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Charlie Catholique, Vice-Chair
Environmental Monitoring Advisory Board
PO Box 2577
Yellowknife, NT X1A 2P9
Canada

10 July 2019

Dear Mr. Catholique:

Subject: 2018 Environmental Air Quality Monitoring Report

Please find enclosed the Diavik Diamond Mines (2012) Inc. (DDMI) Environmental Air Quality Monitoring Report for 2018. This report summarizes air quality observations from the following programs conducted at DDMI throughout 2018:

- Total Suspended Particulate (TSP) Continuous Monitors;
- Dustfall Monitoring as part of the Aquatic Effects Monitoring Program (AEMP);
- Snow Core Program as part of the AEMP;
- 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.

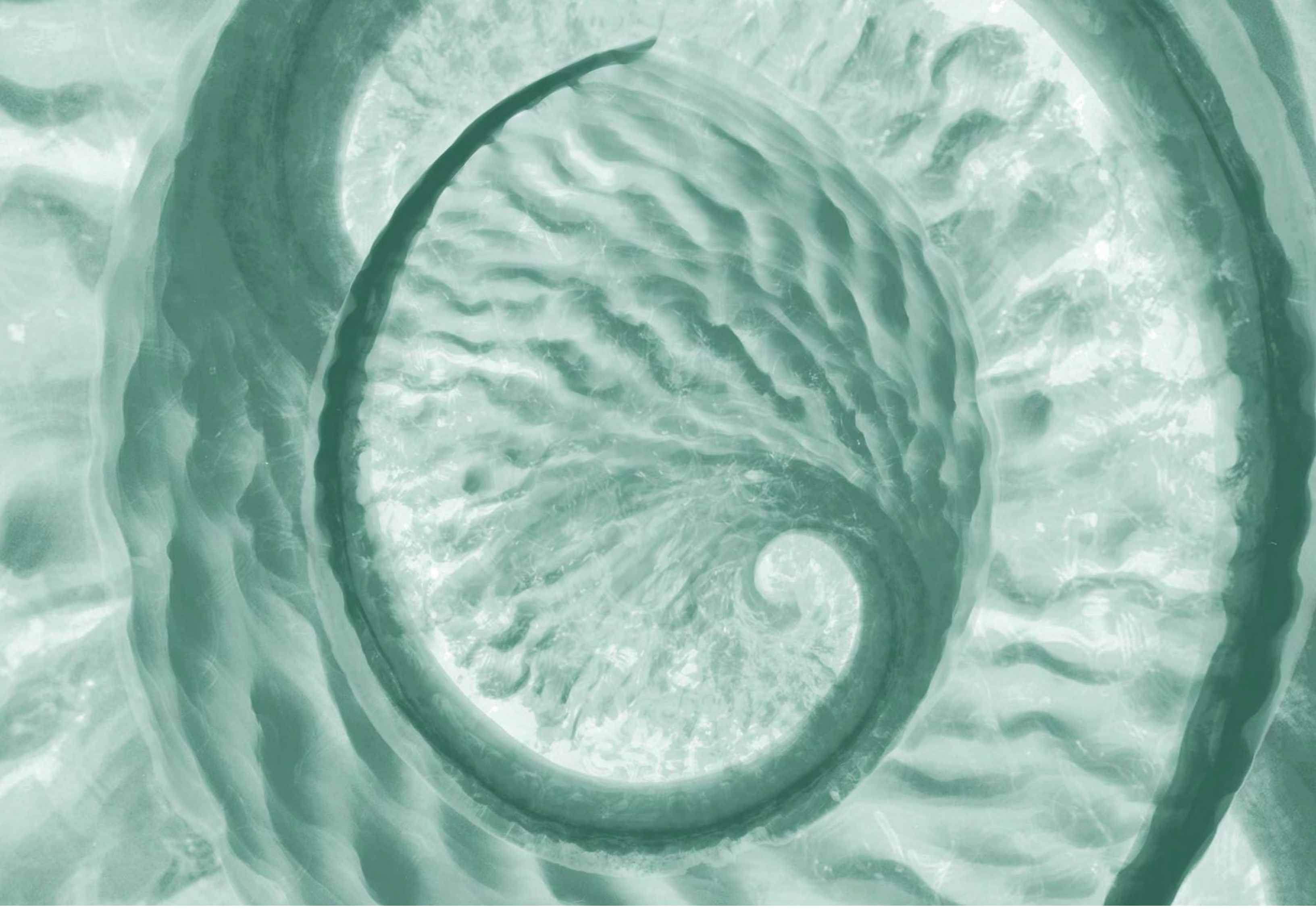
Please do not hesitate to contact the undersigned if you have any questions related to our response.

Yours sincerely,

Sean Sinclair
Superintendent, Environment

cc: John McCullum, EMAB
Aileen Stevens, GNWT

Attachment 1: DDMI 2018 Environmental Air Quality Monitoring Report



Diavik Diamond Mine

2018 Environmental Air Quality Monitoring Report

July 2019

Project No.: 0207514-0019

The business of sustainability

July 2019

Diavik Diamond Mine

2018 Environmental Air Quality Monitoring Report

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EXECUTIVE SUMMARY

Diavik Diamond Mines (2012) Inc. has been collecting and reporting air quality related data since initial site construction in 2001. In June of 2013, Diavik Diamond Mines submitted an Environmental Air Quality Monitoring Plan (EAQMP) to the Environmental Monitoring Advisory Board. The components of the EAQMP include total suspended particulate (TSP) monitoring, dust deposition (dustfall) monitoring (as part of the Aquatic Effects Monitoring Program (AEMP)), a snow core program (as part of the AEMP), reporting to the National Pollutant Release Inventory (NPRI), and reporting to the national greenhouse gas reporting program (GHGRP). This report presents an updated Environmental Air Quality Monitoring Report for the Diavik Diamond Mine for the calendar year 2018.

In 2018, TSP was measured at the Communications Building (CB) station. The TSP monitoring at A154 Dike station was suspended in 2018 due to issues with the equipment. There was no exceedance of the Government of the Northwest Territories (GNWT) 24-hour average TSP guideline (120 μg/m^3) at the CB station. The maximum daily mean value was 23.2 μg/m^3, and the minimum value was 0.3 μg/m^3. The 2018 annual mean TSP concentration at the CB station was 3.6 μg/m^3 and was well below the annual GNWT standard (60 μg/m^3). TSP monitoring at the CB station achieved a data completeness of 86% in 2018 (314 valid daily data out of 365).

In 2018, dustfall was monitored at 14 dustfall gauges and 27 snow survey stations located at varying distances around the mine. Snow water chemistry was measured at 19 of the snow survey stations and compared to effluent quality criteria (EQC) set out in the Wek'èezhìi Land and Water Board (WLWB) Water Licence W2015L2-0001.

Annual dustfall estimated from each of the 14 dustfall gauges ranged from 78 to 796 mg/dm^2/y in 2018. The annual dustfall rates estimated from dustfall gauges were less than the former BC objective for the mining industry (621 to 1,059 mg/dm^2/y) for all stations except for Dust 3 (796 mg/dm^2/y; 25 m from the Mine), Dust 7 (667 mg/dm^2/y; 1,147 m from the Mine but very close to the winter road), Dust 10 (645 mg/dm^2/y; 46 m from the Mine adjacent to the A21 open pit), and Dust 1 (642 mg/dm^2/y; 70 m from the Mine). Annual dustfall rates estimated from the 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y. Annual dustfall rates measured at 4 out of 27 stations during the 2018 snow survey were higher than the former BC objective for the mining industry. These stations include SS1-1 (4,603 mg/dm^2/y; 30 m from the Mine), SS5-3 (1,349 mg/dm^2/y; 270 m from the Mine), SS5-2 (1,007 mg/dm^2/y; 65 m from the Mine), and SS5-1 (751.5 mg/dm^2/y; 31 m from the Mine). This former BC objective was used for comparison purposes only; there are currently no dustfall standards or objectives for the Northwest Territories. The higher overall dustfall rates in 2018 in comparison to the past few years were likely influenced by the surface activity at the mine, particularly at the A21 open pit, which began in December 2017.

Snow water chemistry analysis of interest included those variables with effluent quality criteria (EQC; i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc). All 2018 sample concentrations were less than their associated reference levels as specified by the "maximum concentration of any grab sample" in Water Licence W2015L2-0001.

The Mine reported criteria air contaminant (CAC) emissions as part of the annual NPRI submission and emissions were estimated using published emission factors. Compared to 2017, 2018 emissions of carbon monoxide (CO) and volatile organic compounds (VOC) increased by about 25%. Sulphur dioxide (SO_2) emissions in 2018 increased by 525%(110.6 tonnes) relative to 2017 (17.7 tonnes). The increase in SO_2 emissions was due to increased fuel usage and blasting at A21 open pit. NO_x emissions were relatively consistent between 2017 and 2018. There was an increase of about 35% to 45% of total particulate matter (TPM), particulate matter ≤ 10 μm in diameter (PM_{10}) and particulate matter ≤ 2.5 μm in diameter ($PM_{2.5}$) emissions in 2018 compared to 2017 due to increased road traffic, rock re-mine, diesel usage, incineration and waste-oil combustion.

The Mine reported greenhouse gas (GHG) emissions as part of the annual national Greenhouse Gas Emissions Reporting Program (GHGRP) submission, and carbon dioxide equivalent (CO_2e) emissions were estimated using published emission factors and 100-year global warming potential (GWP) ratios. Starting for 2017 reporting, the GHGRP was changed to require all facilities to report that emit the equivalent of 10,000 tonnes of CO_2e (tCO_2e) or more per year, compared to the previous 50,000 tCO_2e per year threshold.

Mine GHG emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) totaled 209,436 tCO_2e in 2018, a 7.4% increase from 2017 due to increased diesel usage for power generation and transportation. GHG emissions at the Mine in 2018 were primarily from stationary equipment fuel combustion (73%) and mobile equipment fuel combustion (27%). In 2018, the Mine's 9.2 megawatt wind farm helped to reduce the Mine's GHG footprint by generating 18.0 gigawatt-hours of electricity which saved 4.5 million litres of diesel fuel and thereby prevented the direct release of 12,100 tCO_2e.

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ACRONYMS AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP	Aquatic Effects Monitoring Program
BC	British Columbia
BC ENV	British Columbia Ministry of Environment and Climate Change
CAC	Criteria air contaminants
CB	Communications Building
CEPA	*Canadian Environmental Protection Act*
CH_4	Methane
cm	Centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
d	Day
DDMI	Diavik Diamond Mines (2012) Inc.
dm^2	Square decimetre
Dustfall	Dust deposition
EA	Environmental Agreement
EAQMP	Environmental Air Quality Monitoring Plan
ECCC	Environment and Climate Change Canada
EMAB	Environmental Monitoring Advisory Board
EMS	Environmental Management System
ENR	Department of Environment and Natural Resources
EQC	Effluent quality criteria
ERM	ERM Consultants Canada Ltd.
GHG	Greenhouse gas
GHGRP	Greenhouse Gas Emissions Reporting Program
GNWT	Government of the Northwest Territories

GWP	Global warming potentials
L	Litre
m	Metre
Maxxam	Maxxam Analytics
mg	Milligram
N_2O	Nitrous oxide
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPRI	National Pollutant Release Inventory
O_3	Ozone
PM_{10}	Particulate matter ≤ 10 μm in diameter
$PM_{2.5}$	Particulate matter ≤ 2.5 μm in diameter
QA/QC	Quality assurance and quality control
SO_2	Sulphur dioxide
SOP	Standard operating procedure
SO_x	Oxides of sulphur
tCO_2e	Tonnes of carbon dioxide equivalent
the Mine	Diavik Diamond Mine
TPM	Total particulate matter (the same as TSP)
TSP	Total suspended particulate (the same as TPM)
VOCs	Volatile organic compounds
WLWB	Wek’èezhìi Land and Water Board
μg	Microgram
y	Year

1. INTRODUCTION

Diavik Diamond Mines (2012) Inc. (DDMI) has been collecting and reporting air quality related data since initial site construction in 2001. In June of 2013, DDMI submitted an Environmental Air Quality Monitoring Plan (EAQMP) to the Environmental Monitoring Advisory Board (EMAB). The EAQMP was developed to address Article 7.2 (a) of the Environmental Agreement (EA; DDMI 2000). The EAQMP and its results are not part of a Regulatory Instrument but are subject to review by EMAB and the Parties identified under EA Article 7.5.

The purpose of this report is to provide a summary of the 2018 air quality monitoring and emissions data in relation to the Diavik Diamond Mine's (hereafter referred to as the Mine) operational activities. This *2018 Environmental Air Quality Monitoring Report* summarizes air quality observations from the following programs conducted at the Mine:

- Total Suspended Particulate (TSP) Continuous Monitors;
- Dustfall Monitoring as part of the Aquatic Effects Monitoring Program (AEMP);
- Snow Core Program as part of the AEMP;
- 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.

In 2018, the primary sources of fugitive dust were associated with unpaved road and airstrip usage, and construction and mining activities at A21. Major waste rock material transfers in 2018 included the use of haul roads to move waste rock (7,623,715 tonnes) and kimberlite ore to the crusher (2,529,725 tonnes). Another source of fugitive dust is truck traffic along the ice road to the Mine. To suppress dust generation, roads, parking areas and laydown areas were watered during the summer as needed. The Underground Mine production in 2018 continued at A154 and A418, as well as stripping and production at the A21 open pit. Fugitive dust generation is expected to be greatest during snow-free periods where and when there is site activity. It was expected that the highest fugitive dust generation and resulting dustfall occurred in areas closest to the roads, the airstrip, and mine footprint such as near A21 between May and September.

The 2018 predominant wind directions at the site were from southeast and northwest; although, winds in general can be described as omnidirectional. Therefore, the expectation is that airborne material will be deposited in all directions around the mine with a northwest and a southeast emphasis.

As part of a review of the 2017 Environmental Air Quality Monitoring Report, Arcadis submitted 19 comments and recommendations to DDMI, and responses to those comments and recommendations are included in Appendix A.

2. CONTINUOUS TOTAL SUSPENDED PARTICULATE MONITORING

2.1 Background

Total suspended particulate (TSP) consists of small airborne particles such as dust, smoke, ash and pollen with aerodynamic diameters of typically less than 100 microns (μm). TSP is a concern for human health and welfare, as well as for animals and plants, due to effects on breathing and respiratory systems, damage to lung tissue, cancer and premature death. TSP that settles out of the air onto surfaces is called dust deposition or dustfall. Ambient TSP monitoring in strategic locations can provide monitoring information to assist in understanding, tracking and responding to potential dust deposition concerns.

In 2012 an updated air dispersion modelling assessment was undertaken for the entire the Mine (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 (GNWT 2014) 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 offsite (4.1 mg/dm^2/y) and are generally greater than predicted in the earlier model. For example, 100 mg/dm^2/y was originally predicted adjacent to A154 pit (Cirrus Consultants 1998).

Two TSP monitors were installed at the Mine 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 (Figure 2.1-1; DDMI 2013).

2.2 Methods

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 to minimize data loss during extreme weather conditions, as recommended by the manufacturer.

The monitoring of TSP concentrations is continuous with hourly concentrations recorded over the course of 2018.

2.2.1 Monitoring Locations

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 (Figure 2.1-1). The location of the A154 Dike monitor and the site near the CB were selected based on the proximity to the boundary of the Mine footprint, the results of the updated air dispersion modelling assessment, and power requirements. The locations of the DDMI TSP stations are presented in Table 2.2-1 and Figure 2.1-1. In 2018, the A154 Dike station was not operational due to issues with flow and ambient relative humidity (RH) of the TSP sampler.

2.2.2 Monitor Maintenance

The DDMI TSP Monitoring Standard Operating Procedure (SOP) ENVI-801-0613 R4 (DDMI 2016) was in place and includes information about monthly, quarterly and annual servicing requirements for the samplers. The 2018 sampler maintenance and calibration records provided by DDMI are included in Appendix B.

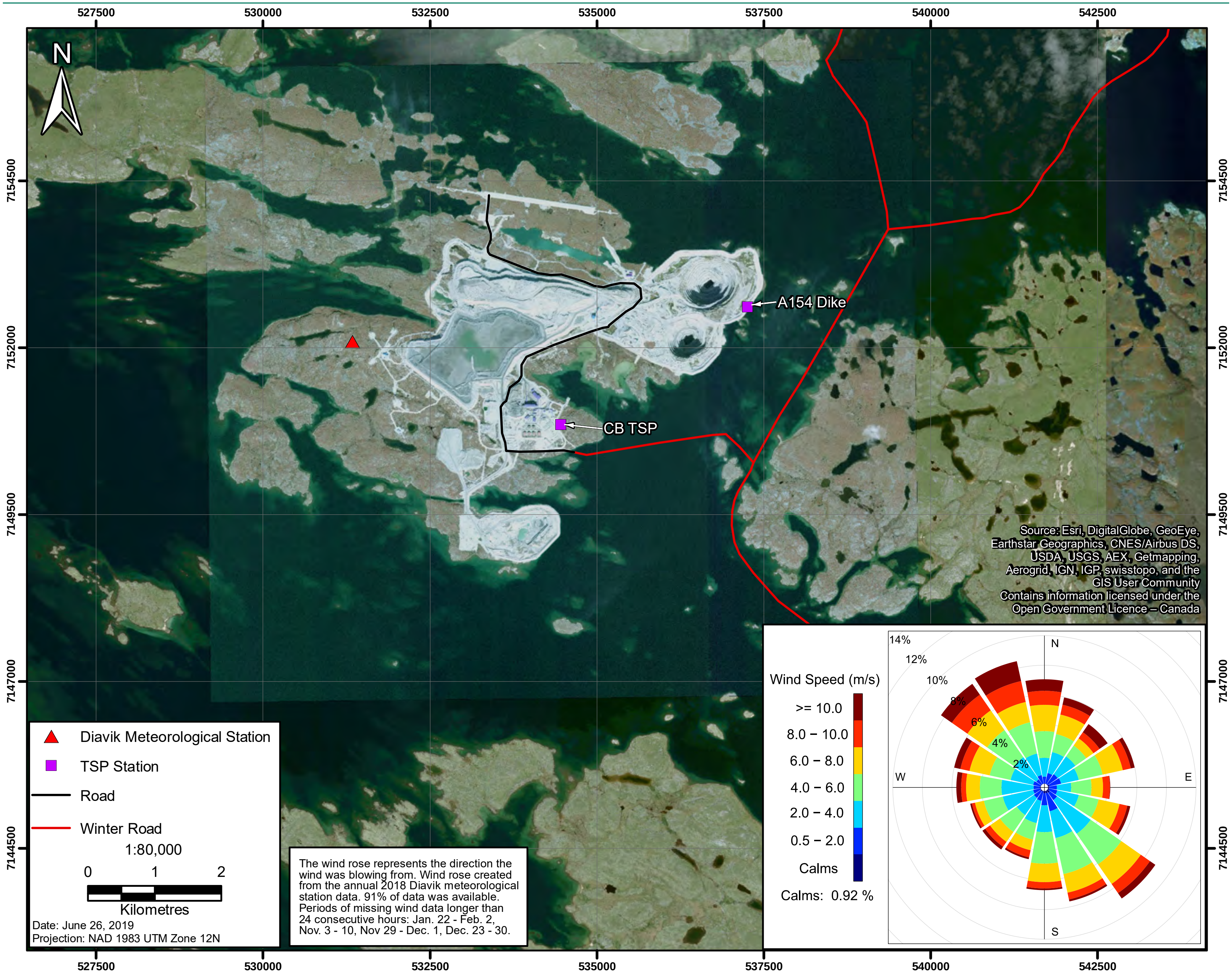

Figure 2.1-1: TSP Monitoring Locations, 2018

Table 2.2-1: DDMI TSP Stations UTM Coordinates[1]

Station	Zone	Metres East	Metres North
CB	12W	534,460	7,150,847
A154 Dike[2]	12W	537,258	7,152,609

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

[2]*Station was not operational in 2018 due to issues with the sampler.*

2.2.3 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) procedures applied to TSP monitoring included the following:

- adherence to the revised DDMI TSP Monitoring SOP ENVI-801-0613 R4 (DDMI 2016);
- incorporation of the DDMI TSP into the DDMI Environmental Management System; and
- review of monitoring data and retention of calibration and maintenance records.

Where applicable, observations were adjusted by ERM using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data* (Alberta Environment and Parks 2016). This included:

- Hourly TSP concentrations between 0 and -3 μg/m^3 were set to 0 μg/m^3. This occurred 21% of the time in 2018 for the CB station.
- Hourly TSP concentrations below -3 μg/m^3 were flagged as invalid and removed from the dataset calculations. This occurred 11% of the time in 2018 for the CB station.
- For calculating valid daily TSP averages, if more than 25% (6 hours) of the hourly data in a day were invalid then the daily TSP average would also be flagged as invalid. This occurred 14% of the time in 2018 for the CB station.

Descriptions for periods of missing or invalid data are included in Appendix C.

2.2.4 Analysis

Annual 24-hour TSP concentration plots were generated for the CB station and the average annual TSP concentration was calculated from the valid hourly data. The 24-hour data were examined for trends and compared with predicted concentrations.

Periods of seasonal or event-driven elevated concentrations were compared with known site activities and natural smoke events (e.g., forest fires) to assist with identification of dominant sources or seasonal factors. The results of this analysis are presented in this report and will be used to update and modify the dust management SOPs incorporated in the Environmental Management System (EMS) if necessary.

2.3 Results

TSP results were compared to the GNWT Department of Environment and Natural Resources (ENR) *Guideline for Ambient Air Quality Standards* in the Northwest Territories (GNWT 2014). ENR uses two guideline values for TSP:

- 24-hour average: 120 μg/m^3; and
- annual arithmetic mean: 60 μg/m^3.

Figure 2.3-1 shows the 2018 24-hour average TSP concentrations for the CB monitoring station compared to the 24-hour GNWT guideline. Table 2.3-1 summarizes the TSP results. Appendix C contains tabulated 24-hour average TSP concentrations along with descriptions for periods of missing or invalid data.

Table 2.3-1: 2018 TSP Results, Diavik Diamond Mine

Station	2018 TSP Concentration (µg/m³)			No. of Daily TSP Exceedances (>120 µg/m³)	No. of Days with Valid Data Used[1]
	Annual Mean	Max. Daily Mean	Min. Daily Mean		
CB	3.6	23.2	0.3	0	314

[1] Number of days with at least 75% (18 hours) of valid hourly data availability, out of 365 days.

In 2018, the annual mean TSP concentration measured at the CB station was 3.6 µg/m^3 and was well below the annual mean standard of 60 µg/m^3. There was no exceedance of the 24-hour average TSP standard (120 µg/m^3) at the CB station. The maximum daily mean value was 23.2 µg/m^3, and the minimum value was 0.3 µg/m^3.

TSP monitoring at the CB station achieved a data completeness of 86% in 2018 (314 valid daily data out of 365). The invalid data has been due to equipment malfunctions, missing data or operator error. Data were also considered missing if less than 75% (i.e., 18 hourly measurements) of the observations within a day were valid due to sampler malfunctions or invalid data flag (Alberta Environment and Parks 2016). Values on these days were not included in the calculations of arithmetic mean.

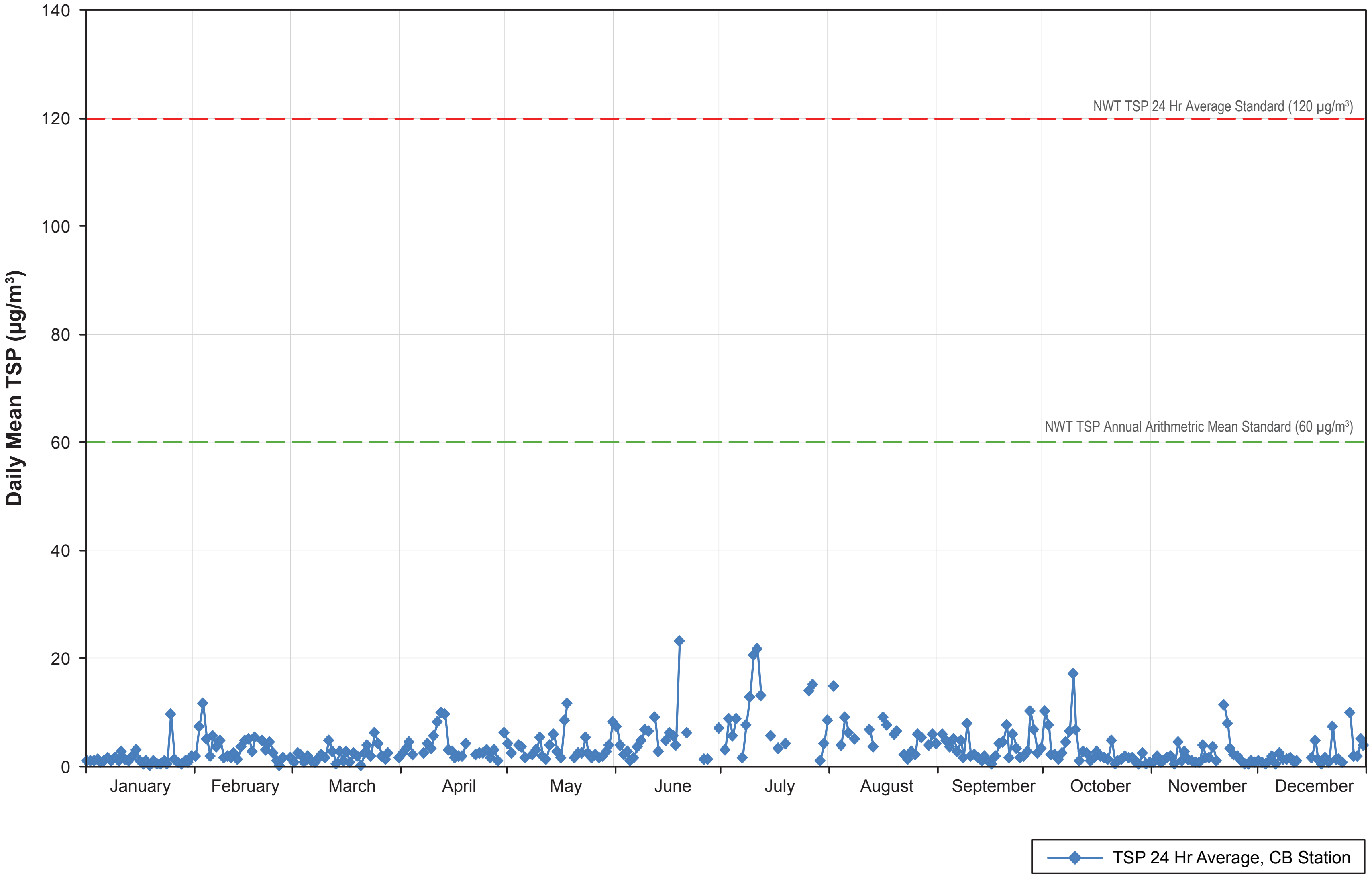

Figure 2.3-1: 2018 Daily Mean TSP, CB Station

3. DUSTFALL MONITORING

Community interest in the possible effects of dust deposition (dustfall) on wildlife and aquatic environments are the basis of the focus of DDMI's EAQMP on TSP and dustfall. Dustfall is the deposition of airborne particulate matter on vegetation, snow and water, and it is monitored using dustfall collection gauges and snow cores.

