APPENDIX H:
AIR QUALITY ASSESSMENT
RWDI

Prepared for:
Canadian Environmental Assessment Agency

Prepared by:
Ambershaw Metallics Inc.
1184 Roland Street, Suite 500
Thunder Bay, ON
P7B 5M4

Tel: (807) 707-9959

REPORT

AMI PROJECT ENVIRONMENTAL – BASELINES SERVICES

NORTHWEST, ONTARIO

AIR QUALITY ASSESSMENT
RWDI # 1701998
November 24, 2017

SUBMITTED TO

Nicola Lower
Natural Sciences Lead
Palmer Environmental Consulting Group Inc.
374 Wellington Street West, Suite 3,
Toronto, ON M5V 1E3
nicola@pceg.ca

SUBMITTED BY

Robert Jean
Project Manager
robert.jean@rwdi.com

Mike Lepage
Principal
mike.lepage@rwdi.com

RWDI AIR Inc.
Consulting Engineers & Scientists
600 Southgate Drive
Guelph, Ontario, N1G 4P6
T: 519.823.1311
F: 519.823.1316

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1 INTRODUCTION

Ambershaw Metallics Inc. (Ambershaw) has been exploring and developing the Bending Lake site known as the AMI Mine Project (the Project), located in the Kenora Mining Division and the Dryden (MNR) District, Ontario, approximately 285 km (177.1 mi) northwest of Thunder Bay, Ontario (Figure 1). Ambershaw continues to develop the Project towards Pre-Feasibility Status through: Environmental Baseline Studies which were initiated in 2011-2012 on the Bending Lake site.

The purpose of this report is to summarize the existing baseline conditions in the study area of the Project in terms of climatic conditions, current background levels for airborne contaminants such as criteria air contaminants and trace metals.

2 PROJECT OVERVIEW

Ambershaw Metallics Inc., a privately held Canadian company, intends to construct and operate a DR-grade pellet manufacturing operation in Northwestern Ontario producing an estimated 1.9 million tonnes per year of DR-grade pellets from 8 million tonnes of crude ore. The mine, coarse crusher, fine crusher, dry cobber, concentrator circuit, pelleting plant and related support facilities are to be located on the northwest side of Bending Lake.

The orebody is a banded magnetite formation of the Algoma type, striking northwest and dipping approximately 55 degrees to the southwest. The major portion of the orebody creates a footprint approximately 1.25 km long and 500 metres wide and has a proven thickness of approximately 300 metres. The weight recovery of the ore is between 28 and 29% according to bulk sample testing conducted by Lakefield Research in 1977.

Ambershaw intends to work with the federal and provincial governments towards commencing a bulk sampling program. Baseline study will support advanced exploration permitting. Baseline programs in support of a federal environmental assessment and provincial Class environmental assessments will commence in 2017 or as appropriate. Ambershaw intends to work towards submission of an environmental assessment in support of modular-based full scale production in 2020.

3 CLIMATE CONDITIONS

3.1 Background

Site-specific climate information is available at the Project site. Two data stations were installed for the Bending Lake Iron Ore Project by RWDI in 2011. On-Site Metrological data were available from August 2011 to May 2012 (Station 1 and 2) and from September 2012 to August 2013 (Station 2). Station 1 and 2 are located approximately 17 km (North) and 14km (East), respectively, from the Project site.

Additional baseline data for climatic conditions were also gathered from other sources. Environment Canada provides climate normal and averages for two stations near the Project site: Dryden Airport and Dryden City. Historical monthly data were available at both stations, with data from 1981 to 2010 used for the comparison. Dryden Airport and Dryden City stations are both located 80 km (North West) from the Project site and assumed to be representative of the study area because of its proximity. The Metrological Station location details are listed in Table 1 and displayed in Figure 1.

