in July and August were caused mainly by large ash from forest fires burning just across the border in the Yukon. In this case, there was a fairly good correlation between $PM_{2.5}$ and PM_{10} from forest fire smoke. Inuvik also experienced slight elevations in $PM_{2.5}$ from the Yukon wildfires, while Fort Smith was impacted by the fires burning in Wood Buffalo National Park.

Health Messaging from Wildfires

The Air Quality Health Index (AQHI) is a health risk communication tool developed by ECCC and Health Canada. The AQHI, available in Yellowknife, Inuvik, and Fort Smith forecasts health risks related to air quality for the current and next day. It translates air quality monitoring data into a health scale from 1 to 10, and provides associated health-based messaging for the public, such as suggestions to adjust your activity level to protect yourself when the air quality is poor.

Figure 23: Air Quality Health Index



Figure 24: Summer 2019 Hourly AQHI for Yellowknife

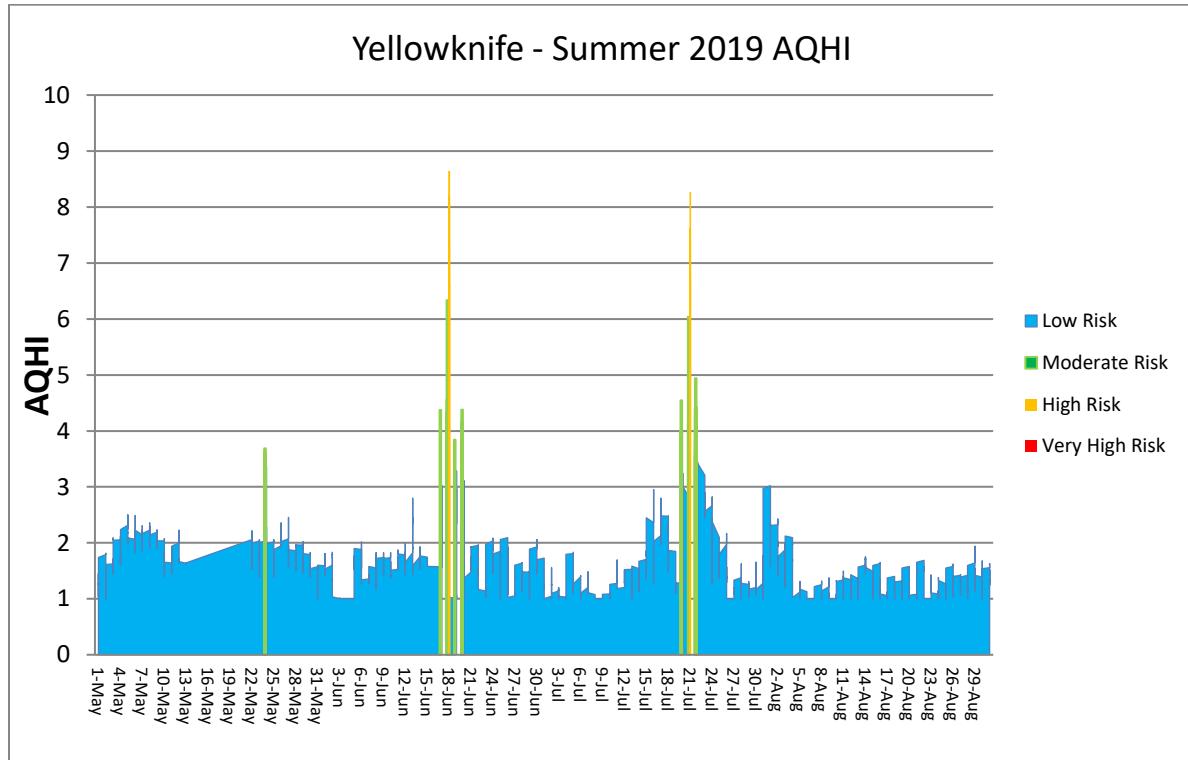


Figure 25: Summer 2019 Hourly AQHI for Inuvik

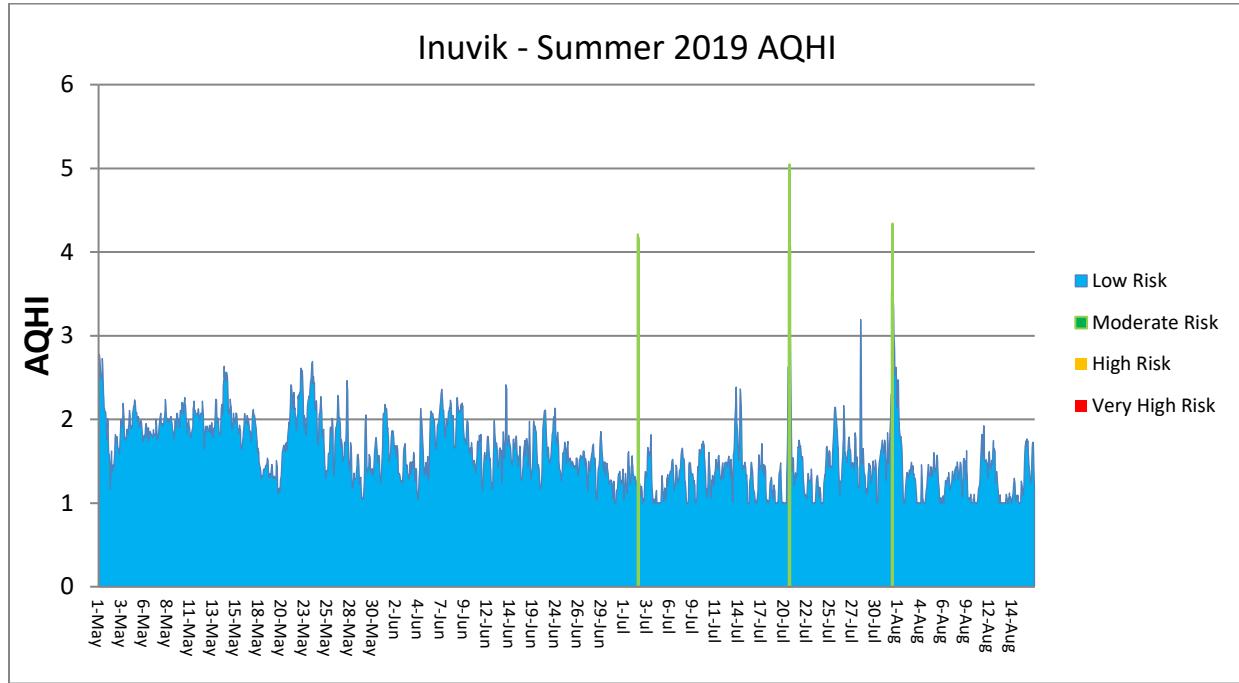
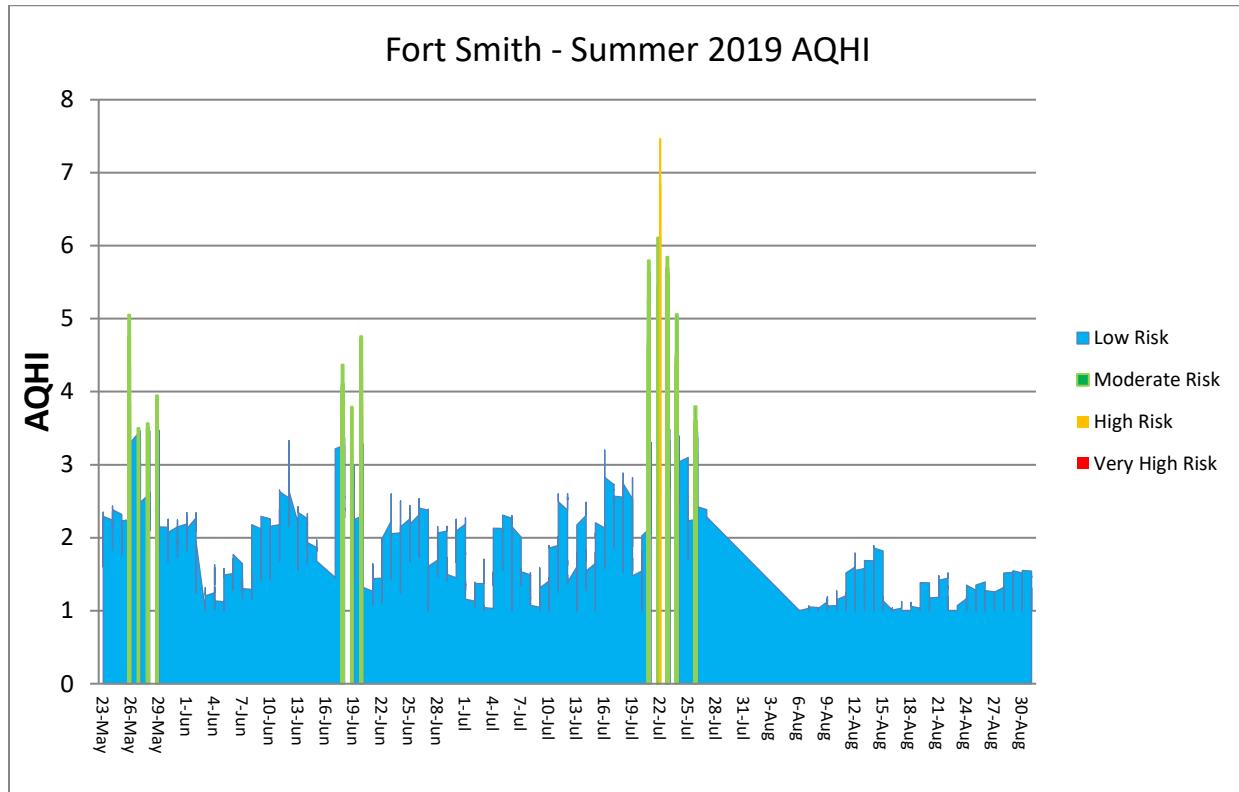


