AMBIENT AIR QUALITY MONITORING GUIDELINE

IN SUPPORT OF THE ENVIRONMENTAL AGREEMENTS AND MEMORANDUMS OF UNDERSTANDING WITH MINE OPERATORS

Government of
Northwest Territories

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AAQL	Ambient Air Quality Limits
AEMP	Aquatic Effects Monitoring Program
ASTM	American Society for Testing Materials
BC	British Columbia
CCME	Canadian Council of Ministers of the Environment
EA	Environmental Agreement
ECC	Department of Environment and Climate Change
ECCC	Environment and Climate Change Canada
FEM	Federal Equivalent Method
FRM	Federal Reference Method
GNWT	Government of the Northwest Territories
MDL	method detection limit
MOU	Memorandum of Understanding
MSC	Meteorological Service of Canada
MVLWB	Mackenzie Valley Land and Water Board
NAPS	National Air Pollution Surveillance
NO_2	nitrogen dioxide
NWT	Northwest Territories
ON	Ontario
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter less than 10 micrometers
$PM_{2.5}$	particulate matter with aerodynamic diameter less than 2.5 micrometers
PSD	passive sampling device
QA	Quality Assurance
QC	Quality Control
RMS	root mean square
SO_2	sulfur dioxide
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
WMO	World Meteorological Organization

LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
hr	hour
m	metre
mg/dm^2-day	milligram per square decimeter per day
ppbv	parts per billion (by volume)
ppmv	parts per million (by volume)
sec	seconds
µg/m^3	microgram per cubic meter
µm	micrometer
°C	degrees Celsius
%	percent

EXECUTIVE SUMMARY

The Government of the Northwest Territories (GNWT) Department of Environment and Climate Change (ECC) is working to protect and manage air quality in the Northwest Territories (NWT). To help meet this objective, this Ambient Air Quality Monitoring Guideline (guideline) has been developed to support the implementation of air quality monitoring as outlined in Environmental Agreements (EAs) and Memorandums of Understanding (MOUs) with diamond mine operators within the NWT. ECC's authority to create this guideline is based on the clauses of the EAs and MOUs requiring air quality monitoring, which are legally binding documents.

The purpose of this guideline is to provide technical guidance to diamond mine operators for the operation and maintenance of air quality monitoring stations, data analysis, and reporting. This guideline has been developed to harmonize monitoring and to ensure consistent air quality monitoring practices across diamond mines in the NWT. The intent of the guideline is to complement and supplement the existing monitoring approaches of each mine, lay out clear expectations, and clarify the minimum requirements for monitoring and reporting. This will ensure the collection of accurate air quality monitoring data, and that the data is collected and reported to ECC in a timely fashion.

1.0 INTRODUCTION

1.1 Background

The Government of the Northwest Territories (GNWT) Department of Environment and Climate Change (ECC) is working to protect and manage air quality in the Northwest Territories (NWT). Complementing this role, ECC is also responsible for administration of three Environmental Agreements (EAs) and one Memorandum of Understanding (MOU) signed with the NWT's diamond mine operators. In the context of air quality management, the EAs and the MOU are a step toward closing an existing gap in the NWT's regulatory framework.

1.2 Purpose and Scope

This air quality monitoring guideline for diamond mine operators has been developed to ensure consistent air quality monitoring practices in the NWT throughout the construction, operation, and closure phases of a mine. The intent of the guideline is to complement and supplement the existing monitoring approaches of each mine, lay out clear expectations, clarify the minimum requirements for monitoring, add context to the requirements set out in the EAs and the MOU, and to formalize best practices. The guideline is not intended to change the design of a currently accepted air monitoring plan, affect data continuity, or create a negative impact. Discussions with ECC are allowed under the guideline for alternative methods to those presented in the guideline (see Section 1.5). ECC's authority to create this guideline is based on the clauses of the EAs and the MOU requiring air quality monitoring, which are legally binding documents.

The purpose of the guideline is to provide guidance for ambient air quality monitoring that is required through the EAs and MOU in place with the diamond mine operators in the NWT. This guideline is scoped to existing diamond mines, namely Diavik, Snap Lake, Ekati, and Gahcho Kué, and is intended to be a technical reference document that each mine can use to refine their own detailed air quality monitoring plan. The guideline will also apply to future mines with EAs or MOUs containing clauses that address air quality monitoring.

For clarity, this guideline is not intended to provide guidance regarding source emissions testing or greenhouse gas emissions. This guideline is intended to address environmental air quality and does not consider occupational health and safety within the mine site.

A jurisdictional scan was conducted as a basis for this guideline. The guidance from other jurisdictions that were reviewed in preparation of this guideline include:

1. Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines: National Air Pollution Surveillance Program (https://ccme.ca/en/res/ambientairmonitoringandqa- qcguidelines_ensecure.pdf)
2. Environment Canada. 2001. Meteorological Services of Canada (MSC) guidelines for co-operative climatological autostations, version 3.0.
3. BC Field Sampling Manual – Part B1 (https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual)
4. Alberta's Air Monitoring Directive (https://open.alberta.ca/publications/air-monitoring-directive-2016)
5. Operations Manual for Air Quality Monitoring in Ontario (https://www.ontario.ca/document/operations-manual-air-quality-monitoring-ontario-0)
6. Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA 2000. EPA-454/R-99-005, Section 3 (Siting and Exposure), February 2000

7. Guide to Meteorological Instruments and Methods of Observation. WMO 2008. World Meteorological Organization-No. 8, 7th edition, Geneva Switzerland

The requirements set out in this guideline are considered minimum requirements to ensure that the quality of data being collected from monitoring programs is acceptable. Mine and station operators may choose to follow more stringent specifications or more intensive procedures.

1.3 Objectives

The objectives of an ambient air quality monitoring program at NWT diamond mines are to:

- confirm whether the commitments outlined in the EA/MOU are being fulfilled;
- monitor impacts on local air quality by demonstrating compliance with applicable Federal and Territorial ambient air quality standards and limits;
- track trends in ambient air quality;
- compare ambient data to environmental assessment predictions[1];
- review the effectiveness of mitigation measures;
- outline response plans to respond to exceedances of air quality criteria or increasing trends in monitored contaminants; and,
- facilitate data gathering necessary to support adaptive management and refinement of mitigation measures.

1.4 Methodology and Approach

To develop this guideline document, a detailed review of the following documents was conducted:

- Ekati Environmental Agreement originally made on January 6, 1997 between Canada, GNWT, BHP Diamond Inc. (BHP), and as amended in 2003, 2013 and 2018
- Diavik Environmental Agreement originally made on March 8, 2000 between Canada, GNWT, Diavik Diamond Mines (DDMI), Dogrib Treaty 11 Council (Tłı̨chǫ Government), Łútsël K'é Dene Band, Yellowknives Dene First Nation (YKDFN), North Slave Métis Alliance, and Kitikmeot Inuit Association
- Snap Lake Environmental Agreement made on May 18, 2004 between Canada, GNWT, De BeersCanada Inc (De Beers), Dogrib Treaty 11 Council (Tłı̨chǫ Government), Łútsël K'é Dene Band, YKDFN, and North Slave Métis Alliance
- Ni Hadi Xa Agreement originally made in December 2014 between De Beers, Deninu Kų́ę́ First Nation, Łútsël K'é Dene First Nation, North Slave Métis Alliance, NWT Métis Nation, Yellowknife Dene First Nation, and Tłı̨chǫ Government
- Air Quality Memorandum of Understanding between De Beers Gahcho Kué and GNWT Department of Environment and Natural Resources (ENR) made on April 23, 2015
- Ekati Air Quality Monitoring Program and the following Environmental Assessments: BHP, 2000; Mackenzie Valley Environmental Impact Review Board, 2001
- Diavik Air Quality Monitoring Program and the Comprehensive Study Report (ENVI-302-0613 R1)

[1] It should be noted that when making this comparison maximum model predictions are generally considered to be accurate to within a factor of two of the monitored results.

