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Napoleon Mackenzie, Chair
Environmental Monitoring Advisory Board
PO Box 2577
Yellowknife, NT X1A 2P9
Canada

24 January 2019

Dear Mr. Mackenzie:

Subject: Environmental Air Quality Monitoring and Management Plan, Version 2

Please find enclosed an update to the Diavik Diamond Mines (2012) Inc. (DDMI) Environmental Air Quality Monitoring and Management Plan (EAQMMP), Version 2 (Attachment 1). The purpose of the EAQMMP V2 is to remove continuous total suspended particulate (TSP) monitoring while maintaining the other elements of DDMI's air quality monitoring and management programs. This letter and the attached technical memorandum prepared by ERM for DDMI provide the rationale for this change.

The prediction and measurement of airborne particulate matter that falls out on aquatic systems and terrestrial vegetation is evaluated when determining the impact of DDMI operations to the local and regional environment. Direct measurements of dust deposition quantify dust accumulation on vegetation, snow and water and address general community concerns relating to dust.

DDMI updated its Air Dispersion Modelling (ADM) in 2012 and additional key components of DDMI's Air Quality monitoring and related environmental management programs and reporting requirements include:

- Dustfall collection and monitoring;
- Verification stack monitoring of incinerators;
- Annual snow core sampling program (dustfall and dust chemistry);
- Lichen and vegetation dust monitoring programs;
- Greenhouse Gas and National Pollutant Release Inventory calculations from all onsite sources;
- Aquatic Effects Monitoring Program to evaluate operational effects, including dust deposition, to Lac de Gras; and
- On-going environmental programs to reduce emissions such as:
  - Construction of a crusher which is 100% enclosed;
  - Vehicle count and usage reduction program;
  - Tracking fuel and vehicle use across the mine to optimize usage;
  - Use of ultra-low sulphur (~4.3 ppm) diesel fuel;
  - Watering of roadways and airstrip during the summer months to reduce dust;

- Use of dust suppressants in specific areas (e.g. taxiway, helipad);
- Installation and effective operation of 4 x 2.3 MW wind turbines, reducing annual diesel fuel consumption by roughly 10%;
- Construction of incinerators which include secondary combustion chambers and water scrubbers; and
- Heat recovery from the electrical generators and boilers.

The Diavik site ADM Assessment was updated in 2012 following significant engagement with Environment and Climate Change Canada, the Government of Northwest Territories, and the Environmental Monitoring Advisory Board (EMAB) on the development of model input parameters and on the outputs of the model. Based on model outputs, version one of the EAQMMP was developed and reviewed by parties. The finalization of the new EAQMMP included several presentations to EMAB. At that time DDMI requested that EMAB consolidate input from all EMAB advisors regarding the new EAQMMP and to our knowledge no formal review of the ADM was requested and the Board was satisfied with the EAQMMP. Note that it is not feasible or valuable to update the ADM modelling based on yearly changes in mine footprint, specific mining activities or yearly variations in winds. The goal of the monitoring programs are to assess the current conditions on site and help determine the current effects of the Project on the environment. In part to verify DDMI's 2012 ADM, two (2) TSP samplers were installed in April of 2013 to monitor TSP at the mine boundary. In the EAQMMP Version 1, DDMI committed to monitor TSP continuously at these locations for one year, after which the monitoring would be re-assessed to determine if the data was valuable and still required. Before conducting the re-assessment (Attachment 2), DDMI operated the TSP samplers from April 2013 until December 2018.

Throughout the period of TSP monitoring, DDMI was involved in underground mining of the A154 and A418 ore bodies and surface construction of the A21 dike, which included significant blasting, re-mining, crushing and haulage of waste rock from the Waste Rock Storage Area – North Country Rock Pile across the East Island of Lac De Gras. Based on over four years of TSP sampler operation (2014 to 2017), with an overall average performance rate of 70%, results confirmed that TSP values largely remained below the Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT-ENR) 24-hr Guideline. It is also significant to note that while obtaining 70% data performance, missing results were distributed randomly and there is no evidence to suggest that the missing values would deviate from or change the long-term trends identified using the current dataset. DDMI's ADM predictions have been conservatively higher than field measurements of TSP at the mine boundary and consistent with direct measurements of accumulated dustfall particulates, demonstrating confidence in the conservative model predictions.

A technical memorandum that provides detail of the re-assessment and associated conclusions developed by ERM consultants is included as Attachment 2. In light of the information summarized above and provided in Attachment 2, DDMI has determined that continued TSP monitoring is not a valuable component of the air quality monitoring initiatives at the Diavik mine. Results have not proven useful in developing adaptive management strategies for improving air quality at the site. In addition, equipment reliability issues have required significant on-site and off-site maintenance programs that have impeded their availability and caused strain on Environment department resources. For the reasons noted above, DDMI has elected to discontinue TSP monitoring. DDMI would like to emphasize that it will still be continuing all remaining components of the EAQMMP that track items of community concern while continuing to provide valuable data that is utilized in the adaptive management of air quality on site; the EAQMMP Version 2 reflects these commitments. In addition, DDMI's ongoing Aquatic Effects Monitoring Program (AEMP) enables the monitoring and assessment of the effects of accumulation of project-related dust and air emissions on aquatic receptors.