Figure 26: Summer 2019 Hourly AQHI for Fort Smith



Figures 24, 25, and 26 demonstrate the frequency that the AQHI reached the various levels of risk throughout the summer of 2019 in Yellowknife, Inuvik, and Fort Smith.

Since the AQHI is only available in Yellowknife, Inuvik, and Fort Smith there is a gap in health-related messaging for the rest of the territory. The Norman Wells station will have AQHI operational by the summer of 2021. ECCC is continuing to develop tools to provide air quality-related information for regions across Canada, including all the regions of the NWT. These tools use meteorological information and smoke modeling software to predict and disseminate real-time and predicted conditions for a geographic area. They are a valuable complement to the Air Quality Monitoring Network, and can assist NWT residents in making health related decisions based on air quality during wildfire seasons.



Image – courtesy of John Mckay (photo taken on July 30, 2014 at approximately 7:00 PM)

The 2019 wildfire season paled in comparison to the 2014 season when the City of Yellowknife often appeared to be enveloped in heavy fog from wildfire smoke. The above photo was taken at approximately 7:00 PM on July 30, 2014. In Yellowknife at this time of the year, the sun doesn't set until approximately 10:00 PM.

ENR collaborates closely with GNWT Health and Social Services, ECCC and Health Canada during wildfire events by providing up to date wildfire smoke influenced data which assists in accessing the state of the deteriorating air quality. GNWT Health and Social Services is responsible for providing information on health effects related to wildfire smoke and issues public health advisories during periods of poor air quality. ECCC issues special air quality statements and along with Health Canada provides additional expert advice and specialized technical support when it is required.

Summary

The results of the 2019 report indicate that the overall air quality of the NWT is very good. Major industries causing air pollution are extremely limited compared to larger Canadian centers. Regions that have major industrial influences such as pulp and paper mills, steel plants, oil and gas production, etc. are more likely to experience poorer air quality at times. This is not to say that the NWT is not at risk. An increase in wildfires over the past several years has been observed in the NWT as well as in neighbouring provinces. Smoke from wildfires as well as other pollutants can reach the NWT from a long distance away. It is very important that the GNWT continue to measure air quality across the NWT to ensure it is tracked now and for future generations.