Table 1: Meteorological Station Locations

Station Name	Latitude	Longitude	Elevation (m)
Bending Lake Station 1	49°28'57.510" N	91°55'47.431" W	439
Bending Lake Station 2	49°18'39.326" N	92°09'44.867" W	435
Dryden City	49°47'00.000" N	92°50'00.000" W	371.9
Dryden Airport	49°50'00.000" N	92°45'00.000" W	412.7

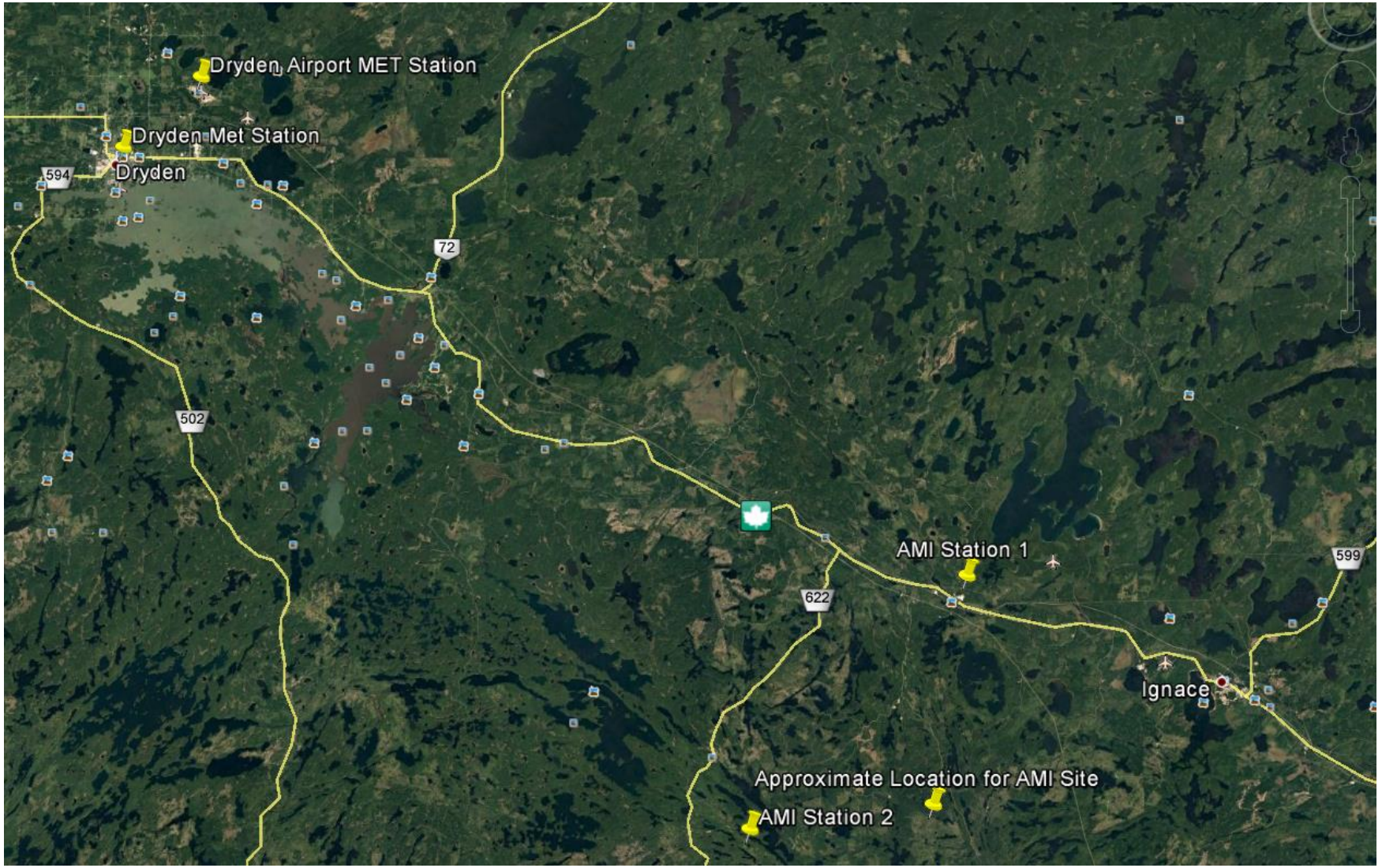

Figure 1: Locations for Project Site and Met Stations

3.2 Temperature and Humidity

Table 2 shows the overall mean monthly temperature for each month of the year for the Dryden Airport, Dryden City, and the two Bending Lake weather stations. Table 3 shows the mean daily maximum temperature, and Table 4 shows the mean daily minimum temperature. The values for 2012-2013 at Bending Lake Station 2 are very similar to the long-term values at the Dryden stations; whereas, those at for 2011-2012 at both Bending Lake stations are somewhat warmer than the long-term averages at the Dryden stations. Mean daily maximum temperatures in the study area range from around -10°C in January to +23°C in July, and mean daily minimum temperatures range from around -20°C in January to +13°C in July.