Please do not hesitate to contact the undersigned if you have any questions related to this submission.

Yours sincerely,

Sean Sinclair
Superintendent, Environment

cc: John McCullum, EMAB

Attachment 1: Diavik Diamond Mine Environmental Air Quality Monitoring Plan, Version 2
Attachment 2: Memorandum - Total Suspended Particulate (TSP) Sampler Assessment

Diavik Diamond Mine Environmental Air Quality Monitoring and Management Plan

Version 2

Document #: ENVI-302-0613 R1

24 January 2019

Contents page

1. Introduction

The Environmental Air Quality Monitoring and Management Plan (EAQMMP) has been developed by Diavik Diamond Mines (2012) Inc. (DDMI) to identify air quality monitoring requirements on site. The components of the EAQMMP include dust deposition (dustfall) monitoring (as part of the Aquatic Effects Monitoring Program (AEMP)), a snow core program (as part of the AEMP), and reporting to the National Pollutant Release Inventory (NPRI), and the national Greenhouse Gas Reporting Program (GHGRP) to Environment and Climate Change Canada (ECCC).

DDMI has been collecting and reporting air quality related data since initial site construction in 2001, when the dust monitoring program was first initiated. The program is in accordance with DDMI's commitments made during the Environmental Assessment and is a requirement of the AEMP. The program is designed to achieve the following objectives:

- Determine dustfall rates at various distances from the Mine Footprint; and
- Determine the chemical characteristics to dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result of mining activities, as well as deposition onto tundra vegetation.
- Comply with regulatory reporting requirements such as NPRI and GHGRP.

As background to the EAQMMP, in 2012, an updated air dispersion modelling assessment was undertaken for the entire Mine to assess two (2) mine phases; the transition to an underground mine (open pit and underground) for 2011, and underground mine only (Golder, 2012). With the commencement of open pit mining at A21 and continued underground mining of A418 and A154, the transition phase model is currently of relevance. After the completion of surface mining at A21 the underground only phase will resume use. The modelling results indicated for off-site receptors that:

- Predicted annual SO_2 concentrations and maximum 1 hour concentrations are lower than the air quality criteria for receptors located in the vicinity of the Mine;
- Maximum 24-hr concentrations of NO_2 are predicted to be lower than the air quality criteria in the vicinity of the Mine. A single 1-hour prediction, (1 out of 8760 hours modelled) was 5% above the air quality criteria. The annual average result of 61 micrograms per cubic metre (*u*g/m^3) was very close to the criteria of 60 *u*g/m^3 in the vicinity of the Mine;
- Annual TSP concentrations are predicted to be lower than air quality guidelines for receptors located in the vicinity of the Mine. For two (2) days per year 24-hr concentrations of TSP are predicted to exceed the air quality criteria;
- Maximum 24-hr PM_{10} concentrations are predicted to exceed air quality criteria 11 days per year for receptors in the vicinity of the Mine;

- Maximum 24-hr $PM_{2.5}$ concentrations are predicted to exceed air quality criteria 14 days per year for receptors in the vicinity of the Mine; and

- Maximum TSP deposition rates are predicted to be higher on the Mine site (222.2 $mg/dm^2/y$) than off-site (4.1 $mg/dm^2/y$) and generally greater than originally predicted. For example 100 $mg/dm^2/y$ was originally predicted adjacent to A154pit (Cirrus Consultants, 1998).

These modelling results, the general interest in dust deposition effects on vegetation, wildlife and the aquatic environment, and the lack of a community in the vicinity (i.e. >180 km to nearest community) of the mine are the basis for the focus of DDMI's EAQMMP on dust deposition. Direct measurements of dust deposition quantify dust accumulation on vegetation, snow and water and reflect community concerns related to dust deposition.

There are a number of air quality monitoring and management programs being undertaken at the Mine including:

- Verification stack monitoring of incinerators;
- Lichen and vegetation dust monitoring program (every 3 -5 years);
- Dustfall gauge (continuous collection, quarterly analysis) and snowcore monitoring (annually);
- Snow water chemistry (annually);
- Regulatory reporting of GHG emissions (annually);
- On-going environmental programs to reduce emissions to air on a daily basis include:
  - Construction of a new crusher which is 100% enclosed;
  - Installation of four (4) wind turbines (4 x 2.3 MW), reducing annual diesel fuel consumption by roughly 10%;
  - Vehicle reduction program;
  - Tracking fuel and vehicle use across the mine to optimize usage;
  - Using ultra-low sulphur (~4.3 ppm) diesel fuel;
  - Watering of roadways during the summer months;
  - Aircraft/flight optimization to minimize air traffic;
  - Dust suppressant application to the airport apron (tarmac) and helipad during the summer months;
  - Construction of new incinerators which include secondary combustion chambers and water scrubbers; and
  - Heat recovery from the electrical generators.

It is recognized that the EAQMMP may evolve as data is generated and as discussions with Mine stakeholders continue.