If you have questions regarding ENR's air quality monitoring program or require further information please contact us at the address below:

Environmental Stewardship and Climate Change Division
Department of Environment and Natural Resources
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.enr.gov.nt.ca/en/services/air-quality

Appendix A: 2019 Data Capture & Select Statistical Information

PM _{2.5} Data								Percentile (24-hr)			>28 ug/m ³	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	Max 24-hr	25	50	75	# days	% days
Yellowknife	361	98.9	8657	98.9	4.4	217.7	54.0	2.0	3.2	4.6	5	1.4
Inuvik	341	93.4	8233	94.0	4.3	99.0	19.7	2.5	3.7	5.3	0	0.0
Norman Wells	347	95.0	8366	95.5	5.1	373.2	122.5	2.7	4.1	5.6	3	0.8
Fort Smith	309	84.7	7445	85.0	7.2	163.0	65.3	4.1	5.6	8.3	7	1.9

PM ₁₀ Data								Percentile (24-hr)			>50 ug/m ³	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	Max 24-hr	25	50	75	# days	% days
Yellowknife	365	100.0	8726	99.6	14.8	571.2	92.2	7.4	10.1	15.1	17	4.7
Inuvik	344	94.2	8225	93.9	11.6	418.0	72.0	2.0	6.2	15.3	9	2.5
Norman Wells	349	95.6	8413	96.0	16.4	455.2	153.1	5.7	9.4	21.0	18	4.9
Fort Smith	183	50.1	4506	51.4	10.0	238.9	44.5	5.0	8.9	12.8	0	0.0

O ₃								Percentile (8-hr)			>63 ppb	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	Max 8-hr	25	50	75	# 8-hrs	% 8-hrs
Yellowknife	362	99.2	8705	99.4	26.2	56.1	50.8	21.1	26.6	31.5	0	0.0
Inuvik	281	76.9	6739	76.9	26.7	68.4	47.9	21.2	27.3	32.7	0	0.0
Norman Wells	292	80.0	7026	80.2	26.2	49.7	46.7	20.8	26.4	32.0	0	0.0
Fort Smith	363	99.4	8720	99.5	23.0	57.1	54.7	16.6	23.4	29.7	0	0.0

NO ₂							Percentile (1-hr)			>213 ppb	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	25	50	75	# 1-hrs	% 1-hrs
Yellowknife	365	100.0	8754	99.9	1.3	31.0	0.0	0.0	0.9	0	0.0
Inuvik	358	98.1	8629	98.5	3.2	41.3	0.7	1.5	3.9	0	0.0
Norman Wells	359	98.3	8614	98.3	1.7	25.5	0.1	0.6	2.2	0	0.0
Fort Smith	365	100.0	8746	99.8	2.1	33.5	0.6	1.0	2.1	0	0.0

NO ₂		Percentile (24-hr)			>106 ppb	
Location	Max 24-hr	25	50	75	# days	% days
Yellowknife	15.3	0.0	0.2	1.2	0	0.0
Inuvik	20.0	1.1	2.1	3.8	0	0.0
Norman Wells	8.7	0.5	1.1	2.5	0	0.0
Fort Smith	15.8	0.9	1.3	2.3	0	0.0

SO ₂							Percentile (1-hr)			>172	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	25	50	75	# 1-hrs	% 1-hrs
Yellowknife	324	88.8	7836	89.4	0.17	0.80	0.00	0.06	0.32	0	0.0
Inuvik	360	98.6	8645	98.7	0.10	1.00	0.00	0.00	0.10	0	0.0
Norman Wells	353	96.7	8494	96.7	0.20	0.80	0.00	0.30	0.40	0	0.0
Fort Smith	362	99.1	8706	99.4	0.20	1.00	0.00	0.00	0.30	0	0.0

SO ₂		Percentile (24-hr)			>57 ppb	
Location	Max 24-hr	25	50	75	# days	% days
Yellowknife	0.75	0.00	0.10	0.30	0	0.0
Inuvik	0.90	0.00	0.00	0.20	0	0.0
Norman Wells	0.60	0.00	0.30	0.40	0	0.0
Fort Smith	0.70	0.00	0.00	0.30	0	0.0

CO								Percentile (1-hr)			>13 ppm	
Location	Valid Days	% Valid Days	Valid Hrs	% Valid Hrs	Mean	Max 1-hr	Max 24-hr	25	50	75	# 1-hrs	% 1-hrs
Yellowknife	362	99.1	8702	99.3	0.166	1.318	0.396	0.130	0.150	0.178	0	0.0
Inuvik	317	86.8	7652	87.3	0.314	1.370	0.729	0.248	0.288	0.343	0	0.0
Fort Smith	257	70.4	6199	70.7	0.242	1.894	0.603	0.188	0.245	0.273	0	0.0

CO		Percentile (8-hr)			>5 ppm	
Location	Max 8-hr	25	50	75	# 8-hrs	% 8-hrs
Yellowknife	0.745	0.133	0.155	0.181	0	0.0
Inuvik	0.902	0.251	0.294	0.345	0	0.0
Fort Smith	0.961	0.192	0.247	0.276	0	0.0

Appendix B: Potential Air Pollutants

The NWT air quality monitoring network tracks a number of different potential air pollutants. These are known as Criteria Air Contaminants (CAC's). They represent the gases and compounds most often affecting community air quality and targeted by monitoring programs.