- Snap Lake Air Quality Monitoring Program and the following Environmental Assessments: DeBeers, 2002; Mackenzie Valley Environmental Impact Review Board, 2003
- Gahcho Kué Air Quality Monitoring Program and Environmental Impact Report (EIR 0607-001).

Review of these documents aided in determining shortcomings, strengths, consistencies, and inconsistencies present in each agreement and Air Quality Monitoring Program. This guide was subsequently developed to lay out clear expectations and to clarify minimum requirements for monitoring program.

1.5 Plan Implementation

1.5.1 Operators Developing New Programs

Each Air Quality Monitoring Plan must be acceptable to the Minister. Monitoring programs should be based on science and reasonability as outlined in this guideline, while maintaining the guiding principles and/or purpose of each EA/MOU, plus commitments and measures stemming from a mine's environmental assessment. Discussions with ECC are allowed under the guideline for the use of alternative methods than those described herein. These discussions should be initiated with ECC at the operator's earliest convenience and prior to the completion or update of the Air Quality Monitoring Plan. Operators will need to provide documentation to support the appropriateness of the alternative method. Submissions will be considered on a case-by-case basis at the Minister's discretion.

1.5.2 Operators with Existing Programs

The intent of this guideline is not to create additionalities, change the design, or affect data continuity issues for all the currently accepted air quality monitoring programs. If an existing monitoring program is inconsistent with this guideline, operators are encouraged to discuss with ECC. Should an Air Quality Monitoring Plan not be acceptable to the Minister, each Environmental Agreement or MOU sets out a process to resolve disputes that can be followed.

Operators that are considering changing their accepted air quality monitoring programs such as adding a new monitoring parameter or reflecting an upcoming change in their mine's phase (construction, operation, and closure) should consult this guideline. Operators are expected to propose relevant monitoring parameters consistent with their mine phase and emissions-generating activities. Discussions with ECC are allowed under the guideline for the use of alternative methods than those described herein. These discussions should be initiated with ECC at the operator's earliest convenience and prior to the submission of an updated Air Quality Monitoring Plan. Operators will need to provide documentation to support the appropriateness of the alternative method. Submissions will be considered on a case-by-case basis at the Minister's discretion.

2.0 AIR QUALITY MONITORING GUIDELINES

2.1 General Considerations

2.1.1 Station Siting

In general, when choosing monitoring site locations, the following should be considered:

- Location of local emission sources and site-specific factors affecting dispersion (e.g., prevailing winds, weather patterns, local geography, site features, etc.).
- The extent of the mine's disturbed/development area.
- Access to sites should not be impeded by snow or seasonal closures (i.e., accessible year-round).
- Ideally, access to sites should be available 24 hrs a day for all 7 days of the week.
- Long-term viability of the site; changing station locations should be avoided to ensure that the data will be compatible for long-term trend analysis, and comparison to environmental assessment predictions.
- Where it may be of concern, sites and any external equipment (e.g., sample inlets, etc.) should belocated where they can be protected from unauthorized access.
- Availability of electrical power supply. The use of portable generators for power supply is not recommended. Where necessary, portable generators must be located at least 30 m away from monitoring instruments.

Further information regarding station siting criteria can be found in the Canadian Council of Ministers of the Environment (CCME) document entitled *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines*.[2] General guidance is also provided by the United States Environmental Protection Agency (US EPA)[3] and World Meteorological Organization (WMO)[4].

2.1.2 Data Time Stamping

All monitoring in the NWT must be conducted using Mountain Standard Time. Analyzers, samplers, and data loggers must not be adjusted for Daylight Savings Time. Where applicable, data should be collected and stored in hr-ending average format (e.g., minute data collected between 01:01 and 02:00 are averaged and reported as the 02:00 hr).

[2] https://ccme.ca/en/res/ambientairmonitoringandqa-qcguidelines_ensecure.pdf

[3] Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA 2000. EPA-454/R-99-005, Section 3 (Siting and Exposure), February 2000.

[4] Guide to Meteorological Instruments and Methods of Observation. WMO 2008. World Meteorological Organization-No. 8, 7th edition, Geneva Switzerland.

2.2 Meteorological Monitoring

Meteorological measurements include measurements of wind speed, wind direction, barometric pressure, temperature, relative humidity, solar radiation, and precipitation. Meteorological parameters are required for the analysis of air quality monitoring data, to support air dispersion modelling exercises, and may be used by other disciplines (e.g., hydrology) to aid in project design or as part of environmental programs. The meteorological sensor siting and exposure criteria described below have been developed based on guidance provided by the US EPA and WMO.

2.2.1 Station Siting Considerations

As a rule, meteorological measurements should be representative of meteorological conditions in the area of interest. Consequently, meteorological sensors should be sited at a distance from buildings, or other nearby obstacles to limit the influence of obstructions on the measurements.

Sensors to measure meteorological parameters are mounted on towers or masts. The WMO has recommended that the standard height at which surface wind measurements should be taken is 10 m, which is consistent with most Canadian stations. Ideally, the measurements should be taken over level, open terrain, at least 15 m by 15 m, covered by short grass or other natural surface. Consequently, placing the meteorological station adjacent to the mine's airport (if present) could provide an ideal location for siting, providing the airport location is representative of local meteorological conditions at the mine site and the station is located away from turbulence created by aircraft. This would also serve the double purpose of providing the airport with relevant meteorological data. If obstructions, such as buildings, are present and cannot be avoided, the US EPA provides the following siting criteria:

Table 2.1 Limits on Terrain and Obstacles Near Towers[5]

Distance From Tower (m)	Maximum Obstruction or Vegetation Height (m)	Slope Between Tower & Obstruction (%)
0 – 15	0.3	±2
15 – 30	0.5 – 1.0	±3
30 – 100	3.0	±7
100 – 300	10% of distance from tower to obstruction	±11

In situations where the criteria in **Table 2.1** may be difficult to meet, operators should review potential sites with ECC for approval prior to use.

If the sensor is to be located on the roof of the building, it must be at least one and a half (1.5) building heights above the roof. However, wind sensors should only be located on building rooftops as a last resort.

Careful consideration must be given to rough terrain or valley situations, where local effects such as channelling, slope, and valley winds can have a significant effect on wind flow. Consequently, multiple meteorological stations may need to be considered to capture the local and regional meteorology and the influence that both regimes can have on pollutant dispersion. An operator is expected to demonstrate an understanding of weather and climate over a project's entire footprint.

[5] US EPA, 2008. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final). EPA-454/B-08-002. March 2008.

