GOLDER

REPORT

Air Quality Impact Assessment

Proposed Dance Pit Expansion

Submitted to:

CBM Aggregates (CBM), a division of St. Marys Cement Inc. (Canada)

55 Industrial Street
Toronto, Ontario
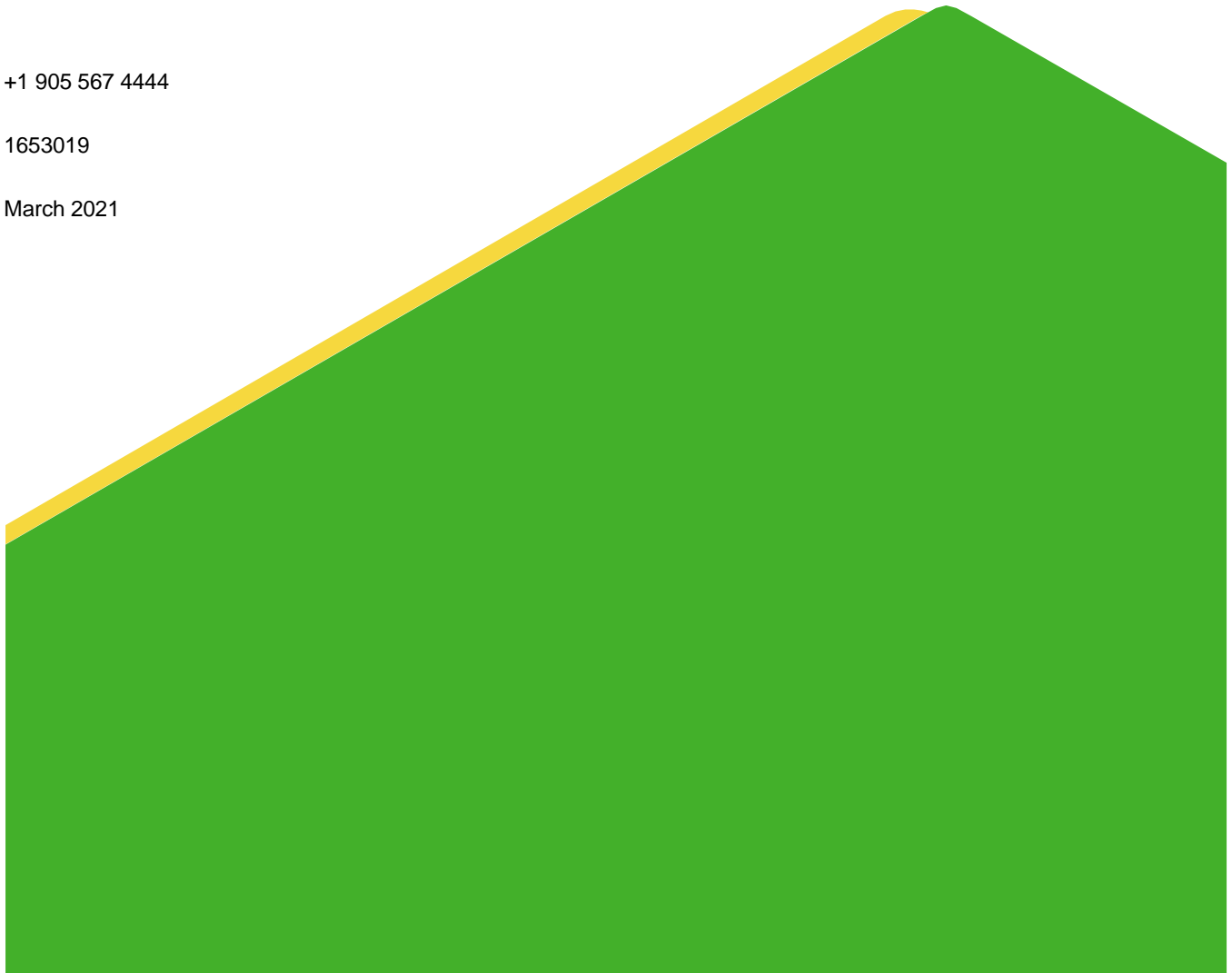M4G 3W9

Submitted by:

Golder Associates Ltd.

6925 Century Avenue, Suite #100, Mississauga, Ontario, L5N 7K2, Canada

+1 905 567 4444

1653019

March 2021

Distribution List

Electronic copy - CBM Aggregates, a Division of St. Marys Cement Inc. (Canada)

Electronic copy - Esher Planning Inc.

Electronic copy - Golder Associates Ltd.

Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX A
Background Air Quality Monitoring Data

APPENDIX B
Emission Calculations - Dance Pit

APPENDIX C
Air Dispersion Modelling Parameters

1.0   INTRODUCTION

Golder Associates Ltd. (Golder) was retained by CBM Aggregates (CBM), a division of St. Marys Cement Inc. (Canada) (SMC), to complete the necessary air quality related study to support the application of a Category 3, Class "A" licence under the Aggregate Resources Act (ARA) associated with the proposed expansion of the existing CBM Dance Pit (MNRF Licence No. 17348) on Part of the North Half of Lots 14 and 15, Concession 10, Township of North Dumfries, Regional Municipality of Waterloo, Ontario. This report summarizes the assessment of potential air quality impacts associated with the Dance Pit Expansion and puts them into context with the existing air quality of the area, through a cumulative effects assessment.

1.1   Purpose

The Aggregate Resources Act (ARA) does not provide specific guidance and standards for air quality assessments, the preparation of a detailed air quality assessment is not typically required for a licence application, in particular an expansion of an existing operation. A detailed assessment, in the form of an Emission Summary and Dispersion Modelling (ESDM) Report to support an Environmental Compliance Approval (ECA) application, would typically be completed once the licence has been granted, and the owner/operator seeks approval from the MECP under Section 9 of the Environmental Protection Act for operation of certain equipment that require an ECA. However, given the location of the proposed expansion area, in proximity to local residences, the Region of Waterloo requested that CBM complete an air quality assessment as part of their application. CBM retained Golder to complete an air quality assessment of the area in order to achieve the following:

■   quantify baseline air quality in the surrounding area;

■   calculate the emissions from current and future pit operations;

■   model the impact of the proposed pit expansion on local air quality; and

■   provide a list of best management practices to help control the potential for fugitive dust generation.

For the purpose of this report, the following definitions are used:

Site - (Figure 1) – The Dance Pit Expansion, or expansion area, that is proposed for licensing under the ARA.

1.2   Site Description

The Site is located on the south side of Cedar Creek Road in a semi-rural setting in the Township of North Dumfries, immediately west of the City of Cambridge. The Site comprises the proposed expansion lands which are adjacent to an existing pit currently operated by CBM. The Site is to the east of the existing pit and is currently being actively farmed. The existing pit encompasses an area of 44.95 ha with 41.33 ha approved for aggregate extraction. The proposed expansion area is approximately 29.05 ha, and the proposed extraction area is approximately 25.27 ha.