Table 5 presents relative humidity averages for Dryden Airport, the only one of the four weather stations for which humidity data were available. The average relative humidity in the early morning (06:00) ranges from 75% to 90%, and is highest in Augusts and September. The relative humidity in the mid-afternoon ranges from 45% to 76%, with the lowest values occurring from April through June and the highest values occurring from November through January.

Table 2: Monthly Mean Temperatures (°C)

Month	Stn 1 (2011-2012)	Stn 2 (2011-2012)	Stn 2 (2012-2013)	Dryden (1981-2010)	Dryden Airport (1981-2010)
Jan	-11.5	-11.4	-14.6	-17.4	-16.8
Feb	-7.5	-7.5	-13.4	-13.4	-12.7
Mar	2.1	2.3	-7	-6.1	-5.8
Apr	3.6	4.1	-0.2	2.7	3
May	10.3	12.8	9.1	10.7	10.8
Jun	NA	NA	16.2	16.2	16.2
Jul	NA	NA	18.3	18.5	18.9
Aug	17.8	18.2	17.7	17.4	17.8
Sept	11.9	12.4	11.4	11.2	11.7
Oct	7.6	8	5.6	4.3	4.2
Nov	-1.5	-1.3	-3.1	-5.7	-5.2
Dec	-9	-8.5	-11.3	-14.2	-13.5
Annual	2.4	2.9	2.4	2	2.4

Table 3: Mean Daily Maximum Temperature (ºC)

Month	Stn 1 (2011-2012)	Stn 2 (2011-2012)	Stn 2 (2012-2013)	Dryden (1981-2010)	Dryden Airport (1981-2010)
Jan	-7.2	-7.1	-10.1	-12.3	-11.6
Feb	-2.8	-2.9	-8.1	-7.8	-7.3
Mar	7.9	7.9	-1.7	-0.2	-0.1
Apr	9.7	9.6	4.4	8.8	8.8
May	17.5	18.8	14.5	17.1	16.9
Jun	NA	NA	21.8	21.8	21.7
Jul	NA	NA	23.1	23.7	24.3
Aug	23.2	23.1	23.2	22.6	23.1
Sept	18.2	18.2	17	15.7	16.5
Oct	12.1	12.2	9.3	8.1	8.2
Nov	1.8	2	-0.1	-2.2	-1.6
Dec	-5.3	-4.9	-7.8	-9.9	-9.1
Annual	7.5	7.7	7.1	7.1	7.5

Table 4: Mean Daily Minimum Temperature (ºC)

Month	Stn 1 (2011-2012)	Stn 2 (2011-2012)	Stn 2 (2012-2013)	Dryden (1981-2010)	Dryden Airport (1981-2010)
Jan	-16.4	-16	-19.8	-22.5	-21.9
Feb	-12.5	-12.4	-19.6	-18.9	-18.1
Mar	-3.8	-3.2	-12.7	-11.9	-11.5
Apr	-2.9	-1.4	-5.7	-3.4	-2.8
May	7.9	8.9	3.3	4.3	4.7
Jun	NA	NA	10.2	10.5	10.5
Jul	NA	NA	13.5	13.2	13.4
Aug	10.6	12.7	12	12.2	12.4
Sept	5.5	7.1	6.3	6.7	6.8
Oct	2.9	4.1	1.7	0.5	0.3
Nov	-5.1	-4.6	-6.2	-9.1	-8.8
Dec	-13.7	-12.6	-15.1	-18.4	-17.8
Annual	-2.8	-1.7	-2.7	-3.1	-2.7

Table 5 presents relative humidity averages for Dryden Airport, the only one of the four weather stations for which humidity data were available. The average relative humidity in the early morning (06:00) ranges from 75% to 90%, and is highest in Augusts and September. The relative humidity in the mid-afternoon ranges from 45% to 76%, with the lowest values occurring from April through June and the highest values occurring from November through January.

Table 5: Mean Relative Humidity

Month	Average Relative Humidity - 0600LST (%)	Average Relative Humidity - 1500LST (%)
Jan	81.5	75.5
Feb	82.2	69.1
Mar	80.5	59.3
Apr	75.8	46.5
May	77.3	45.6
Jun	83.4	51.5
Jul	87.3	53.5
Aug	89.8	54.6
Sept	90.4	60.3
Oct	87.6	66.4
Nov	86.7	75.7
Dec	84.2	78.5
Annual	83.9	61.4

3.3 Precipitation

Precipitation data (rainfall, snowfall, snow depth and total precipitation) were obtained from Environment Canada climate normals at the Dryden City and Dryden Airport stations from 1981 to 2010. The data are presented in Tables 6a, b.