In accordance with the EA and the requirement associated with the Aquatic Effects Monitoring Program (AEMP), a dust monitoring program was initiated in 2001 and has gone through various changes since then. The program was designed to achieve the following objectives:

- determine dustfall rates at various distance from the Mine footprint; and
- determine the chemical characteristics of dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result on mining activities, in support of the AEMP.

In 2018, the dustfall program incorporated three monitoring components, with sampling conducted at varying distance from the Mine infrastructure (13 to 4,646 m):

- dustfall gauges (12 monitoring and 2 control stations);
- dustfall from snow surveys (24 monitoring and 3 control stations); and
- snow water chemistry from snow surveys (16 monitoring and 3 control stations).

Additional information, data and figures can be found in the full *Diavik Diamond Mine: 2018 Dust Deposition Report* (Appendix D; ERM 2019).

3.1 Dustfall Gauges

Dustfall gauges were placed at 14 stations (including two control stations) around the Mine at distances ranging from approximately 13 to 4,646 m from mining operations (Table 3.1-1 and Figure 3.1-1). Each gauge collected dustfall year-round, with samples collected approximately every three months. The average total sampling period for the 14 locations was 360 days.

Dustfall gauge stations consisted of a hollow brass cylinder (52 centimeter (cm) length, 12.5 cm inner diameter) housed in a Nipher snow gauge (Photo 3.1-1). The cylinder collected dustfall, while the Nipher snow gauge reduced air turbulence around the gauge to increase dustfall gauge efficiency. At the end of each sampling period, the retrieved content of the cylinder was processed in the DDMI environment laboratory to determine the mass collected dustfall. This processing involved filtration, drying and weighing of samples as specified in the standard operating procedures (SOPs) ENVR-508-0112 and ENVI-303-0112 (see Appendices E and G of the *Diavik Diamond Mine: 2018 Dust Deposition Report*). The cylinder was then exchanged with a clean and empty cylinder.

Once the mass of collected dustfall at a station was measured, the mean daily dustfall rate over the collection period was calculated as:

$$D = \frac{M}{A*T} \quad \text{[Equation 1]}$$

where:

D = mean daily dustfall rate ($mg/dm^2/d$) during time period T
M = mass of dustfall collected (mg) during time period T
A = surface area of dustfall gauge collection cylinder orifice (dm^2; approximately 1.227 dm^2)
T = number of days of dustfall collection (d)

Table 3.1-1: Dustfall and Snow Water Chemistry Sampling Locations, Diavik Diamond Mine, 2018

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled
			Easting (m)	Northing (m)			
Dustfall Gauges							
Dust 1	Dec 24, (2017; start), Apr 6, Jun 26, Oct 12, Dec 28	369	533964	7154321	70	Land	n/a
Dust 2A	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 3 (2019)	362	535678	7151339	425	Land	n/a
Dust 3	Jan 10 (start), Apr 8, Jun 26, Oct 12, Dec 28	352	535024	7151872	25	Land	n/a
Dust 4	Jan 10 (start), Apr 5, Jun 27, Oct 13, Dec 28	352	531397	7152127	173	Land	n/a
Dust 5	Jan 6 (start), Apr 6, Jun 25, Oct 10, Jan 2 (2019)	361	535696	7155138	1,183	Land	n/a
Dust 6	Dec 24 (2017; start), Apr 12, Jun 26, Oct 12, Dec 28	369	537502	7152934	13	Land	n/a
Dust 7	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 3 (2019)	362	536819	7150510	1,147	Land	n/a
Dust 8	Jan 6 (start), Apr 5, Jun 25, Oct 10, Jan 2 (2019)	361	531401	7154146	1,213	Land	n/a
Dust 9	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 4 (2019)	363	541204	7152154	3,796	Land	n/a
Dust 10	Jan 16 (start), Apr 7, Jun 26, Oct 12, Dec 28	346	532908	7148924	46	Land	n/a
Dust 11	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 3 (2019)	362	531493	7150156	747	Land	n/a
Dust 12	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 3 (2019)	362	529323	7151191	2,326	Land	n/a

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled
			Easting (m)	Northing (m)			
Dust C1	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 4 (2019)	363	534979	7144270	4,646	Land	n/a
Dust C2	Jan 6 (start), Apr 5, Jun 25, Oct 10, Jan 3 (2019)	362	528714	7153276	3,036	Land	n/a
Snow Surveys							
SS1-1	Apr 6	186	533912	7154298	30	Land	
SS1-2-4[2]	Apr 6	186	533909	7154382	115	Land	
SS1-2-5[2]	Apr 6	186	533909	7154382	115	Land	
SS1-3	Apr 6	186	533975	7154514	263	Land	
SS1-4	Apr 6	186	534489	7155083	899	Ice	✓
SS1-5	Apr 6	155	535096	7156290	2,177	Ice	✓
SS2-1-4[2]	Apr 4	153	537550	7153476	145	Ice	✓
SS2-1-5[2]	Apr 4	153	537550	7153476	145	Ice	✓
SS2-2	Apr 4	153	537835	7153489	427	Ice	✓
SS2-3	Apr 6	155	538492	7153940	1,194	Ice	✓
SS2-4	Apr 6	155	539169	7154694	2,164	Ice	✓
SS3-4	Apr 8	157	536585	7151002	613	Ice	✓
SS3-5	Apr 8	157	537676	7150832	1,325	Ice	✓
SS3-6	Apr 8	157	536308	7151578	35	Ice	✓
SS3-7	Apr 8	157	536343	7151359	244	Ice	✓
SS3-8	Apr 8	157	536696	7150809	826	Ice	✓

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled
			Easting (m)	Northing (m)			
SS4-1	Apr 5	185	531497	7152209	61	Land	
SS4-2	Apr 5	185	531361	7152258	203	Land	
SS4-3	Apr 5	185	531328	7152476	346	Land	
SS4-4	Apr 5	185	531147	7153165	1,030	Ice	✓
SS4-5	Apr 5	154	531405	7154124	1,214	Ice	✓
SS5-1-4[2]	Apr 7	156	533143	7148934	31	Land	
SS5-1-5[2]	Apr 7	156	533143	7148934	31	Land	
SS5-2	Apr 7	187	533141	7148899	65	Land	
SS5-3	Apr 7	187	533155	7148687	270	Ice	✓
SS5-4	Apr 7	187	533138	7147947	941	Ice	✓
SS5-5	Apr 7	187	533141	7146959	1,894	Ice	✓
Control 1	Apr 8	157	534941	7144103	4,802	Land	✓[3]
Control 2	Apr 5	154	528714	7153307	3,047	Land	✓[3]
Control 3	Apr 7	156	538636	7148753	3,550	Land	✓[3]

Notes:
[1] UTM Zone 12W, NAD83
[2] Duplicate sample taken for snow water chemistry.
[3] Snow water chemistry sampled over ice, adjacent to the on-land control station; see Section 2.3 for further details.
n/a = not applicable

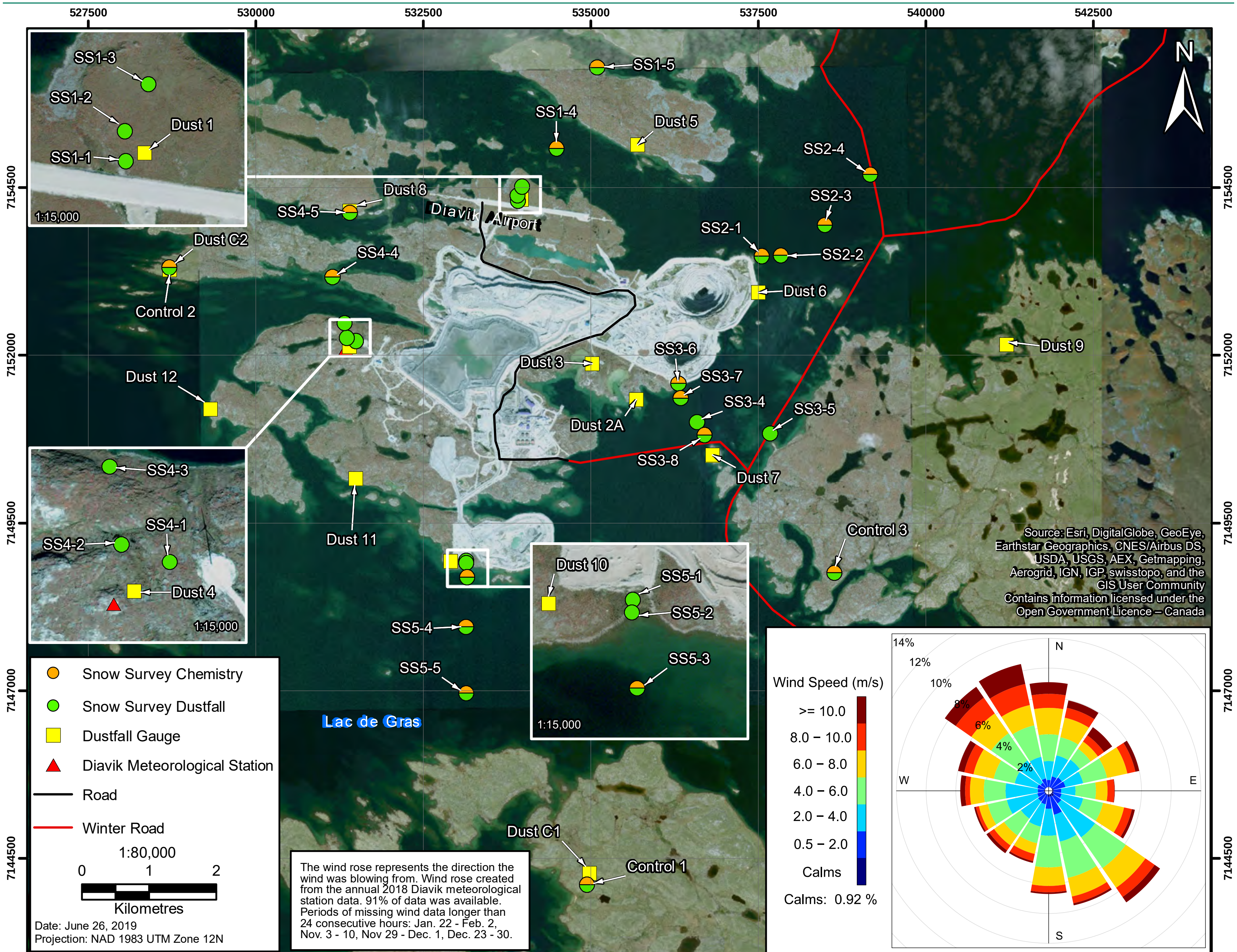

Figure 3.1-1: Dustfall Gauge and Snow Survey Locations, Diavik Diamond Mine, 2018

Photo 3.1-1: Dustfall gauge during sample collection. The dustfall gauge consisted of a hollow brass cylinder (centre) housed inside a Nipher snow gauge (right).

The mean daily dustfall rate (mg/dm^2/d) was then multiplied by 365 days to estimate the mean annual dustfall rate (mg/dm^2/y).

Estimated dustfall rates were compared to the former British Columbia Ministry of Environment and Climate Change (BC ENV) dustfall objectives for mining, smelting and related industries (Table 3.1-2; DDMI 2016). The dustfall objective is no longer used in BC; however, for the purposes of this report, dustfall was compared to the former objective to be consistent with prior dust deposition reports. The dustfall objectives ranged from 1.7 to 2.9 milligram per square decimetre per day (mg/dm^2/d), averaged over 30 days. The 1.7 mg/dm^2/d objective was applied to sensitive locations such as residential areas whereas the 2.9 mg/dm^2/d objective was applied to areas where higher dustfall rates would be expected, such as industrial and mining locations. Both values are presented throughout this report.

Table 3.1-2: Dustfall and Snow Water Chemistry Reference Values

Parameter	Value	Unit	Comment	Source
Dustfall Rate	1.7 - 2.9 (621 - 1,059)	mg/dm^2/d (mg/dm^2/y)	Former objective for the mining, smelting, and related industries	DDMI 2016
Aluminum-Total	3,000	µg/L	Max. grab sample concentration	W2015L2-0001
Ammonia-N	12,000	µg/L	Max. grab sample concentration	W2015L2-0001
Arsenic-Total	100	µg/L	Max. grab sample concentration	W2015L2-0001
Cadmium-Total	3	µg/L	Max. grab sample concentration	W2015L2-0001
Chromium-Total	40	µg/L	Max. grab sample concentration	W2015L2-0001
Copper-Total	40	µg/L	Max. grab sample concentration	W2015L2-0001
Lead-Total	20	µg/L	Max. grab sample concentration	W2015L2-0001
Nickel-Total	100	µg/L	Max. grab sample concentration	W2015L2-0001
Nitrite-N	2,000	µg/L	Max. grab sample concentration	W2015L2-0001
Zinc-Total	20	µg/L	Max. grab sample concentration	W2015L2-0001

3.2 Dustfall Snow Surveys

Dustfall snow surveys were performed at 27 stations (including three control stations), along five transects around the Mine (Table 3.1-1 and Figure 3.1-1). Across stations, the distance from mining operations ranged from approximately 30 to 4,802 m and the average total sampling period in 2018 was 168 days. The start dates correspond to the first snowfall for land stations (October 2, 2017), and shortly after ice freeze up for ice stations (November 2, 2017).

At each snow survey station, a snow corer was used to drill into the snow pack to retrieve a cylindrical snow core (6.1 cm inner diameter; Photo 3.2-1). Cores were extracted at each station and composited in the field to ensure a representative snow sample was obtained for the station. A minimum of three snow cores were collected at each (land and ice) of the snow sampling stations, as outlined in the Snow Core Survey SOP (ENVR-512-0213; see Appendix F of the *Diavik Diamond Mine: 2018 Dust Deposition Report*). Composited samples were bagged and brought to the DDMI environment lab for processing as specified in the Snow Core Survey SOP ENVI-909-0119and the Quality Assurance/Quality Control SOP ENVI-902-0119. Processing of snow cores involved filtration, drying in a high heat oven and weighing. For quality assurance and control, duplicate samples were collected at the stations indicated in Table 3.1-1.

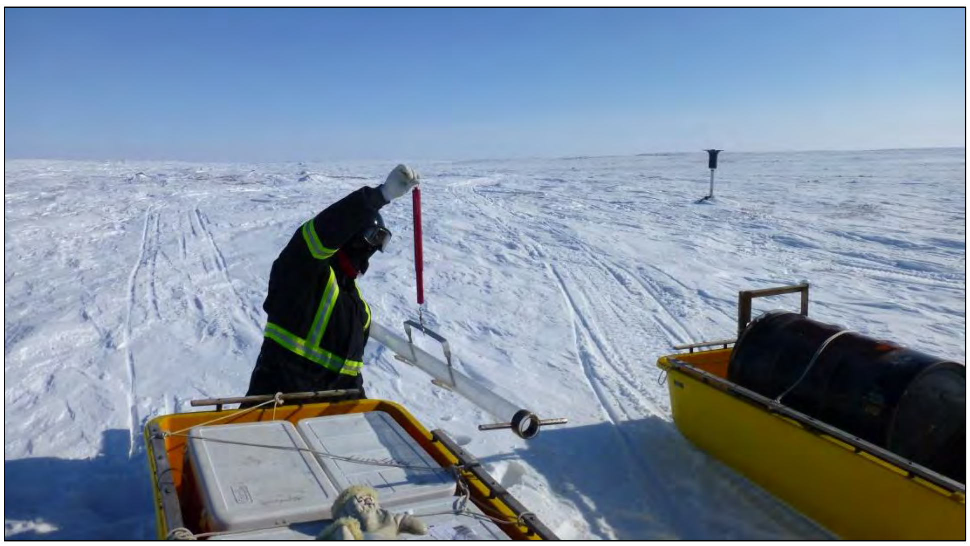

Photo 3.2-1: Snow core sample being weighed, with dustfall gauge in background.

Mean daily dustfall rate (mg/dm^2/d) was then calculated over the collection period using Equation 1, with surface area (A) equal to the surface area of the snow corer tube orifice (0.2922 dm^2) multiplied by the number of snow cores used for the composited sample at the station. The mean annual dustfall rate (mg/dm^2/y) was estimated by multiplying the mean daily dustfall rate by 365 days.

Dustfall rates were compared to the former BC dustfall objective for mining, smelting and related industries (Table 3.1-2) for comparison purposes only.

3.3 Snow Water Chemistry

Snow water chemistry analysis was performed on snow cores extracted from 19 locations (including three control locations; Table 3.1-1 and Figure 3.1-1). These locations included the 16 dustfall snow survey stations that were located on ice, as well as samples taken on ice adjacent to the three control stations. Across stations, the distance from mining operations ranged from approximately 35 m to 4,802 m and the average total sampling period in 2018 was 164 days. At each station located over water, cores were collected for chemistry analysis immediately after the dustfall snow cores were extracted.

Snow water chemistry cores were extracted using a snow corer in accordance with the dustfall snow survey core extraction. A minimum of three cores at each site were extracted and composited to obtain the necessary 3 litres (L) of snow water required for the laboratory chemical analysis. Snow cores were then processed and prepared for shipment to Maxxam Analytics (Maxxam) where the chemical analysis was performed. For quality assurance and control purposes, duplicate samples were collected at the stations indicated in Table 3.1-1.

Effluent Quality Criteria (EQC), including “maximum average concentration” and “maximum concentration of any grab sample,” are stipulated in DDMI’s Water Licence (W2015L2-0001) for aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc (Table 3.1-2). Snow water chemistry results for these variables were compared to the “maximum concentration of any grab sample.” These results are also presented as part of DDMI’s Aquatic Effects Monitoring Program (AEMP) report.

3.4 Results

Dustfall and snow water chemistry results were grouped into zones based on their relative distance from the mine footprint (Table 3.4-1). Although station groupings into zones were first established at the outset of the program, these groupings were recalculated in 2018 using satellite imagery of the site.

Table 3.4-1: Dustfall Results, Diavik Diamond Mine, 2018

Zone ID (m)	Number of Stations in Zone	2018 Dustfall (mg/dm^2/y) from Dustfall Gauges and Dustfall Snow			
		Median	Mean	Maximum	Minimum
0 - 100	9	645	982	4603	95
101 - 250	5	80	143	389	46
251 - 1000	10	211	310	1349	35
1,001 - 2,500	11	81	138	667	19
> 2,500	1	149	-	-	-
Control	5	69	58	85	26

In 2018, the primary sources of fugitive dust were associated with unpaved road and airstrip usage and construction and mining activities at A21. Major waste rock material transfers in 2018 included the use of haul roads to move waste rock (7,623,715 tonnes) and kimberlite ore to the crusher (2,529,725 tonnes). Another source of fugitive dust is truck traffic along the ice road to the Mine. However, the consistency in dust deposition rates near the ice road alignment between winter and summer indicated that the contributions of dust from the ice road were modest relative to other sources. There is no direct measurement of dustfall due to the use of the ice road; even so, dustfall stations immediately downwind of the ice road such as Dust 7, Dust 6, and SS2-4 did not show elevated readings during winter months. To suppress dust generation, roads, parking areas and laydown areas were watered during the summer as needed. Between May and September 2018, approximately 1,006 m^3 of water was applied to the Mine site and 66,472 m^3 of water was applied to haul roads. The exact impact of dust suppression could not be determined from the data collected in 2018; however, it is likely that road watering reduced the amount of dust generated at the Mine in 2018. In 2018, the Underground Mine production continued at A154 and A418, as well as stripping and production at the A21 open pit. Fugitive dust generation is expected to be greatest during snow-free periods where and when there is site activity. It was expected that the highest fugitive dust generation and resulting dustfall occurred in areas closest to the roads, the airstrip, and mine footprint such as near A21 between May and September. Dust 3 (25 m from the Mine) recorded the highest dustfall during the summer months (1,096 mg/dm^2/y) compared to the winter months (455 mg/dm^2/y).

The 2018 predominant wind directions at the site were from southeast and northwest; although, winds in general can be described as omnidirectional. Therefore, the expectation is that airborne material will be deposited in all directions around the mine with a northwest and a southeast emphasis. The results show that both the direction from the mine and the proximity to the mine activity are both strong indicators of dust deposition. This is supported by the fact that Dust 3 which is located only 25 m from the mine, had the highest recorded dustfall rate of the dustfall gauges in 2018 and Dust 7, which is located southeast from the mine and the winter road making it more frequently downwind from the mine, had the second highest recorded dustfall rate in 2018.

Results from the dustfall gauges, dustfall snow surveys, and the snow water chemistry analyses are presented below.

3.4.1 Dustfall Gauges

For each station, total dustfall collected throughout the year is summarized by zone in Table 3.4-1. The following list describes tables or figures that are included in the *Diavik Diamond Mine: 2018 Dust Deposition Report* (Appendix D; ERM 2019):

- 2018 annual dustfall collected at each station, relative to the Mine;
- historical records of annual dustfall for each station from 2002 to 2018;
- a comparison of dustfall versus distance from the Mine footprint for 2018 and historical 2002 to 2018 datasets; and
- boxplots summarizing the dustfall magnitude distribution from all stations during each year from 2002 to 2018.

The greatest estimated dustfall rate measured using gauges occurred at Dust 3 (25 m from the Mine). The Dust 3 measured dustfall rate in 2018 was 796 mg/dm^2/y. Dust 7 (667 mg/dm^2/y) and Dust 10 (645 mg/dm^2/y) recorded the second and third highest dustfall rates measured using gauges, respectively. Both sites are located on the south side of the Mine. Dust 7 is located 1,147 m from the Mine but very close to the winter road (Figure 3.1-1), and Dust 10 is located 46 m from the Mine adjacent to the A21 open pit. Both control stations Dust C2 (78 mg/dm^2/y; 3,036 m west) and Dust C1 (85 mg/dm^2/y; 4,646 m south) recorded the lowest dustfall rates.

The 2018 mean and maximum dustfall values suggest that dustfall rates increased at the Mine in 2018 in comparison to the previous few years. The higher overall dustfall rates in 2018 were likely influenced by the surface activity at the mine, particularly at the A21 open pit, which began in December 2017.

The annual dustfall rates estimated from gauges at each station were less than the former BC objective for the mining industry (621 to 1,059 mg/dm^2/y) except at the four sites that recorded the highest dustfall rates in 2018 (Dust 3, 7, 10, and 1). This former objective was used for comparison purposes only: there are currently no standards or objectives for the Northwest Territories. However, the BC objective is generally used as a standard for comparison at other mines in the region.

3.4.2 Dustfall Snow Surveys

Annual dustfall rates estimated from each snow survey station in 2018 are included in the combined dustfall gauge and snow survey results in Table 3.4-1. Historical records of annual dustfall rates for each station, the relationship between annual dustfall rates and distance from the Mine footprint, boxplots summarizing dustfall rates measured in each year, and the data quality assurance and quality control are presented in the annual dust deposition report (Appendix D).

Annual dustfall rates estimated from 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y. SS1-1 recorded the highest dustfall rate among all station, which is likely due to the proximity of this station to the airstrip. The second and third highest dustfall rates were recorded at SS5-3 (1,349 mg/dm^2/y) and SS5-2 (1,007 mg/dm^2/y), respectively. Both of these stations are located adjacent to the A21 open pit (Figure 3.1-1), where most of the surface mining activity occurred during 2018. Dustfall rates of snow survey generally decreased with increasing distance from the Mine. The lowest dustfall rates were recorded at SS2-4 (19 mg/dm^2/y) followed by SS2-3 (22 mg/dm^2/y). Both of these rates are lower than the rates at the control stations. The lower rates at these two stations may be explained by the upwind location of both stations, in addition to the greater distance from the A21 open pit relative to the control stations. Mean dustfall rates estimated using both dustfall gauges and snow surveys within the 0–100, 101–250, 251–1,000, 1,001–2,500 and Control zones were 982, 143, 310, 138, and 58 mg/dm^2/y, respectively (Table 3.4-1). Dustfall rates at stations SS1-1, SS1-2, SS5-3, and Dust 7 were greater than the upper limit of the 95% confidence interval for their respective zones in 2018. These high dustfall rates, compared to the overall distribution of dustfall rates within each zone, indicated that higher dustfall rates were observed in the vicinity of the A21 open pit, the airstrip, and the winter road southeast of the Mine.

Annual dustfall rates estimated from each snow survey station in 2018 were generally higher than dustfall estimates from the past few years. Annual dustfall rates measured at 4 out of 27 stations during the 2018 snow survey were higher than the former BC objective for the mining industry (621–1,059 mg/dm^2/y). These stations include SS1-1, SS5-1, SS5-2, and SS5-3. This former objective was used for comparison purposes only: there are currently no standards or objectives for the Northwest Territories.

3.4.3 Snow Water Chemistry

Maximum snow water chemistry results for 2018 are presented in Table 3.4-2. All analytical results for snow water chemistry and data quality assurance and quality control analysis are included in *the Diavik Diamond Mine: 2018 Dust Deposition Report* (Appendix D; ERM 2019).

Table 3.4-2: Snow Water Chemistry Results, Diavik Diamond Mine, 2018

Zone ID (m)	Number of Stations in Zone	2018 Maximum Snow Water Chemistry Results (µg/L)										
		Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
0 - 100	1	858	69.0	0.2	0.0	5.5	1.3	0.6	13.2	2.7	89.7	4.8
101 - 250	2	473	81.0	0.1	0.0	2.3	0.7	0.3	5.0	0.5	29.1	2.8
251 - 1000	5	2,080	130	0.3	0.0	13.5	2.8	2.1	32.8	11.7	309	9.4
1,001 - 2,500	8	537	80.0	0.1	0.0	2.7	1.0	0.6	9.0	8.5	133	3.1
Control	3	296	90.0	0.1	0.0	2.2	0.6	0.3	7.7	2.4	66.0	2.6

All 2018 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” in Water Licence W2015L2-0001 (Table 3-1.2).

In general, average concentrations of snow water chemistry variables of interest decreased with increasing distance from the Mine. However, high parameter concentrations were recorded at Station SS3-8, located in the 251-1,000 zone (826 m from the Mine). SS3-8 has a downwind location southeast of the Mine (Figure 3.1-1) and is near the winter road.