The existing pit operates Monday to Friday with extraction between the hours of 7 am and 6 pm and the proposed operations at the Site are intended to conform to these hours. Material is currently extracted (above the water table) using front end loaders and hauled to the below grade mobile crushing plant for processing. The existing pit has an annual production rate of 750,000 tonnes per year and an hourly production rate of approximately 300 tonnes per hour. Extraction is expected to be completed in three Areas. Area 1 is the southernmost area of the expansion lands, while Area 2 is the central area, and Area 3 is the northernmost area

The proposed operations at the Site will not increase the processing capacity of the existing pit and no new equipment will added to the existing pit as a result of the expansion. Material will be extracted from the expansion area by front end loader and transferred to a bin hopper before being conveyed or hauled to the processing plant. The processing plant will remain in the existing pit and the only equipment to be located on a consistent basis in the expansion area will be:

- one front end loader operating within 30m of the extraction face;

- one bin hopper; and

- one conveyor.

No stockpiles will be located in the expansion area. There will be no increase in off-site shipping and all shipping vehicles will continue to use the existing licence entrance/exit. The Site will adhere to a 60 m setback from the eastern property boundary, 30m setback from the northern property boundary and have a 0 m setback along the western and southern boundaries where there are existing operations and a common 0 m boundary is practical. A berm will also be constructed on the Site along the eastern and northern boundaries at a height greater than the existing grade, which will act as a wind break.
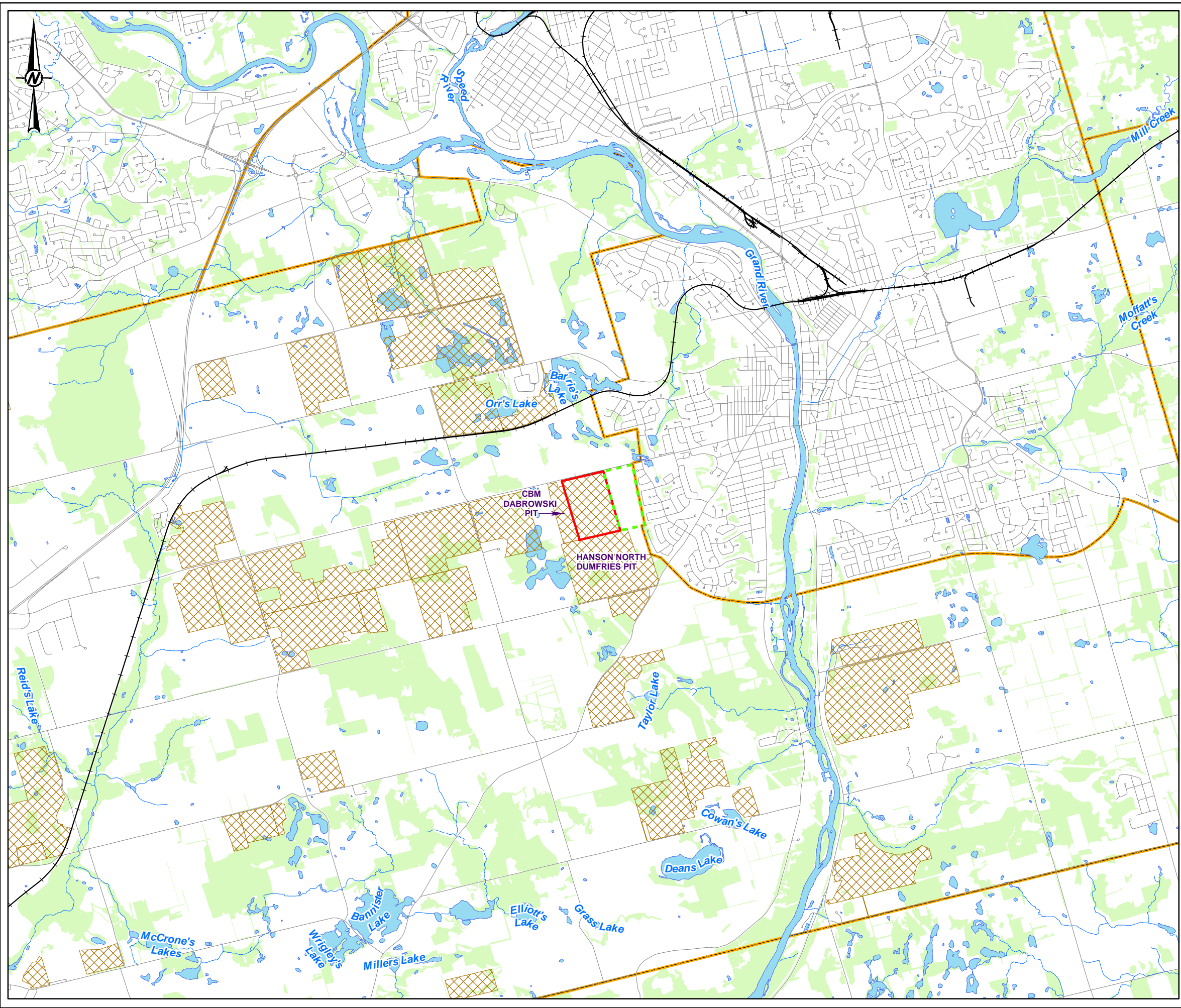
LEGEND

- - - DANCE PIT EXPANSION LICENCE BOUNDARY
—— DANCE PIT LICENCE BOUNDARY
—+— RAILWAY
—— ROAD
—— WATERCOURSE
▨ WATERBODY
▨ EXISTING ACTIVE AGGREGATE SITE
▭ MUNICIPAL BOUNDARY

KEY MAP

PROJECT LOCATION

0   1   2   3
1:50,000   KILOMETERS

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
DANCE PIT EXPANSION
CAMBRIDGE, ONTARIO

TITLE
SITE LOCATION PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-14
DESIGNED	SO
PREPARED	SO/CGE
REVIEWED	KA
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
1653019	0016	0	1

CBM DABROWSKI PIT

HANSON NORTH DUMFRIES PIT

1.3   Indicator Compounds

This assessment of air quality focuses on predicting changes in the concentrations of Criteria Air Contaminants (CACs). These compounds are generally accepted as indicative in changing air quality, and for which relevant air quality criteria exist. The selected indicator compounds fall into two categories:

■   **particulate matter**: suspended particulate matter (SPM), particles nominally smaller than 10 μm in diameter (PM_{10}), and particles nominally smaller than 2.5 μm in diameter ($PM_{2.5}$).;

■   **combustion gases**: NO_X represented by nitrogen dioxide (NO_2) has been identified as the key representative of combustion products.

The crystalline silica fraction of PM_{10} was also identified as an indicator compound. These compounds represent compounds that have the potential to be emitted from the Site. In addition to the compounds listed above, ozone (O_3) was also included in the air quality baseline assessment as it will be used to calculate NO_2 in the effects assessment. Ozone is not emitted directly into atmosphere but is associated with the reaction of NO_X (MECP 2015).