2. Dustfall Monitoring

2.1 Dustfall Gauges

Dustfall gauges are placed at 14 stations (including two control stations) around the Mine at distances ranging from approximately 25 to 4,852 m from mining operations (Figure 1). Twelve of the 14 stations were established between 2002 and 2007 and two (2) additional stations were established in October 2017 to better capture dust generated around A21. Gauges collect dustfall year-round with samples being collected for analysis approximately every three (3) months.

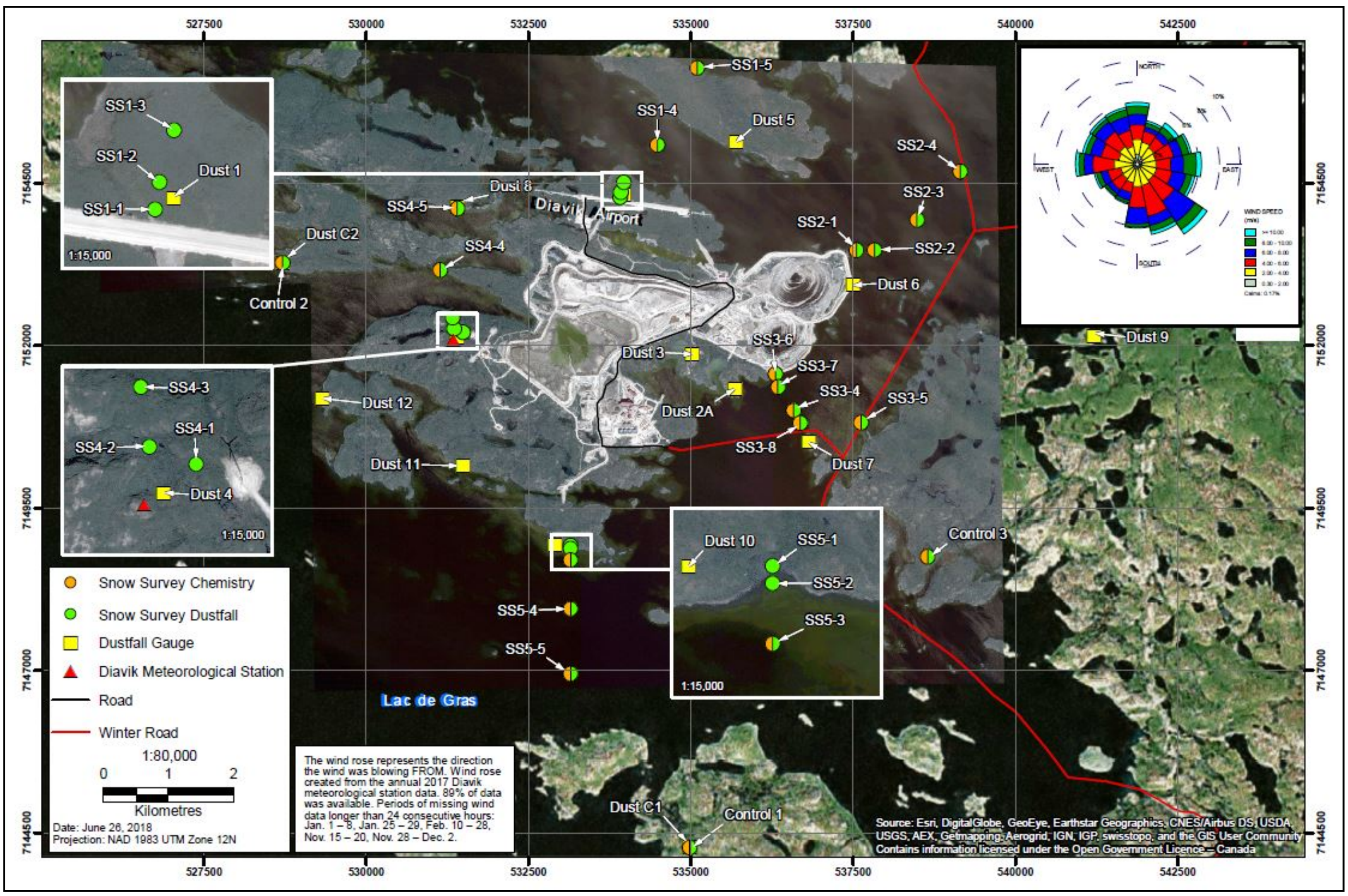


Figure 1 Dustfall Gauge and Snow Survey Locations, Diavik Diamond Mine, 2017.

Dustfall gauge stations consist of a hollow brass cylinder (52 cm length, 12.5 cm inner diameter) housed in a Nipher snow gauge. The cylinders collect dustfall, while the Nipher snow gauge reduce air turbulence around the gauge to increase dustfall catch efficiency. At the end of each sampling period, the cylinders are retrieved, replaced with an empty, clean cylinder, and the contents are processed in the DDMI environment laboratory to determine mass of collected dustfall. This process involves filtration, drying, and weighing of samples as specified in DDMI's internal standard operating procedures (SOPs).

Once mass of collected dustfall at a station is measured, the mean daily dustfall rate ($mg/dm^2/d$) over the collection period is calculated and multiplied by 365 days to convert it to annual units ($mg/dm^2/y$). Dustfall rates are reported annually to EMAB and as part of the AEMP.