4. NATIONAL POLLUTANT RELEASE INVENTORY

4.1 Program Overview

According to ECCC, air issues such as smog and acid rain result from the presence of, and interactions between a group of pollutants known as Criteria Air Contaminants (CAC) and some related pollutants. CAC, in particular, refer to a group of pollutants that include:

- Sulphur oxides (SO_x);
- Nitrogen oxides (NO_x);
- Particulate matter (PM);
- Volatile organic compounds (VOC);
- Carbon monoxide (CO); and
- Ammonia (NH_3).

In addition, ground-level ozone (O_3) and secondary particulate matter are often referred to among the CAC because both ground-level ozone and secondary particulate matter are by-products of chemical reactions between the CAC (ECCC 2017).

CAC are produced from a number of sources, including burning of fossil fuels and it is because of these shared sources that CAC are grouped together.

While there is no regulatory requirement or standard for these pollutant releases in the Northwest Territories, the National Pollutant Release Inventory (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 ECCC and is a requirement of the *Canadian Environmental Protection Act* (CEPA 1999) for owners and operators of facilities that meet the NPRI reporting requirements published in the Canada Gazette, Part I (ECCC 2018). Reporting requirements are normally revised every one or two years, with accompanying revised guidance documents (ECCC 2019a). NPRI reports containing emissions of CACs are to be submitted to ECCC before June 1 each year.

NPRI substance emissions were derived by DDMI using emission factor calculations provided by ECCC NPRI Toolbox (ECCC 2019b). 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 on-site weather station were used to calculate NPRI values.

4.2 Results

Table 4.2-1 compares the Mine's 2018 NPRI CAC emission submission results against the 2017 NPRI submission results. NPRI reports for previous years (2001 to 2017) are available on the NPRI website (ECCC 2019c). NPRI results for the previous year are typically released by ECCC in April, 22 months following submission on June 1 of each year (e.g., 2018 data reported by June 1, 2019 is expected to be released by ECCC in April of 2020).

There was an increase of about 24% of CO and 25% of VOCs emissions in 2018 compared to 2017. SO_2 emissions increased by 525% in 2018 relative to 2017. These emissions increases are due to increased diesel usage and increased blasting at A21 open pit in 2018. NO_x emissions were relatively consistent between 2017 and 2018.

TPM, PM_{10}, and $PM_{2.5}$ emissions increased by about 40%, 45% and 35%, respectively in 2018 compared to 2017 due to increased road traffic, rock re-mine, diesel usage, incineration and waste-oil combustion.

Table 4.2-1: NPRI Results for CAC Emissions, Diavik Diamond Mine, 2017 and 2018

CAC Emissions	2018 Reporting Threshold (tonnes)	2017 (tonnes)	2018 (tonnes)	Reasons for Changes from Previous Year
Carbon Monoxide (CO)	20	675	833.7	Increased diesel usage and blasting in 2018
Sulphur Dioxide (SO_2)	20	17.7	110.6	Increased blasting due to A21 open pit mining and increased fuel usage in 2018
Oxides of Nitrogen (NO_x expressed as NO_2)	20	2,275	2,281	No change
Volatile Organic Compounds (VOCs)	10	57.8	72.3	Increased diesel usage in 2018
Total Particulate Matter (TPM)	20	726	1194.7	Increased incineration, rock re-mine, increased road traffic, and waste-oil combustion in 2018
Particulate Matter ≤ 10 µm (PM_{10})	0.5	238	425.9	Increased road traffic, increased diesel usage and increased incineration in 2018
Particulate Matter ≤ 2.5 µm ($PM_{2.5}$)	0.3	56	87.4	Increased re-mine, increased road traffic, and increased diesel usage in 2018

5. GREEHOUSE GAS REPORTING

5.1 Program Overview

While there is no territorial regulatory requirement or standard for GHG release in the Northwest Territories, the national Greenhouse Gas Emissions Reporting Program (GHGRP) is Canada's legislated, publicly accessible inventory of facility-reported GHG data and information. The program is administrated by ECCC and is requirement of the CEPA 1999 for owners or operators of facilities that emit GHGs above a certain threshold. Starting for 2017 reporting, the GHGRP requirement applied to all facilities that emit the equivalent of 10,000 tonnes of carbon dioxide equivalent units (tCO_2e) or more, per year (ECCC 2019d). The previous threshold was 50,000 tCO_2e per year. GHG reports are to be submitted prior to June 1 each year.

GHG emissions were derived by DDMI using emission factor calculations in the Guidance Manual for Estimating Greenhouse Gas Emissions (Environment Canada 2004). Operational values such as fuel usage and mobile equipment hours were recorded at the Mine throughout the year.

Three GHG emissions are calculated for the Mine: CO_2, methane (CH_4) and nitrous oxide (N_2O). To calculate CO_2e, 100-year Global Warming Potentials (GWP) are used to convert CH_4 and N_2O from tonnes to tCO_2e. The CH_4 and N_2O GWP multipliers used were 25 and 298, respectively (ECCC 2019e).

5.2 Results

Table 5.2-1 compares 2017 and 2018 GHG emissions results for the Mine. The 2018 GHG emission reporting information were filed with ECCC on May 29, 2019. GHG reports for previous years (2001 to 2017) are published by ECCC and available from the open government website (ECCC 2019c).

Table 5.2-1: GHG Equivalents for the Diavik Diamond Mine, 2017 and 2018

Constituent	2017 (tCO_2e)	2018 (tCO_2e)
CO_2e	194,968	209,436
CH_4	233	260
N_2O	6,875	9,313

GHG emissions results for the previous year are typically released by ECCC in April, 22 months following submission on June 1 of each year (e.g., 2018 data reported by June 1, 2019 is expected to be released by ECCC in April of 2020).

CO_2e emissions increased between from 2017 to 2018 at the Mine (Table 5.2-1) due to increased diesel usage for power generation and transportation in 2018. GHG emissions at the Mine are primarily derived from stationary equipment fuel combustion and mobile equipment fuel combustion (73% and 27% of GHG emissions, respectively).

In 2018, the Mine's 9.2 megawatt wind farm (consisting of four turbines; Photo 5.2-1) generated 18.0 gigawatt-hours of electricity (9.2% energy penetration) and saved 4.5 million litres of diesel fuel needed for power, thereby reducing the Mine's CO_2e by 12.1 kilotonnes.

**Photo 5.2-1: The Diavik 9.2 megawatt wind farm.
The wind farm consists of four wind turbines.**

6. SUMMARY

One TSP monitoring station (CB station) was operational in 2018; the other TSP monitoring station (A154 Dike) was suspended due to issues with the equipment. There was no exceedance of the GNWT 24-hour average TSP guideline (120 μg/m^3) at the CB station. The maximum daily mean value was 23.2 μg/m^3, and the minimum value was 0.3 μg/m^3. The 2018 annual mean TSP concentration at the CB station was 3.6 μg/m^3 and was well below the annual GNWT standard (60 μg/m^3). TSP monitoring at the CB station achieved a data completeness of 86% in 2018 (314 valid daily data out of 365).

In 2018, dustfall was monitored at 14 dustfall gauges and 27 snow survey stations located at varying distances around the mine. Snow water chemistry was measured at 19 of the snow survey stations and compared to EQC set out in the WLWB Water Licence W2015L2-0001.

Annual dustfall estimated from each of the 14 dustfall gauges ranged from 78 to 796 mg/dm^2/y in 2018. Annual dustfall rates estimated from the 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y. The annualized dustfall rates estimated from dustfall gauges and snow surveys were less than the former BC objective for the mining industry (621 to 1,059 mg/dm^2/y) for all stations except for Dust 3, Dust 7, Dust 10, and Dust 1, and SS1-1, SS5-3, SS5-2, and SS5-1 stations. This former BC objective was used for comparison purposes only: there are currently no dustfall standards or objectives for the Northwest Territories. The higher overall dustfall rates in 2018 compared to the past few years were likely influenced by the surface activity at the mine, particularly at the A21 open pit, which began in December 2017.

Because the dustfall gauges continuously collect dust throughout the year, and the snow surveys are only representative of dustfall accumulated over the snow cover period, the reported annual dustfall results from the dustfall gauges are expected to provide a better estimate of annual dustfall compared to snow survey results for similar geographic areas. However, results obtained from both methods showed similar spatial patterns, with dustfall generally decreasing with distance away from the Mine.

Snow water chemistry analysis of interest included those variables with effluent quality criteria (EQC; i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc). All 2018 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” in Water Licence W2015L2-0001.

The Mine reported CAC emissions as part of the annual NPRI submission and emissions were estimated using published emission factors. Compared to 2017, 2018 emissions of CO and VOC increased by about 25%. SO_2 emissions in 2018 increased (110.6 tonnes; 525% increase) relative to 2017 (17.7 tonnes). The increase of SO_2 emissions were due to increased fuel usage and blasting at A21 open pit. NO_x emissions were relatively consistent between 2017 and 2018. There was an increase of about 35% to 45% of TPM, PM_{10} and $PM_{2.5}$ emissions in 2018 compared to 2017 due to increased road traffic, rock re-mine, diesel usage, incineration and waste-oil combustion.

The Mine reported GHG emissions as part of the annual national GHGRP submission and CO_2e emissions were estimated using published emission factors and 100-year GWP ratios. Starting for 2017 reporting, the GHGRP was changed to require all facilities to report that emit the equivalent of 10,000 tCO_2e or more per year, compared to the previous 50,000 tCO_2e per year threshold.

Mine GHG emissions of CO_2, CH_4 and N_2O totalled 209,436 tCO_2e in 2018, a 7.4% increase from 2017 due to increased diesel usage for power generation and transportation. GHG emissions at the Mine in 2018 were primarily from stationary equipment fuel combustion (73%) and mobile equipment fuel combustion (27%). In 2018, the Mine’s 9.2 megawatt wind farm helped to reduce the Mine’s GHG footprint by generating 18.0 gigawatt-hours of electricity which saved 4.5 million litres of diesel fuel and thereby prevented the direct release of 12,100 tCO_2e.

7. REFERENCES

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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APPENDIX A RESPONSES TO COMMENTS ON THE 2017 AIR QUALITY MONITORING REPORT

Memorandum

Date: January 9, 2019

To: Sean Sinclair, Superintendent - Environment - HSE

From: Andres Soux, Principal Consultant

Cc: Carol Adly, Project Manager
Marc Wen, Partner in Charge

Subject: **Responses to Arcadis Comments**

As part of a review of the 2017 Environmental Air Quality Monitoring Report (AQMR), Arcadis submitted 19 comments and recommendations to Diavik Diamond Mines Inc. This memorandum (Table 1) provides a response to those comments and recommendations.

Prepared by:

Andres Soux, M.Sc.
Principal Consultant

Table 1. Responses to Comments on the 2017 AQMR

Comment Number	ERM Response
1	The TSP Sampler Assessment Memorandum (TSPSAM 2018) addresses the location of current monitoring. In addition, the year to year variations in wind, as seen through small changes in annual wind roses, do not justify moving monitoring stations. The winds near the mine site tend to be omnidirectional with no dominant wind directions. Therefore, there is not one dominant upwind or downwind wind direction. The current locations for monitoring were based on modelling from 2012 that used the year of maximum emissions to help site TSP monitoring stations and are well placed to assess the effects of emissions from the mine site including the A21 pit area. It is not feasible to update the modelling based on yearly changes in mine footprint or yearly variations in winds. In fact, the monitoring suggests that TSP monitoring is no longer required based on arguments made in the TSPSAM.
2	Standard Operating Procedures (SOPs) relevant to the Environmental Air Quality Monitoring Program will be included for all data in the 2018 report.
3	It is not known why the TSP concentration at A154 dike was greater than at CB on August 13, 2017. There was observed forest fire smoke in the area whose origin was from British Columbia. Both TSP monitors were operating properly on this day and there were no unusual mining operations that would have been likely to create a difference in TSP concentrations between the two stations. TSP concentrations were elevated at both stations above typical daily values due to forest fire smoke. It is not possible to isolate the exact cause that one station was higher than the other. It is not atypical to find concentration variations between stations based on natural spatial variability in TSP concentrations.
4	Acknowledged
5	Acknowledged
6	Maintenance issues persisted with the A154 Dike sampler after continuous on site troubleshooting and required significant off site repairs.
7	Acknowledged
8	Acknowledged
9	The quarterly sampling of dustfall is not intended to provide high temporal resolution data. Even monthly dustfall sampling would not provide this. The data are used to show seasonal trends in dustfall rates and as part of the aquatic effects program. The comparison to BC Objectives was done to provide a comparison to a known standard not as a means to determine compliance. As the BC Objectives have been rescinded no comparison to these values will be done in the future.
10	EK35 is only applied to the airport taxi area and helipad and the runway was watered. Therefore, it is difficult to estimate the relative effectiveness of each method using only dustfall sampling. A qualitative assessment suggests greater dust suppression using EK 35. If possible greater analysis will be presented in future reports.
11	The forest fire event in August 2017 was a short term event, lasting roughly three days with only one of those days showing an exceedance of TSP. It is highly unlikely that there would be much of an impact on a 30-day dustfall reading due to this event. Therefore there is no indication that the high TSP values were related to events other than the observed forest fire smoke.

Comment Number	ERM Response
12	The value of 480 mg/dm²/y is the average annual rate. The other rates were for specifically winter months (January – March and October – December) and summer months (March – July) so they are not the same as the annual rate.
13	The goal of the TSP monitoring is not to situate TSP monitors at the location of highest TSP concentrations. If this were the goal then the monitors should be placed in the centre of one of the pits where the greatest amount of mining activity is taking place or directly on a haul road to evaluate the maximum emissions from that source. The goal of TSP monitoring is to measure representative concentrations of TSP at the mine site to identify the overall effect of emissions on the atmospheric environment and to track trends in air quality over time. The current location of TSP monitors has achieved this aim.
14	The main goal of the monitoring program is not to validate previous modelling results. The main goal of the monitoring program is to assess the current conditions on site and help determine the effects of the Project on the environment. It is not feasible nor useful to re-model every time there are changes in mining operations. The ongoing monitoring has and will be able to assess the effects of the changes.
15	The value for ammonia from SS3-6 in Table 3.1-1 from the Dust Deposition Report (Appendix E of the AQMR) is consistent with the value for the 0-100 m zone in Table 3.4-2 from the AQMR.
16	The SS3-4 sample location is close to a winter road which may explain the higher than expected readings.
17	The dust canisters tipped over during transport and some water leaked out. Diavik updated the procedure to ensure a watertight seal and uses a specific carrying case now to reduce the chance of sampling tipping over during transport. Further discussion will be provided if similar events occur in the future.
18	The DDMI laboratory is accredited by the Canadian Association for Laboratory Accreditation (CALA) and abides by all rules governing this organization and submits all SOPs for scrutiny to CALA.
19	Emission inventories are calculated using published ECCC emission factors and emission estimation calculators from the ECCC toolboxes. Calculation inputs vary based on emission source and may include fuel usage or operating hour statistics. More detailed calculation methodologies will be included in future reporting.

APPENDIX B TSP MONITORING STATION CALIBRATION AND MAINTENANCE RECORDS

Rio Tinto

AQ Unit Verification and Calibration Sheet

Area:	8000	**No:**	ENVI-622-1031
Effective Date:	2016-October 25	**Revision:**	0
Task:	AQ Unit Calibration	**By:**	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	Communication Shack
Instrument Serial Number	5014i203191211
Date	25-Jan-2018
Verification and Calibration Type	Monthly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	-23.8	-23.6	0.20	+/- 0.2°C	Pass		-			
1 Point	Ambient Relative Humidity	77.6	72	-7.22	+/- 2%	Fail	74.3	0.03	5.5	8.7	
1 Point	Flow Temperature	17.4	17.4	0.00	+/- 0.2°C	Pass		-			
1 Point	Barometer Pressure	724.7	763.5	38.80	+/- 10 mmHg	Fail	763.5	0.00	0.9982	1.0514	
1 Point	Volumetric Flow Rate	16.68	16.58	0.60	+/- 2%	Pass		-			
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage		Final High Voltage	
Initial Beta Count		Final Beta Count	
Final Beta		8000-13000	

Leak Test

Start Value VAC	70.4	mmHg		
Start Value FLOW (AQ Unit)	16.66	LPM		
Start Value FLOW (SLR Pro)	16.63	LPM		
Leak Check Adapter VAC	125.4	mmHg		
Leak Check Adapter FLOW (AQ Unit)	16.67	LPM		
Leak Check Adapter FLOW (SLR Pro)	16.49	LPM		
Flow Variance	-0.06%	LPM	+/-2.5%	Pass

Auto Mass Coefficient Calibration Completed

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By Justin Grandjambe

Signature:

Monthly	Quarterly	Annually	
			1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
			Auto Detector Calibration
			Leak Check
			Clean Inlet Assemblies & Sample Tubes
			Check Cam (grease as needed)
			Calibrate AmTemp
			Calibrate RH
			Calibrate Flow Temp
			Calibrate Baro Pressure
			Auto Flow Calibration
			Calibrate Vacuum Pressure Span
			Calibrate Flow Pressure Span
			Auto Mass Calibration
			Pump Reuild

COMMENTS

Barometric pressure taken from Weather Underground

Rio Tinto

AQ Unit Verification and Calibration Sheet

Area:	8000	**No:**	ENVI-622-1031
Effective Date:	2016-October 25	**Revision:**	0
Task:	AQ Unit Calibration	**By:**	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	Communication Shack
Instrument Serial Number	5014i203191211
Date	29-Mar-2018
Verification and Calibration Type	Quarterly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	-25.5	-25.1	0.40	+/- 0.2°C	Fail	-2.3	-22.80	-2.2	-2.3	
1 Point	Ambient Relative Humidity	66.5	67	0.75	+/- 2%	Pass		-			
1 Point	Flow Temperature	16.6	17.3	0.70	+/- 0.2°C	Fail	-0.4	17.70	-0.2	-0.4	
1 Point	Barometer Pressure	767.9	766.6	-1.30	+/- 10 mmHg	Pass		-	Span		
1 Point	Volumetric Flow Rate	16.66	16.58	0.48	+/- 2%	Pass		-			
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage	1360	Final High Voltage	1480
Initial Beta Count	7491	Final Beta Count	9241
Final Beta	9241	8000-13000	Pass

Leak Test

Start Value VAC	67.7	mmHg	
Start Value FLOW (AQ Unit)	16.67	LPM	
Start Value FLOW (SLR Pro)	16.58	LPM	
Leak Check Adapter VAC	121.8	mmHg	
Leak Check Adapter FLOW (AQ Unit)	16.67	LPM	
Leak Check Adapter FLOW (SLR Pro)	16.46	LPM	
Flow Variance	0.00%	LPM	+/-2.5%

Auto Mass Coefficient Calibration Completed No

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermomet	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermomet	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By Justin Grandjambe

Signature:

Monthly	Quarterly	Annually	
			1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
			Auto Detector Calibration
			Leak Check
			Clean Inlet Assemblies & Sample Tubes
			Check Cam (grease as needed)
			Calibrate AmTemp
			Calibrate RH
			Calibrate Flow Temp
			Calibrate Baro Pressure
			Auto Flow Calibration
			Calibrate Vacuum Pressure Span
			Calibrate Flow Pressure Span
			Auto Mass Calibration
			Pump rebuild

COMMENTS

Unable to do the Auto Mass Calibration as the bench on the AQ unit does not function properly

Rio Tinto

AQ Unit Verification and Calibration Sheet

Area:	8000	**No:**	ENVI-622-1031
Effective Date:	2016-October 25	**Revision:**	0
Task:	AQ Unit Calibration	**By:**	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	Communication Shack
Instrument Serial Number	5014i203191211
Date	12-Jun-2018
Verification and Calibration Type	Monthly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	6.9	4.1	-2.80	+/- 0.2°C	Fail	5.5	-1.40	-2.3	-0.8	
1 Point	Ambient Relative Humidity	88.2	90.95	3.12	+/- 2%	Fail	89.6	-0.01	8.7	7.4	
1 Point	Flow Temperature	21.5	21.4	-0.10	+/- 0.2°C	Pass		-			Adjusted two times until it was in closer range
1 Point	Barometer Pressure	752.7	752.3	-0.40	+/- 10 mmHg	Pass		-	Span		
1 Point	Volumetric Flow Rate	16.67	15.01	11.06	+/- 2%	Fail		-	16.64	15	Adjusted two times until it was in closer range
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage		Final High Voltage	
Initial Beta Count		Final Beta Count	
Final Beta		8000-13000	

Leak Test

Start Value VAC	67.8	mmHg		
Start Value FLOW (AQ Unit)	16.67	LPM		
Start Value FLOW (SLR Pro)	16.68	LPM		
Leak Check Adapter VAC	121.4	mmHg		
Leak Check Adapter FLOW (AQ Unit)	16.67	LPM		
Leak Check Adapter FLOW (SLR Pro)	16.61	LPM		
Flow Variance	0.00%	LPM	+/-2.5%	Pass

Auto Mass Coefficient Calibration Completed

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By Justin Grandjambe

Signature:

Monthly	Quarterly	Annually	
			1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
			Auto Detector Calibration
			Leak Check
			Clean Inlet Assemblies & Sample Tubes
			Check Cam (grease as needed)
			Calibrate AmTemp
			Calibrate RH
			Calibrate Flow Temp
			Calibrate Baro Pressure
			Auto Flow Calibration
			Calibrate Vacuum Pressure Span
			Calibrate Flow Pressure Span
			Auto Mass Calibration
			Pump Reuild

COMMENTS

Rio Tinto

AQ Unit Verification and Calibration Sheet

Area:	8000	**No:**	ENVI-622-1031
Effective Date:	2016-October 25	**Revision:**	0
Task:	AQ Unit Calibration	**By:**	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	Communication Shack
Instrument Serial Number	5014i203191211
Date	28-Jun-2018
Verification and Calibration Type	Quarterly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	16.6	16.8	0.20	+/- 0.3°C	Pass		-			
1 Point	Ambient Relative Humidity	35.3	36	1.98	+/- 2%	Pass		-			
1 Point	Flow Temperature	22.7	22.8	0.10	+/- 0.2°C	Pass		-			
1 Point	Barometer Pressure	755.8	756.666	0.87	+/- 10 mmHg	Pass		-		Span	
1 Point	Volumetric Flow Rate	16.67	16.15	3.22	+/- 2%	Pass		-			
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage	1370	Final High Voltage	1370	
Initial Beta Count	7611	Final Beta Count	7726	
Final Beta	7726	8000-13000		Pass

Leak Test

Start Value VAC	65	mmHg	
Start Value FLOW (AQ Unit)	16.67	LPM	
Start Value FLOW (SLR Pro)	15.92	LPM	
Leak Check Adapter VAC	114.3	mmHg	
Leak Check Adapter FLOW (AQ Unit)	16.68	LPM	
Leak Check Adapter FLOW (SLR Pro)	15.88	LPM	
Flow Variance	-0.06%	LPM	+/-2.5%

Auto Mass Coefficient Calibration Not completed

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Monthly	Quarterly	Annually	
			1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
			Auto Detector Calibration
			Leak Check
			Clean Inlet Assemblies & Sample Tubes
			Check Cam (grease as needed)
			Calibrate AmTemp
			Calibrate RH
			Calibrate Flow Temp
			Calibrate Baro Pressure
			Auto Flow Calibration
			Calibrate Vacuum Pressure Span
			Calibrate Flow Pressure Span
			Auto Mass Calibration
			Pump rebuild

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By SS2

Signature: JG signing for SS2

COMMENTS

temp verification from streamline pro temp probe, relative humidty verification from airport, barometric pressure verification from airport, mass calibration not completed due to bent bench. Hygromet

AQ Unit Verification and Calibration Sheet

Area:	8000	**No:**	ENVI-622-1031
Effective Date:	2016-October 25	**Revision:**	0
Task:	AQ Unit Calibration	**By:**	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	Communication Shack
Instrument Serial Number	5014i203191211
Date	12-Jul-2018
Verification and Calibration Type	Monthly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	17.9	17.94	0.04	+/- 0.2°C	Pass		-			
1 Point	Ambient Relative Humidity	84.8	87	2.59	+/- 2%	Fail	87	0.00	6.8	5.1	RH value taken from the airport
1 Point	Flow Temperature	23.2	21.7	-1.50	+/- 0.2°C	Fail	22.45	-0.75	-0.4	0.4	Adjusted two times to get with in range
1 Point	Barometer Pressure	756.3	756.9	0.60	+/- 10 mmHg	Pass		-		Span	
1 Point	Volumetric Flow Rate	16.67	15.83	5.31	+/- 2%	Fail	15.8	0.00	16.66	15.8	Adjusted two times to get with in range
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage		Final High Voltage	
Initial Beta Count		Final Beta Count	
Final Beta		8000-13000	

Leak Test

Start Value VAC	75.7	mmHg		
Start Value FLOW (AQ Unit)	16.67	LPM		
Start Value FLOW (SLR Pro)	16.62	LPM		
Leak Check Adapter VAC	129.7	mmHg		
Leak Check Adapter FLOW (AQ Unit)	16.65	LPM		
Leak Check Adapter FLOW (SLR Pro)	16.45	LPM		
Flow Variance	0.12%	LPM	+/-2.5%	Pass

Auto Mass Coefficient Calibration Completed No

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By Justin Grandjambe

Signature:

Monthly | Quarterly | Annually

- 1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
- Auto Detector Calibration
- Leak Check
- Clean Inlet Assemblies & Sample Tubes
- Check Cam (grease as needed)
- Calibrate AmTemp
- Calibrate RH
- Calibrate Flow Temp
- Calibrate Baro Pressure
- Auto Flow Calibration
- Calibrate Vacuum Pressure Span
- Calibrate Flow Pressure Span
- Auto Mass Calibration
- Pump Reuild

COMMENTS

The RH calibration was missed, and was completed the next day.