Annual rainfall in the area is in the range from 500 to 600mm, with the highest rainfall occurring in June and July (over 100mm per month). The area receives between 100 and 200 cm of snowfall annually, which is fairly evenly distributed across the cold weather months (November through March). The monthly average depth of snow on the ground ranges between 26 to 45 cm during the period from December through March. In terms of total precipitation, the driest months tend to be December through March (less than 30mm of total precipitation each month), and the wettest months tend to be June and July (over 100mm each month).

Table 6a: Rainfall and Snowfall

Month	Dryden (1981-2010)	Dryden Airport (1981-2010)	Dryden (1981-2010)	Dryden Airport (1981-2010)
Jan	0.1	0.2	27.1	30.1
Feb	1	2.1	19.7	19.9
Mar	7.5	6.7	19.6	25.1
Apr	32.2	24.7	5.3	13.9
May	64.7	69.2	0.5	3.4
Jun	110.1	115.2	0	0
Jul	127.6	103.1	0	0
Aug	83	83.5	0	0
Sept	99.5	87.7	0.9	1.1
Oct	46.9	49.2	9.4	14.6
Nov	14.1	13	28.4	35.3
Dec	0	1.2	28.1	31.1
Annual	586.8	555.8	138.9	174.7

Table 6b: Snow Depth and Total Precipitation

Month	Dryden (1981-2010)	Dryden Airport (1981-2010)	Dryden MET (1981-2010)	Dryden Airport MET (1981-2010)
Jan	38	30	27.2	26.5
Feb	45	34	20.6	20
Mar	39	27	27.1	29.9
Apr	0	5	37.5	39.6
May	0	0	65.2	73.4
Jun	0	0	110.1	115.2
Jul	0	0	127.6	103.1
Aug	0	0	83	83.7
Sept	0	0	100.4	88.9
Oct	0	1	56.2	63.6
Nov	0	8	42.6	46.7
Dec	26	19	28.1	29.1
Annual	NA	NA	725.7	719.7

3.4 Wind

Table 7 shows mean monthly wind speeds for Dryden Airport and the two Bending Lake weather stations. The long-term mean annual wind speed at Dryden Airport is 12.4 km/h; whereas, the mean annual speeds measured at the Bending Lake stations were lower, ranging from 5.4 to 7.3 km/h. This is presumably due to the less exposed nature of the Bending Lake stations, compared to the weather station at Dryden Airport. The Bending Lake stations are expected to be more representative of wind conditions at the proposed mine site.

Table 7: Monthly Mean Wind Speed

Stations	Stn 1 (2011-2012)	Stn 2 (2011-2012)	Stn 2 (2012-2013)	Dryden Airport MET (1981-2010)
Jan	6.3	7.3	7.5	11.5
Feb	5.8	6.7	6.5	12.5
Mar	5.7	8.1	6.8	13
Apr	5.5	7.7	8.4	13.3
May	3	9.1	9	13.2
Jun	NA	NA	6	12.5
Jul	NA	NA	5.6	11.3
Aug	4.3	5	4.7	11.1
Sept	5.1	5.9	5.9	12.7
Oct	5.8	8	7.7	13.4
Nov	6.3	7.8	7.2	12.8
Dec	6.1	7.5	5.7	11.6
Annual	5.4	7.3	7	12.4

Figure 2 presents a wind rose for Dryden Regional Airport for the period from 1999 to 2017. It shows that the winds there come most often from directions between south and west. Figure 3 shows a wind rose for Bending Lake Station 1, showing that winds there came most often from directions between south-southwest and west northwest during the period from 2011 to 2012. At Bending Lake Station 2 from 2011 to 2012 (Figure 4), on the other hand, winds from the southeast and south-southeast were also relatively frequent. Winds from the northeast quadrant were least frequent at both Bending Lake stations.