2.2 Dustfall Snow Surveys

Dustfall is assessed as part of the snow surveys at 27 stations and include three control stations, along five transects around the Mine (Figure 1). Across stations, the distance from mining operations range from approximately 325 to 4,852 m. The median exposure period is 159 days. The start dates used to calculate the exposure duration correspond to the first snowfall for land stations, and shortly after ice freeze up, once ice conditions are safe for work at on-ice stations.

At each snow survey station, a snow corer is used to drill into the snow pack to retrieve a cylindrical snow core (6.1 cm inner diameter). Cores are extracted at each station and composited in the field to obtain a representative snow sample for the station. A minimum of three (3) snow cores are collected at each (land and ice) snow sampling station. Composited samples are bagged and brought to the DDMI environment laboratory for processing in accordance with our SOPs. Processing of snow cores requires filtering, drying and weighing.

Mean daily dustfall rate ($mg/dm^2/d$) is calculated for the collection period, with the surface area equal to the surface area of the snow corer tube orifice and multiplied by the number of snow cores used for the composite sample at each station. The mean annual dustfall rate ($mg/dm^2/y$) is estimated by multiplying the mean daily dustfall rate by 365 days.

Dustfall rates are included in annual reports submitted to EMAB, and are also reported as part of the AEMP.

2.3 Snow Water Chemistry

Snow water chemistry analysis is performed on snow cores extracted from 19 of the 27 snow survey stations and include three (3) control locations (Figure 1). These locations include the 16 snow survey dustfall stations that are located on ice, as well as samples taken on ice adjacent to the three control stations. Chemistry samples are not collected from land stations due to the impact of natural sediment and vegetation dust contamination in the snow. Across stations, the distance from mining operations ranges from approximately 60 to 4,852 m, and the median sampling exposure duration is 158 days. At each station located on ice, cores are collected for chemistry analysis immediately after the dustfall snow cores are extracted.

Snow water chemistry cores are extracted using a snow corer in accordance with the dustfall snow survey core extractions. A minimum of three (3) cores at each site are extracted and composited to obtain the required 3 L of snow water for the laboratory chemical analysis. Snow cores are then processed and prepared for shipment to an external lab where the chemical analysis is performed.

While not a regulatory requirement, snow water chemistry data are compared to DDMI's Water License (W2015L2-0001) Effluent Quality Concentrations (EQCs) for aluminium, ammonia, arsenic cadmium, chromium, copper, lead, nickel, nitrite and zinc. DDMI compares the measured total metals for dust with the water license EQC only because they reflect recognizable concentrations that provide a comparative reference. There is no intention or requirement that snow samples must meet the EQC. Snow water chemistry results are provided annually in both DDMI's Dust Deposition Report and the AEMP.

2.4 National Pollutant Registry Inventory

While there is no regulatory requirement or standard for Critical Air Contaminants (CAC) and related pollutant releases in the Northwest Territories, the NPRI is a legislated, publicly accessible inventory used to track the amount of pollutant releases (to air, water, and land), disposals and transfers for recycling. The program is administered by Environment and Climate Change Canada (ECCC) and is a requirement of the *Canadian Environmental Protection Act* (CEPA: 1999) for owners or operators of facilities that meet the NRPI reporting requirements published in the *Canada Gazette*, Part 1.

NPRI substance emissions were derived by DDMI using emission factor calculations provided by ECCC's NPRI Toolbox. Operational values such as fuel usage and mobile equipment hours were recorded at the Mine throughout the year and weather conditions from the Mine's (onsite) weather station were used to calculate NPRI values.

NPRI reports are submitted by DDMI annually to ECCC before June 1st.

2.5 Greenhouse Gas Reporting

While there is no territorial regulation or standard for GHG release in the Northwest Territories, the national Greenhouse Gas (GHG) Emissions Reporting Program is Canada's legislated, publicly accessible inventory of facility-reported GHG data and information. The program is administered by ECCC and is a requirement of the CEPA 1999 for owners and operators of facilities that emit GHGs above a certain threshold.

GHG emissions are derived by DDMI using published emission factor calculations in the *Guidance Manual for Estimating Greenhouse Gas Emissions.* Operational values such as fuel usage and mobile equipment hours are recorded at the Mine throughout the year. DDMI submits GHG reports annually to ECCC before June 1st.

2.6 AEMP Water Quality Action Levels

Action Levels for water quality variables will be applied to all measured variables in the event that dust deposited from mining activities is linked to changes to water chemistry. The action levels are set to be relatively sensitive to the first indication of Mine influence on water chemistry. Details on actions levels can be found in the DDMI Aquatic Effects Monitoring Program Design Plan Version 5.

3. Quality Assurance/Quality Control Procedures

Dustfall gauge, dustfall snow core survey, and snow water chemistry sampling and analysis are conducted by experienced technicians following DDMI's internal SOPs. This helps to ensure proper field sampling and laboratory analysis. As part of the program, duplicate and blank samples are obtained for snow survey and snow water chemistry sample sites.

4. Reporting

DDMI will provide an annual report that summarizes the results of each component of the Environmental Air Quality Monitoring Program at the Diavik mine.