Precautions must be taken to ensure that wind measurement probes are not influenced by turbulence caused by the tower. Open lattice towers are preferred over solid towers, as they minimize the potential turbulence generated by the tower. To mitigate any tower effects, the boom should extend outward from acorner of the tower into the wind direction of primary concern. This will minimize the tower's influence on wind measurements, in particular measurements of the wind direction of primary concern. The sensor(s) should also be placed at a distance of at least twice the maximum diameter or diagonal of the tower away from the tower.

With respect to temperature measurements, the sensor should be no closer to an obstruction than four times the nearest obstruction height and at least 30 m from large, paved areas. As per MSC guidance,the standard height for climatological purposes is 1.25 to 2 m above ground, but different heights maybe required for other purposes. Typically, the sensor is mounted at 2 m above ground, or in regions with abundant snow accumulations, up to 1.5 m above maximum snow depth. Other situations to avoid include proximity to large industrial heat sources, rooftops with exhaust ducting or potential for heat radiation, vehicle parking areas, steep slopes, shaded areas, and wetlands.

Probes used for measuring incoming solar radiation should be located with an unrestricted view of the sky in all directions during all seasons, with the lowest solar elevation angle possible. They should be located to avoid obstructions casting a shadow on the sensor at any time. Sensor height is not critical for these units. It should be noted that collection of solar radiation is currently considered industry best practice for NWT mines but is not considered a monitoring requirement at this time.

Precipitation gauges should be located well away from roads and other high-traffic areas where measurements may be affected by project activities. Sensor height is not critical for these units and they are typically placed at ground level (i.e., 0.5 to 2.0 m above ground level) for easy access, or in regions with abundant snow accumulations, approximately 1 m above maximum snow depth.

All instruments must be installed in a secure manner or as per manufacturer's direction.

2.2.2 Monitoring Parameters

The tower system continuously measures the following meteorological parameters:

- wind speed at 10 m above the ground
- wind direction at 10 m above the ground
- barometric pressure at 10 m above the ground
- temperature at ~1.25-2 m above the ground, or 1.5 m above maximum snow depth
- relative humidity at ~2-10 m above the ground
- solar radiation at ~1-2 m above the ground
- precipitation at ~0.5-2 m above ground level, or 1 m above maximum snow depth.

2.2.3 Monitoring Methods

The following methods are standard recommended methods for the measurement of meteorological parameters.

Table 2.2 Standard Meteorological Measurement Methods

Parameter	Method
Wind Speed and Direction	Determination of wind speed by (cup or propeller) anemometer and wind direction by bi-directional wind vanes.
Barometric Pressure	Aneroid or electronic barometer.
Temperature	Electrical resistance thermometer sensor such as a platinum or copper resistance temperature detector. The sensor must be housed in a radiation shield to protect the sensor from thermal radiation.
Relative Humidity	Electrical hygrometer or psychrometer.
Solar Radiation (if monitored)	First/second class pyranometers with World Meteorological Organization (WMO) specifications.
Rainfall	Weighing-type or tipping bucket-type rain gauge.

If an operator deems any parameter outlined in the guideline as not relevant to meeting the needs of their Air Quality Monitoring Plan, they should provide rationale and justification to ECC for its removal.

If wind speed data may be used for dispersion modelling purposes, a low threshold anemometer should be used. This will ensure that the true percentage of calm periods are captured in the data and will enhance the reliability of modeled pollutant concentrations.

2.2.4 Monitoring Frequency

Meteorological monitoring shall be conducted year-round throughout the construction, operation, and closure phases of the mine. Meteorological data are measured continuously, at a recommended sampling frequency of once every 5 secs and are recorded hourly.

2.2.5 Quality Assurance/Quality Control Procedures

The Quality Assurance/Quality Control (QA/QC) procedures for the meteorological monitoring program include the following:

- Data are to be downloaded from the station regularly and manually checked by personnel trained in air quality monitoring for extreme values (e.g., maximums and minimums) and anomalous data that may indicate problems with the system. It is recommended that this is done informally (i.e., industry best practice) daily and formally each week (or shorter period during extreme weather conditions).
  - Check readings for extreme high or low values, sudden and unexpected changes over a short time period, or values which do not appear to agree with the maximum value possible for the date and latitude.
  - Check for long periods of constant values. This could be indicative of power failures or defectiveprobes.
- Sensors shall be calibrated on a schedule consistent with each sensor's requirements (generally every 12 to 24 months) based on manufacturer specifications and professional experience.

- The station shall be attended weekly (as weather conditions permit) to ensure that sensors within reach are free of debris, frost, or damage that may prevent accurate measurement of meteorological data. A checklist should be developed that allows an organized approach to determining the condition of the station.
- Data shall be downloaded consistent with detailed written operating instructions from personnel trained in air quality monitoring.

Generally, the operation, service, and maintenance of all instruments must follow manufacturer's direction. It is also recommended that spare sensors for all parameters be kept on site as a preventative maintenancemeasure.

All meteorological equipment are expected to operate at a 75% completeness (i.e., the amount of valid time/data represented for the indicated averaging/monitoring period) level or higher over the monitoring period of interest. Following industry best practice, operators should aim to operate at 90% or higher completeness level if the meteorological data is to be used for modelling purposes. For calculating averages and conducting statistical analyses (see **Section 2.6**), a minimum completeness of 75% should be considered, to be consistent with QA/QC protocols described in the National Air Pollution Surveillance Program guidance document listed in **Section 1.2**. Any averaging period with less than 75% completeness should be disregarded.

2.3 Particulate Matter Monitoring

Particulate matter (PM) is generally grouped into three size fractions:

- Total Suspended Particulate (TSP) – which includes particulate matter nominally less than 100 µm in aerodynamic diameter
- Coarse Particulate Matter (PM_{10}) – which includes particulate matter nominally less than 10 µm in aerodynamic diameter
- Fine Particulate Matter ($PM_{2.5}$) – which includes particulate matter nominally less than 2.5 µm in aerodynamic diameter.

PM emissions can be generated by a variety of on-site sources: wind erosion of local landscapes, movement of vehicles/equipment, airstrip activities, construction activities, blasting activities, the combustion of diesel fuel, waste incineration (if present) and (infrequently) dust migration from distant regions.

2.3.1 Station Siting Considerations

A summary of siting criteria for PM monitoring is presented in **Table 2.3**. The monitoring station's sampling inlet and manifold shall meet the requirements of the most recent version of the National Air Pollution Surveillance (NAPS) Program's *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines* Sections 8.2 and 8.3.

Table 2.3 Particulate Matter Sample Probe Siting Criteria[6]

Pollutant	Height Above Ground (m)	Distance from Supporting Structure (m) Vertical	Distance from Supporting Structure (m) Horizontal[1]	Other Spacing Criteria
TSP/PM_{10}/$PM_{2.5}$	2 to 15	>2	>2	a. Distance from the sampler to any air flow obstacle (i.e., buildings, terrain features, etc.) must be >2× height of obstacle above the sampler b. Airflow must be unrestricted through an arc of at least 270 degrees c. No nearby furnace or incineration flues d. Distance of sampler from major roads/haul roads should be >25 m for sampler inlet heights 2 to 5 m • PM gradients near unpaved roads have large horizontal gradients; therefore, careful consideration needs to be given when siting near unpaved roads e. In the instance of co-located samples, there must be a separation distance of 2 m, but no more than 4 m, between the sampler units. f. Minimum exhaust conduit length of 3 m from the monitor inlet downwind according to the prevailing wind direction. The placement of the exhaust conduit must also consider the potential impact on other nearby samplers.