Particulate Matter (PM_{2.5}) and (PM₁₀)

A sub-portion of TSP, these very small particulates are named for the diameter size of the particles contained within each group – PM₁₀ contains particles with a diameter of 10 microns (1 millionth of a metre) or less, while PM_{2.5} (a sub-portion of PM₁₀) contains particles with a diameter of 2.5 microns or less. The significance of these microscopic particles is that they can be inhaled and are associated with health effects including aggravation of existing pulmonary and cardiovascular disease. Generally, the smaller the particle, the greater the penetration into the lung and the greater the associated health risk.

Sources of particulates that can be inhaled include road dust and wind-blown soil, which make up the majority of the PM₁₀ particles. Particles in the PM_{2.5} size range primarily result from combustion of fossil fuels for industrial activities, commercial and residential heating, as well as vehicle emissions, wildfire smoke and chemical reactions between other gases emitted to the air.

The national Canadian Ambient Air Quality Standards (CAAQS) has set a limit for PM_{2.5} but has not yet established a limit for PM₁₀. The CAAQS 24-hour average limit for PM_{2.5} is 28 $\mu\text{g}/\text{m}^3$ and this concentration has been adopted under the *NWT Environmental Protection Act* as the NWT AAQS for PM_{2.5}. Several Canadian jurisdictions (e.g. BC, Ontario, Newfoundland and Labrador) have adopted a PM₁₀ concentration of 50 $\mu\text{g}/\text{m}^3$ (24-hour average) as an acceptable limit.

Sulphur Dioxide (SO₂)

SO₂ is a colourless gas, with a pungent odour at elevated concentrations, which can have negative effects on human and environmental health. Certain types of vegetation (especially lichens) are very sensitive to SO₂ impacts. SO₂ also plays a role in acid deposition and formation of secondary fine particulate through chemical reactions with other pollutants in the air.

There are some natural sources of SO₂ in ambient air (wildfires, volcanoes) but human activity is the major source. Emissions of SO₂ primarily result from the burning of fossil fuels containing sulphur. Sources include natural gas processing plants, gas plant flares and oil refineries, metal ore smelting, power generating plants and commercial or residential heating.

The NWT AAQS for SO₂ are 172 ppb (1-hour average), 57 ppb (24-hour average) and 11 ppb (annual average).

Nitrogen Oxides (NO_x)

Nitrogen oxides (NO_x) consist of a mixture of nitrogen based gases, primarily nitric oxide (NO) and nitrogen dioxide (NO₂). Emissions of both NO and NO₂ results from the high temperature combustion of fossil fuels. The predominant emission is NO, which then rapidly converts to NO₂ through chemical reaction in the atmosphere. NO is a colourless and odourless gas, whereas NO₂ is a reddish-brown colour with a pungent, irritating odour. NO₂ is considered the more toxic and irritating of the two gases and, at elevated concentrations, is associated with both acute and chronic respiratory effects. Both gases play a role in the atmospheric reactions resulting in acid deposition and secondary pollutant formation (i.e. O₃ and fine particulate).

Because of the greater health effects of NO₂, development of air quality standards has focused on this gas, rather than NO or total NO_x. The NWT AAQS are reflective of national maximum desirable levels of 213ppb (1-hour average), 106ppb (24-hour average) and 32ppb (annual average).

Ground Level Ozone (O₃)

Ground level ozone (O₃) should not be confused with stratospheric O₃, which occurs at much higher elevations and forms a shield that protects life on the planet from the sun's harmful ultraviolet radiation. The gas is the same but at ground level O₃ is regarded as undesirable due to its association with a variety of human health concerns, environmental impacts and property damage. O₃ is a highly reactive gas and is defined as a secondary pollutant. It is not emitted in large quantities from any source but is formed through a series of complex chemical reactions involving other pollutants called precursors (e.g. NO_x and volatile organic compounds or VOCs) in the presence of sunlight.