4.1 Timing/Frequency

The annual report will be submitted by June 30 of the following year; for example, the annual report for the 2018 calendar year will be submitted by June 30, 2019.

4.2 Report distribution

The annual report will be submitted to the Environmental Monitoring Advisory Board (EMAB) and Government of the Northwest Territories. DDMI will ask that it be placed on the EMAB website to be available more broadly.

5. References

Golder Associates Ltd. 2012. Diavik Diamond Mine Air Dispersion Modelling Assessment.

Memorandum

Refer to File: B.1_Diavik TSP Sampler Assessment Memo

Date:	January 26, 2018
To:	David Wells, Superintendent - Environment - HSE
From:	Jem Morrison, Atmospheric Scientist Andres Soux, Principal Consultant
Cc:	Carol Adly, Project Manager Marc Wen, Partner in Charge
Subject:	**Total Suspended Particulates (TSP) Sampler Assessment**

1. INTRODUCTION

Diavik Diamond Mine (2012) Inc. (DDMI) installed two continuous total suspended particulate (TSP) samplers at the Diavik Diamond Mine (the Mine) in accordance with their Environmental Air Quality Monitoring Plan (EAQMP; DDMI 2013) in April 2013. The locations of the monitors were selected based on proximity to the Mine boundary, with careful consideration of the TSP results from the updated air dispersion modelling assessment, and in consideration of the availability of power (DDMI 2013).

TSP consists of small airborne particles such as dust, smoke, ash and pollen with aerodynamic diameters of typically less than 100 µm. TSP is generally associated with aesthetic and environmental impacts. TSP that settles out of the air onto surfaces is called dust deposition or dustfall, which can be a concern for animals that consume vegetation covered in particulates. As part of the Wildlife Monitoring Program, Diavik conducts a lichen survey and vegetation assessment every three years.

In 2012 an updated air dispersion modelling assessment was undertaken for the entire Mine site (Golder 2012). The modelling results indicated that:

- Annual TSP concentrations are predicted to be lower than the Government of the Northwest Territories (GNWT) Guidelines for Ambient Air Quality Guidelines for receptors located in the vicinity of the Mine;
- For two days per year, 24-hour concentrations of TSP are predicted to exceed the air quality criteria; and
- Maximum TSP deposition rates (dustfall) are predicted to be higher on the Mine site (222.2 $mg/dm^2/y$) than off site (4.1 $mg/dm^2/y$) and are generally greater than predicted in the earlier model.

Two TSP monitors were installed in April 2013 in an effort to monitor ambient TSP levels near the Mine site. TSP monitoring is undertaken at two locations—one sampler is near the A154 Dike (along the southeast corner of the A154 pit) and the second sampler is within the Communications Building (CB) adjacent to the accommodations complex (Table 1; Figure 1).

Table 1. DDMI TSP Stations UTM Coordinates[1]

Station	Zone	Metres East	Metres North
CB	12W	534,460	7,150,847
A154 Dike	12W	537,258	7,152,609

[1] *World Geodetic System 1984 (WGS-84)*

This memo will assess the TSP monitoring program to date using data collected since the start of 2014, and examine the value of continued monitoring in light of the generally very low levels of TSP, the usefulness of monitoring TSP at the Diavik Diamond Mine, and the challenges involved with TSP monitoring. The specific tasks that will be undertaken for the memo preparation are:

- a review of the air quality regulatory environment of the Northwest Territories (NWT);
- a review of the last four years of TSP monitoring at the Diavik Diamond Mine;
- a review of the Air Quality Monitoring Program with relation to TSP;
- recommendations for future TSP monitoring.

2. REVIEW OF AIR QUALITY REGULATORY ENVIRONMENT

The Department of Environment and Natural Resources (ENR), as part of the Government of the Northwest Territories (GNWT), has established air quality guidelines under the *Environmental Protection Act* (GNWT 2014). These include a standard for the maximum concentration of TSP, which was adopted from the Canadian National Ambient Air Quality Objectives (NAAQO). ENR uses two standards for TSP:

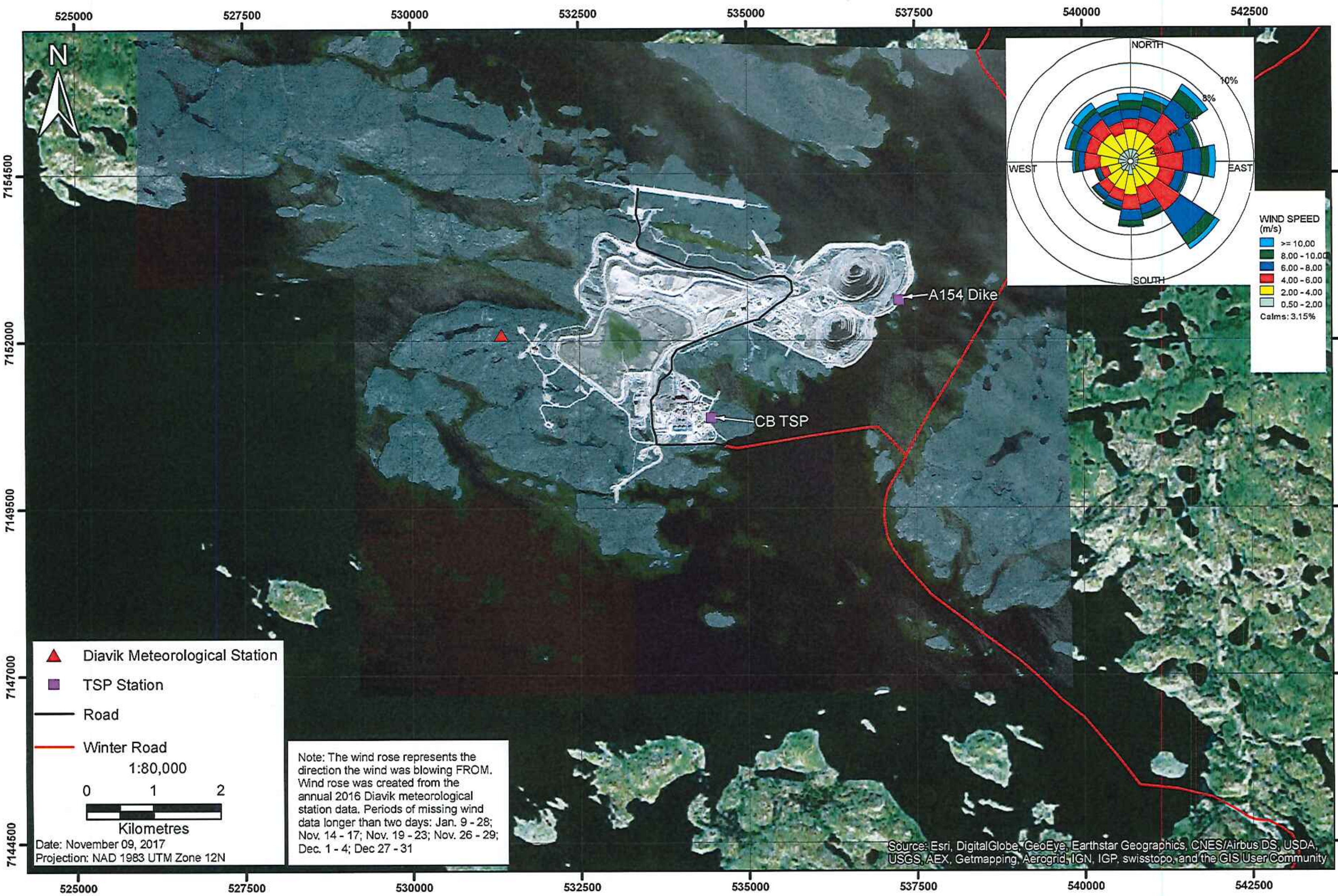
1. 24-hour average: 120 $\mu g/m^3$; and
2. Annual arithmetic mean: 60 $\mu g/m^3$.

In 2016, the GNWT undertook an engagement and consultation process with stakeholders with the goal of updating the Northwest Territories (NWT) Air Regulatory Framework. It is anticipated that amendments to the Air Regulatory Framework will be brought to the GNWT Legislative Assembly in 2018.

2.1 Review of the TSP Monitoring Program

TSP monitoring is undertaken using the Thermo SHARP 5014i monitor that uses beta attenuation monitoring technology. Ambient air is drawn through a subsonic orifice at a controlled flow rate; continuous mass measurements are conducted and hourly mass concentrations are calculated and stored in the iSeries platform data logging system. The sampling equipment is contained within a climate-controlled shelter and the monitoring of TSP concentrations is continuous with hourly concentrations recorded.

Figure 1
TSP Monitoring Locations



All monitoring data over the period of record undergo a quality assurance and quality control review to ensure that only high quality data are used for analysis. Where applicable, observations were adjusted by ERM using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2016). For example, hourly average TSP concentrations that were between 0 and -3 µg/m³ were adjusted to zero, and any values less than -3 µg/m³ were removed and marked as invalid. Daily data were considered missing or invalid if less than 75% (i.e., 18 hourly measurements) of the observations within a day were valid due to sampler malfunctions or invalid data flags (Alberta Environment and Sustainable Resource Development 2016). Values on these days were not included in the arithmetic mean calculations.

The data presented in this section include complete calendar years of data from 2014 through 2016 and the data available up to October 10, 2017. Table 2 provides the annual, maximum and minimum TSP concentration (µg/m³) for the year 2014 through 2017. Additional information on the methods, and more in depth analysis of the data collected can be found in the *2014-2015 Environmental Air Quality Monitoring Report* (ERM 2016) and the *2016 Environmental Air Quality Monitoring Report* (ERM 2017).