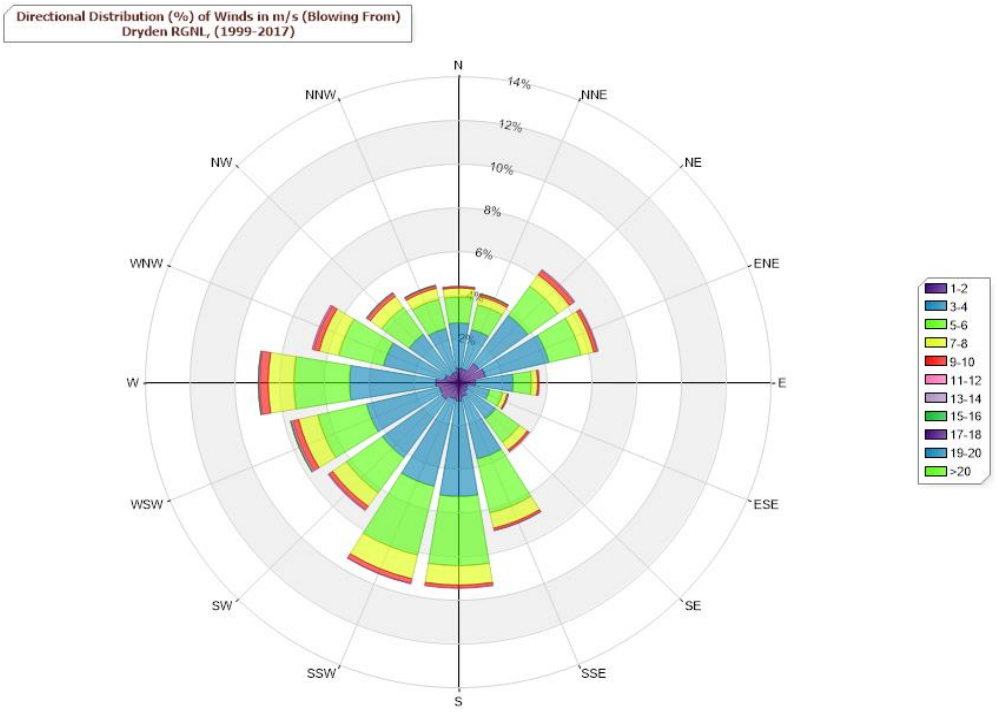

Figure 2: Wind Rose for Dryden Regional Airport (1999 – 2017)

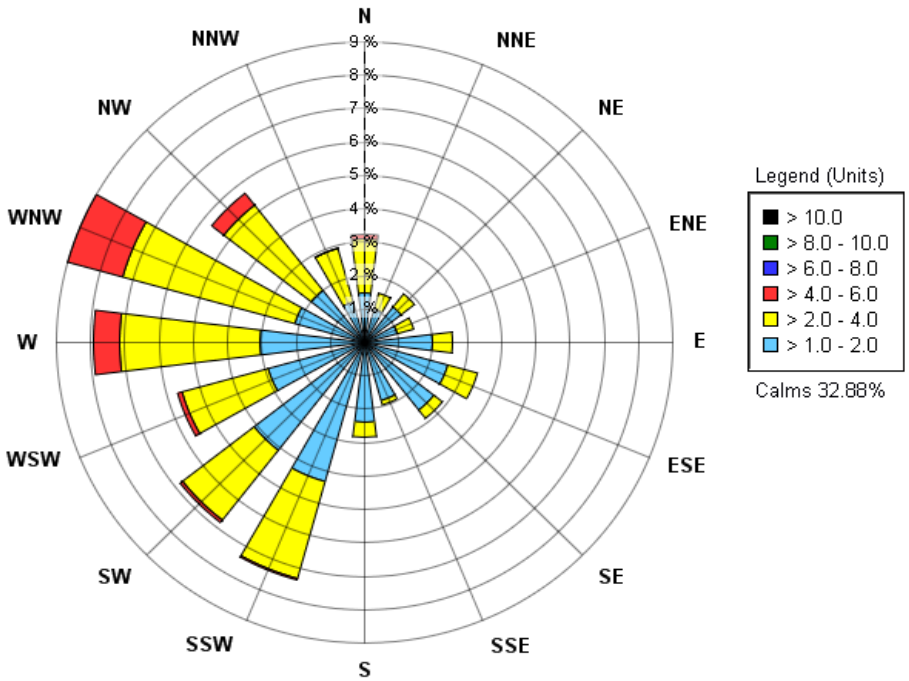

Figure 3: Wind Rose for Bending Lake Station 1 (2011-2012)