RioTinto

AQ Unit Verification and Calibration Sheet

Area:	8000	No:	ENVI-622-1031
Effective Date:	2016-October 25	Revision:	0
Task:	AQ Unit Calibration	By:	D. Dul
		Page:	1 of 1

Customer Name	DIAVIK
Instrument Location	
Instrument Serial Number	5014i203191211
Date	9-Sep-2018
Verification and Calibration Type	Monthly

	Description	As Found	Standard	As Found Variance	Allowable Variance	Outcome	Adjusted to	Final Variance	Set Point as Found	Set Point Adjusted to	Comments
1 Point	Ambient Air Temperature	6	5.5	-0.50	+/- 0.2°C	Fail	5.7	-0.20	0.2	0.6	
1 Point	Ambient Relative Humidity	52	61	17.31	+/- 2%	Fail	56	-0.08	5.1	-0.9	
1 Point	Flow Temperature	19.5	19.5	0.00	+/- 0.2°C	Pass		-			
1 Point	Barometer Pressure	761	760	-1.00	+/- 10 mmHg	Pass		-	Span		
1 Point	Volumetric Flow Rate	16.66	17.19	3.08	+/- 2%	Fail		-	16.64	17.2	Adjusted twice to get within range
Calibrate	Vacuum Pressure Span			-	50-70 mmHg			-			
Calibrate	Flow Pressure Span			-	20-30 mmHg			-			
Calibrate	Auto Flow Calibration			-	+/- 2%			-			

Auto Detector Calibration

Initial High Voltage		Final High Voltage	
Initial Beta Count		Final Beta Count	
Final Beta		8000-13000	

Leak Test

Start Value VAC	70.3	mmHg		
Start Value FLOW (AQ Unit)	16.68	LPM		
Start Value FLOW (SLR Pro)	16.67	LPM		
Leak Check Adapter VAC	124.5	mmHg		
Leak Check Adapter FLOW (AQ Unit)	16.67	LPM		
Leak Check Adapter FLOW (SLR Pro)	16.5	LPM		
Flow Variance	0.06%	LPM	+/-2.5%	Pass

Auto Mass Coefficient Calibration Completed

Standards Used	Description	S/N	Calibration Date	Due Date
Flow	Stream Line Pro	HL130101	2-Feb-17	2-Feb-18
Temperature	Stream Line Pro	T130101	26-Jan-17	26-Jan-18
Pressure	Stream Line Pro	HL130101	26-Jan-17	26-Jan-18
Temperature	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Relative Humidity	Traceable Hygrometer Thermome	160718539	29-Aug-16	29-Aug-18
Manometer/Pressure/Vacuum	Traceable Monometer/Pressure/V	160885583	31-Oct-18	31-Oct-18

Technical Data: Thermo Manual P/N 106428-00 dated 2 April 2014
Thermo Fisher Procedure Number 106430-00 revision A

Firmware updated to:

Calibration Complete By Justin Grandjambe

Signature:

Monthly	Quarterly	Annually	
			1 Pt. Varification (Am Temp, RH, Flow Temp, Baro Pressure & Vol. Flow Rate)
			Auto Detector Calibration
			Leak Check
			Clean Inlet Assemblies & Sample Tubes
			Check Cam (grease as needed)
			Calibrate AmTemp
			Calibrate RH
			Calibrate Flow Temp
			Calibrate Baro Pressure
			Auto Flow Calibration
			Calibrate Vacuum Pressure Span
			Calibrate Flow Pressure Span
			Auto Mass Calibration
			Pump Reuild

COMMENTS

APPENDIX C DAILY TSP DATA, 2018

Appendix C: Daily TSP Data, 2018

Date	CB Station	
	Daily TSP, µg/m³	Comments
1-Jan-18	1.2	
2-Jan-18	1.2	
3-Jan-18	1.0	
4-Jan-18	1.4	
5-Jan-18	0.7	
6-Jan-18	1.2	
7-Jan-18	1.5	
8-Jan-18	1.0	
9-Jan-18	1.6	
10-Jan-18	1.1	
11-Jan-18	2.9	
12-Jan-18	1.4	
13-Jan-18	1.2	
14-Jan-18	1.9	
15-Jan-18	3.2	
16-Jan-18	1.2	
17-Jan-18	0.6	
18-Jan-18	1.1	
19-Jan-18	0.3	
20-Jan-18	1.2	
21-Jan-18	0.4	
22-Jan-18	0.6	
23-Jan-18	1.1	
24-Jan-18	0.4	
25-Jan-18	9.8	
26-Jan-18	1.5	
27-Jan-18	0.8	
28-Jan-18	0.5	
29-Jan-18	1.0	
30-Jan-18	0.7	
31-Jan-18	2.0	
1-Feb-18	2.0	
2-Feb-18	7.4	

Date	CB Station	
	Daily TSP, µg/m^3	Comments
3-Feb-18	11.6	
4-Feb-18	5.2	
5-Feb-18	1.8	
6-Feb-18	5.8	
7-Feb-18	3.6	
8-Feb-18	4.9	
9-Feb-18	1.8	
10-Feb-18	2.0	
11-Feb-18	1.8	
12-Feb-18	2.7	
13-Feb-18	1.5	
14-Feb-18	3.6	
15-Feb-18	4.9	
16-Feb-18	5.1	
17-Feb-18	3.0	
18-Feb-18	5.3	
19-Feb-18	-	Too many negative values.
20-Feb-18	4.7	
21-Feb-18	3.2	
22-Feb-18	4.5	
23-Feb-18	2.6	
24-Feb-18	1.2	
25-Feb-18	0.3	
26-Feb-18	1.6	
27-Feb-18	-	Too many negative values.
28-Feb-18	1.6	
1-Mar-18	0.9	
2-Mar-18	2.6	
3-Mar-18	2.4	
4-Mar-18	0.8	
5-Mar-18	1.9	
6-Mar-18	1.0	
7-Mar-18	0.9	
8-Mar-18	1.5	
9-Mar-18	2.2	

Date	CB Station	
	Daily TSP, µg/m^3	Comments
10-Mar-18	1.5	
11-Mar-18	4.9	
12-Mar-18	2.7	
13-Mar-18	0.5	
14-Mar-18	2.7	
15-Mar-18	1.2	
16-Mar-18	2.8	
17-Mar-18	0.9	
18-Mar-18	2.6	
19-Mar-18	2.0	
20-Mar-18	0.3	
21-Mar-18	2.6	
22-Mar-18	3.8	
23-Mar-18	2.0	
24-Mar-18	6.2	
25-Mar-18	4.3	
26-Mar-18	2.0	
27-Mar-18	1.4	
28-Mar-18	2.7	
29-Mar-18	-	Too many missing and negative values.
30-Mar-18	-	Too many missing and negative values.
31-Mar-18	1.7	
1-Apr-18	2.6	
2-Apr-18	3.4	
3-Apr-18	4.5	
4-Apr-18	2.4	
5-Apr-18	-	Too many missing and negative values.
6-Apr-18	-	Too many negative values.
7-Apr-18	2.6	
8-Apr-18	4.4	
9-Apr-18	3.4	
10-Apr-18	5.7	
11-Apr-18	8.2	
12-Apr-18	9.9	
13-Apr-18	9.8	

Date	CB Station	
	Daily TSP, µg/m³	Comments
14-Apr-18	3.2	
15-Apr-18	2.9	
16-Apr-18	1.7	
17-Apr-18	2.1	
18-Apr-18	1.9	
19-Apr-18	4.2	
20-Apr-18	-	Too many negative values.
21-Apr-18	-	Too many negative values.
22-Apr-18	2.2	
23-Apr-18	2.6	
24-Apr-18	2.5	
25-Apr-18	3.1	
26-Apr-18	1.8	
27-Apr-18	3.2	
28-Apr-18	1.0	
29-Apr-18	-	Too many negative values.
30-Apr-18	6.2	
1-May-18	4.3	
2-May-18	2.5	
3-May-18	-	Too many negative values.
4-May-18	4.1	
5-May-18	3.8	
6-May-18	1.7	
7-May-18	-	Too many negative values.
8-May-18	2.4	
9-May-18	3.1	
10-May-18	5.4	
11-May-18	1.9	
12-May-18	1.3	
13-May-18	3.9	
14-May-18	6.0	
15-May-18	2.7	
16-May-18	1.7	
17-May-18	8.6	
18-May-18	11.6	

Date	CB Station	
	Daily TSP, µg/m^3	Comments
19-May-18	-	Too many negative values.
20-May-18	1.8	
21-May-18	2.4	
22-May-18	2.5	
23-May-18	5.3	
24-May-18	2.6	
25-May-18	1.7	
26-May-18	2.1	
27-May-18	1.7	
28-May-18	1.8	
29-May-18	2.7	
30-May-18	3.9	
31-May-18	8.3	
1-Jun-18	7.4	
2-Jun-18	3.9	
3-Jun-18	2.2	
4-Jun-18	2.9	
5-Jun-18	1.0	
6-Jun-18	1.7	
7-Jun-18	3.7	
8-Jun-18	4.8	
9-Jun-18	7.0	
10-Jun-18	6.5	
11-Jun-18	-	Too many negative values.
12-Jun-18	9.1	
13-Jun-18	2.8	
14-Jun-18	-	Too many negative values.
15-Jun-18	4.9	
16-Jun-18	6.3	
17-Jun-18	5.7	
18-Jun-18	4.0	
19-Jun-18	23.2	
20-Jun-18	-	Too many negative values.
21-Jun-18	6.3	
22-Jun-18	-	Too many negative values.

Date	CB Station	
	Daily TSP, µg/m^3	Comments
23-Jun-18	-	Too many negative values.
24-Jun-18	-	Too many negative values.
25-Jun-18	-	Too many negative values.
26-Jun-18	1.5	
27-Jun-18	1.5	
28-Jun-18	-	Too many negative values.
29-Jun-18	-	Too many missing and negative values.
30-Jun-18	7.3	
1-Jul-18	-	Too many negative values.
2-Jul-18	3.0	
3-Jul-18	8.9	
4-Jul-18	5.8	
5-Jul-18	8.9	
6-Jul-18	-	Too many negative values.
7-Jul-18	1.6	
8-Jul-18	7.6	
9-Jul-18	13.0	
10-Jul-18	20.5	
11-Jul-18	21.8	
12-Jul-18	13.1	
13-Jul-18	-	Too many negative values.
14-Jul-18	-	Too many negative values.
15-Jul-18	5.6	
16-Jul-18	-	Too many negative values.
17-Jul-18	3.5	
18-Jul-18	-	Too many negative values.
19-Jul-18	4.3	
20-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.
21-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.
22-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.
23-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.
24-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.

Date	CB Station	
	Daily TSP, µg/m^3	Comments
25-Jul-18	-	Too many missing values. Ethernet cable was unplugged causing a blank blue screen on the unit.
26-Jul-18	14.1	
27-Jul-18	15.2	
28-Jul-18	-	Too many negative values.
29-Jul-18	1.2	
30-Jul-18	4.2	
31-Jul-18	8.7	
1-Aug-18	-	Too many negative values.
2-Aug-18	14.8	
3-Aug-18	-	Too many negative values.
4-Aug-18	3.9	
5-Aug-18	9.3	
6-Aug-18	6.3	
7-Aug-18	-	Too many negative values.
8-Aug-18	5.1	
9-Aug-18	-	Too many negative values.
10-Aug-18	-	Too many negative values.
11-Aug-18	-	Too many negative values.
12-Aug-18	6.9	
13-Aug-18	3.7	
14-Aug-18	-	Too many negative values.
15-Aug-18	-	Too many negative values.
16-Aug-18	9.2	
17-Aug-18	7.6	
18-Aug-18	-	Too many negative values.
19-Aug-18	6.1	
20-Aug-18	6.5	
21-Aug-18	-	Too many negative values.
22-Aug-18	2.1	
23-Aug-18	1.4	
24-Aug-18	2.7	
25-Aug-18	2.3	
26-Aug-18	5.8	
27-Aug-18	5.3	
28-Aug-18	-	Too many negative values.

Date	CB Station	
	Daily TSP, µg/m^3	Comments
29-Aug-18	4.1	
30-Aug-18	5.9	
31-Aug-18	4.4	
1-Sep-18	-	Too many negative values.
2-Sep-18	6.1	
3-Sep-18	4.8	
4-Sep-18	3.7	
5-Sep-18	5.1	
6-Sep-18	2.8	
7-Sep-18	4.7	
8-Sep-18	1.8	
9-Sep-18	8.0	
10-Sep-18	2.0	
11-Sep-18	2.1	
12-Sep-18	1.8	
13-Sep-18	1.0	
14-Sep-18	2.0	
15-Sep-18	1.1	
16-Sep-18	0.7	
17-Sep-18	1.9	
18-Sep-18	4.2	
19-Sep-18	4.5	
20-Sep-18	7.8	
21-Sep-18	1.7	
22-Sep-18	6.0	
23-Sep-18	3.4	
24-Sep-18	1.6	
25-Sep-18	1.8	
26-Sep-18	2.9	
27-Sep-18	10.3	
28-Sep-18	6.9	
29-Sep-18	2.5	
30-Sep-18	3.4	
1-Oct-18	10.3	
2-Oct-18	7.7	

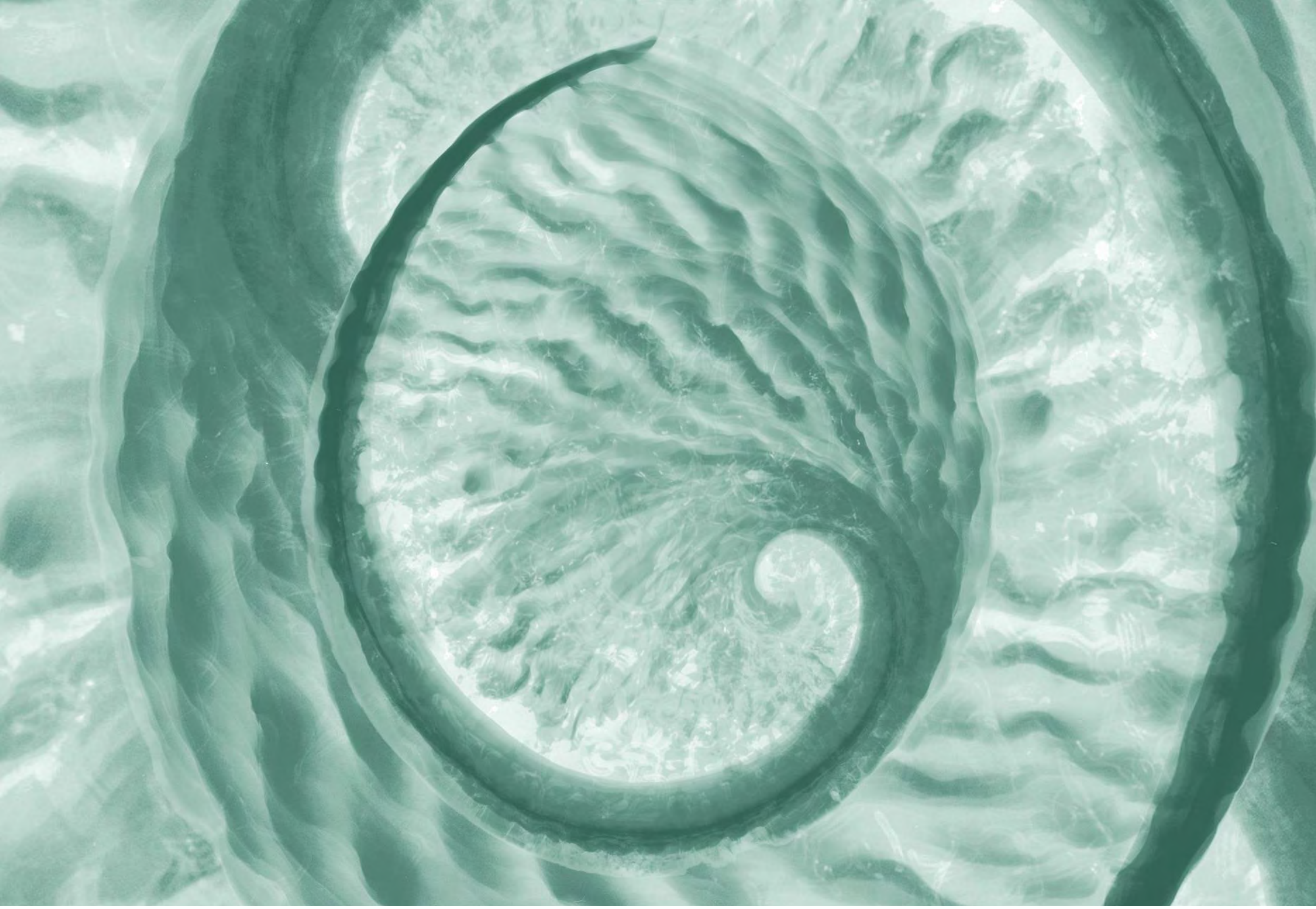
Date	CB Station	
	Daily TSP, µg/m^3	Comments
3-Oct-18	2.2	
4-Oct-18	2.4	
5-Oct-18	1.3	
6-Oct-18	2.4	
7-Oct-18	4.6	
8-Oct-18	6.5	
9-Oct-18	17.1	
10-Oct-18	6.9	
11-Oct-18	1.1	
12-Oct-18	2.9	
13-Oct-18	2.5	
14-Oct-18	1.2	
15-Oct-18	1.8	
16-Oct-18	2.8	
17-Oct-18	2.0	
18-Oct-18	1.6	
19-Oct-18	1.3	
20-Oct-18	4.8	
21-Oct-18	0.6	
22-Oct-18	1.2	
23-Oct-18	1.3	
24-Oct-18	1.9	
25-Oct-18	1.8	
26-Oct-18	1.7	
27-Oct-18	0.7	
28-Oct-18	0.5	
29-Oct-18	2.4	
30-Oct-18	0.4	
31-Oct-18	0.9	
1-Nov-18	0.8	
2-Nov-18	1.8	
3-Nov-18	0.9	
4-Nov-18	1.1	
5-Nov-18	1.7	
6-Nov-18	1.9	

Date	CB Station	
	Daily TSP, μg/m³	Comments
7-Nov-18	0.6	
8-Nov-18	4.6	
9-Nov-18	1.1	
10-Nov-18	2.7	
11-Nov-18	1.3	
12-Nov-18	1.0	
13-Nov-18	0.9	
14-Nov-18	0.7	
15-Nov-18	4.1	
16-Nov-18	1.6	
17-Nov-18	1.8	
18-Nov-18	3.6	
19-Nov-18	1.1	
20-Nov-18	-	Too many negative values.
21-Nov-18	11.4	
22-Nov-18	8.1	
23-Nov-18	3.4	
24-Nov-18	2.3	
25-Nov-18	1.9	
26-Nov-18	1.0	
27-Nov-18	0.6	
28-Nov-18	0.5	
29-Nov-18	1.0	
30-Nov-18	0.8	
1-Dec-18	1.2	
2-Dec-18	0.8	
3-Dec-18	0.6	
4-Dec-18	1.1	
5-Dec-18	2.0	
6-Dec-18	0.5	
7-Dec-18	2.6	
8-Dec-18	1.3	
9-Dec-18	1.3	
10-Dec-18	1.6	
11-Dec-18	0.9	

Date	CB Station	
	Daily TSP, µg/m³	Comments
12-Dec-18	1.2	
13-Dec-18	-	Filter tape error.
14-Dec-18	-	Filter tape error.
15-Dec-18	-	Filter tape error.
16-Dec-18	1.7	
17-Dec-18	4.8	
18-Dec-18	1.3	
19-Dec-18	0.6	
20-Dec-18	1.6	
21-Dec-18	0.9	
22-Dec-18	7.4	
23-Dec-18	1.3	
24-Dec-18	1.5	
25-Dec-18	0.8	
26-Dec-18	-	Too many negative values.
27-Dec-18	10.1	
28-Dec-18	2.1	
29-Dec-18	1.9	
30-Dec-18	5.2	
31-Dec-18	3.8	

Note: TSP sampler at A154 Dike station was not operational in 2018 due to issues with the equipment.

APPENDIX D DIAVIK DIAMOND MINE: 2018 DUST DEPOSITION REPORT (DATED JUNE 2019)



Diavik Diamond Mine

2018 Dust Deposition Report

June 2019

Project No.: 0207514-0018

The business of sustainability

June 2019

Diavik Diamond Mine

2018 Dust Deposition Report

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Canada V6E 2J3

EXECUTIVE SUMMARY

Potential air and water quality concerns associated with airborne fugitive dust, which may result from Diavik Diamond Mine (the "Project") mining activities, were identified in the Diavik Diamond Mine Environmental Assessment (DDMI 1998). In accordance with the Environmental Assessment and requirements associated with the Aquatic Effects Monitoring Program (AEMP), a dust monitoring program was initiated in 2001. The program was designed to achieve the following objectives:

- determine dust deposition (dustfall) rates at various distances from the mine project footprint; and
- determine the chemical characteristics of dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result of mining activities, in support of the AEMP.

In 2018, dustfall monitoring included three components, with sampling conducted at varying distances around the mine from 13 to 4,802 metres (m) away from infrastructure:

1. Dustfall gauges (12 monitoring and 2 control locations);
2. Dustfall from snow surveys (24 monitoring and 3 control locations); and
3. Snow water chemistry from snow surveys (16 monitoring and 3 control locations).

A general increase of dust levels was observed during 2018 relative to 2017. Overall, as expected, dustfall rates decreased with distance from the Project. The proximity to mine activity was the strongest indicator of dustfall deposition; however, areas that were predominantly downwind of the Project received more dustfall than upwind areas. In 2018, Dust 3 (25 m from the Project) had the highest recorded dustfall followed by Dust 7 (1,147 m southeast the Project). Fugitive dust generation also was the greatest during snow-free periods as a result of exposed road surfaces. Dust 3 recorded the highest dustfall rate during the summer months (1,096 mg/dm^2/y) compared to the winter months (455 mg/dm^2/y).

Annual dustfall estimated from each of the 14 dustfall gauges ranged from 78 to 796 mg/dm^2/y. The annualized dustfall rates estimated from the 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y. Although there are no dustfall standards for the Northwest Territories, dustfall rates at all stations except SS1-1 and SS5-3 in 2018 were lower than the non-residential objective of 2.9 mg/dm^2/d (1,059 mg/dm^2/y) documented in the former British Columbia (BC) Ministry of Environment dustfall objectives for mining, smelting, and related industries (DDMI 2016). This objective used in the 2015 Dust Deposition Report is no longer used in BC.

Snow water chemistry analytes of interest included those variables with effluent quality criteria (EQC; i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc) or a load limit (i.e., phosphorous) specified in the Type "A" Water Licence (W2015L2-0001, formerly W2007L2-0003). All 2018 sample concentrations were less than associated reference levels as specified by the "maximum concentration of any grab sample" in Water Licence W2015L2-0001. Concentrations of aluminum, chromium, and nickel have generally increased in recent years, while concentrations of most other analytes have generally had no clear trend in recent years. Typically, concentrations decreased with distance from the Project. In general, 2018 sample concentrations were lower than in 2017.

ACKNOWLEDGEMENTS

This report was prepared for Diavik Diamond Mines (2012) Inc. (DDMI) by ERM Consultants Canada Ltd. (ERM). Fieldwork and on site sample analyses were completed by DDMI, and other sample analyses were completed by Maxxam Analytics. Data analyses and reporting were completed by Talaat Bakri (M.Sc.) and reviewed by Andres Soux (M.Sc.). The project was managed by Carol Adly (M.Sc.), and Marc Wen (M.Sc., R.P.Bio.) was the partner in charge.

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ACRONYMS AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP	Aquatic effects monitoring program
BC	British Columbia
BC MOE	British Columbia Ministry of Environment
cm	Centimetre
d	Day
DDMI	Diavik Diamond Mines (2012) Inc.
DL	Detection limits
dm^2	Square decimetre
Dustfall	Dust deposition
EQC	Effluent quality criteria
ERM	ERM Consultants Canada Ltd.
Fugitive Dust	Atmospheric dust arises from mechanical disturbance of granular material exposed to the air and is not discharged to the atmosphere in a confined flow stream.
IQR	The interquartile range of the box plot. In box plots, the middle 50% of data occurs within the limits of the interquartile range.
L	Litre
m	Metre
mg	Milligram
Q1	The lower quartile of the box plot. In box plots, 25% of data are less than this value.
Q3	The upper quartile of the box plot. In box plots, 25% of data are greater than this value.
QA/QC	Quality assurance and quality control
the Project	Diavik Diamond Mine
RPD	Relative percent difference
SOP	Standard operating procedure
WLWB	Wek’èezhìi Land and Water Board
y	Year
µg	Microgram

1. INTRODUCTION

Potential air and water quality concerns associated with airborne fugitive dust, which may result from Diavik Diamond Mine (the “Project”) mining activities, were identified in the Diavik Diamond Mine Environmental Assessment (DDMI 1998). In accordance with the Environmental Assessment and requirements associated with the Aquatic Effects Monitoring Program (AEMP), a dust monitoring program was initiated in 2001. The program was designed to achieve the following objectives:

- determine dust deposition (dustfall) rates at various distances from the mine project footprint; and
- determine the chemical characteristics of dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result of mining activities, in support of the AEMP.

Since 2001, the dustfall monitoring program has gone through various changes, including an increase in the number of sampling locations, the relocation of some sampling stations, and improvements to the dustfall sampling methodology. A description of annual changes is provided in Appendix A. This report includes a comparison between the 2018 observations of dustfall to all site-specific data collected between 2002 and 2018. Appendix A of the Dust Deposition Report summarizes the amendments and additions to the dustfall monitoring program since 2001. Historical dustfall monitoring results have been presented each year in the Diavik Diamond Mine Dust Deposition reports from 2001 to 2017 (DDMI 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). The historical data presented are not considered to represent baseline conditions because construction of the mine began in 2001.

2. METHODOLOGY

The 2018 dustfall monitoring program incorporated three monitoring components, with sampling completed at varying distances around the mine along five transects, including three control locations (Table 2-1, Figure 2-1):

1. Dustfall gauges (12 monitoring and 2 control locations);
2. Dustfall from snow surveys (24 monitoring and 3 control locations); and
3. Snow water chemistry from snow surveys (16 monitoring and 3 control locations).

2.1 Dustfall Gauges

Dustfall gauges were placed at 14 stations (including two control stations) around the Project at distances ranging from approximately 13 to 4,646 metres (m) from mining operations (Table 2-1; Figure 2-1). All 12 stations (plus two control stations) collected dustfall year-round, with samples collected approximately every three months. The average total sampling period for the 12 year-round locations was 360 days.

Dustfall gauges consisted of a hollow brass cylinder (52 centimetres (cm) length, 12.5 cm inner diameter) housed in a Nipher snow gauge (Photo 2.1-1). The cylinder collected dustfall, while the Nipher snow gauge reduced air turbulence around the gauge to increase dustfall catch efficiency. The cylinder was exchanged with an empty, clean cylinder at the end of each sampling period, and the content of the cylinder that was retrieved was processed in the Diavik Diamond Mines (2012) Inc. (DDMI) environment lab to determine the mass of collected dustfall. This processing involved filtration, drying in a high heat oven, and weighing of samples as specified in the Dust Gauge Collection Standard Operating Procedure (SOP; ENVR-508-0112; Appendix E) and the Quality Assurance/Quality Control SOP (ENVR-303-0112; Appendix G.