Table 2. 2014 to 2017 TSP Results, Diavik Diamond Mine

Year	Station	TSP Concentration (µg/m³)			No. of Daily TSP Exceedances (>120 µg/m³)	No. of Valid Days[1]/
		Annual Mean	Max. Daily Mean	Min. Daily Mean		
2014	Communications Building	14.5	82.2	1.9	0	162 (44%)
	A154 Dike	8.7	64.4	0.3	0	202 (55%)
2015	Communications Building	13.6	124	0.5	1	318 (87%)
	A154 Dike	2.3	16.3	0.1	0	293 (80%)
2016	Communications Building	10.3	150.5	0.7	1	316 (87%)
	A154 Dike[2]	-	-	-	-	0 (0%)
2017	Communications Building[3]	11.3	97.9	0.8	0	192/283 (68%)
	A154 Dike[4]	11.4	241.1	1.3	1	181/261 (69%)

[1] *Number of days with 18 or more hours of hourly data.*
[2] *The A154 Dike was off site for repairs for the majority of 2016.*
[3] *Data are from January 1 to October 10, 2017.*
[4] *Data are from January 23 to October 10, 2017.*

<u>TSP Concentrations</u>

In 2014, the annual mean TSP concentration was 14.5 µg/m³ at the CB Station and 8.7 µg/m³ at the A154 Dike Station. The annual mean TSP at both stations was lower than the annual mean TSP standard of 60 µg/m³ and there were no exceedances of the 24-hour mean TSP standard of 120 µg/m³.

In 2015 at the CB Station, the maximum daily TSP concentration of 124 µg/m³ was greater than the 24-hour mean standard (120 µg/m³) on one occasion (February 5, 2015). The overall annual mean (13.6 µg/m³) was lower than the annual mean standard (60 µg/m³).

In 2016 at the CB Station, the maximum daily TSP concentration of 150.5 µg/m³ was greater than the 24-hour mean standard (120 µg/m³) on one occasion (January 29, 2016); however, the overall annual mean for 2016 (10.3 µg/m³) was lower than the annual mean standard (60 µg/m³).

So far to date in 2017, the mean TSP concentrations of 11.3 and 11.4 µg/m³ for the monitoring period(s) for the CB and A154 Dike respectively are low compared to the annual mean standard (60 µg/m³). During the monitoring period, TSP concentrations at the CB station did not exceed the 24-hour standard. TSP at the A154 Dike location did exceed the 24-hour standard, but the exceedance may be related to heavy smoke from nearby forest fires during the period in question (August 13–19).

The readings at the CB are expected to be higher than those at the A154 Dike due the communication building's proximity to many of the diesel combustion sources (i.e., boilers and power house), the processing plant, and the run of mine (ROM) ore stockpiles (Figure 1).

Over the nearly four years of data presented in this memo, there have been a total of three 24-hour exceedances. These results are lower than the prediction from the 2012 dispersion model of two 24-hour exceedances (>120 µg/m³) per year. The annual arithmetic mean (>60 µg/m³) has never been exceeded for any year at either station. For the CB station, there is no evidence of an increasing trend over the four years of daily data assessed in this memo. Overall, the TSP monitoring program has shown that TSP levels are very low, with a few exceedances, but not more than the prediction in the 2012 dispersion modelling report.

TSP Monitoring Locations

The 2012 modelling assessment was used as a basis for deciding where to install the TSP monitors. The two TSP monitors are located very near to where the maximum 24-hour TSP concentration was predicted for both modelling scenarios (Golder 2012). Air dispersion modelling is conservative by nature so as to estimate the maximum concentrations of air contaminants. The model year is based on the year (2015) when the highest volume of material was mined so as to present a conservative estimate of mine emissions over the life of the mine. It is reasonable to assume that all other years will have maximum concentrations that are no higher than the modelled year. Therefore, as the locations where the monitors are located are very close to the modelled maximum location and the model year is the year of maximum emissions, it is safe to conclude that the current monitoring locations are capturing close to the maximum TSP concentrations outside the Mine site.

Wind roses from the Golder (2012) dispersion modelling report and included in this memo indicate that there is not one dominant wind direction and that the wind in general tends to be omnidirectional. The similarity between the model year wind rose and the wind rose presented here indicates that the location of the modelled maximum would be very close to the location of the maximum based on the 2016 wind rose.

Based on the facts presented above it does not appear to be necessary to re-evaluate the location of the TSP monitoring locations to better capture maximum concentrations outside the Mine site.

Data Completeness

Data completeness requirements vary by jurisdiction. The criterion for data completeness used in the processing of TSP data for DDMI was 90% taken from the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2016). For modelling purposes, British Columbia uses 75% (per quarter) as the cut off for data completeness, with one year of data required (BCMOE 2015). The recommended amendments to the GWNT Air Regulatory Framework would put in place an 85% data completeness criterion (GNWT 2016). Over the history of the program, low data completeness has occurred due to mechanical and operational issues. DDMI has taken corrective actions such as increased internal sampler observations, maintenance, calibration by Mine personnel, as well as bringing in outside consultants to manage and assist in maintenance and repair.

The TSP data collected in 2014 and the available data in 2017 are below all three jurisdictions' current and proposed data completeness criteria. The TSP data collected in 2015 (A154 and CB sampler) and 2016 (CB sampler) are above the data completeness criterion used by the BC MOE, indicating valid data. Over the 2014 to 2017 operational period assessed in this memo, TSP monitoring data completeness for each monitoring locations is approximately 72% for the CB sampler and 68% for the A154 sampler, which is below the GNWT (proposed) data completeness requirement. In spite of this there is substantial data indicating that overall TSP concentrations are well below annual average standards with very few exceedances of 24-hour standards.