Note: When a probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouse located on the roof

[6] Adapted from NAPS, BC, AB and ON guidance documents

In general, locations near potential PM sources (e.g., haul roads, unpaved parking lots, stockpiles, or other fugitive sources) are to be avoided unless these sources are part of the monitoring objectives. PM gradients near roads have large horizontal and vertical gradients immediately adjacent to the road. Therefore, careful consideration needs to be given when siting near roads.

At a minimum, one site should be chosen in the predominant downwind direction of mining operations, located within the property boundary at the extent of the mine's disturbed/development area. Additional monitoring sites should generally be chosen to be representative of nearby receptors of concern (e.g., nearby populated areas, sensitive ecosystems, etc.) and can be chosen based on an analysis of project dispersion modelling conducted during the environmental assessment stage. Relevant stakeholder input should also be considered when choosing the number and locations of air quality monitoring stations.

2.3.2 Monitoring Methods

Commercially available analyzers that are recognized by the US EPA as a Federal Reference Method (FRM) or Federal Equivalent Method (FEM) should be used. A full list of designated FRM or FEM methods can be found on the US EPA's website.[7] For reference, the following are common commercially available analyzers; identification of these does not exclude the use of other commercially available analyzers.

- Ecotech HiVol 3000 High Volume Air Sampler
- Tisch Environmental High Volume Air Sampler
- Thermo Fisher Scientific Model SHARP-5030
- Thermo Fisher Scientific Model 5030i
- Teledyne API T640 PM Mass Monitor
- Met One BAM-1020 with Smart Heater System
- Thermo Scientific 5014i.

Operation, service, and maintenance of the analyzers/instruments should be in accordance with the instrument manufacturer's operation manual unless otherwise mentioned.

FRM and FEM methods can be either continuous or non-continuous in nature. Continuous samplers collect concentration measurements in real time typically at high measurement frequencies (e.g., 1 minute). Concentrations at longer averaging periods (e.g., 24 hrs) are calculated by averaging the high-frequency data. Non-continuous samplers collect samples over discrete averaging times (e.g., 1 hr, 24 hr) and provide concentration values for only the collection/averaging time.

In cases where speciation of PM (i.e., the determination of the chemical composition of PM) may be warranted, non-continuous samplers using filter media will be required. The filter media should be sent to a laboratory that can analyze the filter media and provide elemental analysis. The chosen laboratory should be accredited by an appropriate accreditation body (e.g., Canada Association for Laboratory Accreditation), and should be consulted to ensure that proper filter media is chosen for the given analysis. The need for speciation of PM is mine site specific and should be discussed with ECC prior to developing monitoring plans.

[7] https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants

2.3.3 Shelter

Monitoring stations that house continuous monitoring equipment for particulate or gas analysis must be equipped with climate control functions. The station's heating, ventilation, and air conditioning (HVAC) system must maintain a year-round internal temperature range of 20°C to 30°C that is stable to within ± 2°C over a one-hr period. However, if guidance from the instrument manufacturer indicates a greater tolerance, then the equipment tolerance can be adopted for the shelter.

The shelter must also protect the station's instrumentation from:

- Precipitation and rodent impacts
- Fluctuations in internal temperature, pressure or humidity that may be caused by improperly sized air conditioning units, or intrusion of ambient air
- Excessive dust and dirt
- Environmental stress including temperature extremes, vibration, corrosive chemicals, intense light, or radiation pertinent to a manufacturer's specification.

2.3.4 Monitoring Frequency

ECC has outlined ambient standard limits for TSP and $PM_{2.5}$ based on 24 hr and annual averaging periods, as outlined in the *Guideline for Ambient Air Quality Standards in the Northwest Territories*. These Ambient Air Quality Limits (AAQL) are provided in **Table 2.4**[8]. Consequently, monitoring of these two size fractions (TSP and $PM_{2.5}$) is required at all sites. As an industry best practice, monitoring of PM_{10} is recommended. PM_{10} data can be compared to a 24-hr average value of 50 µg/m for reporting purposes, which is adopted from British Columbia (BC) and Ontario (ON). While not an official limit, this PM_{10} value can be considered a non-binding criterion (i.e., guideline) for comparative purposes.

Table 2.4 Particulate Matter Ambient Air Quality Limits and Guidelines

Averaging Period	Pollutant – TSP (µg/m³)	Pollutant – PM_{10} (µg/m³)	Pollutant – $PM_{2.5}$ (µg/m³)
24-hr average	120	50	28
Annual arithmetic mean	60	--	10

Monitoring all three size fractions of PM is important for multiple reasons. First, the limiting effect on which the standards are based is not the same for each size fraction. TSP can have an impact on visibility and additionally can affect lichen that caribou feed on, while PM_{10} and $PM_{2.5}$ primarily impact human health. While both PM_{10} and $PM_{2.5}$ impact human health, their direct impacts on human health are significantly different, with $PM_{2.5}$ being able to penetrate deeper into the lungs and cause premature deaths[9]. The guidelines for PM_{10} and $PM_{2.5}$ are based on toxicological studies conducted on animals; consequently, many of the known health impacts from exposure to PM_{10} and $PM_{2.5}$ are expected in wildlife[10]. Second, monitoring all three size fractions will allow for evaluating long-term

[8] ECC may update these values from time-to-time to reflect the Canadian Ambient Air Quality Standards (CAAQS) as they evolve. Operators should review, and confirm, the currently adopted NWT standard with ECC.
[9] Health Impacts of Air Pollution in Canada: Estimates of morbidity and premature mortality outcomes – 2021 Report. Health Canada.
[10] Integrated Science Assessment for Particulate Matter. US EPA 2019. EPA/600/R-19/188, December 2019.

trends of general air quality and can help inform mitigation planning, if necessary. Lastly, one of the objectives of the monitoring plan is to compare ambient data to the mine's environmental assessment air quality predictions. For example, PM10 was assessed by Snap Lake, Diavik, and Gahcho Kué in their environmental assessment and can, therefore, be monitored for comparison purposes to the environmental assessment.

For non-continuous sampling, monitoring of PM concentrations should be carried out according to a standard "1-in-6" schedule (i.e., a single 24-hr sample is collected every six days). Annual means should be calculated from the 24-hr samples for a given calendar year.

For continuous sampling, PM concentrations should be measured using real-time monitors with data logged on a one-minute basis (or lowest instrument resolution) and reported on an hourly basis. 24 hr and annual averages can subsequently be calculated from the one-minute resolution data. 24-hr averages should be calculated on a "midnight to midnight" basis for comparison to the relevant AAQL or guideline.

2.3.5 Quality Assurance/Quality Control Procedures

2.3.5.1 Instrumentation

The station shall be attended weekly (as weather conditions permit) to ensure that sensors within reach are free of debris, frost, or damage that may prevent accurate measurement. A checklist should be developed that allows an organized approach to determining the fitness of the station.