The national standards provide a Maximum Acceptable Level of 82ppb for O₃ based on a 1-hour average, and an annual Maximum Acceptable Level of 15ppb. The Canada-wide Standards (CWS) process has also set an acceptable limit of 63ppb based on an 8-hour average. The CWS 8-hour limit has been adopted under the NWT Environmental Protection Act as the NWT AAQS for O₃.

Carbon Monoxide (CO)

Carbon monoxide (CO) is a colourless, odourless and tasteless gas produced by the incomplete combustion of fuels containing carbon. The primary source is vehicle exhaust especially in cities with heavy traffic congestion. Other sources include industrial processes and fuel combustion for building heating. One natural source is wildfires.

CO affects humans and animals by interfering with the ability of the blood to transport oxygen around the body.

The NWT standards for CO reflect the national Maximum Desirable Levels of 13ppm (1-hour average) and 5ppm (8-hour average). CO values are reported in ppm as opposed to other gaseous pollutants, which are reported in ppb.

Acid Deposition

Acidity in precipitation is measured in pH units on a scale of 0 to 14. A value of seven indicates neutral, values less than seven indicate acidic conditions and values greater than seven indicate alkaline conditions. Even clean precipitation is slightly acidic—around a pH of 5.6—due to the presence of naturally occurring concentrations of carbon dioxide, and minor amounts of sulphate and nitrate ions. The introduction of sulphur dioxide and nitrogen oxide emissions from combustion of fossil fuels for industrial, commercial and individual activities can result in an increase in acidic compounds in the atmosphere—often in areas far removed from the original emission sources. The removal of these sulphur and nitrogen compounds through atmospheric washout is reflected in the increased acidity (lower pH values) of precipitation. Calcium and magnesium ions—mostly from natural sources—act to neutralize acidity in precipitation.

Generally, precipitation with a pH value of 5.0 or less is termed 'acidic'. However, assessment of acid precipitation is usually based on deposition to an area over a specified time period (e.g. kilograms per hectare per year, kg/ha/yr) rather than review of specific precipitation event parameters. Also, the degree of impact to a particular environment is influenced by its 'buffering' capacity or ability to tolerate the acidic inputs. Therefore, determination of acceptable limits usually requires a range of values to reflect the differing tolerances of various geological regions.

Appendix C:

Air Quality Monitoring History in the Northwest Territories

1974	<ul style="list-style-type: none"> GNWT began monitoring air quality in Yellowknife with the installation of a high-volume air sampler at the Post Office site.
1989	<ul style="list-style-type: none"> Monitoring of acid precipitation at the Snare Rapids hydro-electric site began.
1992	<ul style="list-style-type: none"> SO₂ analyzer installed at a second Yellowknife site at City Hall.
1997	<ul style="list-style-type: none"> SO₂ monitoring in N'dilo began and continued until 2000.
1998	<ul style="list-style-type: none"> O₃ analyzer added in Yellowknife to the City Hall site.
2000	<ul style="list-style-type: none"> A SO₂ analyzer was installed in the ENR building in Fort Liard in March followed by a H₂S analyzer in October.
2002	<ul style="list-style-type: none"> Yellowknife City Hall SO₂ analyzer relocated to new air monitoring trailer located at École Sir John Franklin High School (current location).
2003	<ul style="list-style-type: none"> Daring Lake summer sampling of PM_{2.5} began (the same sampler is used for PM₁₀ and PM_{2.5} monitoring). Air monitoring trailers were installed in Inuvik, Norman Wells and Fort Liard. CO and NO_x analyzers and continuous fine particulate sampler (PM_{2.5}) added to the Yellowknife station. SO₂ and H₂S monitored at Norman Wells station. SO₂, H₂S, NO_x and PM_{2.5} monitored at Inuvik station. SO₂, H₂S, and PM_{2.5} monitored at Fort Liard station The O₃ analyzer that was operating at the Yellowknife City Hall location is relocated to the new École Sir John Franklin High School station. ENR initiated the upgrade of the Data Acquisition System at all stations moving to a specialized air monitoring system, which will allow more efficient and quality controlled data collection. Continuous PM_{2.5} samplers were installed in Inuvik and Fort Liard. A second high-volume sampler was installed at the École Sir John Franklin High School station in Yellowknife.
2004	<ul style="list-style-type: none"> PM_{2.5} sampler was installed in Norman Wells. Data Acquisition System was significantly upgraded. New components were installed inside the stations and a new data management, analysis and reporting system is brought on-line.