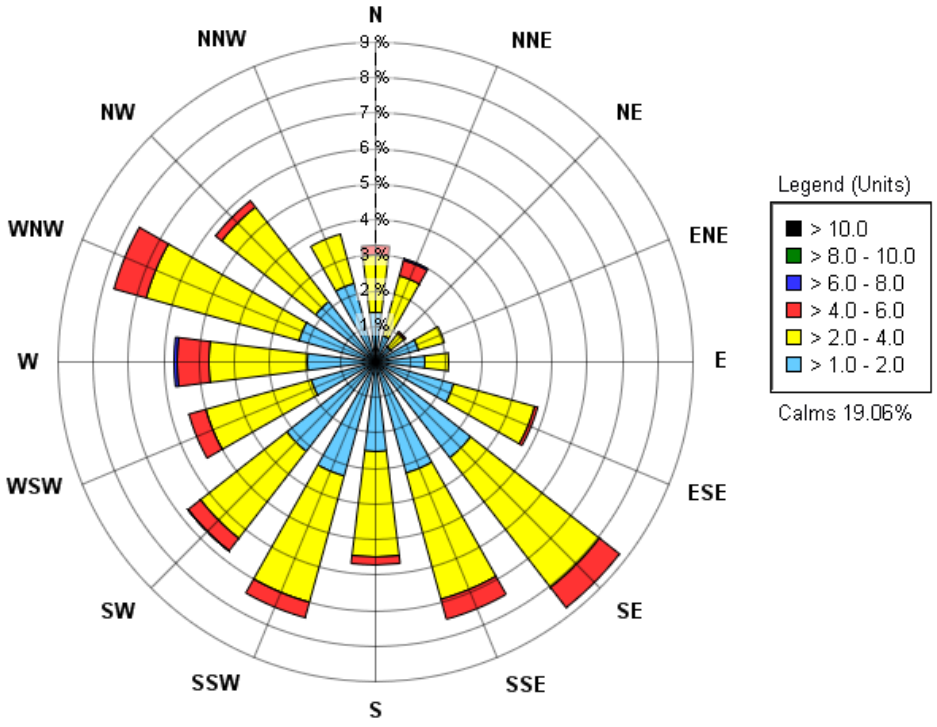

Figure 4: Wind Rose for Bending Lake Station 2 (2011-2012)

4 EXISTING AIR QUALITY

4.1 Air Quality Objectives

The Province of Ontario has Ambient Air Quality Criteria (AAQCs), which are effects-based levels in air, based on health and/or other effects. They are used in environmental assessments, special air monitoring studies, and assessments of general air quality to determine the potential for adverse effects. In addition, the Canadian Council of Ministers of the Environment (CCME) has developed Canadian ambient air quality standards (CAAQS) for some air pollutants. AAQCs and CAAQS are shown in Table 8 for a selection of potentially relevant air contaminants. Unless otherwise noted, concentrations thresholds are expressed in units of micrograms of contaminant per cubic metre of air ($\mu g/m^3$).

Table 8: Air Quality Criteria and Standards

Pollutant	Criterion ($\mu g/m^3$)	Averaging Period	Source	Notes
Ground-level ozone (O_3)	165 (0.080 ppm)	1 hour	AAQC	
	130 (0.065 ppm)	8 hours	CAAQS	annual 4th highest
Total Suspended particulate (TSP)	120	24 hours	AAQC	
	60	1 year	AAQC	
Inhalable particulate (PM_{10})	50	24 hours	AAQC	
Respirable particulate ($PM_{2.5}$)	28	24 hours	CAAQS	98th %-ile drops to 27 in 2020
	10	1 year	CAAQS	drops to 8.8 in 2020
Nitrogen Dioxide (NO_2)	400 (0.1 ppm)	1 hour	AAQC	
	200 (0.2 ppm)	24 hours	AAQC	
	120 (0.06 ppm)	1 hour	CAAQS	99th %-ile of daily max in effect by 2020
	34 (0.017 ppm)	1 year	CAAQS	in effect by 2020
Carbon Monoxide (CO)	36,200 (30 ppm)	1-hour	AAQC	
	15,700 (13 ppm)	8-hour	AAQC	
Sulphur Dioxide (SO_2)	690 (0.25 ppm)	1-hour	AAQC	
	275 (0.1 ppm)	24 hours	AAQC	
	55 (0.02 ppm)	1 year	AAQC	
	193 (0.07 ppm)	1 hour	CAAQS	99th %-ile of daily max in effect by 2020
	14 (0.005 ppm)	1 year	CAAQS	in effect by 2020
Arsenic	0.3	24 hours	AAQC	
Titanium	120	24 hours	AAQC	
Manganese	0.1 (Mn in $PM_{2.5}$)	24 hours	AAQC	
	0.2 (Mn in PM_{10})	24 hours	AAQC	
	0.4 (Mn in TSP)	24 hours	AAQC	
Nickel	0.02 (Ni in PM_{10})	1 year	AAQC	
	0.04 (Ni in TSP)	1 year	AAQC	
	0.1 (Ni in PM_{10})	24 hours	AAQC	
	0.2 (Ni in TSP)	24 hours	AAQC	
Copper	50	24 hours	AAQC	
Iron	4	24 hours	AAQC	