1.4   Applicable Guidelines

The relevant air quality criteria used for screening the air quality effects of the Site include the Ontario criteria and federal standards and objectives where provincial guidelines are not available. The Ontario Ministry of the Environment, Conservation and Parks (MECP) has set guidelines related to ambient air concentrations and are summarized in *Ontario's Ambient Air Quality Criteria* (AAQC) document (MECP 2018). The Ontario AAQCs are characterized as desirable ambient air concentrations. They are not regulatory limits, and measured concentration are frequently above the criteria values at various locations across Ontario due to weather conditions and long-range transportation, but represent an indicator of good air quality. The Ontario AAQCs are used for screening the air quality effects in environmental assessments, studies using ambient air monitoring data, and assessment of general air quality in a community or across the province (MECP 2017).

There are two sets of federal objectives and criteria: the National Ambient Air Quality Objectives (NAAQOs) and the Canadian Ambient Air Quality Standards (CAAQSs) (formerly National Ambient Air Quality Standards (NAAQS)). Similar to the Ontario AAQCs, the NAAQOs are benchmarks that can be used to facilitate air quality management on a regional scale and provide goals for outdoor air quality that protect public health, the environment, or aesthetic properties of the environment (CCME 1999). The federal government has established the following levels of NAAQOs (Health Canada 1994):

■   the maximum ***Desirable*** level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology; and

■   the maximum ***Acceptable*** level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.

The CAAQSs have been developed under the *Canadian Environmental Protection Act* (CEPA) and include standards for $PM_{2.5}$ and ozone that must be achieved by 2020. In 2015 the standard was phased in, with the final standard phase in date in 2020 (Government of Canada 2013). Like the Ontario AAQCs, the CAAQSs are not regulatory limits and are used as national targets for $PM_{2.5}$ and ozone, excluding Quebec (CCME 2014). The CAAQSs are based on the long term averages of measurement data not a short term measurement value.

A summary of the applicable Ontario and federal objectives and criteria are listed in Table 1.

Table 1: Ontario and Canadian Regulatory Air Quality Objectives and Criteria

Substance	Averaging Period	Ontario Ambient Air Quality Guidelines(a) (µg/m3)	Canadian Ambient Air Quality Standards(b) (µg/m3)	National Ambient Air Quality Standards and Objectives(c) (µg/m3)	
				Desirable	Acceptable
SPM(d)	24-Hour	120	—	—	120
	Annual	60(e)	—	60	70
PM10	24-Hour	50(f)	—	—	—
PM2.5	24-Hour	30	27(g)	—	—
	Annual	—	8.8	—	—
Crystalline Silica (<10 µm)	24-Hour	5	—	—	—
NO2	1-Hour	400(h)	79(i)	—	400
	24-Hour	200(h)	—	—	200
	Annual	—	22.5 (i)	60	100
O3	1-Hour	165	—	100	160
	8-Hour	—	128	—	—

Notes:

(a)   MECP (2018)

(b)   CAAQS published in the Canada Gazette Volume 147, No. 21 - May 25, 2013. Final standard phase in date of 2020 used.

(c)   CCME (1999)

(e)   Geometric mean

(f)   Interim AAQC and is provided as a guide for decision making (MECP 2018)

(g)   Compliance is based on the 98th percentile of the annual monitored data averaged over three years of measurements.

(h)   Standard is for nitrogen oxides (NO_X) but is based on the health effects of NO_2.

(i)   Canadian ambient air quality standard for NO_2 is effective from 2025. The 1-hour standard is based on the three-year average of the 98th percentile of the daily maximum 1-hour average concentration.

Bolded   values represent the criteria used in the assessment. 1 hour CAAQS for NO_2 was not used in this assessment as it is primarily a monitoring based standard that applies to the 98th percentile of the annual monitored data averaged over three years of measurements.

2.0   BACKGROUND AIR QUALITY

The background air quality represents the existing conditions of air quality before the operation of the Site. Sources include industrial facilities, roadways, long range transboundary air pollution, small regional sources and large industrial sources. Background air quality can be described using both regional concentrations, based on publicly available data and information on current activities and operations for neighbouring industrial sources.

2.1   Monitoring Data

Background air quality was assessed using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC 2017). Monitoring stations are typically sited in locations where there are potential concerns about local air quality or in population centers, therefore there are no locations in the immediate area of the Site, and stations located some distance away must be used to estimate contributions to air quality from other stationary sources, mobile sources and long range transportation.

The closest air quality monitoring station is located at West Ave. and Homewood in Kitchener (Kitchener). The Kitchener station is generally upwind of the Site and is considered to be the most representative station of the study area due to proximity to the Site location and the prevailing wind direction. However, it is located in the centre of Kitchener, i.e. in a more urban environment and would be influenced more significantly by local traffic emissions. The use of data from this station is therefore considered to be conservative and likely to represent an over-estimate of background emissions. Details of the development of background air quality approximations are provided in Appendix A.

Table 2 provides the background air quality values, based on Kitchener stations. There is no monitoring data available for SPM and PM_{10}, however, an approximation of the background SPM and PM_{10} concentrations can be estimated from the available $PM_{2.5}$ monitoring results. $PM_{2.5}$ is a subset of PM_{10}, and PM_{10} is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM_{10} levels, and PM_{10} concentrations will be greater than the corresponding levels of $PM_{2.5}$. The mean levels of $PM_{2.5}$ in Canadian locations are found to be about 54% of the PM_{10} concentrations and about 30% of the SPM concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background SPM and PM_{10} concentrations for the study area. Crystalline Silica is not monitored in Ontario; therefore, a background concentration was estimated using 6% of the PM_{10} concentrations (US EPA 1996).

The monitoring data was used as part of the cumulative effects assessment to describe the existing airshed. The concentrations presented in Table 2 were added to the modelled concentrations from the cumulative modelling assessment.

Table 2: Background Air Quality Values (90th Percentile, Average for Annual Only)

Indicator	Averaging Period	Project Criteria [µg/m³]	Kitchener (17 km NW) [µg/m³]	Background[µg/m³]	Background as a Percentage of Project Criteria [%]
SPM	24-hour	120	46.67	46.67	39%
	Annual	60	26.48	26.48	44%
PM10	24-hour	50	25.93	25.93	52%
PM2.5	24-hour	27	14.00	14.00	52%
	Annual	8.8	7.94	7.94	90%
Crystalline Silica1	24-hour	5	—	1.56	31%
NO2	1-Hour	400	24.45	24.45	6%
	24-Hour	200	22.26	22.26	11%
	Annual	22.5	6.36	6.36	28%
O3	1-Hour	165	88.31	88.31	54%
	8-Hour	128	100.09	100.09	78%

Notes:

µg/m = microgram per cubic metre

1.   Crystalline Silica concentrations derived from PM_{10} concentrations based on a 6% ratio (US EPA 1996).

Bolded values represent the background air quality.