Government or industry standards do not exist for verifying and calibrating PM monitors. Consequently, focus is given to the verification and calibration of instrument parameters such as flow, temperature, pressure and other instrument-specific parameters. These parameters should be checked as per the manufacturer's operation manual. Operators should also consult the most recent version of the NAPS Program's *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines* Section 11 for more information on verification and calibration of PM analyzers. All external performance checks and calibrations must be recorded, and the documentation must be available for inspection and/or submission to the regulatory agency.

The monitoring station's sampling inlet and manifold shall meet the requirements of the most recent versionof the NAPS Program's *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines* Section 8.2 and Section 8.3. All connection tubing, connectors and fittings of the sampling line must be made of chemically inert material (e.g., borosilicate glass (e.g., Pyrex), quartz or Teflon).

For non-continuous sampling, the following checks should be conducted:

- Use filters within 30 days of conditioning by the laboratory
- Retrieve filter within 5 days of the sampling event
- Record end and elapsed time, sample volume, filter temperature, ambient temperature (minimum, maximum and average), and ambient pressure
- Check filter (new & exposed) integrity (perforations, missing pieces, large cracks, etc.)
- Avoid contamination of exposed filter surface area while handling
- Exposed filter should always be darker than new filter
- Check for integrity and cleanliness of screen, gasket (tight seal on filter)
- Check for proper sampling run times and flow rate

- Filter tare weight should always be less than weight of exposed filter
- Field/travel blanks should be collected with every sample.

2.3.5.2 Data

For non-continuous data, laboratory results should be reviewed to ensure that, in general, TSP concentrations exceed PM_{10} concentrations, and PM_{10} concentrations exceed $PM_{2.5}$ concentrations (within error of the laboratory method). While not every time period will balance (i.e., TSP > PM_{10} > $PM_{2.5}$), the majority of samples should.

For continuous monitors, the QA/QC procedures for the collected data include the following:

- Data are to be downloaded from the station regularly and manually checked by personnel trained in air quality monitoring for extreme values (e.g., maximums and minimums) and anomalous data that may indicate problems with the system. It is recommended that this is done informally on a daily basis and formally each month (or shorter period during extreme weather conditions).
  - For PM_{10} and $PM_{2.5}$, a key check is to ensure that the values for the same hour are very close. While not every hour will balance (i.e., TSP > PM_{10} > $PM_{2.5}$), the majority of hours should.
  - Concentration values of the various PM size fractions should rise and fall in similar trends (e.g., washout during rain events).
  - Check for long periods of constant values. This could be indicative of power failures or defective probes.
- Sensors shall be calibrated on a schedule consistent with each sensor's requirements based on manufacturer specifications and professional experience.
- Data shall be downloaded consistent with detailed written operating instructions from personnel trained in air quality monitoring.

All samples and equipment are expected to operate at a 75% or higher completeness level over the monitoring period of interest. For calculating averages and conducting statistical analyses (see **Section 2.6**), a minimum completeness of 75% should be considered, following QA/QC protocols described in the National Air Pollution Surveillance Program guidance document listed in **Section 1.2**. Any averaging period with less than 75% completeness should be disregarded.

2.4 Dustfall Monitoring

Dustfall refers to the amount of PM of all size fractions that settles onto a collection surface in a given amount of time. It is a measure of the amount of PM present in the ambient air that is deposited on the ground or other surfaces. Trace elements within dustfall, especially heavy metals, can adversely affect the environment including soil quality, water quality, vegetation and animals that forage on vegetation. In addition, dustfall can represent a public concern from an aesthetic or nuisance perspective and has been raised as a concern by local Indigenous governments.

2.4.1 Station Siting Considerations

As the intent of dustfall monitoring is to measure general dustiness in areas of concern (e.g., aquatic ecosystems, wildlife habitat, etc.), locations of dustfall monitoring should be selected to be representative of potentially impacted receptors. If monitoring at specific receptors of concern is not feasible, locations should be selected at or within the property boundary in the direction of key receptors.

In general, locations near potential PM sources (e.g., haul roads, unpaved parking lots, stockpiles or other fugitive sources) are to be avoided unless these sources are part of the monitoring objectives. Dustfall monitoring should be located at least 20 m from buildings and other obstacles, allowing unrestricted air flow in at least three of the four cardinal points. For rooftop installations, dustfall monitoring should be positioned away from chimneys and building edges.

Individual mines may have additional site-specific monitoring objectives (e.g., dustfall monitoring transects). These objectives can be taken into consideration when determining appropriate monitoring site locations.

2.4.2 Monitoring Methods

Dustfall monitoring shall follow ASTM Method D1739-98 (re-approved 2017). The dustfall collector consists of a stainless steel or weatherproof plastic container held in a suitable bracket and affixed to a supporting pole, approximately 2 m above ground. The container is to be prepared, cleaned, and sealed by an accredited laboratory with a measured quantity of reagent water that acts to prevent resuspension of any material that settles into the container. The container is then opened in the field and left for a period of 30 days. At the end of the sampling period, the container is sealed and returned to the laboratory for analysis.

All material collected in the container, including rain and snow, shall be kept in the container and submitted to the laboratory as part of the sample.

2.4.3 Monitoring Frequency

ECC has not developed limits for dustfall; therefore, dustfall results shall be compared to the guidelines shown in **Table 2.5**, which are adopted from BC[11]. The value chosen from the table for the diamond mines in question should be the "Industrial / Other" value given the remote location of the mines. It should be noted that, in BC, these guidelines are for comparative purposes only and are not considered actionable levels. In accordance with the averaging period of the guidelines, sample changeover should occur every 30 days, as close as possible to the beginning of the calendar month. While calendar month is based on current industry best practices, operators may provide rationale and justification for alternative changeover times (e.g., general 30-day period).

[11] British Columbia Ministry of Environment and Climate Change Strategy (BC ENV). 2016. Memorandum to Director of Monitoring, Assessment & Stewardship: Dustfall Monitoring and Pollution Control Objectives

Table 2.5 Dustfall Guidelines

Receptor Type	Averaging Period	Dustfall Guideline (mg/dm^2-day)
Residential / Parkland	1 month	1.75
Industrial / Other	1 month	2.90

The values presented in **Table 2.5** are provided to protect against concerns over aesthetics or nuisance issues. However, if concerns exist over the protection of soil/water/vegetation and/or the tracking of accumulation of metals or other contaminants in the environment, additional sampling of the specific media of concern would be more appropriate (see **Section 3.0**).

2.4.4 Quality Assurance/Quality Control Procedures

Standard operating procedures shall be developed and followed to ensure quality control. All containers shall be clearly labeled in the field with an identification number, date, and time of sample collection. Visual inspections shall be conducted to ensure the integrity of the sampling container and to determine the possible presence of interfering materials (e.g., algae growth, wildlife fecal matter).

During periods of high precipitation, care should be taken to ensure containers do not overflow, invalidating the sample. It is recommended that the sample container be routinely checked, and a new container deployed if liquid level rises to within 2.5 centimetres of the top of the container. In such circumstances, both containers are used to determine the total dustfall during the 30-day sampling period. Larger sized sampling containers can also help prevent liquid overflow.

During freezing weather conditions, care should be taken to ensure liquid within the containers does not freeze, invalidating the sample. It is recommended that the laboratory be consulted and an antifreeze agent such as isopropyl alcohol be added to the containers during the preparation stage.