Pollutant	Criterion (µg/m³)	Averaging Period	Source	Notes
Lead	0.5	24 hours	AAQC	
	0.2	30 days	AAQC	
Chromium	0.5	24 hours	AAQC	
Cadmium	0.025	24 hours	AAQC	
	0.005	1 year	AAQC	
Vanadium	2	24 hours	AAQC	
Zinc	120	24 hours	AAQC	

4.2 Air Quality Measurements

Current air quality conditions were determined by looking at published air pollutant monitoring data from the most representative available monitoring station operated by the Ontario Ministry of Environment and Climate Change (MOECC), and from ambient monitoring studies conducted at other similar sites in Northern Ontario. The air pollution monitoring data were used as a representation of present-day outdoor concentrations of the contaminants of concern (CACs and trace metals) in the study area. These are referred to as background concentrations.

The most representative air monitoring station currently operated by the MOECC is located at 615 James Street, Thunder Bay, Ontario, which is on the order of 250 km from the project site. Currently, the station records data only for O_3, NO_2, and $PM_{2.5}$. Table 9 summarizes recent monitoring data for those contaminants. The data indicate that concentrations of O_3 and NO_2 are currently within their AAQCs. $PM_{2.5}$ is within the standard for the 1-year averaging period, but exceeds the standard for the 24-hour averaging period.

Table 9: Summary of 2015 Monitoring Data for Thunder Bay (µg/m³ unless otherwise indicated)

Pollutant	AAQC (µg/m³)	90th Percentile 1-hr	Maximum 1-hr	Maximum 24-hr	1-Year Average
O_3	0.08 ppm (1-hr)	0.039 ppm	0.062 ppm	0.048 ppm	0.024 ppm
$PM_{2.5}$	28 (24-hr) 10 (1-yr)	11	91	32	6.5
NO_2	0.2 ppm (1-hr) 0.1 ppm (24-hr)	0.016 ppm	0.050 ppm	0.027 ppm	0.0075

Until 2003, the station also recorded CO, SO_2 and a selection of airborne metals. Table 10 summarizes data from 2002. For O_3, NO_2, and $PM_{2.5}$, the 2002 data are similar in magnitude to those shown in Table 9 for the year 2015. For the other air contaminants, the 2002 data show that the concentrations are well within the applicable AAQCs.

Table 10: Summary of 2002 Monitoring Data for Thunder Bay (µg/m^3 unless otherwise indicated)

Pollutant	AAQC (µg/m^3)	90th Percentile 1-hr	Maximum 1-hr	90th Percentile 24-hr	Maximum 24-hr	Maximum 8-hr	1-Year Average
O_3	0.08 ppm (1-hr)	0.039 ppm	0.078 ppm	-	0.048 ppm	-	0.023 ppm
PM_{10}	50 (24-hr)			25	53	-	13
$PM_{2.5}$	28 (24-hr) 10 (1-yr)	14	199	-	37	-	6.2
NO_2	0.1 ppm (1-hr) 0.2 ppm (24-hr)	0.024 ppm	0.064 ppm	-	0.036 ppm	-	0.012
CO	30 ppm (1-hr) 13 ppm (8-hr)	0.94 ppm	4.3 ppm	-	-	3.1	0.47 ppm
SO_2	0.25 ppm (1-hr) 0.1 ppm (24-hr) 0.02 ppm (1-yr)	0.001 ppm	0.047 ppm	-	0.005 ppm	-	0.0005 ppm
Manganese in PM_{10}	0.2 (24-hr)	-	-	0.024	0.044	-	0.008
Nickel in PM_{10}	0.1 (24-hr); 0.02 (1-yr)	-	-	0.002	0.006	-	0.002
Copper in PM_{10}	n/a	-	-	0.05	0.085	-	0.022
Iron in PM_{10}	n/a	-	-	0.89	1.8	-	0.34
Lead in PM_{10}	n/a	-	-	0.01	0.02	-	0.01
Chromium in PM_{10}	n/a	-	-	0.004	0.008	-	0.002
Cadmium in PM_{10}	n/a	-	-	0.27	3	-	0.096
Vanadium in PM_{10}	n/a	-	-	0.005	0.01	-	0.005
Zinc in PM_{10}	n/a	-	-	0.025	0.06	-	0.012