Once the mass of collected dustfall at a station was measured, the mean daily dustfall rate over the collection period was calculated as:

$$D = \frac{M}{A*T} \qquad \text{[Equation 1]}$$

where:

D = mean daily dustfall rate (mg/dm^2/d) during time period T
M = mass of dustfall collected (mg) during time period T
A = surface area of dustfall gauge collection cylinder orifice (dm^2; approximately 1.227 dm^2)
T = number of days of dustfall collection (d)

The mean daily dustfall rate (mg/dm^2/d) was then multiplied by 365 days to estimate the mean annual dustfall rate (mg/dm^2/y).

Estimated dustfall rates were compared to the former British Columbia Ministry of Environment (BC MOE) dustfall objectives for mining, smelting and related industries (Table 2.1-1; DDMI 2016). The dustfall objective is no longer used in BC; however, for the purposes of this report, dustfall was compared to the former objective to be consistent with prior dust deposition reports. The dustfall objectives ranged from 1.7 to 2.9 milligram per square decimetre per day (mg/dm^2/d), averaged over 30 days. The 1.7 mg/dm^2/d objective was applied to sensitive locations such as residential areas whereas the 2.9 mg/dm^2/d objective was applied to areas where higher dustfall rates would be expected, such as industrial and mining locations. Both values are presented throughout this report. Snow water chemistry data were compared to effluent quality criteria (EQC) set out in Wek'èezhìi Land and Water Board (WLWB) Water Licence W2015L2-0001 (formerly W2007L2-0003).

Table 2-1: Dustfall and Snow Water Chemistry Sampling Locations, Diavik Diamond Mine, 2018

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled[2]
			Easting (m)	Northing (m)			
Dustfall Gauges							
Dust 1	Dec 24, (2017; start), Apr 6, Jun 26, Oct 12, Dec 28	369	533964	7154321	70	Land	n/a
Dust 2A	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 3 (2019)	362	535678	7151339	425	Land	n/a
Dust 3	Jan 10 (start), Apr 8, Jun 26, Oct 12, Dec 28	352	535024	7151872	25	Land	n/a
Dust 4	Jan 10 (start), Apr 5, Jun 27, Oct 13, Dec 28	352	531397	7152127	173	Land	n/a
Dust 5	Jan 6 (start), Apr 6, Jun 25, Oct 10, Jan 2 (2019)	361	535696	7155138	1,183	Land	n/a
Dust 6	Dec 24 (2017; start), Apr 12, Jun 26, Oct 12, Dec 28	369	537502	7152934	13	Land	n/a
Dust 7	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 3 (2019)	362	536819	7150510	1,147	Land	n/a
Dust 8	Jan 6 (start), Apr 5, Jun 25, Oct 10, Jan 2 (2019)	361	531401	7154146	1,213	Land	n/a
Dust 9	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 4 (2019)	363	541204	7152154	3,796	Land	n/a
Dust 10	Jan 16 (start), Apr 7, Jun 26, Oct 12, Dec 28	346	532908	7148924	46	Land	n/a
Dust 11	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 3 (2019)	362	531493	7150156	747	Land	n/a
Dust 12	Jan 6 (start), Apr 7, Jun 25, Oct 10, Jan 3 (2019)	362	529323	7151191	2,326	Land	n/a

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled[2]
			Easting (m)	Northing (m)			
Dust C1	Jan 6 (start), Apr 8, Jun 25, Oct 10, Jan 4 (2019)	363	534979	7144270	4,646	Land	n/a
Dust C2	Jan 6 (start), Apr 5, Jun 25, Oct 10, Jan 3 (2019)	362	528714	7153276	3,036	Land	n/a
Snow Surveys							
SS1-1	Apr 6	186	533912	7154298	30	Land	
SS1-2-4[3]	Apr 6	186	533909	7154382	115	Land	
SS1-2-5[3]	Apr 6	186	533909	7154382	115	Land	
SS1-3	Apr 6	186	533975	7154514	263	Land	
SS1-4	Apr 6	186	534489	7155083	899	Ice	✓
SS1-5	Apr 6	155	535096	7156290	2,177	Ice	✓
SS2-1-4[3]	Apr 4	153	537550	7153476	145	Ice	✓
SS2-1-5[3]	Apr 4	153	537550	7153476	145	Ice	✓
SS2-2	Apr 4	153	537835	7153489	427	Ice	✓
SS2-3	Apr 6	155	538492	7153940	1,194	Ice	✓
SS2-4	Apr 6	155	539169	7154694	2,164	Ice	✓
SS3-4	Apr 8	157	536585	7151002	613	Ice	✓
SS3-5	Apr 8	157	537676	7150832	1,325	Ice	✓
SS3-6	Apr 8	157	536308	7151578	35	Ice	✓
SS3-7	Apr 8	157	536343	7151359	244	Ice	✓
SS3-8	Apr 8	157	536696	7150809	826	Ice	✓
SS4-1	Apr 5	185	531497	7152209	61	Land	
SS4-2	Apr 5	185	531361	7152258	203	Land	
SS4-3	Apr 5	185	531328	7152476	346	Land	
SS4-4	Apr 5	185	531147	7153165	1,030	Ice	✓
SS4-5	Apr 5	154	531405	7154124	1,214	Ice	✓

Station ID	2018 Sampling Dates	Total Sample Exposure Duration (days)	UTM Coordinates[1]		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled[2]
			Easting (m)	Northing (m)			
SS5-1-4[3]	Apr 7	156	533143	7148934	31	Land	
SS5-1-5[3]	Apr 7	156	533143	7148934	31	Land	
SS5-2	Apr 7	187	533141	7148899	65	Land	
SS5-3	Apr 7	187	533155	7148687	270	Ice	✓
SS5-4	Apr 7	187	533138	7147947	941	Ice	✓
SS5-5	Apr 7	187	533141	7146959	1,894	Ice	✓
Control 1	Apr 8	157	534941	7144103	4,802	Land	✓[4]
Control 2	Apr 5	154	528714	7153307	3,047	Land	✓[4]
Control 3	Apr 7	156	538636	7148753	3,550	Land	✓[4]

Notes:

[1] UTM Zone 12W, NAD83

[2] n/a = not applicable

[3] Duplicate sample taken for snow water chemistry.

[4] Snow water chemistry sampled over ice, adjacent to the on-land control station; see Section 2.3 for further details.

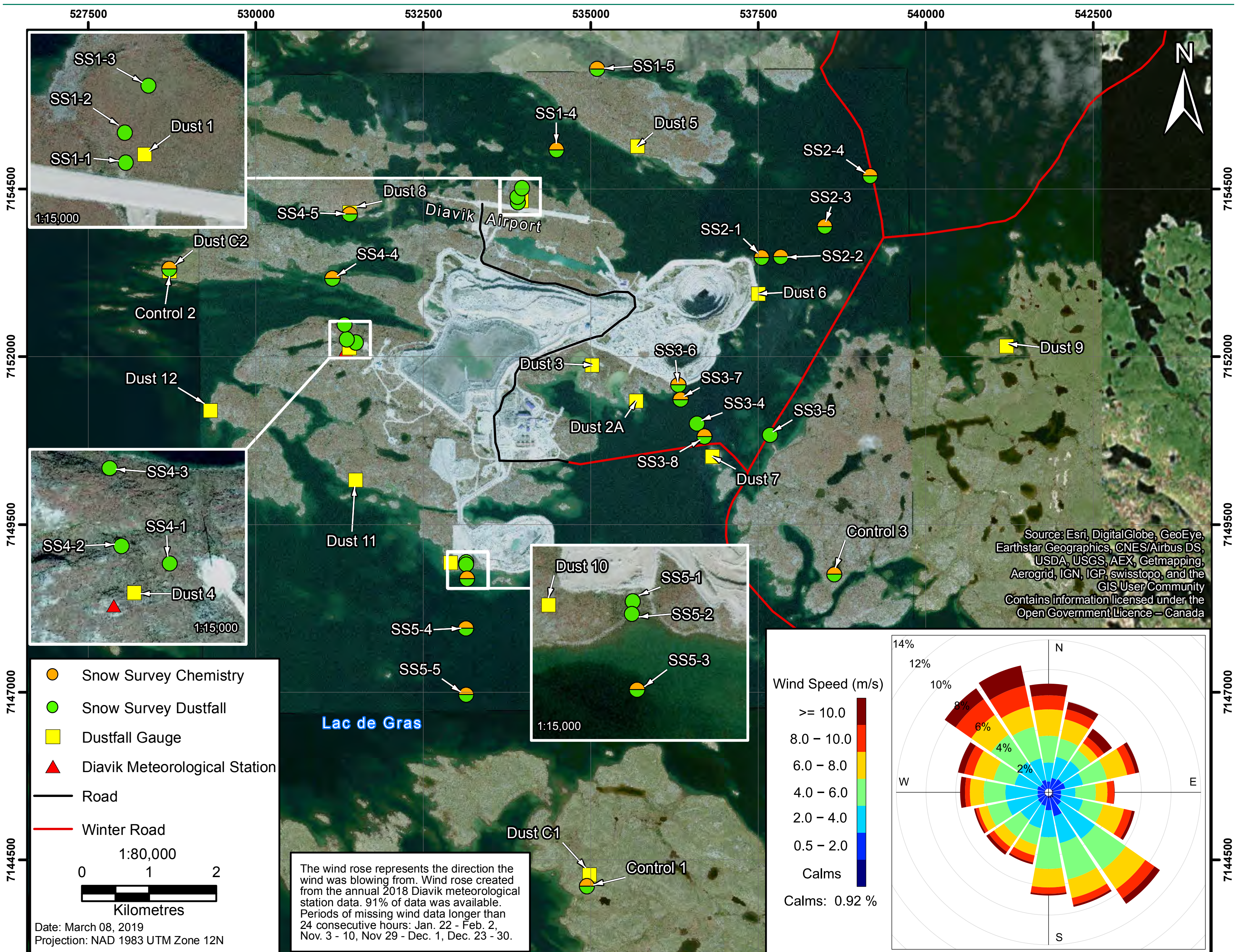


Figure 2-1: Dustfall Gauge and Snow Survey Locations, Diavik Diamond Mine, 2018

Photo 2.1-1: Dustfall gauge during sample collection. The dustfall gauge consisted of a hollow brass cylinder (centre) housed inside a Nipher snow gauge (right).

Table 2.1-1: Dustfall and Snow Water Chemistry Reference Values

Parameter	Value	Unit	Comment	Source
Dustfall Rate	1.7–2.9 (621–1,059)	$mg/dm^2/d$ ($mg/dm^2/y$)	Former objective for the mining, smelting, and related industries	DDMI 2016
Aluminum-Total	3,000	µg/L	Max. grab sample concentration	W2015L2-0001
Ammonia-N	12,000	µg/L	Max. grab sample concentration	W2015L2-0001
Arsenic-Total	100	µg/L	Max. grab sample concentration	W2015L2-0001
Cadmium-Total	3	µg/L	Max. grab sample concentration	W2015L2-0001
Chromium-Total	40	µg/L	Max. grab sample concentration	W2015L2-0001
Copper-Total	40	µg/L	Max. grab sample concentration	W2015L2-0001
Lead-Total	20	µg/L	Max. grab sample concentration	W2015L2-0001
Nickel-Total	100	µg/L	Max. grab sample concentration	W2015L2-0001
Nitrite-N	2,000	µg/L	Max. grab sample concentration	W2015L2-0001
Zinc-Total	20	µg/L	Max. grab sample concentration	W2015L2-0001

2.2 Dustfall Snow Surveys

Dustfall snow surveys were performed at 27 stations (including three control stations), along five transects around the Project (Table 2-1 and Figure 2-1). Across stations, the distance from mining operations ranged from approximately 30 to 4,802 m and the average total sampling period in 2018 was 168 days. The start dates correspond to the first snowfall for land stations (October 2, 2017), and shortly after ice freeze up for ice stations (November 2, 2017).

At each snow survey station, a snow corer was used to drill into the snow pack to retrieve a cylindrical snow core (6.1 cm inner diameter; Photo 2.2-1). Cores were extracted at each station and composited in the field to ensure a representative snow sample was obtained for the station. A minimum of three snow cores were collected at each (land and ice) of the snow sampling stations, as outlined in the Snow Core Survey SOP (ENVR-512-0213; Appendix F). Composited samples were bagged and brought to the DDMI environment lab for processing as specified in the Snow Core Survey SOP (ENVR-512-0213; Appendix F) and the Quality Assurance/Quality Control SOP (ENVR-303-0112; Appendix G). Processing of snow cores involved filtration, drying in a high heat oven and weighing. For quality assurance and control, duplicate samples were collected at stations SS1-2, SS2-1, and SS5-1.

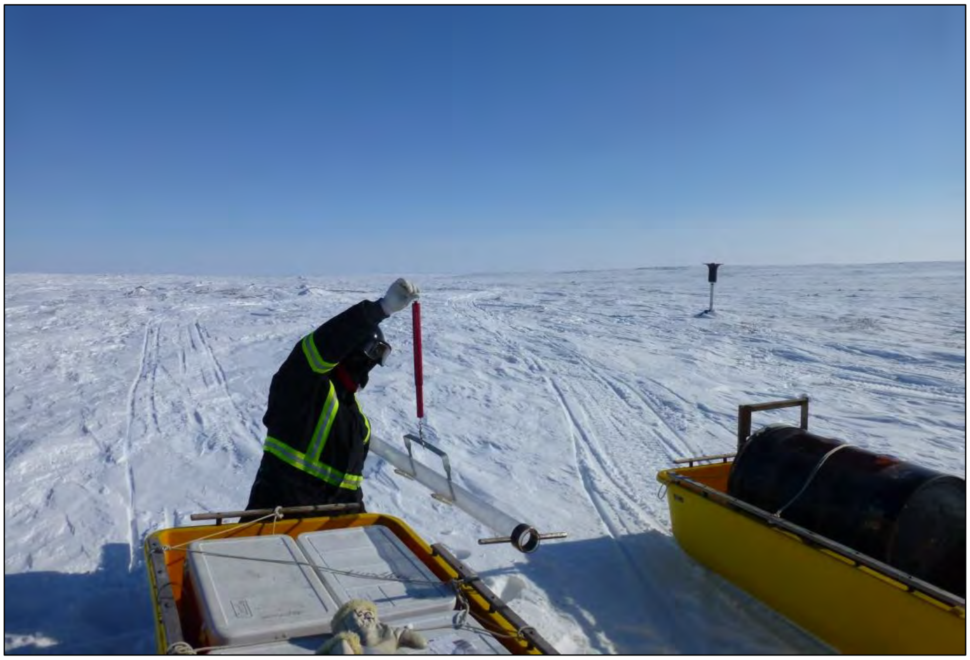


Photo 2.2-1: Snow core sample being weighed, with dustfall gauge in background.

Mean daily dustfall rate (mg/dm^2/d) was then calculated over the collection period using Equation 1, with surface area (A) equal to the surface area of the snow corer tube orifice (0.2922 dm^2) multiplied by the number of snow cores used for the composited sample at the station. The mean annual dustfall rate (mg/dm^2/y) was estimated by multiplying the mean daily dustfall rate by 365 days.

Dustfall rates were compared to the former BC dustfall objective for mining, smelting and related industries (Table 2.1-1) for comparison purposes only.

2.3 Snow Water Chemistry

Snow water chemistry analysis was performed on snow cores extracted from 19 locations (including three control locations; Table 2-1 and Figure 2-1). These locations included the 16 dustfall snow survey stations that were located on ice, as well as samples taken on ice adjacent to the three control stations. Across stations, the distance from mining operations ranged from approximately 35 m to 4,802 m and the average total sampling period in 2018 was 164 days. At each station located over water, cores were collected for chemistry analysis immediately after the dustfall snow cores were extracted.

Snow water chemistry cores were extracted using a snow corer in accordance with the dustfall snow survey core extraction. A minimum of three cores at each site were extracted and composited to obtain the necessary 3 litres (L) of snow water required for the laboratory chemical analysis as required (see Appendix F). Snow cores were then processed and prepared for shipment to Maxxam where the chemical analysis was performed. For quality assurance and control purposes, duplicate samples were collected at stations SS2-1 and SS4-5, and an equipment blank sample was collected at station SS5-5. Snow water chemistry sampling methodology is detailed in SOP ENVR-512-0213 (see Appendix F).

EQC, including “maximum average concentration” and “maximum concentration of any grab sample,” are stipulated in DDMI’s Water Licence (W2015L2-0001) for aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc (Table 2.1-1). Snow water chemistry results for these variables were compared to the “maximum concentration of any grab sample.” These results are also presented as part of DDMI’s Aquatic Effects Monitoring Program (AEMP) report.

DDMI measures the chemistry of snow samples as this assists with characterizing the chemical content of the particulate material deposited over time. This is measured as the total metals and nutrients concentrations of the melted snow sample and makes direct comparison to maximum grab sample concentrations for EQCs difficult. It is important to note that the dust monitoring program is not designed to assess effects in the context used for most other AEMP water quality components.

DDMI compares the measured total metals levels for dust with EQC only because this is a recognizable concentration that provides a comparative reference. Similarly, DDMI contrasts measured dustfall rates with the former British Columbia Ministry of Environment (BC MOE) dustfall objectives for mining, smelting and related industries. There is no intention or requirement that snow samples must meet the EQC or BC MOE objective.

3. RESULTS

Dustfall and snow water chemistry results were grouped into zones based on their relative distance from the mine footprint (Table 3-1). Although station groupings into zones were first established at the outset of the program, these groupings were re-established in 2013 using satellite imagery of the site.

In 2018, the primary sources of fugitive dust were associated with unpaved road and airstrip usage and construction and mining activities at A21. Due to construction and mining activities at A21, the distance to mining operations has been recalculated. The revised distances to mining operations are shown in Tables 2-1 and 3-1.

Major waste rock material transfers in 2018 included the use of haul roads (7,623,715 tonnes) and the transfers of kimberlite ore to the crusher (2,529,725 tonnes). Another source of fugitive dust is truck traffic along the ice road to the Project. However, the consistency in dust deposition rates near the ice road alignment between winter and summer indicated that the contributions of dust from the ice road were modest relative to other sources. There is no direct measurement of dustfall due to the use of the ice road; however, dustfall stations immediately downwind of the ice road such as Dust 7, Dust 6, and SS2-4 did not show elevated readings during winter months. To suppress dust generation, roads, parking areas and laydown areas were watered during the summer as needed. Between May and September 2018, approximately 1,006 m^3 of water was applied to the Project site and 66,472 m^3 of water was applied to haul roads. The exact impact of dust suppression could not be determined from the data collected in 2018; however, it is likely that road watering reduced the amount of dust generated at the Mine in 2018. In 2018, the Underground Mine production continued at A154 and A418, as well as stripping and production at the A21 open pit. Fugitive dust generation is expected to be greatest during snow-free periods where and when there is site activity. It was expected that the highest fugitive dust generation and resulting dustfall occurred in areas closest to the roads, the airstrip, and mine footprint such as near A21 between May and September. Dust 3 (25 m from the Project) recorded the highest dustfall during the summer months (1,096 $mg/dm^2/y$) compared to the winter months (455 $mg/dm^2/y$).

The 2018 predominant wind directions at the site were from southeast and northwest; although, winds in general can be described as omnidirectional. Therefore, the expectation is that airborne material will be deposited in all directions around the mine with a northwest and a southeast emphasis. The results show that both the direction from the mine and the proximity to the mine activity are both strong indicators of dust deposition. This is supported by the fact that Dust 3, which is located only 25 m from the mine, had the highest recorded dustfall rate of the dusfall gauges in 2018 and Dust 7, which is located southeast from the mine and the winter road making it more frequently downwind from the mine, had the second highest recorded dustfall rate in 2018.

Results from the dustfall gauges, dustfall snow surveys, and the snow water chemistry analyses are presented below.

3.1 Dustfall Gauges

For each station, total dustfall collected throughout the year is summarized in Table 3-1, annual 2018 dustfall and the station location relative to the Project is presented in Figure 3.1-1, and the historical records of annual dustfall are presented in Figures 3.1-2 and 3.1-3. A comparison of 2018 dustfall versus distance from the mine footprint is presented in Figure 3.1-4. Boxplots summarizing the dustfall magnitude distribution measured in each year are presented in Figure 3.1-5. Detailed information on 2018 measurements and calculations for each station are included in Appendix B.

Table 3-1: Dustfall and Snow Water Chemistry Results, Diavik Diamond Mine, 2018

Zone	Station	Approx. Distance from Mining (m)	Dustfall (mg/dm²/y)	Snow Water Chemistry (µg/L)										
				Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
0-100 m	Dust 1	70	642	-	-	-	-	-	-	-	-	-	-	-
	Dust 3	25	796	-	-	-	-	-	-	-	-	-	-	-
	Dust 6	13	163	-	-	-	-	-	-	-	-	-	-	-
	Dust 10	46	645	-	-	-	-	-	-	-	-	-	-	-
	SS1-1	30	4,603	-	-	-	-	-	-	-	-	-	-	-
	SS3-6	35	138	858.0	69.0	0.18	0.010	5.54	1.29	0.61	13.2	2.7	89.7	4.8
	SS4-1	61	95	-	-	-	-	-	-	-	-	-	-	-
	SS5-1	31	752	-	-	-	-	-	-	-	-	-	-	-
	SS5-2	65	1,007	-	-	-	-	-	-	-	-	-	-	-
Mean			**982**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Median			**645**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Standard Deviation			**1,396**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
95% Confidence Interval (Mean +/-)			**1,073**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Upper Limit of 95% Confidence Interval			**2,056**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Lower Limit of 95% Confidence Interval			**0**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

Zone	Station	Approx. Distance from Mining (m)	Dustfall (mg/dm²/y)	Snow Water Chemistry (µg/L)										
				Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
101-250 m	Dust 4	173	152	-	-	-	-	-	-	-	-	-	-	-
	SS1-2	115	389	-	-	-	-	-	-	-	-	-	-	-
	SS2-1	145	46	136.0	81.0	0.06	0.0025	0.77	0.55	0.20	3.10	0.50	24.3	1.6
	SS3-7	244	80	473.0	55.0	0.09	0.006	2.32	0.65	0.30	5.0	0.5	29.1	2.8
	SS4-2	203	47	-	-	-	-	-	-	-	-	-	-	-
Mean			**143**	**304.50**	**68.00**	**0.07**	**0.00**	**1.55**	**0.60**	**0.25**	**4.06**	**0.50**	**26.70**	**2.20**
Median			**80**	**304.50**	**68.00**	**0.07**	**0.00**	**1.55**	**0.60**	**0.25**	**4.06**	**0.50**	**26.70**	**2.20**
Standard Deviation			**144**	**238.29**	**18.38**	**0.019**	**0.00**	**1.10**	**0.07**	**0.07**	**1.36**	**0.00**	**3.39**	**0.85**
95% Confidence Interval (Mean +/-)			**179**	**2141.00**	**165.18**	**0.17**	**0.02**	**9.85**	**0.64**	**0.62**	**12.20**	**0.00**	**30.49**	**7.62**
Upper Limit of 95% Confidence Interval			**322**	**2445.50**	**233.18**	**0.25**	**0.02**	**11.39**	**1.24**	**0.87**	**16.26**	**0.50**	**57.19**	**9.82**
Lower Limit of 95% Confidence Interval			**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.50**	**0.00**	**0.00**

Zone	Station	Approx. Distance from Mining (m)	Dustfall (mg/dm²/y)	Snow Water Chemistry (µg/L)										
				Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
251-1,000 m	Dust 2A	425	267	-	-	-	-	-	-	-	-	-	-	-
	Dust 11	747	391	-	-	-	-	-	-	-	-	-	-	-
	SS1-3	263	192	-	-	-	-	-	-	-	-	-	-	-
	SS1-4	899	112	323.0	94.0	0.052	0.0025	1.70	0.43	0.19	4.3	0.5	26.9	2.2
	SS2-2	427	35	181.0	130.0	0.123	0.0057	1.02	0.56	0.39	3.5	0.5	43.6	2.0
	SS3-4	613	61	178.0	26.0	0.01	0.003	0.43	0.38	0.11	2.6	0.5	30.3	1.7
	SS3-8	826	422	2,080.0	120.0	0.32	0.021	13.50	2.78	2.13	32.8	7.2	223.0	9.4
	SS4-3	346	43	-	-	-	-	-	-	-	-	-	-	-
	SS5-3	270	1,349	554.00	82.00	0.15	0.007	1.34	1.29	1.07	2.83	11.70	309.00	3.00
	SS5-4	941	231	537.00	50.00	0.15	0.003	1.96	1.00	0.56	5.27	8.50	133.00	3.00
Mean			**310**	**642.17**	**83.67**	**0.13**	**0.01**	**3.33**	**1.07**	**0.74**	**8.54**	**4.82**	**127.63**	**3.55**
Median			**211**	**430**	**88**	**0.14**	**0.00**	**1.52**	**0.78**	**0.48**	**3.87**	**3.85**	**88.30**	**2.60**
Standard Deviation			**390**	**723.35**	**40.09**	**0.11**	**0.01**	**5.01**	**0.91**	**0.76**	**11.93**	**4.95**	**117.22**	**2.91**
95% Confidence Interval (Mean +/-)			**279**	**759.11**	**42.07**	**0.11**	**0.01**	**5.26**	**0.95**	**0.80**	**12.52**	**5.20**	**123.01**	**3.06**
Upper Limit of 95% Confidence Interval			**589**	**1401.28**	**125.74**	**0.25**	**0.014**	**8.59**	**2.03**	**1.54**	**21.05**	**10.01**	**250.65**	**6.61**
Lower Limit of 95% Confidence Interval			**31**	**0.00**	**41.60**	**0.02**	**0.00**	**0.00**	**0.12**	**0.00**	**0.00**	**0.00**	**4.62**	**0.49**