2.2   Industrial Emissions Sources

The Site is located in a semi- rural setting with residences and the City of Cambridge to the East and farmland and other active aggregate extraction operations in other directions.   In particular, the pits following are located within a 2 km radius:

■   CBM Dance and Dabrowski Pits are located immediately west of the Site;

■   Lehigh Hanson Materials Ltd. Cambridge Pit (The Hanson Pit) is located immediately South of the Site;

■   Dufferin Aggregates Butler Pit is located North of Cedar Creek Road. This pit is now closed and undergoing rehabilitation.

■   Belair Construction Oliver Pit is located 1.2 km West of the Site on the east side of Edworthy Side Road

■   The Lafarge Brown Pit located 1.9 km West of the Site on the west side of Edworthy Side Road

■   Preston Sand and Gravel Galt and Blair Pits located 1.2 km North of the Site.

The majority of these existing pits are located over 1 km from the Site and are therefore not expected to contribute significantly to predicted concentrations of relevant indicator compounds at the closest residences, which are primarily located immediately East of the Site. Background air quality from local monitoring stations would therefore be considered representative of contributions from these locations and detailed emission calculations are not required to be included in the cumulative modelling assessment for the Site.

The Hanson Pit is located directly South of the existing Site and although it is not typically upwind of the prevailing wind direction across the Site, it would be expected to contribute to cumulative concentrations of particulate matter at the residences closest to the Site. In 2017, the Hanson Pit reported annual emissions of $PM_{2.5}$ and PM_{10} to the National Pollutant Release Inventory (NPRI). These emissions were carried through into the cumulative modelling assessment for the Site.

Similarly, the CBM Dabrowski Pit and the existing Dance Pit are located immediately west of the Site. There is an active plant on the Dance Pit property and occasionally portable equipment is operated on the Dabrowski Pit property. Emission rates for these two Pits were calculated using site-specific information. Detailed emission calculations are provided in Appendix B. These emissions were carried through into the cumulative modelling assessment for the Site.

2.3 Summary of Background Air Quality

The background air quality in the area around the Site has been described by considering regional concentrations and local contributions from neighbouring industrial sources. This data will be used as part of the cumulative effects assessment to inform the impact of the Site on the existing airshed. Detailed emission rates calculated for existing local industries (identified in Section 2.2) were included in the cumulative modelling assessment. The predicted concentrations estimated from the cumulative modelling assessment were added to the background concentrations estimated from monitoring data (Section 2.1) to characterize the cumulative impact on air quality.

3.0   SITE DESCRIPTION AND EMISSIONS

As stated above, no processing of material will occur on the Site, the only activities will be the extraction of material by front end loader before it is transferred to a bin hopper and either conveyed or hauled to the processing plant located at Dance Pit. No stockpiles will be located in the expansion area. The Site will adhere to a 60 m setback from the eastern property boundary, 30m setback from the northern property boundary and have a 0m setback along the western and southern boundaries where there are existing operations and a common boundary with the existing operations is practical. A berm will also be constructed on the Site along the eastern and northern boundaries at a height greater than the existing grade, which will act as a wind break.

It should be acknowledged that the proposed expansion does not introduce any additional sources of emissions to the property, all of the sources that will operate at the Site are currently in operation at the existing Pit and will be moved to the Site once extraction commences.

Emission calculations are provided below for each of the main sources of emission at the Site.

3.1   Extraction and Material Handling

Extraction of material occurs through the use of loaders. One loader will be used at the extraction face to remove material and transport aggregate to the bin hopper. From the bin hopper, material drops onto a conveyor and is transported to the plant located in the existing pit for processing. Potential emissions from this activity includes particulate matter as a result of the disturbance of material during handling.

It was assumed that material handling operations will occur throughout the typical operating hours of the Site, which will align with the current Dance Pit operations.

Predictive emission factors for particulate emissions were developed using equations (USEPA 2006). The following predictive emissions equation was used in determining the emission factors for material handling:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:

    EF .... = particulate emission factor (kg/Mg)
    k .... = particle size multiplier for particle size range (see Table 3)
    U .... = mean daily wind speed (3.69 m/s)
    M .... = moisture content of material (percent) (%).

Table 3: Particle Size Assumptions Material Transfer

Size Range	k
SPM	0.8
PM$_{10}$	0.35
PM$_{2.5}$	0.053

The following is a sample calculation for the SPM emission factor from the material handling of aggregate. A mean wind speed of 3.69 m/s is used below for illustration purposes although the emissions in the model were varied on an hour by hour basis, depending on the corresponding wind speed data record in the meteorological dataset. A moisture content of 4.8% was assumed.

$$\text{EF} = 0.74 \times 0.0016 \times \frac{\left(\frac{3.69}{2.2}\right)^{1.3}}{\left(\frac{4.8}{2}\right)^{1.4}}$$

$$\text{EF} = 0.00074 \frac{\text{kg}}{\text{Mg}}$$

The following is a sample calculation for the SPM emission rate for a material handling rate of 300 tonnes/hour.

$$\text{ER} = \frac{0.00074 \text{ kg}}{\text{Mg}} \times \frac{300 \text{ Mg}}{\text{hour}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}}$$

$$\text{ER} = 0.06 \frac{\text{g}}{\text{s}}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above. Extraction rates and material handling activities are not anticipated to increase from current rates as extraction transitions from the existing pit to the Site. Material will primarily be conveyed to the crushing plant located in the existing pit for processing, however equipment may also be hauled. Therefore, emissions rates were also calculated for truck loading from the bin hopper conveyor using predictive emission factors obtained from US EPA AP-42 Chapter 11.19.2 – Crushed Stone Processing, Table 11.19.2-1 (U.S. EPA, 2006).

Table 4: Emission Rates - Extraction and Material Handling

Source Description	Maximum Capacity [Mg/hour]	Emission Factors [kg/Mg]			Emission Rates [g/s]		
		SPM	PM_{10}	$PM_{2.5}$	SPM	PM_{10}	$PM_{2.5}$
Drop from Loader	300	7.37E-04	3.22E-04	4.88E-05	6.13E-02	2.68E-02	4.06E-03
Haul Truck Loading	300	5.00E-05	5.00E-05	5.00E-05	4.17E-03	4.17E-03	4.17E-03

3.2   Non-Road Vehicles – Exhaust Emissions

As described previously, the only vehicle is expected to be routinely operating at the Site is a loader. Emission rates for the loader were calculated using the non-road module of the US EPA Motor Vehicle Emission Simulator (MOVES), based on a model year of 2016 .The emission factors developed for the trucks are provided in Table 5.