Greenstone Gold Mine's Hardrock project is a proposed gold mine at Geraldton, Ontario. It is in a similar setting to the Bending Lake area. Stantec conducted monitoring at the site from December 2014 through June 2015. These data give a further indication of existing air quality conditions in the Bending Lake area. The data are summarized in Tables 11 and 12. The concentrations of PM, NO_2 and SO_2 are similar in magnitude but somewhat lower than those measured at Thunder Bay in 2015. The concentrations of all contaminants are well within their applicable AAQC's.

Table 11: PM, NO_2 and SO_2 Measurements at the Hardrock Project Site (Geraldton) in 2015

Pollutant	Criteria (µg/m³)	90th Percentile 1-hr	Maximum 1-hr	90th Percentile 24-hr	Maximum 24-hr	Period Average
PM_{10}	50 (24-hr)	-	-	26	44	11
$PM_{2.5}$	28 (24-hr) 10 (1-yr)	-	-	9.2	26	4.9
NO_2	0.2 ppm (1-hr) 0.1 ppm (24-hr)	0.0056	0.039	0.0059	0.011	0.0017
SO_2	0.25 ppm (1-hr) 0.1 ppm (24-hr) 0.02 ppm (1-yr)	0.0008	0.0044	0.0007	0.0014	0.00028

Table 12: TSP and Metals Measurements at the Hardrock Project Site (Geraldton) in 2015

Pollutant	Criteria (µg/m³)	90th Percentile 24-hr	Maximum 24-hr
TSP	120	26.4	40.9
Mercury in TSP	10	0.000015	0.00003
Lithium in TSP	4.8	0.0083	0.0084
Aluminum in TSP	4.8	0.23	0.27
Antimony in TSP	25	0.0031	0.0031
Arsenic in TSP	0.3	0.01	0.012
Barium in TSP	10	0.003	0.0004
Beryllium in TSP	0.01	0.00031	0.00031
Boron in TSP	120	0.0018	0.007
Cadmium in TSP	0.025	0.00062	0.00014
Chromium in TSP	n/a	0.0015	0.0016
Cobalt in TSP	0.1	0.00061	0.0016
Copper in TSP	50	0.29	0.38
Iron in TSP	4	0.63	0.72
Lead in TSP	0.5	0.0031	0.006
Magnesium in TSP	120	0.38	0.49
Manganese in TSP	0.4	0.012	0.013
Molybdenum in TSP	120	0.0046	0.016
Nickel	n/a	0.0012	0.0025
Potassium in TSP	8	0.1	0.16
Selenium in TSP	10	0.0031	0.0031
Silver in TSP	1	0.0015	0.0016

Pollutant	Criteria (µg/m³)	90th Percentile 24-hr	Maximum 24-hr
Strontium in TSP	120	0.0021	0.0032
Thallium in TSP	0.2	0.0031	0.0031
Tin in TSP	10	0.0031	0.0031
Titanium in TSP	120	0.015	0.019
Vanadium in TSP	5	0.0015	0.0016
Zinc in TSP	120	0.014	0.13

5 CONCLUSIONS

This report has presented a summary of existing climate conditions in the Bending Lake area based on data from on-site weather stations and from Dryden Airport. It has also presented a summary of existing air quality conditions in the area, based on data from monitoring programs conducted in other locations that are reasonably similar to the Bending Lake area (Thunder Bay and Geraldton). The air quality data indicate that existing concentrations of air contaminants are well within acceptable levels, with the possible exception of fine particulate matter ($PM_{2.5}$) concentrations. The 24-hour levels of $PM_{2.5}$ may exceed the applicable Canadian Ambient Air Quality Standard, based on data from Thunder Bay. Occasional days of elevated particulate matter occur throughout northern Canada, as a result of various factors, such as forest fires, traffic on unpaved roads, etc.