Zone	Station	Approx. Distance from Mining (m)	Dustfall (mg/dm²/y)	Snow Water Chemistry (µg/L)										
				Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
1,001-2,500 m	Dust 5	1,183	156	-	-	-	-	-	-	-	-	-	-	-
	Dust 7	1,147	667	-	-	-	-	-	-	-	-	-	-	-
	Dust 8	1,213	127	-	-	-	-	-	-	-	-	-	-	-
	Dust 12	2,326	105	-	-	-	-	-	-	-	-	-	-	-
	SS1-5	2,177	175	423.0	80.0	0.13	0.0061	2.7	0.58	0.30	9.0	2.8	38.6	3.1
	SS2-3	1,194	22	28.6	34.0	0.025	0.0025	0.18	0.48	0.05	1.0	0.5	7.6	1.1
	SS2-4	2,164	19	11.1	37.0	0.01	0.0025	0.26	0.05	0.01	0.67	0.5	6.7	0.5
	SS3-5	1,325	81	103.0	73.0	0.03	0.003	0.8	0.3	0.2	3.5	1.9	39.3	1.2
	SS4-4	1,030	61	96.6	72.0	0.05	0.0025	0.8	0.3	0.22	3.3	0.5	26.2	1.4
	SS4-5	1,214	40	286.0	75.0	0.07	0.003	2.2	0.5	0.22	5.9	0.5	22.7	2.6
	SS5-5	1,894	57	82.1	42.0	0.022	0.0025	0.72	0.28	0.08	3.00	1.1	19.5	1.4
+2,500 m	Dust 9	3,796	149	-	-	-	-	-	-	-	-	-	-	-
Mean			**138**	**147.20**	**59.00**	**0.05**	**0.0030**	**1.11**	**0.36**	**0.15**	**3.76**	**1.11**	**22.94**	**1.61**
Median			**93**	**96.60**	**72.00**	**0.03**	**0.0025**	**0.77**	**0.33**	**0.19**	**3.33**	**0.50**	**22.70**	**1.40**
Standard Deviation			**175**	**150.93**	**20.25**	**0.04**	**0.0014**	**0.99**	**0.18**	**0.11**	**2.90**	**0.91**	**13.13**	**0.91**
95% Confidence Interval (Mean +/-)			**111**	**139.58**	**18.73**	**0.04**	**0.0013**	**0.91**	**0.17**	**0.10**	**2.68**	**0.84**	**12.14**	**0.84**
Upper Limit of 95% Confidence Interval			**249**	**286.78**	**77.73**	**0.09**	**0.0043**	**2.02**	**0.53**	**0.25**	**6.44**	**1.96**	**35.09**	**2.45**
Lower Limit of 95% Confidence Interval			**27**	**7.62**	**40.27**	**0.01**	**0.0018**	**0.19**	**0.194**	**0.053**	**1.08**	**0.27**	**10.80**	**0.77**

Zone	Station	Approx. Distance from Mining (m)	Dustfall (mg/dm²/y)	Snow Water Chemistry (µg/L)										
				Aluminum	Ammonia	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Nitrite	Phosphorous	Zinc
Control	Dust C1	4,646	85	-	-	-	-	-	-	-	-	-	-	-
	Dust C2	3,036	78	-	-	-	-	-	-	-	-	-	-	-
	Control 1	4,802	32	151.0	46.0	0.032	0.0025	1.11	0.230	0.12	2.88	0.5	28.2	2.2
	Control 2	3,047	26	64.2	37.0	0.052	0.0025	0.6	0.29	0.09	2.4	1.2	14.9	2.0
	Control 3	3,550	69	296.0	90.0	0.080	0.0025	2.2	0.64	0.35	7.7	2.4	66.0	2.6
Mean			**58**	**170.40**	**57.67**	**0.055**	**0.00**	**1.30**	**0.39**	**0.18**	**4.32**	**1.37**	**36.37**	**2.27**
Median			**69**	**151.00**	**46.00**	**0.052**	**0.00**	**1.11**	**0.29**	**0.12**	**2.88**	**1.20**	**28.20**	**2.20**
Standard Deviation			**27**	**117.11**	**28.36**	**0.024**	**0.00**	**0.81**	**0.22**	**0.14**	**2.92**	**0.96**	**26.51**	**0.31**
95% Confidence Interval (Mean +/-)			**34**	**290.92**	**70.45**	**0.06**	**0.00**	**2.00**	**0.55**	**0.35**	**7.24**	**2.39**	**65.86**	**0.76**
Upper Limit of 95% Confidence Interval			**92**	**461.32**	**128.12**	**0.11**	**0.00**	**3.30**	**0.94**	**0.54**	**11.57**	**3.75**	**102.22**	**3.03**
Lower Limit of 95% Confidence Interval			**24**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.51**
Reference Levels			**621–1,059**	**3,000**	**12,000**	**100**	**3**	**40**	**40**	**20**	**100**	**2,000**	**n/a**	**20**

Notes:

Dash (-) = not available (snow water chemistry not sampled)

n/a = not applicable

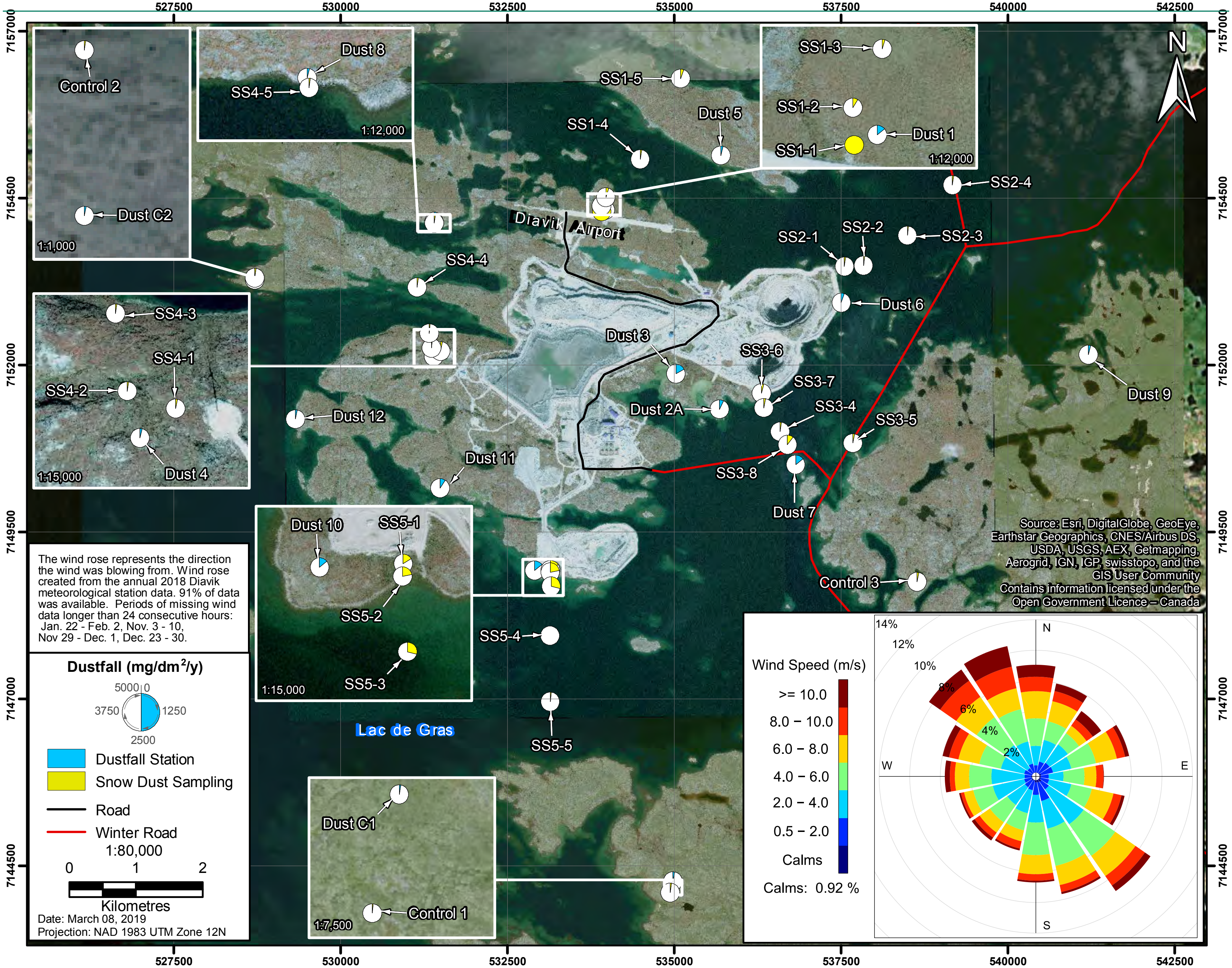
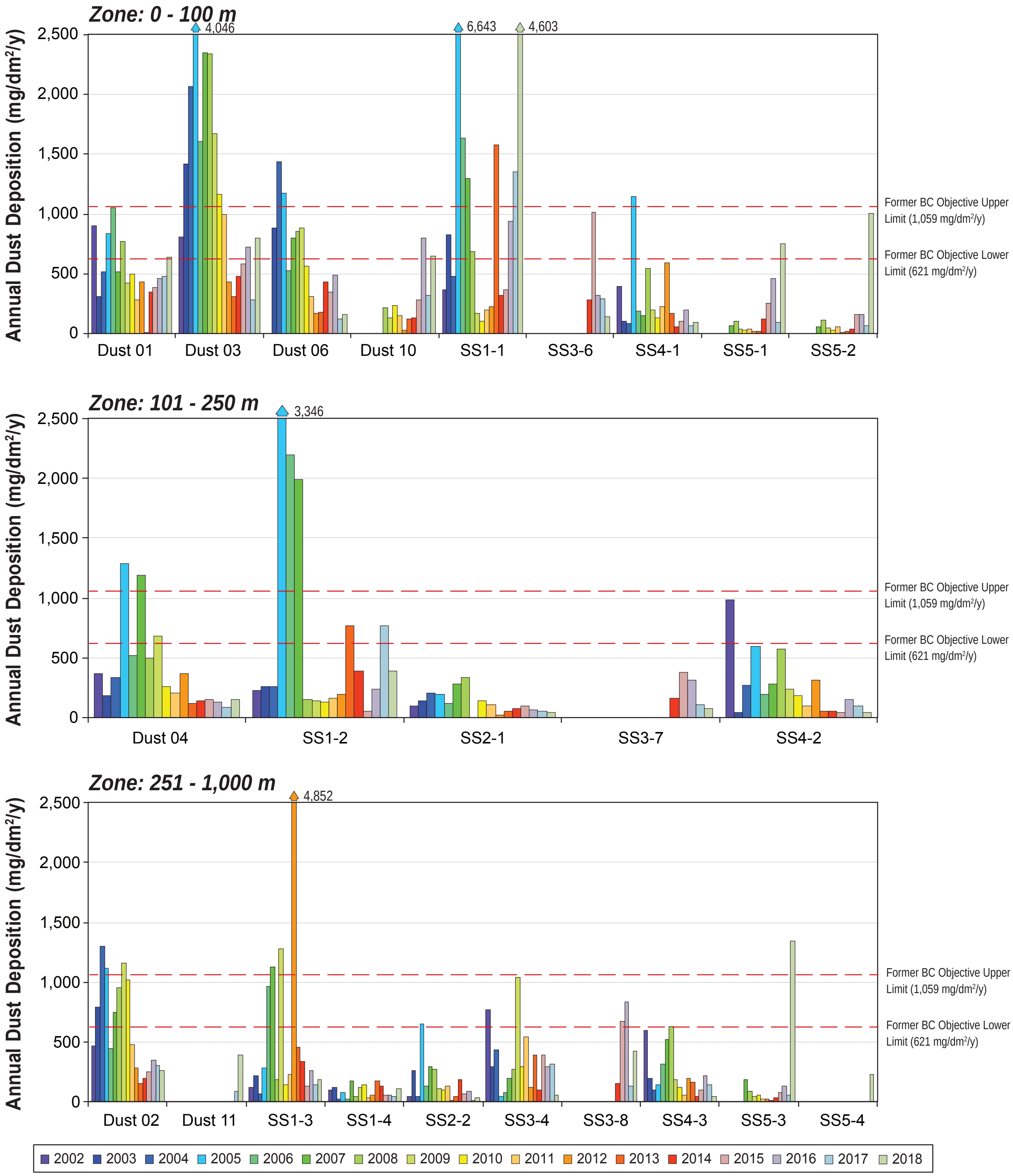
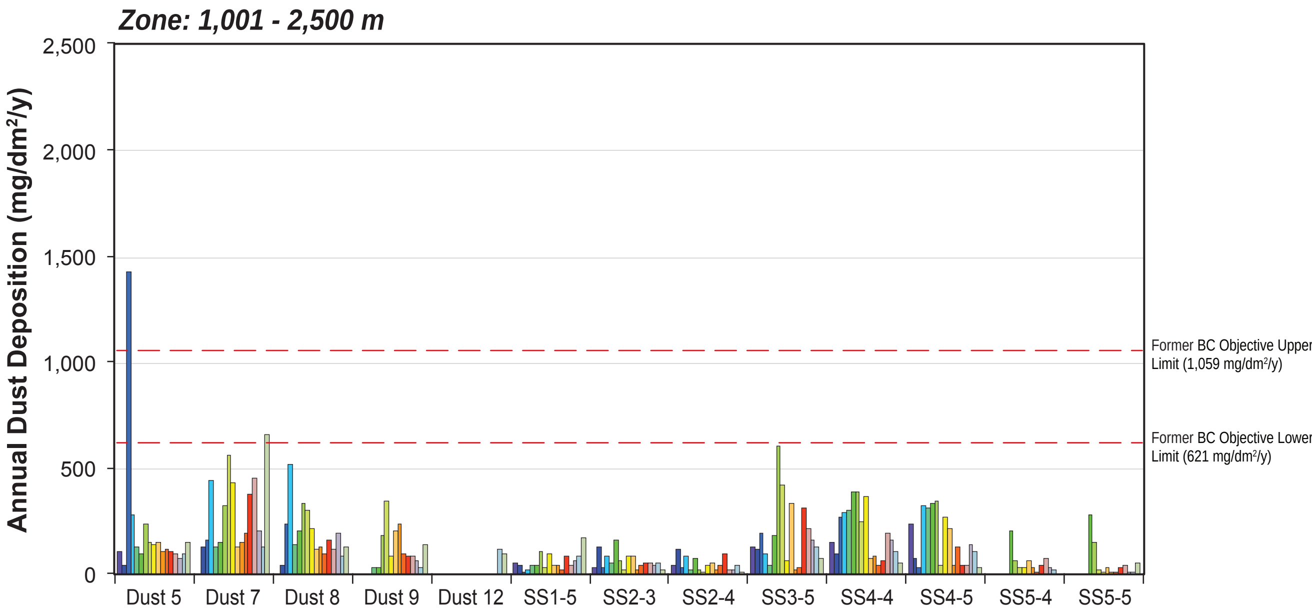


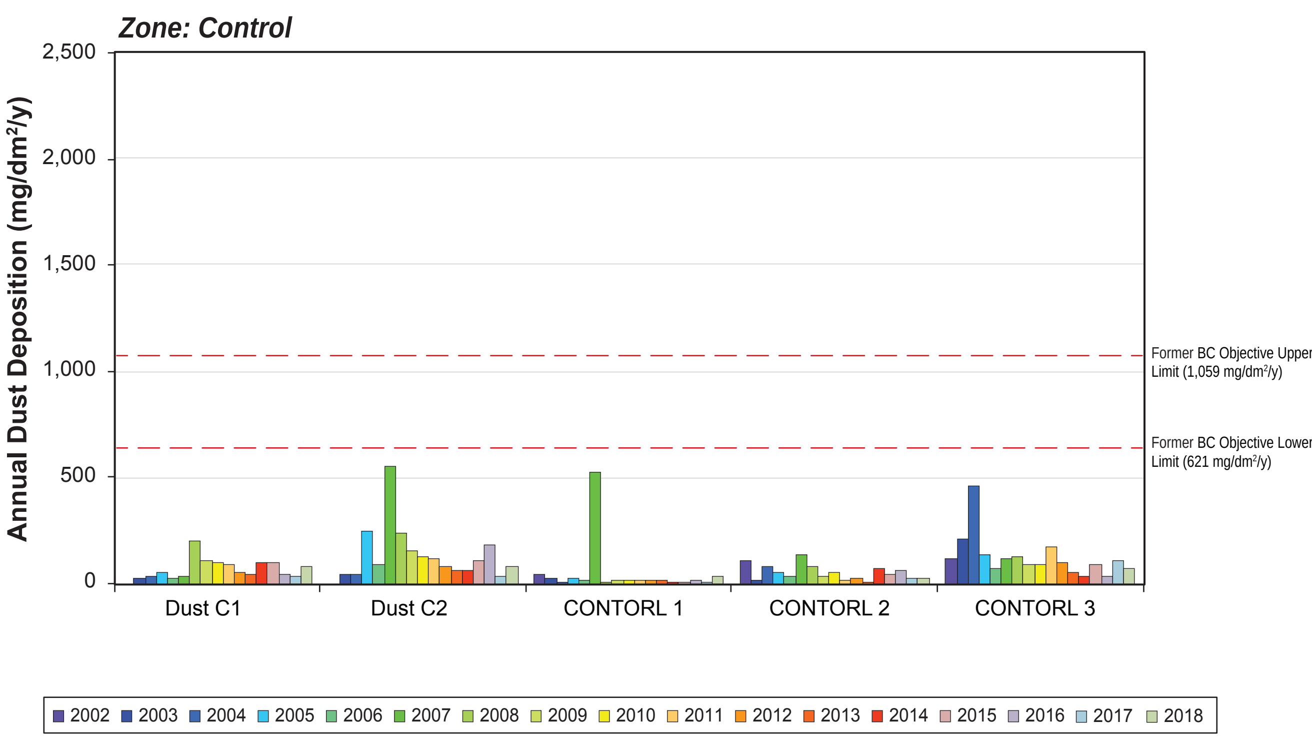
Figure 3.1-1: Dustfall Results, Diavik Diamond Mine, 2018



Notes: *Former BC Objective (DDMI 2016).*
Annual deposition was calculated using the methodology described in Section 2.
See Table 2-1 for actual 2018 sample exposure times.
Station locations have been grouped into zones based on their distance from the 2018 Project footprint (see Section 3 for further details).
SS5-4 moved to 251 – 1000 m zone in 2018.

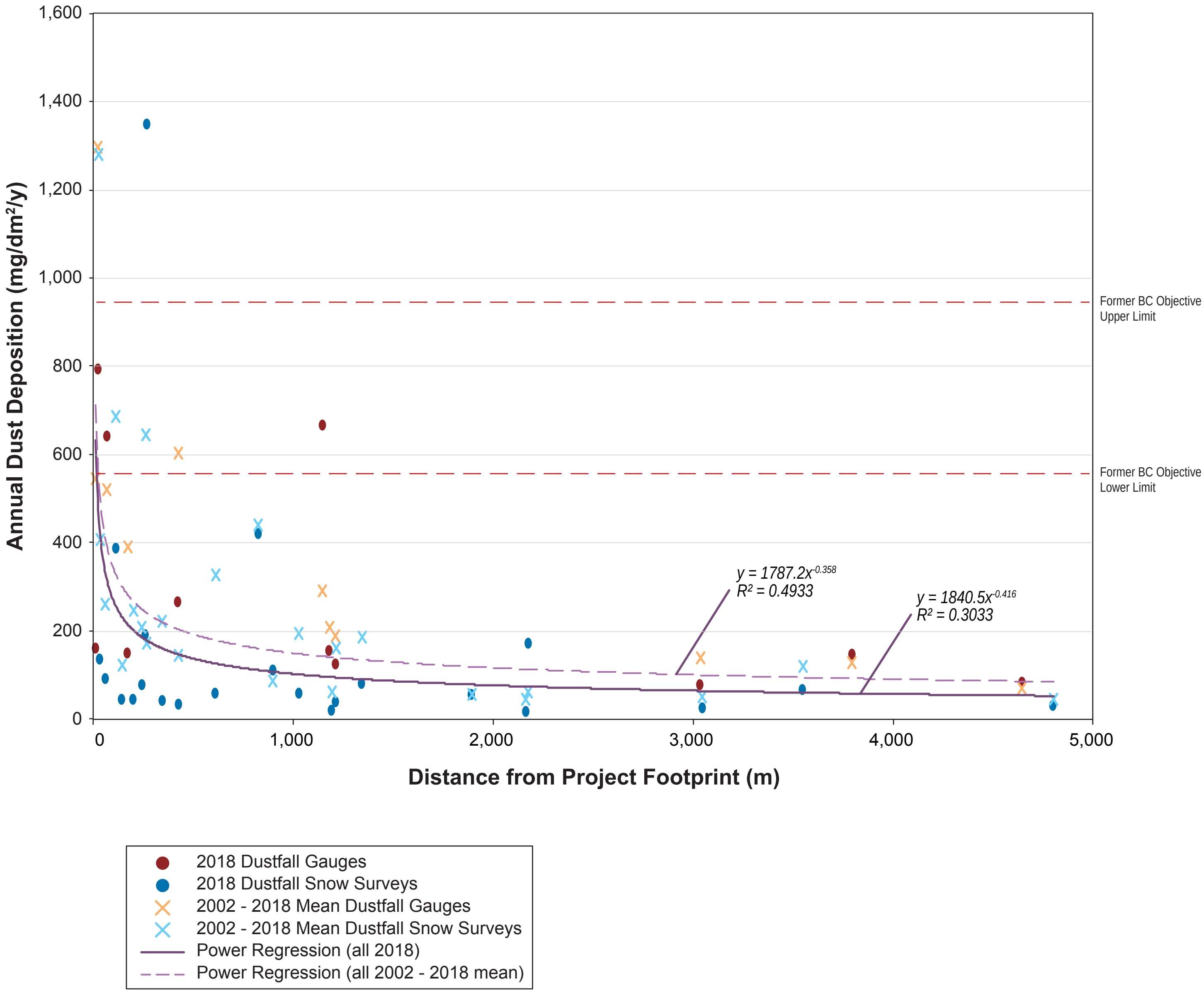
Figure 3.1-2: Calculated Annual Dust Deposition Rates at Dustfall Gauges and Snow Survey Locations up to 1,000 m from the Project Footprint, Diavik Diamond Mine, 2002 to 2018





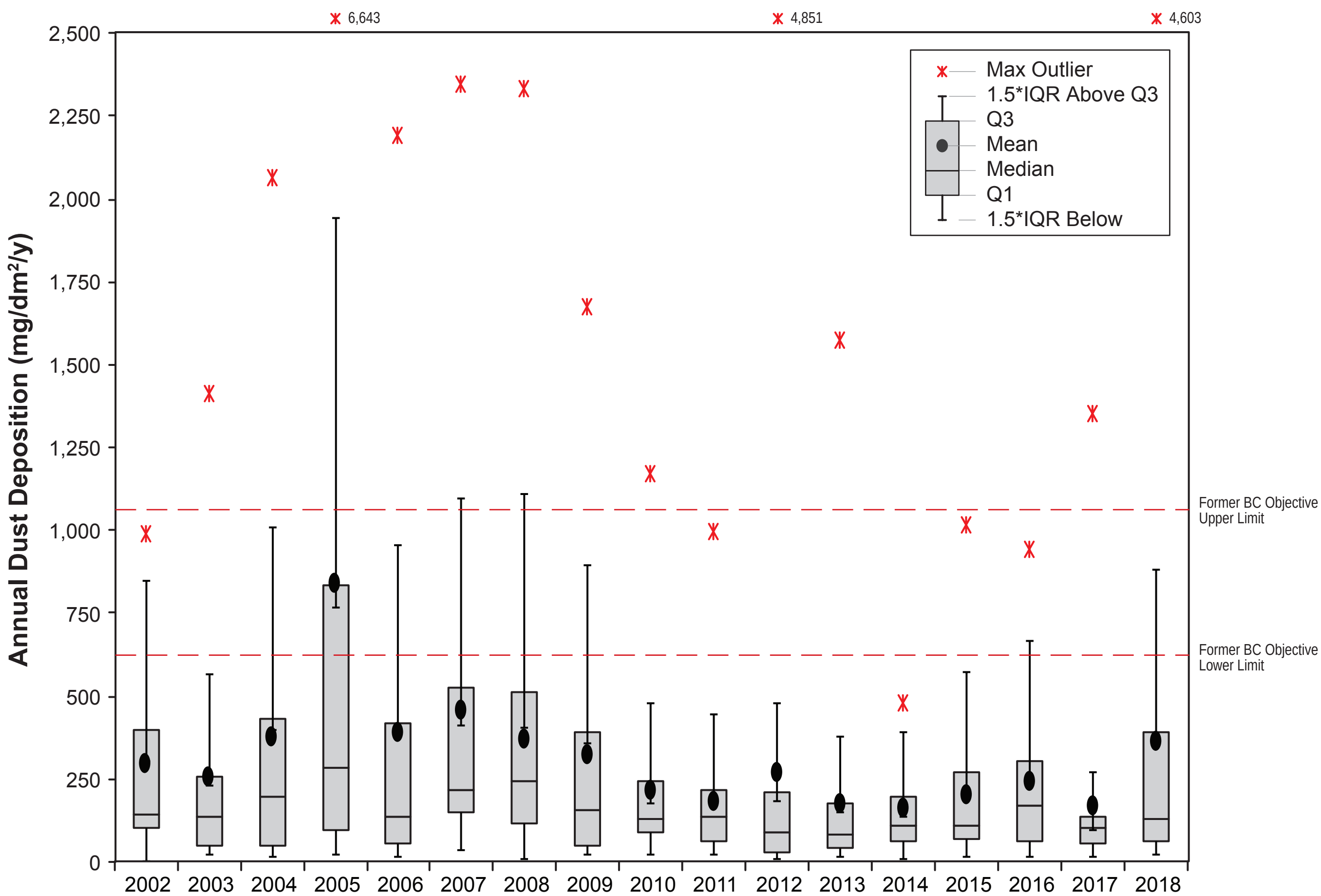
Notes: *Former BC Objective (DDMI 2016).*
Annual deposition was calculated using the methodology described in Section 2.
See Table 2-1 for actual 2018 sample exposure times.
Station locations have been grouped into zones based on their distance from the 2018 Project footprint (see Section 3 for further details).
SS5-4 moved to 251 – 1000 m zone in 2018.

Figure 3.1-3: Calculated Annual Dust Deposition Rates at Dustfall Gauges and Snow Survey Locations greater than 1,000 m from the Project Footprint, Diavik Diamond Mine, 2002 to 2018



Notes: Former BC Objective (DDMI 2016).
Annual deposition is calculated using the methodology described in Section 2.
See Table 2-1 for actual 2018 sample exposure times.

Figure 3.1-4: Dust Deposition Versus Distance from Project Footprint, Diavik Diamond Mine, 2018



Notes: Former BC Objective (DDMI 2016).
Annual deposition is calculated using the methodology described in Section 2.
See Table 2-1 for actual 2017 sample exposure times.
Q1: Lower quartile (25% of data are less than this value) ,
Q3: Upper quartile (25% of data are greater than this value),
IQR = Q3 – Q1 (the interquartile range).