GOLDER

Table 5: Emission Factors for Loaders Calculated Using NONROAD module of MOVES

Compound	Emission Factor (g/HP-hr)
SPM	0.07
PM10	0.07
PM2.5	0.07
NOX	0.91

The following predictive emissions equation was used to calculate the combustion emission rates for the loader:

$$\text{ER} = \text{EF} \times \text{engine horsepower rating} \times \frac{1 \text{ hr}}{3{,}600 \text{ s}}$$

Where:

ER =.................... emission rate (g/s)
EF =.................... emission factor (g/hp-hr).

The following is a sample calculation for the SPM emissions for the loader:

$$\text{ER} = \frac{0.0 \text{ g}}{\text{hp} - \text{hr}} \times 555 \text{ hp} \times \frac{1 \text{ hr}}{3{,}600 \text{ s}}$$

$$\text{ER} = 3.94\text{E} - 03 \text{ g/s}$$

The emissions rates for NOx, PM_{10} and $PM_{2.5}$ were calculated using the same equation and are presented below in Table 6.

Table 6: Emission Rates from Loader Tailpipe

Vehicle ID	# of units	Power (HP)	Emission Rates [g/s]			
			SPM	PM_{10}	$PM_{2.5}$	NO_x
Loader	1	555	3.94E-03	3.94E-03	3.82E-03	5.60E-02

3.3   Vehicles – Unpaved Road Dust

The loader operates within 30 m of the extraction face and the bin hopper. The route is unpaved and has the potential to generate fugitive dust.

The predictive equation in U.S. EPA AP-42 Chapter 13.2.2 – Unpaved Roads (November 2006) was used to calculate the fugitive dust emissions. The equation accounts for a control efficiency for the implementation of dust control measures. The equation is as follows:

$$\text{EF} = \left(k\left(\frac{s}{12}\right)^a \times \left(\frac{W}{3}\right)^b \times 281.9 \right)(1 - \text{control efficiency})$$

Where:

EF .... = particulate emission factor (g/VKT)

k .... = empirical constant for particle size range (pounds (lbs) per vehicle mile travelled (VMT)) (see Table 6)

s .... = road surface silt content (%) assumed to be 4.8% (as per U.S. EPA AP-42 Section 13.2.2 for Sand and Gravel Processing Plant Roads)

W .... = average weight (tons) of the vehicles traveling the road,

a .... = empirical constant for particle size range (dimensionless) (see Table 7)

b .... = empirical constant for particle size range (dimensionless) (see Table 7)

281.9.................... = conversion from pounds per vehicle miles travelled to grams per vehicle kilometres travelled

control efficiency... = reduction of fugitive dust emissions of 90% due to implementation of a fugitive dust best management practice plan (BMPP)

Table 7: Particle Size Assumptions for Unpaved Road Dust

Size Range	k (lb/VMT)	a	b
SPM	4.9	0.7	0.45
PM10	1.5	0.9	0.45
PM2.5	0.15	0.9	0.45

The following is a sample calculation for SPM for the emission factor for vehicles that will travel along unpaved roads within the pit. It was estimated that the loader will have an average weight of 62.1 tons. A control efficiency of 90% was selected to represent the implementation of a BMPP which will include road watering and a speed limit.

$$EF = \left(4.9 \left(\frac{4.8}{12} \right)^{0.7} \times \left(\frac{62.1}{3} \right)^{0.45} \times 281.9 \right) (1 - 90\%)$$

$$EF = 284.4 \text{ g/VKT}$$

The following is a sample calculation for the SPM emission rate for Loaders travelling along the same unpaved road segment:

$$ER = \frac{284.4 \text{ g}}{VKT} \times \frac{14.52 \text{ VKT}}{day} \times \frac{1 \text{ day}}{11 \text{ hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.01 \text{ g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above and presented in Table 8, below.

Table 8: Emission Rates from Unpaved Road

Description	Maximum VKT/day	Average Weight [tonnes]	Average weight [tons]	Emission Rates [g/s]		
				SPM	PM$_{10}$	PM$_{2.5}$
Loader	14.52	56.4	62.1	1.04E-01	2.66E-02	2.66E-03

3.4   Summary of Emissions from the Site

This section outlines the emission rates used in the Air Quality Assessment for the Site, in grams per second, which were calculated for each activity as described above.

Table 9 summarizes the emission rates for each activity at the Site and the percentage that each source contributes to the overall emissions, relative to the existing pit. Crystalline Silica emissions from fugitive sources were estimated using published data on the ratios of Crystalline Silica in PM$_{10}$ (Richards et al, 2009).

It should be acknowledged that the proposed expansion does not introduce any additional sources of emissions to the property, all of the sources that will operate at the Site are currently in operation at the existing Pit and will be moved to the Site once extraction commences. Therefore, the total emissions from pit operations will not increase and the expansion does not result in additional loading to the airshed.

Table 9: Emission Summary for the Site by Source

Source Identifier	Source Description	Emission Data				
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]	Percentage of Overall Emissions [%]
1	Extraction and Material Handling	SPM	N/A	6.55E-02	24	38%
		PM10	N/A	3.10E-02	24	50%
		PM2.5	N/A	8.23E-03	24	56%
		Crystalline Silica	14808-60-7	4.25E-03	24	7%
2	Vehicle Exhaust	SPM	N/A	3.94E-03	1,24	2%
		PM10	N/A	3.94E-03	1,24	6%
		PM2.5	N/A	3.82E-03	1,24	26%
		NOx	10102-44-0	5.60E-02	1,24	100%
3	Unpaved Road Dust	SPM	N/A	1.04E-01	24	60%
		PM10	N/A	2.66E-02	24	43%
		PM2.5	N/A	2.66E-03	24	18%
		Crystalline Silica	14808-60-7	3.65E-03	24	6%

3.5 Emissions from Surrounding Industrial Sources

In addition to emissions from the existing operation and the Site, emission rates were calculated for the adjacent industrial sources identified in Section 2.2 for use in the Cumulative Air Quality Assessment.

3.5.1 Dance and Dabrowski Pits

Emission rates for the existing Dance and Dabrowski Pits were calculated using site specific information on the pit operations. A summary of the emission calculations is provided in Appendix B and summarised in Table 10, below.