2005	<ul style="list-style-type: none"> • NO_x analyzer was installed in March at the Fort Liard station. • O₃ and NO_x analyzers were installed at the Norman Wells station in April. • O₃ analyzer purchased by Environment Canada (Yellowknife office) was installed at the Inuvik station in April. • Due to years of significant data loss caused by extreme cold, the Partisol Dichotomous fine particulate sampler at the Yellowknife Post office station was relocated indoors at the Sir John Franklin station. • The Yellowknife Post Office station was officially closed after the last TSP sample ran on December 6th, 2005. • An Air Quality web site to link with the data management, analysis and reporting system providing public access to air quality data, including archived data, for each monitoring location was developed.
2006	<ul style="list-style-type: none"> • A BAM Particulate Matter (PM₁₀) monitor was installed and began collecting data in April in Yellowknife. • A BAM Particulate Matter (PM₁₀) monitor was installed and began collecting data in October in Inuvik. • The Air Quality Monitoring Network web site was officially released.
2007	<ul style="list-style-type: none"> • A BAM Particulate Matter (PM₁₀) monitor and an Ozone (O₃) analyzer were installed and began collecting data in late August in Fort Liard. • The second phase of the Air Quality Monitoring Network web site was completed, which included database related modifications as well as web design improvements.
2008	<ul style="list-style-type: none"> • There were no significant changes to the network.
2009	<ul style="list-style-type: none"> • A BAM Particulate Matter (PM₁₀) monitor was installed in Norman Wells to complete particulate sampling throughout the network. • Hi-vol sampling was discontinued in Yellowknife, to be replaced with a much improved type of sampling. • Daring Lake particulate monitoring was temporarily discontinued due to malfunction.
2010	<ul style="list-style-type: none"> • The entire Inuvik station was relocated to a more representative location at ball diamond due to ongoing construction activities in the original location. • The PM_{2.5} monitor was upgraded to BAM FEM (Federal Equivalency Method) in Yellowknife.
2011	<ul style="list-style-type: none"> • The PM_{2.5} monitor was upgraded to BAM FEM (Federal Equivalency Method) in Inuvik. • Data acquisition and management system was upgraded in Yellowknife, Norman Wells and Inuvik, including Envista ARM software and PC-based Industrial data loggers. • Manual Partisol Dichotomous Sampler was installed in Yellowknife.

	<ul style="list-style-type: none"> BAMs at all stations began reporting in actual conditions instead of STP, as per federal protocol.
2012	<ul style="list-style-type: none"> Entered into partnership with Aurora Research Institute (ARI) to provide technical operations of the Inuvik station. Installed CO monitoring in Inuvik (end of 2012). Discontinued H₂S monitoring Inuvik (end of 2012). Switched to trace level SO₂ monitoring in Yellowknife to capture background levels. New air quality monitoring network website launched to provide current and historic data to users (http://aqm.enr.gov.nt.ca/).
2013	<ul style="list-style-type: none"> AQHI launched for Yellowknife. PM_{2.5} FEM installed in Norman Wells. Fort Liard Station closed in November 2013 due to logistical issues. New air quality station installed in Fort Smith in December 2013. Yellowknife and Inuvik stations were equipped with trace level CO analyzers. Filter-based particulate sampler (Partisol 2000i-D) installed at the Yellowknife station.
2014	<ul style="list-style-type: none"> H₂S monitoring discontinued at Norman Wells station. Replaced Yellowknife station with a larger, 10' x 25' building. AQHI launched in Inuvik.
2015	<ul style="list-style-type: none"> New deployable units added to the inventory (two E-BAMs and two DustTraks). Black Carbon Aetholometer added to Yellowknife station.
2016	<ul style="list-style-type: none"> A number of trace level instruments installed throughout the network to replace aging and in some cases outdated gas analyzers The Fort Smith station became an official NAPS designated site.
2017	<ul style="list-style-type: none"> New trace level instrument installations continued where required. A new calibration system for the Norman Wells station was installed in order to provide consistency on the calibration instrumentation used with the other three stations.
2018 & 2019	<ul style="list-style-type: none"> New trace level instrument installations continued where required.

mm