All samples and equipment should aim to operate at a minimum of 75% or higher completeness level over the monitoring period of interest.

2.5 Monitoring of Sulfur Dioxide and Nitrogen Dioxide

Potential sources of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) emissions from mining operations include power plants, mine heaters, mine and quarry activities (i.e., mobile & stationary engines, blasting), and incinerators. If mining operations are expected to include power plants and/or incinerators, then monitoring of SO_2 and NO_2 should be considered during the phase(s) of the mine in which these sources may be operated. Ultimately, the decision to monitor SO_2 and NO_2 should be based on the consideration of the guideline objectives outlined in **Section 1.3** and the results of each mine's individual environmental assessment. Emissions of SO_2 and NO_2 can adversely impact public health, cause haze, reduce visibility as well as contribute to the formation of acid deposition, which can adversely impact local vegetation and wildlife.

Two monitoring options for SO_2 and NO_2 are discussed in the sub-sections below: real-time continuous monitoring and non-continuous passive sampling. Operators should consult with ECC before proceeding with non-continuous passive sampling to ensure that the sampling program will meet the objectives and requirements of the mine's EA/MOU.

2.5.1 Continuous Real-time Monitoring

2.5.1.1 Station Siting Considerations

The siting criteria presented in **Table 2.6** should be followed for continuous, real-time monitoring of SO_2 and NO_2. In general, locations near potential sources are to be avoided unless these sources are part of the monitoring objectives. For example, nearby furnace or incinerator flues can increase observed levels of SO_2 and NO_2 if samplers are not properly sited relative to the source. However, this may be desirable in order to directly monitor impacts from these sources.

The monitoring station's sampling inlet and manifold must meet the requirements of the most recent version of the NAPS Program's *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines* Section 8.2 and Section 8.3. All connection tubing, connectors and fittings of the sampling line must be made of chemically inert material (e.g., borosilicate glass (e.g., Pyrex), quartz or Teflon).

Both SO_2 and NO_2 sampling systems should be equipped with particle filters placed upstream of the analyzer. For SO_2, the filter should be capable of removing at least 99% of 1 μm and larger particles. For NO_2, the filter should meet the instrument manufacturer's pore-size specifications. The filter holders should be constructed of an inert material. If the chosen analyzer is equipped with an appropriate internal filter, then external filters may not be required.

Table 2.6 SO2 and NO2 Sample Probe Siting Criteria[12]

Pollutant	Height Above Ground (m)	Distance from Supporting Structure (m) Vertical	Distance from Supporting Structure (m) Horizontal[1]	Other Spacing Criteria
SO_2	3 to 15	>1	>1	a. Distance from the sampler to any air flow obstacle (i.e., buildings, terrain features, etc.) must be >2× height of obstacle above the sampler b. Airflow must be unrestricted through an arc of at least 270 degrees c. Higher objects, such as buildings, should not exceed 30 degrees from the horizontal plane of the sampler body
NO_2	3 to 15	>1	>1	a. Distance from the sampler to any air flow obstacle (i.e., buildings, terrain features, etc.) must be >2× height of obstacle above the sampler b. Airflow must be unrestricted through an arc of at least 270 degrees c. Spacing from major roads/haul roads varies with road traffic d. Higher objects, such as buildings, should not exceed 30 degrees from the horizontal plane of the sampler body

Note: When a probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof

Sampling ports should be oriented facing upwards with water traps to reduce the risk of moisture entering the analyzer. The use of horizontally oriented ports should be avoided.

At a minimum, one site should be chosen in the predominant downwind direction of mining operations, located within the mine property boundary at the extent of the mine's disturbed/development area. Additional monitoring sites should generally be chosen to be representative of nearby receptors of concern (e.g., nearby populated areas, sensitive ecosystems, etc.) and can be informed based on an analysis of project dispersion modelling conducted during the environmental assessment stage. Relevant stakeholder input should also be considered when choosing the number and locations of air quality monitoring stations.

2.5.1.2 Monitoring Methods

For both SO_2 and NO_2, commercially available analyzers that are recognized by the US EPA as FRM or FEM methods should be used. A full list of designated FRM or FEM methods can be found on the US EPA's website[13]. For reference, the following are common commercially available analyzers; the identification of these does not exclude the use of other commercially available analyzers.

- SO_2
  - Thermo Environmental Instruments (TEI) Models 43i SO2 Analyzers.
  - Teledyne API T100
  - Ecotech EC9850T

[12] Adapted from NAPS, BC, AB and ON guidance documents

[13] https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants

- NO_2
  - Thermo Environmental Instruments (TEI) Models 42, 42C, & 42i NOX
  - Teledyne API T200
  - Serinus 40

Operation, service and maintenance of the analyzers should be conducted in accordance with the instrument manufacturer's operation manual. Recommended minimum performance specifications for ambient air gas analyzers are presented in **Table 2.7**.

Table 2.7 Performance Specifications for Continuous Analyzers[14]

Performance Parameter	Pollutant – NOx	Pollutant – SO_2
Minimum Detection Limit	0.4 ppb_v	0.1 ppb_v
Precision	± 2 ppb_v	± 2 ppb_v
Linearity	1 % F.S.	1 % F.S.
Zero Drift / 24 hrs	< 0.5 ppb_v	< 0.2 ppb_v
Span Drift / 24 hrs	< 1 % F.S.	< 0.5 % F.S.
Noise	± 0.2 ppb_v RMS	<0.06 ppb_v RMS
Rise Time (95%)	80 sec	140 sec
Fall Time (95%)	80 sec	140 sec
Operating Temperature Range	10 – 40 °C	10 – 40 °C
Operating Humidity Range	0 - 100 %	0 - 100 %
Nominal Operating Ranges	0 - 500 ppb_v	0 - 500 ppb_v
Operating Voltage	105-125 vac / 60 Hz	105-125 vac / 60 Hz

2.5.1.3 Shelter

Monitoring stations that house continuous monitoring equipment for particulate or gas analysis must be equipped with climate control functions. The station's HVAC system must maintain a year-round internal temperature range of 20°C to 30°C that is stable to within ± 2°C over a one-hr period. However, if guidance from the instrument manufacturer indicates a greater tolerance, then the equipment tolerance can be adopted for the shelter.

The shelter must also protect the station's instrumentation from:

- Precipitation and rodent impacts
- Fluctuations in internal temperature, pressure or humidity that may be caused by improperly sizedair conditioning units, or intrusion of ambient air
- Excessive dust and dirt

[14] Adopted from Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines, National Air Pollution Surveillance Program and Operations Manual for Air Quality Monitoring in Ontario

- Environmental stress including temperature extremes, vibration, corrosive chemicals, intense light,or radiation pertinent to a manufacturer's specification.

2.5.1.4 Monitoring Frequency

ECC has developed AAQLs for SO_2 and NO_2 based on 1 hr, 24 hr and annual averaging periods, as outlined in the *Guideline for Ambient Air Quality Standards in the Northwest Territories*[15]. Therefore, SO_2 and NO_2 should be measured using real-time monitors with data logged on a one-minute basis and reported on an hourly basis. This will allow for the comparison of monitored values to relevant standards. 24-hr averages should be calculated on a "midnight to midnight" basis for comparison to the relevant AAQL. 1-hr averages should be calculated in hour-ending average format (e.g., minute data collected between 01:01 and 02:00 are averaged and reported as the 02:00 hr).