Table 10: Emission Summary for the Dance and Dabrowski Pits by Source

Source Identifier	Source Description	Emission Data			
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]
4	Crushing Plant	SPM	N/A	4.38E-01	24
		PM10	N/A	1.76E-01	24
		PM2.5	N/A	2.49E-02	24
		Crystalline silica	14808-60-7	2.41E-02	24
5	Wash Plant	SPM	N/A	6.46E-02	24
		PM10	N/A	2.81E-02	24
		PM2.5	N/A	4.67E-03	24
		Crystalline silica	14808-60-7	3.86E-03	24
6	Stockpiles	SPM	N/A	5.38E-02	24
		PM10	N/A	2.69E-02	24
		PM2.5	N/A	4.04E-03	24
		Crystalline silica	14808-60-7	3.69E-03	24
7	Paved Road Dust	SPM	N/A	5.19E-02	24
		PM10	N/A	9.97E-03	24
		PM2.5	N/A	2.41E-03	24
		Crystalline silica	14808-60-7	1.37E-03	24
8	Unpaved Road	SPM	N/A	1.64E+00	24
		PM10	N/A	4.17E-01	24
		PM2.5	N/A	4.17E-02	24
		Crystalline silica	14808-60-7	5.72E-02	24

Source Identifier	Source Description	Emission Data			
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]
9	Power Generation Equipment	SPM	N/A	7.62E-02	1, 24
		PM10	N/A	7.62E-02	1, 24
		PM2.5	N/A	7.62E-02	1, 24
		NOx	10102-44-0	1.52E+00	1, 24
10	Nonroad Vehicles - Exhaust Emissions	SPM	N/A	1.54E-02	1, 24
		PM10	N/A	1.54E-02	1, 24
		PM2.5	N/A	1.50E-02	1, 24
		NOx	10102-44-0	1.95E-01	1, 24
11	Paved Road Vehicles - Exhaust Emissions	SPM	N/A	5.06E-03	1, 24
		PM10	N/A	5.06E-03	1, 24
		PM2.5	N/A	3.49E-03	1, 24
		NOx	10102-44-0	5.06E-02	1, 24
12	Material Handling	SPM	N/A	6.13E-02	24
		PM10	N/A	2.68E-02	24
		PM2.5	N/A	4.06E-03	24
		Crystalline silica	14808-60-7	3.68E-03	24

3.5.2   Hanson Pit

Emissions of PM_{10} and $PM_{2.5}$ from the Hanson Pit were estimated using the data reported to the National Pollutant Release Inventory (NPRI) for the Site in 2017. The annual emissions were converted to daily emissions assuming that the pit was operational 300 days per year. SPM emissions were not quantified, therefore the ratio of PM_{10} to SPM emissions from Dance Pit was used to estimate SPM emissions from Hanson Pit. Crystalline silica emission rates were estimated using published data on the ratios of Crystalline Silica in PM_{10} (Richards et al, 2009). A summary of estimated emissions from the Hanson Pit is provided in Table 11, below.

GOLDER

Table 11: Emission Summary for the Hanson Pit

Source Identifier	Source Description	Emission Data			
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]
12	Hanson Pit	SPM	N/A	0.77	24
				0.64	Annual
		PM10	N/A	0.24	24
		PM2.5	N/A	0.17	24
				0.14	Annual
		Crystalline silica	14808-60-7	0.03	24

4.0   DISPERSION MODELLING

The likely environmental effects for the air quality indicators were evaluated with the aid of the AERMOD dispersion model (Version 19121) developed by the United States Environmental Protection Agency (U.S. EPA). Further details are provided in Appendix C and a dispersion modelling plan is presented in Figure 2.

The model was run using meteorological data downloaded from the MECP and all modelling was completed in accordance with the Air Dispersion Guideline for Ontario (MECP, 2017) and regulatory defaults.

NOTE(S)
1. MAX WATER LEVEL BETWEEN APRIL 20TH AND MAY 16TH PLUS 1.5M

REFERENCE(S)
1. IMAGERY: © 2021 MICROSOFT CORPORATION © 2021 MAXAR ©CNES (2021) DISTRIBUTION AIRBUS DS
2. SITE PLAN PROVIDED BY CBM APRIL 2016
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM:UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
DANCE PIT EXPANSION

TITLE
DISPERSION MODELLING PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-14
DESIGNED	SO
PREPARED	SO/CGE
REVIEWED	KA
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
1653019	0016	0	**2**

0   150   300   450

1:7,500   METRES
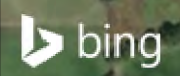
5.0   RESULTS

The results of the air quality dispersion modelling are presented for the Site in Table 12. Maximum concentrations at sensitive receptors under extraction in any of areas 1-3 are presented. Table 13 presents the cumulative maximum concentrations at all receptors. This includes contributions from existing Dance Pit and the neighbouring Hanson Pit, in addition to background air quality.

Overall the results indicate that maximum predicted concentrations of emissions from the Site alone are significantly below the relevant ambient air quality criteria.

When combined with background air quality concentrations and impacts from surrounding pits, maximum predicted concentrations of all indicator compounds are still predicted to be less than the relevant ambient air quality criteria.

The site does not introduce any new sources of emission or impact the rate of processing activities at neighbouring Dance Pit, as a result the Site contributes very little change to the maximum predicted concentrations of any of the indicator compounds. The assumptions in the modelling are conservative as they assume all equipment is operating simultaneously at maximum capacity, 11 hours per day. Similarly, the modelling does not take into account the positive impacts of the berm and vegetation that will be installed in the pit expansion area, which will act as a wind break to both emissions from the expansion and the existing Dance Pit. To further help reduce the likelihood of frequency of exceedance, a series of best management practices are presented in Section 6.0 to help control fugitive dust generation.

Table 12: Maximum Predicted Concentrations of Indicator Compounds from Expansion

Substance	Averaging Period	Criteria [µg/m³]	Maximum Site Concentration [µg/m³]	% Criteria
SPM	24-Hour	120	28.18	23%
	Annual	60	3.07	5%
PM_{10}	24-Hour	50	9.06	18%
$PM_{2.5}$	24-Hour	27	2.63	10%
	Annual	8.8	0.29	3%
Crystalline Silica (<10 µm)	24-Hour	5	1.13	23%
NO_2	1-Hour	400	84.63	21%
	24-Hour	200	12.33	6%
	Annual	22.5	1.43	6%

Table 13: Maximum Predicted Cumulative Concentrations of Indicator Compounds

Substance	Averaging Period	Criteria [µg/m³]	Maximum Cumulative Concentration [µg/m³]	% Criteria
SPM	24-Hour	120	110.44	92%
	Annual	60	33.54	56%
PM$_{10}$	24-Hour	50	45.51	91%
PM$_{2.5}$	24-Hour	27	22.06	82%
	Annual	8.8	8.62	98%
Crystalline Silica (<10 µm)	24-Hour	5	4.15	83%
NO$_2$	1-Hour	400	134.56	34%
	24-Hour	200	37.00	18%
	Annual	22.5	7.95	35%

6.0   BEST MANAGEMENT PRACTICES

The results presented above indicate that predicted concentrations from the Site are below the relevant assessment criteria, however, given the proximity of residential housing on the eastern side of the Site, there is a potential for nuisance impacts.   The assessment includes the consideration of some preventative controls at the Site, (i.e. watering of on-site roadways) but does not take into account reactive controls and/or additional on-site management and/or mitigation measures that could help further manage fugitive dust emissions. In order to minimize the likelihood of nuisance complaints, additional best management practices can be implemented to reduce the potential for fugitive dust emissions. The existing pit operates under an ARA licence and dust is currently managed through best management practices.