Figure 3.1-5: Dust Deposition Box Plot, Diavik Diamond Mine, 2002 to 2018

The greatest estimated dustfall rate measured using gauges occurred at Dust 3 (25 m from the Project). The Dust 3 measured dustfall rate in 2018 was 796 mg/dm^2/y. Dust 7 (667 mg/dm^2/y) and Dust 10 (645 mg/dm^2/y) recorded the second and third highest dustfall rates measured using gauges, respectively. Both sites are located on the south side of the Project. Dust 7 is located 1,147 m from the Project but very close to the winter road (Figure 2-1), and Dust 10 is located 46 m from the Project adjacent to the A21 open pit. Dust 1, which recorded the highest dustfall rate in 2017, recorded the fourth highest rate in 2018 (642 mg/dm^2/y). Similar to 2017, both control stations Dust C2 (3,036 m west; 78 mg/dm^2/y) and Dust C1 (4,646 m south; 85 mg/dm^2/y) recorded the lowest dustfall rates (Table 3-1; Figures 3.1-3 and 3.1-4).

The dustfall rates estimated from dustfall gauges in 2018 were the highest since 2008 (Figures 3.1-2 to 3.1-4). The 2018 mean and maximum dustfall values suggest that dustfall rates increased at the Project in 2018 in comparison to the previous few years. The higher overall dustfall rates in 2018 were likely influenced by the surface activity at the mine, particularly at the A21 open pit, which began in December 2017, while the dustfall rates in 2017 were related mainly to the airstrip.

The annualized dustfall rates estimated from gauges at each station were less than the former BC objective for the mining industry (621 to 1,059 mg/dm^2/y; Figures 3.1-2 to 3.1-4) except at the four sites that recorded the highest dustfall rates in 2018 (Dust 3, 7, 10, and 1). This former objective was used for comparison purposes only: there are currently no standards or objectives for the Northwest Territories. However, the BC objective is generally used as a standard for comparison at other mines in the region.

3.2 Dustfall Snow Surveys

Annual dustfall rates estimated from each snow survey station in 2018 are summarized in Table 3-1. Historical records of annual snow survey dustfall rates for each station are presented in Figures 3.1-2 and 3.1-3. The relationships between annual snow survey dustfall rates and distance from the mine footprint are shown in Figures 3.1-1 and 3.1-4. Boxplots summarizing dustfall rates measured in each year are presented in Figure 3.1-5. 2018 snow survey field datasheets and laboratory results are included in Appendix B. Duplicate samples collected at stations SS1-2, SS2-1, SS4-5, and SS5-1 for QA/QC purposes are discussed in Section 3.4.

Annualized dustfall rates estimated from 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y (Table 3-1; Figures 3.1-2 and 3.1-3). Similar to 2017, SS1-1 recorded the highest dustfall rate among all station. It is likely that the proximity of the SS1-1 station to the airstrip resulted in the relatively high dustfall rates at this station. The second and third highest dustfall rates were recorded at SS5-3 (1,349 mg/dm^2/y) and SS5-2 (1,007 mg/dm^2/y), respectively. Similar to Dust 10, both SS5-3 and SS5-2 stations are located adjacent to the A21 open pit (Figure 2-1), where most of the surface mining activity occurred during 2018. As expected, the snow survey dusfall rates generally decreased with increasing distance from the Project. The lowest dustfall rates were recorded at SS2-4 (19 mg/dm^2/y) followed by SS2-3 (22 mg/dm^2/y). Both of these rates are lower than the rates at the control stations (Table 3-1; Figure 3.1-4). The lower rates at these two stations may be explained by the upwind location of both stations, in addition to the greater distance from the A21 open pit relative to the control stations. Mean dustfall rates estimated using both dustfall gauges and snow surveys within the 0–100, 101-250, 251–1,000, 1,001–2,500 and Control zones were 982, 143, 319, 138, and 58 mg/dm^2/y, respectively (Table 3-1). Dustfall rates at stations SS1-1, SS1-2, SS5-3, and Dust 7 were greater than the upper limit of the 95% confidence interval for their respective zones in 2018. These high dustfall rates, compared to the overall distribution of dustfall rates within each zone, indicated that higher dustfall rates were observed in the vicinity of the A21 open pit, the airstrip, and the winter road southeast of the Project (Table 3-1).

Annualized dustfall estimated from each snow survey station in 2018 were generally higher than dustfall estimates from the past few years (Figures 3.1-2 and 3.1-3). Comparisons of mean and maximum values suggest that dustfall rates were generally higher in 2018 than in 2017 and 2016 (Figures 3.1-4 and 3.1-5).

Annualized dustfall rates measured at 4 out of 27 stations during the 2018 snow survey were higher than the former BC objective for the mining industry (621–1,059 mg/dm^2/y). These stations include SS1-1, SS5-1, SS5-2, and SS5-3. In comparison, only two stations were higher than these objectives in 2017 (SS1-1 and SS1-2). This former objective was used for comparison purposes only: there are currently no standards or objectives for the Northwest Territories.

3.3 Snow Water Chemistry

A summary of the snow water chemistry results for each variable of interest (i.e., variables with EQC and phosphorous) is provided below. The full suite of analytical results for snow water chemistry is included in Appendix D. For QA/QC purposes, duplicate samples were collected at stations SS2-1 and SS4-5, and an equipment blank sample was collected at station SS5-5. Results of QA/QC samples are discussed in Section 3.4.

All 2018 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” in Water Licence W2015L2-0001.

In general, average concentrations of snow water chemistry variables of interest decreased with increasing distance from the Project (Figures 3.3-1 to 3.3-4). However, high parameter concentrations were recorded at Station SS3-8, located in the 251-1,000 zone (826 m from the project). SS3-8 has a downwind location southeast of the Project (Figure 2-1) and is near the winter road. It should be noted that the 0-100 zone has only one (1) sampling location; therefore, no median was reported in Figures 3.3-1 to 3.3-4.

3.3.1 Aluminum

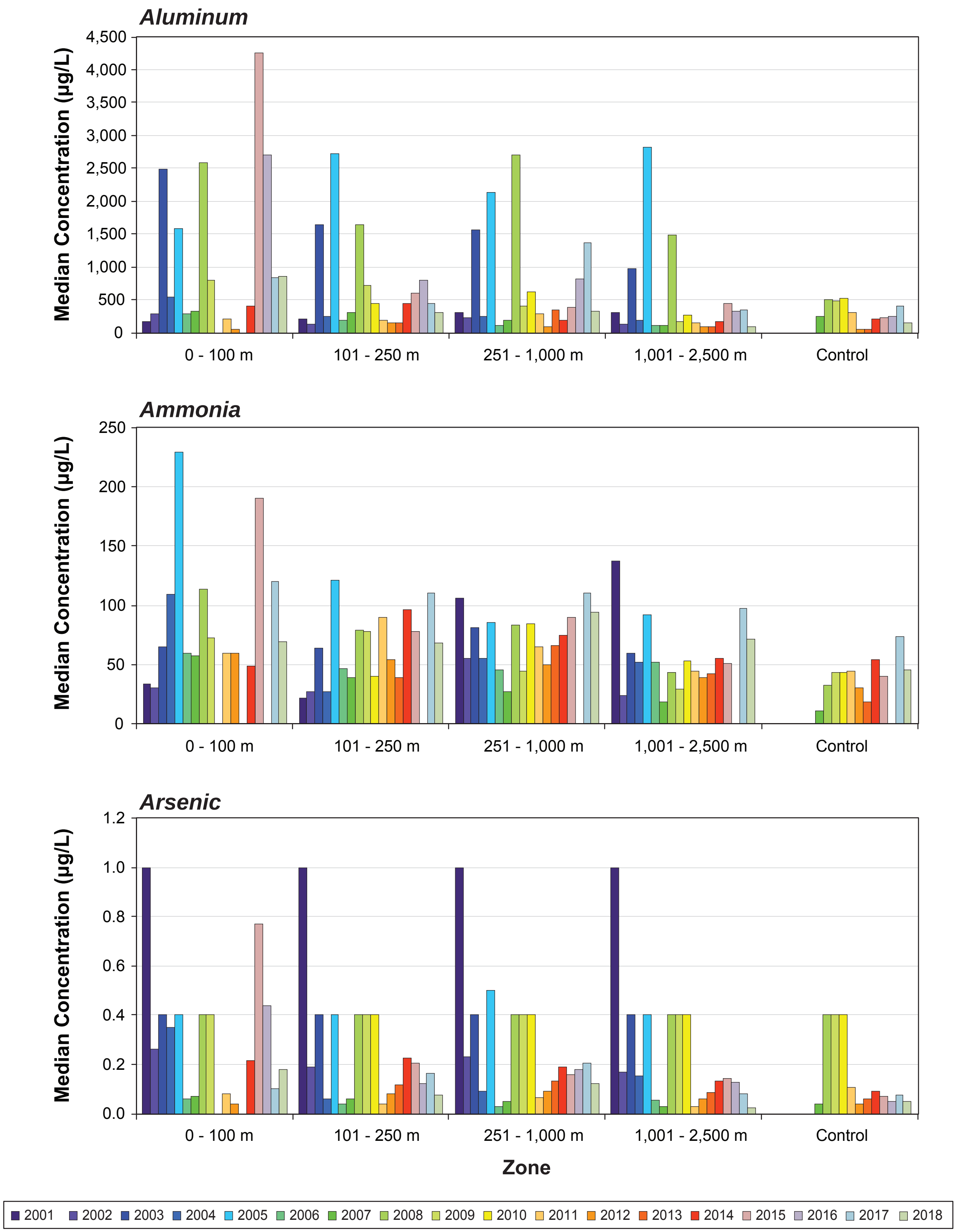
Aluminum concentrations measured in 2018 ranged from 11 µg/L at station SS2-4 in the 1,001-2,500 m zone to 2,080 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Aluminum concentrations in 2018 were greatest in the 0-100 m zone, where only one sample is available (Figure 3.3-1). The median concentrations in all other zones were lower in 2018 than in 2017 and 2016, and none of the locations exceeded the EQC concentration of 3,000 µg/L specified in the Water Licence (Table 3-1; Figure 3.3-1).

3.3.2 Ammonia

Ammonia concentrations measured in 2018 ranged from 26 µg/L at station SS3-4 in the 251-1000 m zone to 130 µg/L at station SS2-2 in the 251-1,000 m zone (Table 3-1). The 2018 median concentrations in all zones are similar to historical data. All 2018 and historical ammonia measurements were below the EQC of 12,000 µg/L specified in the Water Licence for grab sample concentrations.

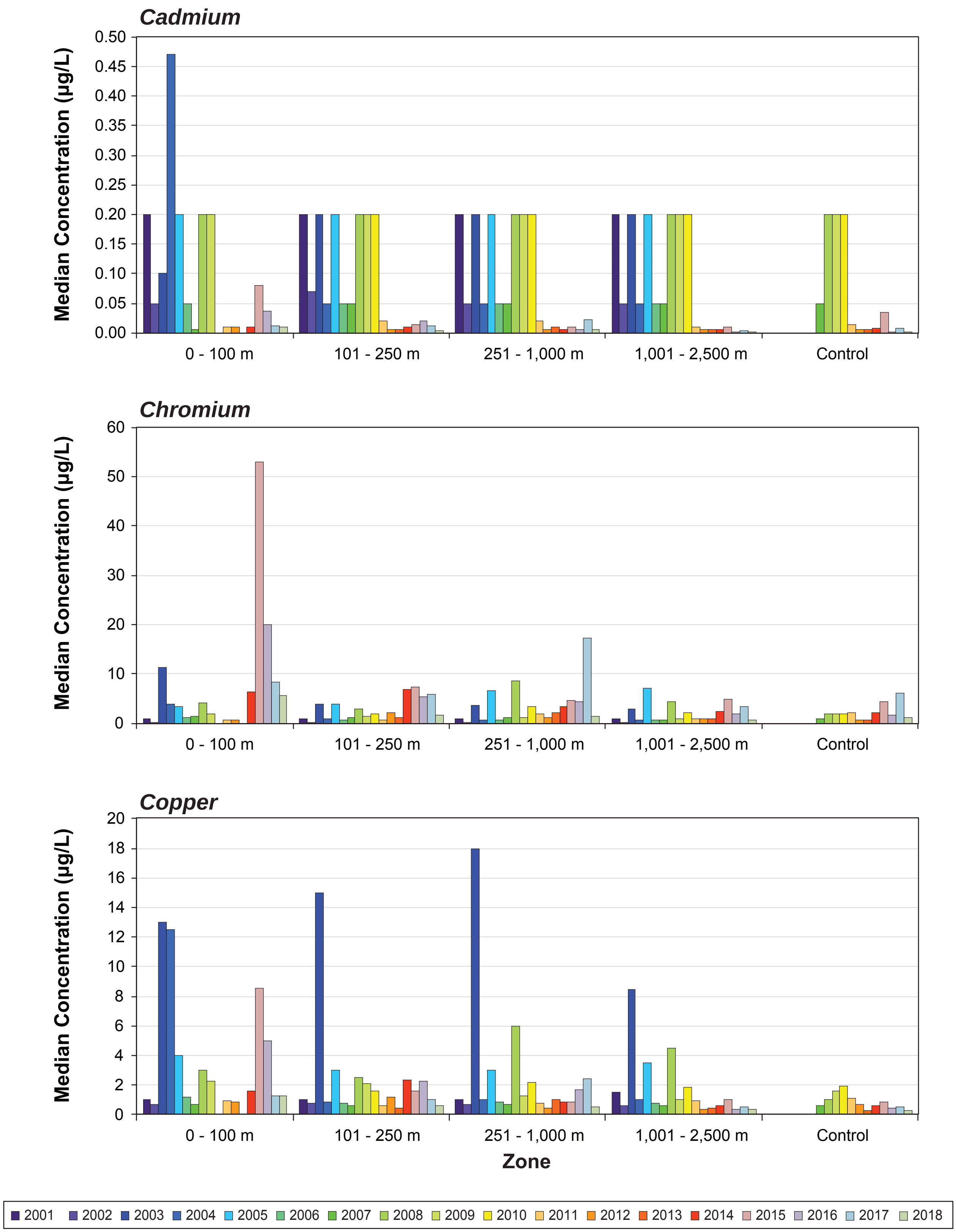
3.3.3 Arsenic

Arsenic concentrations measured in 2018 ranged from 0.01 µg/L at stations SS2-4 in the 1,001-2,500 m zone and SS3-4 in the 251-1000 m zone to 0.32 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 arsenic concentrations generally decreased with increasing distance from the Project (Figure 3.3-1). 2018 median concentrations were lower than 2017 median concentrations in all zones except zone 0-100 m (Figure 3.3-1). All measurements were well below the EQC of 100 µg/L specified in the Water Licence for grab sample concentrations.



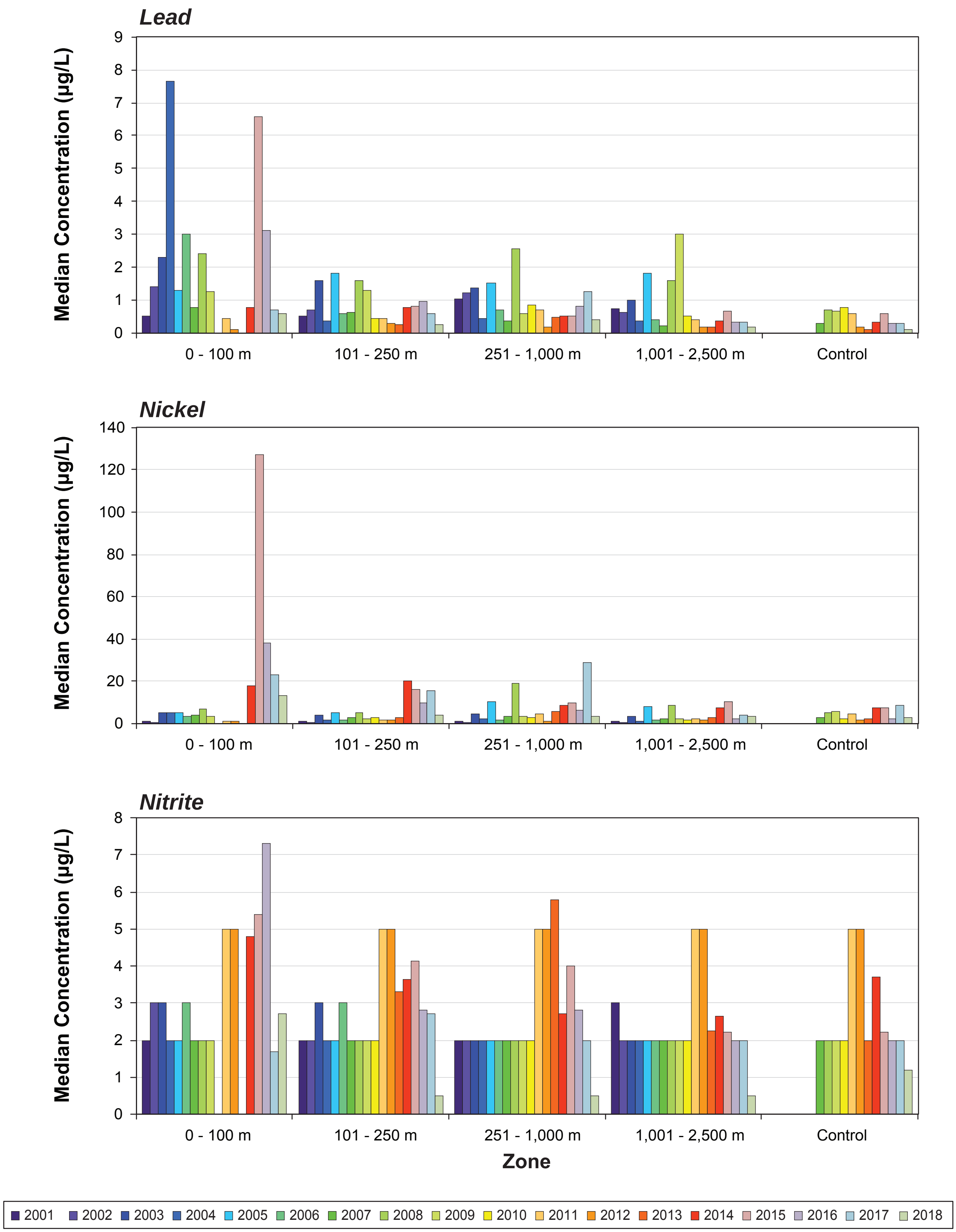
Notes: *The value used for the 0-100 m zone in 2018 represents one sample rather than the median.*
EQC (µg/L) = 3000 for Aluminum, 12000 for Ammonia, and 100 for Arsenic.
Concentration below the analytical detection limit are plotted at half the detection limit.

Figure 3.3-1: Snow Water Chemistry Results: Aluminum, Ammonia and Arsenic, 2001 to 2018



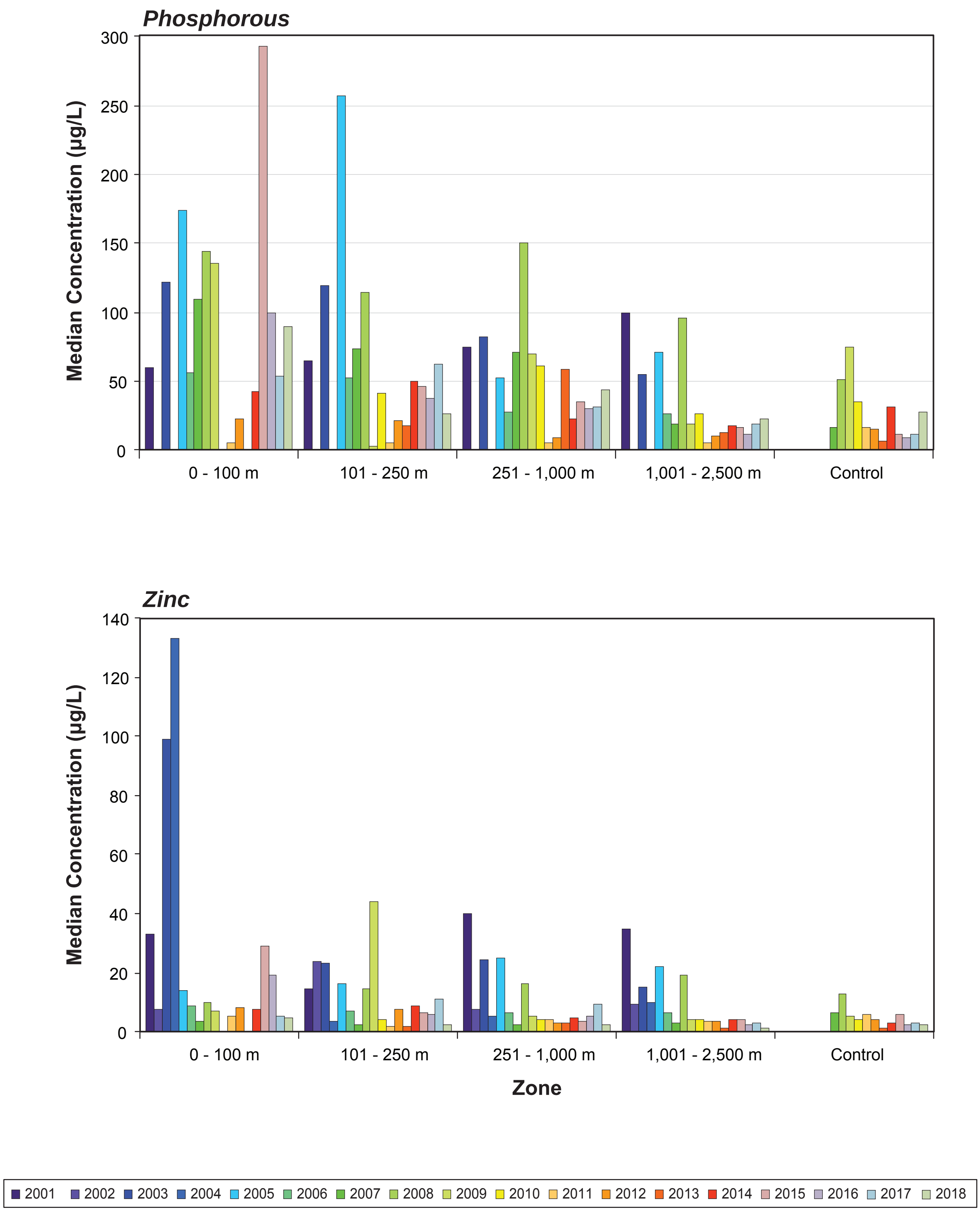
Notes: *The value used for the 0-100 m zone in 2018 represents one sample rather than the median.*
EQC (µg/L) = 3 for Cadmium, 40 for Chromium, and 40 for Copper.
Concentration below the analytical detection limit are plotted at half the detection limit.

Figure 3.3-2: Snow Water Chemistry Results: Cadmium, Chromium and Copper, 2001 to 2018



Notes: *The value used for the 0-100 m zone in 2018 represents one sample rather than the median.*
EQC (µg/L) = 20 for Lead, 100 for Nickel, and 2000 for Nitrite.
Concentration below the analytical detection limit are plotted at half the detection limit.

Figure 3.3-3: Snow Water Chemistry Results: Lead, Nickel and Nitrite, 2001 to 2018



Notes: *The value used for the 0-100 m zone in 2018 represents one sample rather than the median.*
EQC (µg/L) = 20 for Zinc, no EQC specified for Phosphorus.
Concentration below the analytical detection limit are plotted at half the detection limit.

Figure 3.3-4: Snow Water Chemistry Results: Phosphorous and Zinc, 2001 to 2018

3.3.4 Cadmium

Cadmium concentrations measured in 2018 ranged from less than the analytical detection limit (< 0.0025 µg/L) at multiple stations in all zones to 0.02 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 cadmium concentrations were near or below analytical detection limits and were similar for all distance ranges (Figure 3.3-2). Median and overall Cadmium concentrations in 2018 were similar to or less than 2017 and 2016 median and overall concentrations. (Figure 3.3-2). All measurements were less than the EQC of 3 µg/L specified in the Water Licence for grab sample concentrations.

3.3.5 Chromium

Chromium concentrations measured in 2018 ranged from less than the analytical detection limit (< 0.5 µg/L) at multiple stations to 13.5 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 chromium concentrations were greatest in the 101-250 m zone (Figure 3.3-2) and decreased with increasing distance from the Project. The 2018 median concentration in each zone was less than 2017 and 2016 median concentrations (Figure 3.3 2). None of the measurements exceeded the EQC of 40 µg/L specified in the Water Licence for grab sample concentrations.

3.3.6 Copper

Copper concentrations measured in 2018 ranged from 0.1 µg/L at SS2-4 station in the 1,001-2,500 zone to 2.8 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3-1). Median 2018 copper concentrations were greatest in the 251-1,000 m zone (Figure 3.3-2) and in general decreased with increasing distance from the Project. Modest inter-annual variation in copper concentrations was observed from 2014 to 2018 (Figure 3.3-2). The 2018 median concentrations were similar to or less than 2017 concentrations. All measurements were less than the EQC of 40 µg/L specified in the Water Licence for grab sample concentrations.

3.3.7 Lead

Lead concentrations measured in 2018 ranged from 0.01 µg/L at SS2-4 station in the 1,001-2,500 zone to 2.13 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 lead concentrations were greatest in the 251-1,000 m zone (Figure 3.3-3) but in general decreased with increasing distance from the Project. The 2018 median concentration in each zone was less than 2017 and 2016 median concentrations (Figure 3.3-3). All measurements were less than the EQC of 20 µg/L specified in the Water Licence for grab sample concentrations.

3.3.8 Nickel

Nickel concentrations measured in 2018 ranged from 0.67 µg/L at SS2-4 station in the 1,001-2,500 zone to 32.8 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 nickel concentrations were greatest in the 101-250 m zone (Figure 3.3-3) and in general decreased with increasing distance from the Project. The 2018 median concentrations in each zone were less than those measured in 2017 (Figure 3.3-3). All measurements were less than the EQC of 100 µg/L specified in the Water Licence for grab sample concentrations.

3.3.9 Nitrite

Nitrite concentrations measured in 2018 ranged from less than the analytical detection limit (< 2.0 µg/L) at multiple stations to 11.7 µg/L at station SS5-3 in the 251-1,000 m zone (Table 3-1). Median 2018 nitrite concentrations were greatest in the 0-1,00 m zone and decreased with increasing distance down to below the detection limit (Figure 3.3-3). The 2018 median concentrations were less than 2017 concentrations in all zones except the 0-100 m zone (Figure 3.3-3). All measurements were well below the EQC of 2,000 µg/L specified in the Water Licence for grab sample concentrations.

3.3.10 Phosphorous

Phosphorous concentrations measured in 2018 ranged from 6.7 µg/L at SS2-4 station in the 1,001-2,500 zone to 309 µg/L at station SS5-3 in the 251-1,000 m zone (Table 3-1). Median 2018 phosphorous concentrations were greatest (43.6 µg/L) in the 251-1,000 m zone and decreased with increasing distance from the Project (Figure 3.3-4). The 2018 median concentrations were greater than those measured in 2017 except in the 101-250 m zone (Figure 3.3-4). Although the Water Licence has a load limit for phosphorous, there is no EQC specified in the licence.