Table 2.8 Ambient Air Quality Limits for SO_2 and NO_2

Averaging Period	Pollutant – NO_2 (ppb_v)	Pollutant – SO_2 (ppb_v)
1 hr average	213	172
24 hr average	106	57
Annual arithmetic mean	32	11

2.5.1.5 Quality Assurance/Quality Control Procedures

2.5.1.5.1 Instrumentation

The station shall be attended weekly (as weather conditions permit) to ensure that sensors within reach are free of debris, frost, or damage that may prevent accurate measurement. A checklist should be developed that allows an organized approach to determining the fitness of the station.

Operators should consult the most recent version of the NAPS Program's *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines* Section 11 for more information on verification and calibration of gas analyzers. In general, however, instrument Zero and Span Verifications should be conducted daily, or weekly at a minimum. Zero and Span Verifications should be completed as per the manufacturer's operation manual. Calibration of analyzers should be carried out following any of the following events:

1. At least once per month
2. Before the internal performance check shows that the span values are greater than ±10% of the known standard (e.g., span drift of 5% or more)
3. Following repairs/maintenance
4. Following installation or relocation
5. For new analyzers, after the first 3 months of operation
6. When there is an interruption of more than a few days in analyzer operation

[15] ECC may update these values from time-to-time to reflect the Canadian Ambient Air Quality Standards (CAAQS) as they evolve. Operators should review, and confirm, the currently adopted NWT standard with ECC.

7. When there is any other indication (including excessive zero drift or span drift) of possible significant inaccuracy of the analyzer and possibly after a pollution episode
8. SO_2
    a. Quarterly if using weekly zero/span checks
    b. A maximum 6-month interval is permissible if using daily zero/span checks
9. NO_2
    a. Quarterly if using more than daily (e.g., weekly) span checks
    b. Bi-annually if using daily span checks

All external performance checks and calibrations must be recorded, and the documentation must be available for inspection and/or submission to the regulatory agency.

SO_2 analyzers can be sensitive to the presence of water during calibration, which can lead to stability problems, while NO_2 analyzers can be sensitive to the presence of oxygen during calibration. Therefore, care must be taken to avoid introduction of these gases during calibrations.

2.5.1.5.2 Data

The QA/QC procedures for the collected data include the following:

- Data are to be downloaded from the station regularly and manually checked by personnel trained in air quality monitoring for extreme values (e.g., maximums and minimums) and anomalous data that may indicate problems with the system. It is recommended that this is done informally on a daily basis and formally each month (or shorter period during extreme weather conditions).
    - For instruments measuring nitric oxide (NO) and NO_2, a key check is to ensure that the channels balance ($NO + NO_2 = NOx$). While not every hour will balance, the majority of hours should.
- Data shall be downloaded consistent with detailed written operating instructions from personnel trained in air quality monitoring.

All samples and equipment are expected to operate at a 75% or higher completeness level over the monitoring period of interest. For calculating averages and conducting statistical analyses (see **Section 2.6**), a minimum completeness of 75% should be considered, following QA/QC protocols described in the National Air Pollution Surveillance Program guidance document listed in **Section 1.2**. Any averaging period with less than 75% completeness should be disregarded.

2.5.2 Non-Continuous Passive Sampling

Passive sampling devices (PSD) provide a cost-effective indicator of the ambient air quality conditions, typically over longer time periods (usually one month or longer). The use of PSDs is advantageous in areas where access to power may be limited or unavailable, qualitative results are adequate, or to assist in identifying representative monitoring locations. Consequently, they can be used as a screening level approach to determining ambient SO_2 and NO_2 levels. Given the potential drawbacks to PSDs, some of which are discussed below, mine operators should seek approval from ECC prior to using PSDs for SO_2 and NO_2 monitoring to ensure that the sampling program will meet the objectives and requirements of the mine's EA/MOU.

2.5.2.1 Station Siting Considerations

PSDs should be installed under a rain shelter to protect them from weather, animals, human activity and the surroundings. Devices should be installed 2 to 15 m above the ground. However, PSDs are typically installed at 2 to 3 m height for ease of collection. When collecting co-located samples, samplers should be within a 4 m horizontal distance of each other. A summary of siting criteria is presented in **Table 2.6**.

At a minimum, one site should be chosen in the predominant downwind direction of mining operations, located within the mine property boundary at the extent of the mine's disturbed/development area. Additional monitoring sites should generally be chosen to be representative of nearby receptors of concern (e.g., nearby populated areas, sensitive ecosystems, etc.) and can be chosen based on an analysis of project dispersion modelling conducted during the environmental assessment stage. Relevant stakeholder input should also be considered when choosing the number and locations of air quality monitoring stations.

2.5.2.2 Monitoring Methods

A variety of commercially available PSDs exist for both SO_2 and NO_2. Consequently, adevice should be chosen such that, as best as possible, for the period of interest, the method detection limit (MDL) is at least 10 times lower than the relevant AAQL (see **Table 2.8**). Another key factor to considerwith PSDs is the effect of temperature on the device. Many PSDs cannot operate at the low temperatures seen during winter in the NWT. PSDs should not be operated below their manufacturer recommended temperature range.

2.5.2.3 Monitoring Frequency

Passive samplers are exposed in the field for a nominal period of 30 days. As passive sampling is done over a longer period the results cannot be directly compared to shorter averaging periods (e.g., 1 hr). However, it can provide an indication of longer-term air quality trends. Shorter sampling times less than 30 days may be feasible (e.g., 24 hr); however, this should be discussed with the sampler supplier and analytical laboratory to ensure an appropriate detection limit can be achieved for comparison to the corresponding AAQLs.

2.5.2.4 Quality Assurance/Quality Control Procedures

Due to the qualitative nature of PSD sampling, it is recommended that duplicate passive samplers be used at each monitoring location. Field/travel blanks should also be collected with each set of deployed PSDs.

PSDs should be inspected for damage when retrieved from the field and any damage should be noted. Samplers should be transported in a protective container and placed in a sealable bag. Samples should be shipped to the laboratory for analysis as soon as practicable to minimize possible sample degradation.

All samples and equipment are expected to operate at a 75% or higher completeness level over the monitoring period of interest. For calculating averages and conducting statistical analyses (see **Section 4.0**), a minimum completeness of 75% should be considered, following QA/QC protocols described in the National Air Pollution Surveillance Program guidance document listed in **Section 1.2**. Any averaging period with less than 75% completeness should be disregarded.

2.6 Reporting

The mine operator shall produce annual reports summarizing all collected air quality data. The Annual Air Quality Report shall be submitted to the signatories of the EA and/or MOU, as well as the relevant advisory board or monitoring agency, by June 30 of each calendar year for the preceding operating year, or by the date the Environmental Agreement Annual Report is due, whichever date is earlier. All annual reports should be submitted to ECC and to any other party that the mine operator is required to provide monitoring results to, as outlined in the EA or MOU. Annual reports should also be made available to the public. Reports covering shorter time periods (e.g., quarterly) may by requested by ECC. These reports should follow the same general reporting requirements listed below.