The following sections summarize the main sources of fugitive dust emissions associated with the Site and a description of potential preventative control activities that can be implemented to help minimize these emissions. These activities are most beneficial if employed on the areas of concern closest to the residential receptors.

6.1   Identification of the Sources of Fugitive Dust Emissions

Fugitive dust emissions occur due to mechanical disturbances of granular materials exposed to the air. Dust generated from these open sources is termed "fugitive" because it is not discharged to the atmosphere in a confined flow stream, such as in an exhaust pipe or stack (USEPA 1995).

The mechanical disturbance may be equipment movement, the wind or both. Therefore, some fugitive dust emissions occur and/or are intensified by equipment use, while others, i.e., wind erosion emissions, are independent of equipment use.

The main factors affecting the amount of fugitive dust emitted from a source include characteristics of the granular material being disturbed (i.e., particulate size distribution, density and moisture) and intensity and frequency of the mechanical disturbance (i.e., wind conditions and/or equipment use conditions). Precipitation and evaporation conditions can affect the moisture of the granular material being disturbed and, therefore, have an indirect effect on the amount of fugitive dust emitted.

Once dust is emitted, its travelling distance from the source is affected by various parameters. Namely climatic conditions, specifically wind speed, wind direction and precipitation, and particle size distribution. Higher wind speeds increase the distance travelled while precipitation can accelerate its deposition. Finer particulates can travel longer before settling and, therefore, deserve more attention.

Table 14 presents a summary of the main sources of fugitive dust emissions that will be present at the Site, as well as the potential causes for high dust emissions and opacity resulting from these sources. Note that no processing equipment or stockpiles will be located on the proposed expansion area.

Table 14: Sources of Fugitive Dust Emissions at the Site and Potential Causes for High Emissions

Identification of Sources of Fugitive Dust Emissions		Potential Causes for High Emissions and Opacity from Each Source (Parameters/Conditions)
Source Category	**Activity/Source Location**	
Unpaved Roadways	Vehicle traffic on unpaved roadways/existing access road	• number of vehicles/large • weight of vehicles/heavy • silt content/high • wind speed/high • moisture content/dry
Material Handling	Material Extraction Activities	• moisture content/dry • material size/fine • material transfer rate/high • material drop height/high • wind speed/high
	Points where material is off-loaded to conveyors (i.e., drop points)	

6.2   Fugitive Dust Best Management Practices

Control measures to reduce fugitive dust emissions should take into account the sources of the dust emission, the dispersion conditions and the location of sensitive areas. Control measures are in place to minimize one or more factors leading to the generation and/or dispersion of fugitive dust emissions. These control measures can be classified as follows:

■   **Preventative Procedure**: Measure pertaining to the design and installation of structures and the operating procedures which are implemented on a regular basis in order to prevent the generation of dust and/or the dispersion of dust emitted reaching sensitive areas.

■   **Reactive Control Measures**: Measures which are implemented in the event of unexpected circumstances which can lead to the generation of dust and/or the dispersion of dust emitted reaching sensitive areas.

Table 15 presents preventative procedures and reactive control measures for fugitive dust emissions that are associated with the Site.

Table 15: Description of Preventative Procedures and Control Measures for Fugitive Dust Emissions

Emission Source	Preventative Procedure/ Control Measure	Description	Frequency
Unpaved Roadways	Watering and/or chemical suppressants	Water and/or MECP approved substances will be applied as a dust suppressant during non-freezing conditions.	At least 2 litres/m² after 24 hours of no precipitation during drier period (i.e., summer months). Particular attention should be taken to unpaved roads on the eastern side of the Expansion due to the close proximity of residences.
	Speed Limit	Vehicle speed to be restricted.	Speed limit to be enforced of 25 km/hr.
	Re-grading	Applying coarser material to surface of roadways.	Annually in spring and whenever road sampling indicates it is necessary.
Wind Erosion	Silt Fences	A silt fence will be installed on the toe of the berm in the expansion area to help reduce wind erosion from the Site.	Maintain in good operating condition.
Material Handling	Maintain Minimum Drop Height	Material will be dropped from the shortest possible distance.	Continual.

6.3   Recommendations

It is recommended that the following dust mitigation activities are included in the Site Plan for the expansion area:

1)   No processing equipment is to be located on the Site and/or no stockpiling of extracted materials.

2)   Water, or similar dust suppressant, will be applied to roads in the Site on operational days, after 24-hour periods of no precipitation.

3)   A Silt Fence will be installed at the toe of the berm located along the eastern boundary of the Site, and maintained in good operating condition.

4)   A speed limit of 25 km per hour will be imposed on internal roads in the Site.

7.0 CONCLUSIONS

An assessment of potential air quality impacts associated with the Dance Pit Expansion was completed based on modelling of maximum emissions from the Site, a cumulative modelling assessment considering additional sources of air emissions in the immediate vicinity of the Site and the addition of ambient monitoring data to represent regional background air quality.

The results of the cumulative assessment are anticipated to represent a very conservative scenario as they assume that the worst-case meteorological conditions occur at the same time that maximum on-site activities take place, and during 90th percentile ambient air quality conditions. The likelihood of these occurring concurrently is very small and therefore not expected to impact local air quality.

Additionally, the expansion area will include a berm and vegetation, the effects of which are not included in the modelling. This will act as a wind break and is thus expected to further reduce concentrations of dust at locations to the east of the expansion area. The implementation of best management practices identified within this document can also help to reduce dust generation further, and reduce the likelihood of potential nuisance complaints associated with fugitive particulate matter.

The results of the air quality impact assessment for the Dance Pit Expansion are conservative and indicate that the maximum predicted cumulative emissions (i.e. including background and impacts from surrounding pits) are predicted to be below the criteria at surrounding sensitive receptors with the Site resulting in a very small impact in maximum predicted air quality concentrations. The Dance Pit Expansion can therefore proceed with minimal impacts to the local air quality.

8.0   REFERENCES

Alberta Environment and Sustainable Resource Development (2013). Air Quality Model Guideline – Effective October 1st, 2014. ISBN: 978-1-4601-0599-3, Edmonton, Alberta

Canadian Council of Ministers of the Environment (CCME) (1999). *Canadian National Ambient Air Quality Objectives: Process and Status.* Available from ceqg-rcqe.ccme.ca/download/en/133/

Canadian Council of Ministers of the Environment (CCME) (2014). *Canada-Wide Standards for Particulate Matter and Ozone, 2012 Final Report.*

Cole, H.S. and J.E. Summerhays, 1979. *A Review of Techniques Available for Estimation of Short-Term NO2 Concentrations.* Journal of the Air Pollution Control Association, 29(8): 812– 817.

Environment and Climate Change Canada (ECCC) (2017). National Air Pollution Surveillance Program (NAPS). http://www.ec.gc.ca/rnspa-naps/Default.asp?lang=En&n=5C0D33CF-1

Government of Canada (2013). Canada Gazette Vol 147, 21.