3.3.11 Zinc

Zinc concentrations measured in 2018 ranged from 0.5 µg/L at SS2-4 station in the 1,001-2,500 zone to 9.4 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3-1). Median 2018 zinc concentrations were greatest (2.2 µg/L) in the 101-250 m and 251-1,000 m zones and decreased with increasing distance from the Project (Figure 3.3-4). The 2018 median concentrations in each zone were slightly less than those measured in 2017 and 2016 (Figure 3.3-4). All measurements were less than the EQC of 20 µg/L specified in the Water Licence for grab sample concentrations.

3.4 Quality Assurance and Control

Dustfall gauge, dustfall snow survey and snow water chemistry sampling and analysis were conducted by experienced technicians following SOPs ENVR-508-0112 R3, ENVR-512-0213 R3, and ENVI 303-0112 R2 to ensure proper field sampling and laboratory analysis. As part of SOP ENVR 512 0213, duplicate and blank samples were taken for some snow survey and snow water chemistry sample sites (Table 2-1). The results from these samples are summarized in Tables 3.4-1 and 3.4-2.

The relative percent difference (RPD) of duplicate samples from a site represents the amount of variation between duplicates. According to the Project AEMP, the data quality objective for duplicate water quality samples is a RPD of 40% when concentrations are ≥ 5 times the detection limit (DL; AEMP 2017). It is important to note that RPD values are only calculated when concentrations are ≥ 5 times the DL (BC MOE 2013). Several of the calculated RPD values exceeded 40%.

The results of the QA/QC duplicates indicate that snow chemistry is spatially variable on the scale of metres within which the duplicates are collected. The data quality objective from the AEMP (i.e., RPD less than 40%) is designed for surface *liquid* water samples. Surface water in a stream or lake will mix more readily than snow, particularly once snow has settled and has been compacted by wind. Site-specific differences between snow core sampling replicates may not be visible to the sampling team, but may result in differences in the chemical composition of the snow. RPDs were lower overall at station SS4-5 than station SS2-1. RPDs were highest at station SS3-4, as RPDs were greater than 40% for all but one parameter. The absolute differences between observations were similar in magnitude for both duplicates from both locations. The similarity in the magnitude of the variability is consistent with small-scale spatial variation, rather than data quality issues. The results of the sampling network of 19 sites has been demonstrated to detect and quantify Project effects on snow water chemistry (Section 3.3), and these results are concluded to be reliable despite the small-scale variation identified in the QA/QC program.

Dustfall RPD at SS1-1 was 65%, SS2-1 was 15%, and SS5-1 was 31% which shows that small scale variation for dustfall and snow water chemistry measures was similar. There is no similar data quality objective for RPD related to dustfall, although spatial variability in dustfall rates similar to snow chemistry is expected. The concentrations of all parameters in the blank processed at station SS5-5 were much less than those from the non-blank sample (except for cadmium and where the sample was at the detection limit), suggesting the data were of good quality. It is worth noting that during the analysis of Dust 5 in January 2018, the collection tube was found to be leaking and a negligible amount of sample (~<10%) was lost.

Table 3.4-1: Sample Duplicates and Blanks

Parameter	SS1-2	SS2-1	Duplicate Analytical Results (DUPW1/DUPW2; mg/dm²/y; µg/L)				Analytical Detection Limit (µg/L)	SS1-2	Relative Percent Difference [a] (%)				
			SS5-1	SS2-1	SS3-4	SS4-5			SS2-1	SS5-1	SS2-1	SS3-4	SS4-5
Dustfall	515/263	50/43	774/1059	-	-	-	0.1	65%	15%	31%	-	-	-
Aluminum	-	-	-	136/69	178/78.7	286/301	0.2	-	-	-	65%	77%	5%
Ammonia	-	-	-	81/88	26/45	75/82	5	-	-	-	8%	54%	9%
Arsenic	-	-	-	0.06/0.1	0.01/0.03	0.07/0.08	0.02	-	-	-	n/a	n/a	n/a
Cadmium	-	-	-	*0.0025/ 0.0025*	*0.0025/ 0.0025*	*0.0025/ 0.0025*	0.005	-	-	-	n/a	n/a	n/a
Chromium	-	-	-	0.77/1.19	0.43/0.98	2.24/2.18	0.05	-	-	-	43%	78%	3%
Copper	-	-	-	0.55/0.46	0.38/0.21	0.54/0.57	0.05	-	-	-	18%	58%	5%
Lead	-	-	-	0.20/0.22	0.17/0.2	0.22/0.20	0.005	-	-	-	9%	61%	9%
Nickel	-	-	-	3.1/2.6	2.6/1.6	5.86/5.36	0.02	-	-	-	18%	45%	9%
Nitrite	-	-	-	*0.5/0.5*	*0.5/0.5*	*0.5/1*	1	-	-	-	n/a	n/a	n/a
Phosphorous	-	-	-	24.3/26	30.3/23.7	22.7/25.8	2	-	-	-	7%	24%	13%
Zinc	-	-	-	1.6/1.3	1.7/0.5	2.6/2.7	0.1	-	-	-	21%	109%	4%

Notes:

n/a = RPD is not applicable since concentration is less than 5 times the detection limit.

"-" = parameter is not measured.

For measurements that were less than the detection limit, the detection limit was used for calculations and are italicized.

[a] *Relative difference between duplicates, with respect to their mean: RPD = 100 × |rep1 − rep2| / [(rep1 + rep2)/2].*

Table 3.4-2: Analytical Blanks for QA/QC Program

Parameter	SS5-5 Blank (EBW) Sample (µg/L)	Percent Below Non-blank[a] SS5-5 Sample	Detection Limit (µg/L)
Aluminum	0.42	99%	0.2
Ammonia	17.0	60%	5.0
Arsenic	*0.01*	55%	0.02
Cadmium	*0.0025*	0%	0.005
Chromium	*0.025*	97%	0.05
Copper	*0.025*	91%	0.05
Lead	*0.0025*	97%	0.005
Nickel	*0.01*	100%	0.02
Nitrite	*0.50*	55%	1.0
Phosphorous	2.70	86%	2.0
Zinc	0.39	72%	0.1

Notes:

For measurements that were less than the detection limit, half the detection limit was used for calculations and are italicized.

[a] The non-blank sample is the result from the sample collected from station SS5-5.

4. SUMMARY

In 2018, dustfall was monitored at 14 dustfall gauges and 27 snow survey stations located at varying distances around the mine. Snow water chemistry was also measured at 19 of the snow survey stations and compared to EQC set out in the WLWB Water Licence W2015L2-0001 (formerly W2007L2-0003).

Median dustfall rates estimated in 2018 were higher than results in 2017 but lower than results in 2016. In general, dustfall rates in 2018 decreased with distance from the Project. Annual dustfall estimated from each of the 14 dustfall gauges ranged from 78 to 796 mg/dm^2/y. The annualized dustfall rates estimated from the 2018 snow survey data ranged from 19 to 4,603 mg/dm^2/y. Because dustfall gauges continuously collect dust throughout the year, and the snow surveys are only representative of dustfall accumulated over the snow cover period, the reported annual dustfall results from the dustfall gauges are expected to provide a better estimate of annual dustfall compared to snow survey results for similar geographic areas. However, results obtained from both methods showed similar patterns.

Dustfall rates were generally higher in 2018 than in 2017; however, they are within the range of historical data collected for the Project. Annualized dustfall rates estimated from each snow survey station in 2018 were less than some historical dustfall estimates. Comparisons of mean and maximum values suggest that dustfall rates were generally higher in 2018 than in 2017. Overall, as expected, dustfall rates generally decreased with distance from the Project with the lowest dustfall rate recorded at station SS2-4 (2,164 m northeast the Project). Although all control sites are located further away from the Project compared to SS2-4, they all recorded higher dustfall rates than SS2-4, which suggests that dustfall at control sites are potentially affected by the Project. This may be explained by the northeastern location of SS2-4 which is less frequently downwind of the mine relative to other areas and the greater distance of SS2-4 from the A21 open pit relative to the control stations. Whereas all control sites are located south, southeast, and northwest of the Project where winds are more predominant. The potential effects of the Project on the dustfall at the control zone have marginal impacts on the dustfall monitoring program since dustfall rates at the control zone are significantly lower than rates at zones closer to the Project area (e.g., zone 0-100 m, 101-250 m, 251-1000 m). Areas that were closer to the Project, roads, and airstrip received more dustfall than other areas. Mean dustfall rates estimated using both dustfall gauges and snow surveys within the 0–100, 101-250, 251–1,000, 1,001–2,500 and Control zones were 982, 143, 319, 138, and 58 mg/dm^2/y, respectively. Although there are no dustfall standards for the Northwest Territories, most 2018 dustfall rates were less than non-residential 2.9 mg/dm^2/d (1,059 mg/dm^2/y) BC MOE former dustfall objective for the mining, smelting, and related industries (DDMI 2016). Only two stations (SS1-1 and SS5-3) were higher than the BC MOE former dustfall objective. This objective, used in the 2015 Dust Deposition Report (DDMI 2016), is no longer used in BC.

Snow water chemistry analytes of interest included those variables with EQC (i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc) or a load limit (i.e., phosphorous) specified in the Type “A” Water Licence (W2015L2-0001, formerly W2007L2 0003). All 2018 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” specified in Water Licence W2015L2 0001. Concentrations of aluminum, arsenic, chromium, and nickel have generally increased in recent years, while concentrations of copper, lead, phosphorous, and zinc have generally decreased in recent years. Typically, concentrations decreased with distance from the Project. In general, 2018 sample concentrations were lower than in 2017. High concentrations of certain variables of interest (2,080 µg/L aluminum, 13.5 µg/L chromium) were recorded at Station SS3-8, located in the 251-1,000 m zone. However, concentrations of these variables were less than their corresponding EQC.

5. REFERENCES

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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APPENDIX A ANNUAL CHANGES TO DUSTFALL PROGRAM

Appendix A: Annual Changes to Dustfall Program

2001

The 2001 dust monitoring program was based entirely upon snow survey samples collected along four radial transects emanating from the project footprint outward to a distance of approximately 1,000 metres. All sample locations were analyzed for dust deposition, while only those locations on Lac de Gras were analyzed for snow water chemistry.

2002

DDMI amended the dust monitoring program, in response to recommendations made by the Mackenzie Valley Land and Water Board, to include two snow survey control locations. In addition, five dust gauges (passive dust collectors) were deployed, one along each of the snow survey transects and one at a control location, in efforts to enhance the monitoring program.

2003

In response to further recommendations, the dust monitoring program was modified. All four snow survey transects were extended in length to a distance of approximately 2,000 metres from the project footprint. An additional five dust gauges, including a second control, were deployed.

2004

Increased construction activity necessitated further changes to the dust monitoring program. One dust gauge (Dust 02) was removed from its location to accommodate project footprint expansion, and subsequently relocated and redeployed (Dust 2A).

2005

Dust deposition monitoring was carried out with no modifications to either the snow survey or the dust gauge portion of the program.

2006

An additional dust gauge was deployed bringing the total to eleven (including two controls). Testing of Mini-Vol portable air samplers were conducted to determine feasibility of incorporation into the dust monitoring program. Preliminary findings proved the inclusion of the Mini-Vol samplers would be impractical.

2007

The snow survey portion of the program was amended with an additional snow survey transect being incorporated bringing the total number of transects to five. As well, snow water chemistry samples were collected adjacent to the pre-existing control locations as background references.

Two additional dust gauges (temporary) were deployed adjacent to two pre-existing dust gauges. The intent of the temporary gauges was to compare results from the same location when sample collection frequency is altered.

DDMI initiated contact with Environment Canada and Golder Associates with regards to remodeling dust deposition with the intent of revising predictions made in the 1998 environmental effects report.

In light of dust deposition monitoring results from previous years, several control measures were adopted to reduce dust generation on site, including the utilization of EK-35 (suppressant) on the airport apron, taxiway and helipad, and fitting a second 830E haul truck with tank for haul road watering.

2008

All of the dust gauges were modified to accommodate the replacement of the polyacrylic dust gauge inserts with brass Nipher gauge inserts, to minimize loss associated with damage during the collection and handling of the dust gauges.

An additional dust gauge was added to the program bringing the total to twelve permanently deployed (including two control), and two temporary (reference) dust gauges.

Three snow survey sample points were not sampled as they had become overtaken by construction activity and expansion of the project footprint.

Additional preparations for dust deposition modelling were completed including data collection, identification of point source inputs, selection of a modelling program and inputs (with regulator input) and discussion of cumulative effects.

2009

The two temporary dust gauges deployed in 2007 were decommissioned. All twelve permanent gauges were collected quarterly. An error in collection/deployment resulted in “No Data” being collected for Dust 03 between July 11 and September.

Snow survey sampling was conducted in April. An error in collection/analysis resulted in the Dust Deposition sample for SS2-1 being compromised; as such “No Dust Deposition Data” was available for this location.

2010

All twelve permanent dust gauges were collected quarterly during 2010. Overall, there was a reduction of observed dustfall deposition from 2009 to 2010, with the exception of Dust 1 and Dust 10.

Snow survey sampling was conducted throughout the month of April. An error in collection/ processing resulted in two missing stations for the water quality analysis. SS2-1 field results were collected; however, the sample was compromised during processing in the lab. An error also resulted with the collection of SS5-2; data collection for water quality analysis was missed in the field. No data for these two stations resulted in Zone 1 having no data for the various water chemistry results and SS5-2 was not represented in Zone 3 data for 2010.

2011

All twelve permanent dust gauges were collected quarterly during 2011. During collection and repair to Station Dust 5 in September, the sample was compromised and therefore not processed, which resulted in data loss.

Snow survey sampling was conducted throughout the month of April. Due to an internal error shipping samples, water quality samples for stations SS1-4, SS1-5, SS2-1, SS2-2, SS2-3, SS2-4, and SSC-3 arrived at the Maxxam laboratory past the recommended holding time.

2012

All twelve permanent dust gauges were collected quarterly during 2012. During collection in June, repairs were conducted on Station Dust 9 as it was found on its side, the sample was compromised, which resulted in data loss. Overall in 2012, 8 of the 12 dust gauges reported lower deposition rates compared to 2011.

Snow survey sampling was conducted on April 30, and on May 4 and 5.

2013

All twelve permanent dust gauges were collected quarterly during 2013. Station Dust 5 was dismantled upon arrival in September and the sample was compromised, which resulted in data loss for that quarter.

Snow survey sampling was conducted at 24 locations from April 26 to 28.

2014

All twelve permanent dust gauges were collected quarterly during 2014.

Snow survey sampling was conducted at 24 locations from April 7 to May 12. Three additional sites, SS3-6, SS3-7, SS3-8, were installed.

2015

No changes were made to the dustfall program in 2015.

All twelve permanent dust gauges were collected quarterly during 2015.

Snow survey sampling was conducted at 24 locations from March 31 to April 10.

2016

Due to construction activities at A21, the distance to mining operations decreased for dustfall stations Dust 10, SS5-1, SS5-2, SS5-3, SS5-4, SS5-5, Dust C1, and Control 1. The new distances to mining operations are shown in Table 2-1. Dust 10 station was 670 m from mining operations and now is 46 metres from mining operations.

All twelve permanent dust gauges were collected quarterly during 2016.

Snow survey sampling was conducted at 27 locations from March 3 to April 7.

2017

All twelve permanent dust gauges were collected quarterly during 2017.

During collection of Stations Dust 3 Dust 4, Dust 8 and Dust 10 in July were compromised and an indeterminate amount of sample was lost.

Two new permanent dust gauges (Dust 11 and Dust 12) were deployed on 2017-Oct-05.

Dust 11 and 12 are 0.805 km and 2.58 km respectively from mining operations.

Snow survey sampling was conducted at 27 locations from April 1 to April 10.

2018

No changes to the dustfall program were made in 2018. All fourteen permanent dust gauges were collected quarterly during 2018.

APPENDIX B DUSTFALL GAUGE ANALYTICAL RESULTS

Appendix B: Dustfall Gauge Analytical Results

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm^2)	Days Deployed	Dust Deposition (mg/dm^2/d)	Dust Deposition (mg/dm^2/y)
24-Dec-17	Initial Deployment Date									
6-Apr-18	Dust 1	1	114.8	221.2	106.4					
6-Apr-18	Dust 1	2	114.7	229.4	114.7	221.1		103		
26-Jun-18	Dust 1	1	116.6	216	99.4					
26-Jun-18	Dust 1	2	116.6	311.5	194.9					
26-Jun-18	Dust 1	3	116.1	138.2	22.1	316.4		81		
12-Oct-18	Dust 1	1	122.1	243.2	121.1					
12-Oct-18	Dust 1	2	123.1	191.6	68.5	189.6		108		
28-Dec-18	Dust 1	1	116.6	185	68.4	68.4		77		
					TOTALS	**795.5**	**648.56**	**369**	**1.76**	**641.5**
6-Jan-18	Initial deployment date									
8-Apr-18	Dust 2	1	114.8	211.6	96.8	96.8		92		
25-Jun-18	Dust 2	1	115.7	145.1	29.4					
25-Jun-18	Dust 2	2	114.8	146.3	31.5	60.9		78		
10-Oct-18	Dust 2	1	122.4	198.3	75.9					
10-Oct-18	Dust 2	2	122.1	167.6	45.5	121.4		107		
3-Jan-19	Dust 2	1	40,211.6	40,257	45.4	45.4		85		
					TOTALS	**324.5**	**264.56**	**362**	**0.73**	**266.8**
10-Jan-18	Initial deployment date									
8-Apr-18	Dust 3	1	116.9	200.3	83.4					
8-Apr-18	Dust 3	2	117.8	209.5	91.7	175.1		88		
26-Jun-18	Dust 3	1	116.1	155.2	39.1					

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm^2)	Days Deployed	Dust Deposition (mg/dm^2/d)	Dust Deposition (mg/dm^2/y)
26-Jun-18	Dust 3	2	112.2	165	52.8					
12-Oct-18	Dust 3	3	116	177.2	61.2	153.1		79		
12-Oct-18	Dust 3	1	124.4	276.1	151.7					
12-Oct-18	Dust 3	2	122.3	244.5	122.2					
12-Oct-18	Dust 3	3	111.1	235.6	124.5					
12-Oct-18	Dust 3	4	122.8	260.3	137.5	535.9		108		
28-Dec-18	Dust 3	1	115.7	192.7	77	77	62.78	77		
					TOTALS	**941.1**	**767.27**	**352**	**2.18**	**795.6**
10-Jan-18	Initial deployment date									
5-Apr-18	Dust 4	1	114.9	149.7	34.8	34.8		85		
27-Jun-18	Dust 4	1	113.1	196.6	83.5					
27-Jun-18	Dust 4	2	119.3	120	0.7	84.2		83		
13-Oct-18	Dust 4	1	110.5	123.1	12.6					
13-Oct-18	Dust 4	2	110.4	119.6	9.2	21.8		108		
28-Dec-18	Dust 4	1	114	152.6	38.6	38.6		76		
					TOTALS	**179.4**	**146.26**	**352**	**0.42**	**151.7**
6-Jan-18	Initial deployment date									
6-Apr-18	Dust 5	1	114.2	146.3	32.1	32.1		90		
25-Jun-18	Dust 5	1	116.1	134.7	18.6					
25-Jun-18	Dust 5	2	114.8	133.6	18.8					
25-Jun-18	Dust 5	3	115.7	115.7	0	37.4		80		
10-Oct-18	Dust 5	1	120.2	142.1	21.9					
10-Oct-18	Dust 5	2	124	155.2	31.2	53.1		107		
2-Jan-19	Dust 5	1	114.4	180.8	66.4	66.4		84		
					TOTALS	**189**	**154.09**	**361**	**0.43**	**155.8**

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm²)	Days Deployed	Dust Deposition (mg/dm²/d)	Dust Deposition (mg/dm²/y)
24-Dec-17	Initial deployment date									
12-Apr-18	Dust 6	1	115.2	184	68.8	68.8		109		
26-Jun-18	Dust 6	1	114.4	138.6	24.2					
26-Jun-18	Dust 6	2	114.9	117.2	2.3	26.5		75		
12-Oct-18	Dust 6	1	123	155	32					
12-Oct-18	Dust 6	2	121.8	163.4	41.6	73.6		108		
28-Dec-18	Dust 6	1	114.7	148.5	33.8	33.8		77		
					TOTALS	**202.7**	**165.26**	**369**	**0.45**	**163.5**
6-Jan-18	Initial deployment date									
8-Apr-18	Dust 7	1	115.8	155.6	39.8					
8-Apr-18	Dust 7	2	114.9	233.5	118.6					
8-Apr-18	Dust 7	3	115.2	364.9	249.7					
8-Apr-18	Dust 7	4	114.4	116.1	1.7	409.8		92		
25-Jun-18	Dust 7	1	115.8	151.6	35.8					
25-Jun-18	Dust 7	2	114.8	141.1	26.3	62.1		78		
10-Oct-18	Dust 7	1	122.1	177.6	55.5					
10-Oct-18	Dust 7	2	122.9	201.6	78.7					
10-Oct-18	Dust 7	3	122.7	197	74.3					
10-Oct-18	Dust 7	4	121.5	218.2	96.7	305.2		107		
3-Jan-19	Dust 7	1	34,112.9	34,146.8	33.9	33.9		85		
					TOTALS	**811**	**661.20**	**362**	**1.83**	**666.7**
6-Jan-18	Initial deployment date									
5-Apr-18	Dust 8	1	115.8	151.2	35.4	35.4		89		
25-Jun-18	Dust 8	1	120.6	149.8	29.2					
25-Jun-18	Dust 8	2	118	138.8	20.8					

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm²)	Days Deployed	Dust Deposition (mg/dm²/d)	Dust Deposition (mg/dm²/y)
25-Jun-18	Dust 8	3	116.1	116.1	0	50		81		
10-Oct-18	Dust 8	1	122.2	134.8	12.6					
10-Oct-18	Dust 8	2	122.2	140	17.8	30.4		107		
2-Jan-19	Dust 8	1	112.7	151.5	38.8	38.8		84		
					TOTALS	**154.6**	**126.04**	**361**	**0.35**	**127.4**
6-Jan-18	Initial deployment date									
7-Apr-18	Dust 9	1	114.9	148.9	34	34		91		
25-Jun-18	Dust 9	1	113.4	118.6	5.2					
25-Jun-18	Dust 9	2	115.2	131.1	15.9					
25-Jun-18	Dust 9	3	117.9	125.5	7.6					
25-Jun-18	Dust 9	4	115.8	153.2	37.4					
25-Jun-18	Dust 9	5	112.7	114.7	2					
25-Jun-18	Dust 9	6	114.4	115.3	0.9					
25-Jun-18	Dust 9	7	115.8	118.5	2.7					
25-Jun-18	Dust 9	8	115.5	117.2	1.7					
25-Jun-18	Dust 9	9	116.2	116.3	0.1	73.5		79		
10-Oct-18	Dust 9	1	122.3	157.5	35.2					
10-Oct-18	Dust 9	2	117.6	144.3	26.7	61.9		107		
4-Jan-19	Dust 9	1	29,107.7	29,119.7	12	12		86		
					TOTALS	**181.4**	**147.89**	**363**	**0.41**	**148.7**
16-Jan-18	Initial deployment date									
7-Apr-18	Dust 10	1	126.1	384.7	258.6					
7-Apr-18	Dust 10	2	119.8	253.5	133.7					
7-Apr-18	Dust 10	3	115.9	122.8	6.9	399.2		81		
26-Jun-18	Dust 10	1	114.1	263.4	149.3					

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm^2)	Days Deployed	Dust Deposition (mg/dm^2/d)	Dust Deposition (mg/dm^2/y)
26-Jun-18	Dust 10	2	115.2	115.6	0.4	149.7		80		
12-Oct-18	Dust 10	1	123.1	141.2	18.1					
12-Oct-18	Dust 10	2	115.2	162.9	47.7					
12-Oct-18	Dust 10	3	122.3	178.5	56.2	122		108		
28-Dec-18	Dust 10	1	115.4	194.9	79.5	79.5		77		
					TOTALS	**750.4**	**611.79**	**346**	**1.77**	**645.4**
6-Jan-18	Initial deployment date									
7-Apr-18	Dust 11	1	115.7	219.7	104					
	Dust 11	2	119.1	123.3	4.2	108.2		91		
25-Jun-18	Dust 11	1	115.2	214.6	99.4					
	Dust 11	2	116.4	220.6	104.2					
	Dust 11	3	113.7	115.6	1.9	205.5		79		
10-Oct-18	Dust 11	1	117.8	135.7	17.9					
	Dust 11	2	122.9	183.5	60.6	78.5		107		
3-Jan-19	Dust 11	1	38,952.5	39,035.5	83	83		85		
					TOTALS	**475.2**	**387.42**	**362**	**1.07**	**390.6**
6-Jan-18	Initial deployment date									
7-Apr-18	Dust 12	1	115.1	149.9	34.8					
	Dust 12	2	118.6	119.6	1	35.8		91		
25-Jun-18	Dust 12	1	116	137.2	21.2					
	Dust 12	2	119.8	144.8	25	46.2		79		
10-Oct-18	Dust 12	1	122.8	134.8	12					
	Dust 12	2	121.8	136	14.2	26.2		107		
3-Jan-19	Dust 12	1	39,838.7	39,858.6	19.9	19.9		85		
					TOTALS	**128.1**	**104.44**	**362**	**0.29**	**105.3**

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm^2)	Days Deployed	Dust Deposition ($mg/dm^2/d$)	Dust Deposition ($mg/dm^2/y$)
6-Jan-18	Initial deployment date									
8-Apr-18	Dust C1	1	115	143.3	28.3					
	Dust C1	2	115.9	116.5	0.6	28.9		92		
25-Jun-18	Dust C1	1	115.3	147	31.7	31.7		78		
10-Oct-18	Dust C1	1	123.4	137.2	13.8					
	Dust C1	2	121.8	139.2	17.4	31.2		107		
4-Jan-19	Dust C1	1	30,986.2	30,998.1	11.9	11.9		86		
					TOTALS	**103.7**	**84.55**	**363**	**0.23**	**85.0**
6-Jan-18	Initial deployment date									
5-Apr-18	Dust C2	1	114.8	139	24.2	24.2		89		
25-Jun-18	Dust C2	1	114.6	141	26.4	26.4		81		
10-Oct-18	Dust C2	1	123.6	133.7	10.1					
	Dust C2	2	122.2	134.2	12	22.1		107		
3-Jan-19	Dust C2	1	31,343.9	31,366.1	22.2	22.2		85		
					TOTALS	**94.9**	**77.37**	**362**	**0.21**	**78.0**