The report should include a summary of overall operations related to the air quality monitoring, such as thefrequency of site visits and calibrations, parameters monitored and equipment model numbers, etc. The report should also include a map showing the active mine area, property boundaries, and monitoring stations, including scaling and north arrow. Finally, the report should include a statistical analysis of all parameters collected, as per **Table 2.9** below. This table is not intended to be an exclusive list of all relevant statistics. Mine operators can, at their discretion, include other, more detailed, statistical analyses. As outlined in **Section 1.3**, the objectives of the monitoring and subsequent reporting will serve to verify the accuracy of the environmental assessment of the project, monitor impacts on local air quality, verify the effectivenessof mitigation measures, and confirm whether the commitments outlined in the EA/MOU are being fulfilled.

Table 2.9 Annual Reporting Statistics

Parameter	Statistics
Wind Speed	Based on hourly measurements: • Mean • Minimum • Maximum • Frequency of calms (i.e., < 0.5 m/s) • Data completeness
Wind Direction	Based on hourly measurements: • Seasonal windrose plots • Annual windrose plot • Data completeness
Barometric Pressure Temperature Relative Humidity	Based on hourly measurements for each month of the year: • Mean • Minimum • Maximum • Data completeness Based on daily values, calculated from hourly measurements, for each month of the year: • Mean • Minimum • Maximum • Data completeness

Parameter	Statistics
Solar Radiation	Based on hourly measurements, for each month of the year: • Mean • Minimum • Maximum • Data completeness
Precipitation	Based on hourly measurements, for each month of the year: • Mean • Minimum measurable value • Maximum • Data completeness • Cumulative annual precipitation as rainfall equivalency
TSP, PM_{10}, $PM_{2.5}$	Based on hourly measurements: • Mean • Minimum • Maximum • Data completeness Based on daily values calculated from hourly measurements or event sampling: • Mean • Minimum • Maximum • Data completeness • Comparison to relevant AAQL or guideline • Frequency of exceedances of relevant AAQL or guideline • Comparison to environment assessment predictions
Dustfall	Based on event measurements: • Mean • Minimum • Maximum • Data completeness • Comparison to relevant guideline • Number and frequency of exceedances of relevant guideline
SO_2 (passive) NO_2 (passive)	Based on event measurements: • Mean • Minimum • Maximum • Data completeness • Comparison to relevant AAQL • Comparison to environmental assessment predictions

Parameter	Statistics
SO_2 (continuous) NO_2 (continuous)	Based on hourly measurements: • Mean • Minimum • Maximum • Data completeness • Comparison to relevant AAQL • Frequency of exceedances of relevant AAQL • Comparison to environmental assessment predictions Based on daily values calculated from hourly measurements: • Mean • Minimum • Maximum • Data completeness • Comparison to relevant AAQL • Frequency of exceedances of relevant standard limit • Comparison to environmental assessment predictions

For all parameters collected, the data completeness (i.e., the amount of valid data represented for the indicated averaging/monitoring period) should be included. This should be compared to the total potential number of samples or total time possible for the indicated averaging/monitoring period. All samples and equipment are expected to operate at a 75% or higher completeness over the monitoring period of interest. A detailed analysis of any parameter that does not meet the 75% uptime criteria should be conducted to determine causes (e.g., equipment failure, data loss, etc.). For calculating averages and conducting statistical analyses, a minimum completeness of 75% should be considered, following QA/QC protocols. Any averaging period with less than 75% completeness should be disregarded. If equipment and/or results are below the 75% uptime or 75% data completeness criteria, operators are required to explain the factors that caused this, with evidence to support their findings, and a plan of action to avoid the problems that resulted in failure to collect sufficient data in the future.

ECC has developed AAQLs for contaminants of concern, as outlined in the *Guideline for Ambient Air Quality Standards in the Northwest Territories*. These AAQL, as updated by the GNWT from time to time, should be used when assessing collected data.

When comparing results to relevant AAQL or guidelines, a summary of the number of exceedances and locations of exceedances should be tabulated. For each exceedance, an in-depth analysis should be conducted to determine potential causes and sources. Furthermore, it is highly recommended that each mine maintains a log of dust events/complaints that have been observed by either on-site staff or off-property stakeholders.The log should include the date and time of the event/compliant, the on-site operations during the time of events, and a list of corrective actions taken to mitigate the event/complaint. The log should be included in the mine’s annual report.

Each mine is expected to have an Adaptive Management Plan, which should establish thresholds or early warning signs for the implementation of mitigative measures. Air quality monitoring data should be reviewed relative to adaptive management action levels (see **Table 2.10**) and any events that triggered adaptive management protocols should be discussed in the annual report. Adaptive management trigger criteria are outlined in the *Proposed NWT Air Regulations Framework* and are adopted here; however, if site specific criteria have been developed then those should be used for annual reporting purposes. The report should also include any responses to air quality issues, whether the responses were initiated bythe facility or by other agents.

Following the third full year of monitoring, the reports must also assess longer-term effects and trends. This longer-term analysis of ambient air quality trends is critical to determining if additional mitigation is necessary.

Table 2.10 Adaptive Management Action Levels & Triggering Criteria

Action Level	Triggering Criteria
1st Action Level A) Investigate causal factors of elevated emissions B) Investigate & implement mitigative measures C) Findings & response plan logged internally and kept on-site	1) Concentrations between 80% & 90% of the applicable AAQL or guideline **-OR-** 2) 10% - 20% year to year increase inconcentrations **AND** above 50% of the applicable AAQL or guideline
2nd Action Level A) Investigate causal factors of elevated emissions B) Investigate & implement mitigative measures C) Submit findings & response plan to ECC	1) Concentrations above 90% of the applicable AAQL or guideline **-OR-** 2) More than 20% year to year increase in concentrations **AND** above 50% of the applicable AAQL or guideline

Note that "applicable AAQL or guideline" refers to values provided in this document.

3.0 LINKAGES TO OTHER MONITORING PROGRAMS

It is important to recognize the interconnections between air quality and other required monitoring programs, such as the Aquatic Effects Monitoring Program (AEMP). An AEMP is required for all diamond mines that deposit direct wastes (e.g., effluent) or indirect wastes (e.g., seeps, run off, groundwater, air) into the aquatic environment. Development of an AEMP should follow the "Guidelines for Aquatics Effects Monitoring Programs" developed by the Mackenzie Valley Land and Water Board (MVLWB) and the GNWT, with consideration of the general guidance, monitoring methods and instruments provided in **Section 2.2**. Air quality monitoring programs will seek to complement other monitoring programs where possible, based on project-specific considerations that impact monitoring program and design. In consideration of this, operators should consider the benefits of collecting specific media of concern (e.g., water) to compliment the air quality monitoring.

4.0 DOCUMENTATION AND RECORD KEEPING

All mines must maintain records relevant to the operation of their ambient air monitoring stations.This includes the installation, calibration, and maintenance of the instrumentation, as well as incidents and events with the potential to affect data validity. All mines must maintain the following records:

- Station start-up records;
- Inspection and maintenance records;
- Verification and calibration records; and
- Non-conformance and corrective action records.

Detailed documentation and record keeping is vital in helping to identify issues before they arise. Accurate record keeping also helps establish the proficiency of a station's operation.

6.0 REFERENCES

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