Monitor Maintenance

Operationally, the TSP samplers require extensive amounts of maintenance and calibration, and under the extreme environment in the NWT the samplers are performing at their operational limits. The frequent high winds and extremely cold temperatures can hinder the effectiveness of the monitors. The 5014i sampler manual states that the monitor's air temperature operating range is from -30°C to 50°C. The CB sampler experienced sampling temperatures less than -30°C 12.5% of the time using the data available for this memo. The equipment is certified through the Environmental Protection Agency (EPA) and it is possible the equipment will operate satisfactorily outside of the sampled temperature range. There is no obvious correlation between periods of missing data and periods of time below the -30°C threshold; however, the accuracy of the data is not guaranteed outside the range specified in the manual. Therefore, it could be argued data completeness above 87.5% is not possible at this location solely due to ambient weather conditions. In addition to the challenges of operating the monitors, the remote location of the Mine can make off-site repair of the TSP samplers costly and take significant amounts of time, which would also affect data completeness.

3. DIAVIK'S AIR QUALITY MONITORING PROGRAM

Air quality monitoring at Diavik is conducted under the mandate of two programs: the Environmental Air Quality Monitoring Plan (EAQMP) and the Aquatic Effects Monitoring Program (AEMP).

The EAQMP includes the following:

- TSP Continuous Monitors;
- emission monitoring and reporting to the Environment and Climate Change Canada (ECCC) National Pollutant Release Inventory (NPRI); and
- greenhouse gas (GHG) monitoring and reporting to ECCC.

The AEMP includes the following:

- dustfall monitoring; and
- snow core (water chemistry) program.

The purpose of the dustfall and snow core programs is to assist in evaluating aquatic effects in Lac de Gras. The design of this program is regulated by the Wek'eezhii Land and Water Board through the AEMP. Dustfall deposition results from airborne particulate matter of all size fractions that have been deposited on the earth's surface. Dustfall deposition is used to determine the accumulation of deposited particulate matter in aquatic systems and on localized vegetation which can be a health concern for wildlife. Both the lichen and permanent vegetation monitoring plots are co-located with the dustfall monitors. The lichen and vegetation monitoring programs are completed every three years as part of the Diavik Wildlife Monitoring Program.

In terms of air monitoring, the AEMP is concerned only with deposited material that can potentially affect aquatic life. TSP refers to particles that are suspended in air at the time of sampling and thus TSP monitoring is not relevant to the AEMP. TSP concentrations do not correlate well with dustfall deposition rates as the two quantities depend on different factors of dispersion and settlement. Therefore, TSP cannot be used as a surrogate for dustfall deposition, nor as a good indicator of health effects on aquatic or terrestrial wildlife.

Measured TSP concentrations also include the fractions of particulate matter (PM) contained in PM_{10} (PM less than or equal to 10 µm in diameter) and $PM_{2.5}$ (PM less than or equal to 2.5 µm in diameter). PM_{10} and particularly $PM_{2.5}$ concentrations are much better indicators of the potential effects on human health than TSP. Therefore, if monitoring for the purposes of evaluating impacts on human health were required, TSP would not be the most suitable indicator. Furthermore, as there are no human receptor locations outside of the Mine fence line, there is no need to conduct monitoring that relates to human health. Therefore, TSP monitoring is not needed to help assess health impacts on humans or wildlife. Air quality monitoring of the work area is regulated by the Workers Safety and Compensation Commission (WSCC) through the GNWT *Mine Safety Act*.

4. CONCLUSIONS AND RECOMMENDATIONS

It is the opinion of the authors of this memo that TSP monitoring can be discontinued at Diavik Mine for these reasons:

- Over the nearly four years of data presented in this report, there have been a total of three 24-hour exceedances of the GNWT standard for TSP. These results are below what was predicted from the 2012 dispersion model which predicted two 24-hour exceedances (>120 µg/m³) per year. The annual average TSP concentrations are far below the GNWT annual arithmetic mean standard (>60 µg/m³) at both stations for all years of measurement. The TSP data collected in 2015 (A154 and CB sampler) and 2016 (CB sampler) are above the data completeness criteria used by the BC MOE, indicating that data completeness targets for these years would have been met if British Columbia criteria were applied instead of Alberta standards.
- The arctic environment presents challenges to the operational performance of the TSP samplers. Temperatures below the manufacturers recommended operating temperatures have been recorded approximately 12.5% of the time for the data presented in this report.
- The AEMP uses dustfall monitoring and snow core monitoring of airborne particulate matter that has settled onto the earth's surface to aid in determining the effect of accumulation of particulates in aquatic systems and on localized vegetation. This deposition can be a health concern for wildlife. TSP, however, refers to particles that are suspended in air at the time of sampling; therefore, TSP monitoring is not useful to the AEMP and the determination of wildlife health effects.
- TSP monitoring is not a good indicator for human health impacts. In addition, there are no human health receptors outside of the fence line of Diavik Mine.
- Using the 2012 Air Dispersion Modelling Assessment, the locations of the two TSP monitors are very close to where the maximum TSP concentration was predicted and have captured representative data during their respective periods of operation.

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