Health Canada (1994). National Ambient Air Quality Objectives for Carbon Monoxide. Executive Summary, Desirable, Acceptable and Tolerable Levels. ISBN 0-662-25642-5

Lall, R., Kendall., M., Ito, K., Thurston, G.D. (2004) Estimation of Historical Annual $PM_{2.5}$ Exposures for Health Effects Assessment. Atmospheric Environment 38 (2004) 5217 – 5226. Accessed https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileID/13226.

Ministry of the Environment, Conservation and Parks (MECP). 2011. *Air Pollution - Local Air Quality - Ontario Digital Elevation Model Data*. Retrieved June 28, 2016, from Ontario Ministry of the Environment, Conservation and Parks: https://www.ontario.ca/environment-and-energy/map-regional-meteorological-and-terrain-data-air-dispersion-modelling

Ministry of the Environment, Conservation and Parks (MECP). 2017. *Air Dispersion Modelling Guideline for Ontario, Version 3.0.* PIBS: 5165e03, Toronto, Ontario

Ministry of the Environment, Conservation and Parks (MECP) (2017). Air Quality in Ontario 2016 Report

Ministry of the Environment, Conservation and Parks (MECP) (2018). Ontario's Ambient Air Quality Criteria, PIBS# 6570e01. Standards Development Branch, Ontario Ministry of the Environment and Climate Change

Richards, J.R.., Brozell, T.T., Rea, C, Boraston, G, Hayden, J.(2009) PM_4 Crystalline Silica Emission Factors and Ambient Concentrations at Aggregate Producing Sources in California. Published in Journal of the Air & Waste Management Association. Volume 59, pp1287 - 1295

United States Environmental Protection Agency (U.S. EPA). 1995. *Compilation of Air Pollutant Emission Factors.* Volume 1: Stationary Point and Area Sources. AP-42 Fifth Edition (and updates). Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.

United States Environmental Protection Agency (USEPA) (1996). Ambient Levels of Noncancer Health Effects of Inhaled Crystalline and Amorphous Silica: Health Issue Assessment

United States Environmental Protection Agency (U.S. EPA). 2003. *Comparison of Regulatory Design Concentrations: AERMOD vs. ISCST3, CTDMPLUS, ISC-PRIME*. Staff Report, EPA-454/R-03-002. Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina.

United States Environmental Protection Agency (U.S. EPA). 2004a. *AERMOD: Description of Model Formulation*. EPA-454/R-03-004. Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina.

United States Environmental Protection Agency (USEPA) (2006). Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources (AP-42). published on-line at http://www.epa.gov/ttn/chief/ap42/index.html

United States Environmental Protection Agency (U.S. EPA). 2005. *40 CRF Par 51 Revision to the Guideline on air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and other Revisions.* Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina.

United States Environmental Protection Agency (USEPA) (2010). Crank case emission factors and load factors for non-road Engine Modelling (Compression Ignition) – U.S. EPA 009d (July, 2010)

Signature Page

Golder Associates Ltd.

Katherine Armstrong, M.Sc.
Air Quality Specialist

Sean Capstick, P.Eng.
Principal

KSA/FSC/ng

Golder and the G logo are trademarks of Golder Associates Corporation

https://golderassociates.sharepoint.com/sites/107388/project files/6 deliverables/air/report/final/1653019-r-rev0 cbm dance pit aqia 23mar2021.docx

APPENDIX A

Background Air Quality Monitoring Data

1.1   Monitoring Data

Background air quality was assessed using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC 2017). Monitoring stations are typically sited in locations where there are potential concerns about local air quality or in population centers, therefore there are no locations in the immediate area of the Site and stations located some distance away must be used to estimate contributions to air quality from other stationary sources, mobile sources and long range transportation.

The closest air quality monitoring station is located at West Ave. and Homewood in Kitchener (Kitchener). The location of this air monitoring station, relative to the Site is summarized in Table 1 .

Table 1: Location of Air Monitoring Stations

Station	Address	NAPS Station ID	Latitude and Longitude	Distance to the Site (km)	Direction
Kitchener	West Ave. & Homewood	61502	43.44383, -80.50381	17	Northwest, generally upwind

The air flow into the study area is predominantly from the northwest. The Kitchener station (NAPS ID 61502) is generally upwind of the Site and is considered to be the most representative station of the study area due to proximity to the Site location and the prevailing wind direction. However, it is located in the centre of Kitchener, i.e. in a more urban environment and would be influenced more significantly by local traffic emissions. The use of data from this station is therefore considered to be conservative and likely to represent an over-estimate of background emissions.

Table 2 provides a summary of the monitoring data available from this stations for the period from 2000 through 2018. At the time of this assessment, complete datasets were available up until 2018, with only partial information being available for 2019 and 2020.

Table 2: Availability of Ambient Air Quality Data

Compound	Years of Availability
SPM	—
PM$_{10}$	—
PM$_{2.5}$	2000 – 2018
NO$_2$	2000 – 2018
NO	2000 – 2018
O$_3$	2000 - 2018

"—" indicates that data for the parameter were not available at that station.

There is no monitoring data available for SPM and PM_{10}, however, an approximation of the background SPM and PM_{10} concentrations can be estimated from the available $PM_{2.5}$ monitoring results. $PM_{2.5}$ is a subset of PM_{10}, and PM_{10} is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM_{10} levels, and PM_{10} concentrations will be greater than the corresponding levels of $PM_{2.5}$. The mean levels of $PM_{2.5}$ in Canadian locations are found to be about 54% of the PM_{10} concentrations and about 30% of the SPM concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background SPM and PM_{10} concentrations for the study area.

The continuous monitoring station listed in Table 1 was used to reflect the existing conditions in the study area. The existing air quality levels, based on background air concentrations from available monitoring stations are summarized in the following sections. The available air monitoring data represents the combined effect of emissions from sources near to each of the monitoring stations, as well as the effect of the emissions transported into the region. The emissions transported into the region could be considered to be the 'background air quality', which would be added to dispersion modelling results as part of the impacts assessment.

Although gaseous monitoring equipment records concentrations in units of parts per million parts (ppm) or parts per billion parts (ppb), regulatory criteria are established on the basis of micrograms per cubic metre (µg/m³). In this section, monitoring results for gaseous compounds are presented in the units of µg/m³, to facilitate the comparison of monitoring to criteria. The conversion from ppm to µg/m³ is unique to each compound, based on the molecular weight of the compound and standard atmospheric conditions (1 atmosphere of pressure and 25°C). In contrast, particulate and metals monitoring equipment records concentrations in units of µg/m³, allowing for direct comparison to the regulatory criteria.

1.2 Comparison of Monitored Data by Indicator Compound

The graphs in the following sections present simplified box-and-whisker plots showing the available concentration data. The box on the figures represents the bounds of the middle 50% of the data points. The top of the box represents the 75th percentile concentration, while the bottom of the box represented the 25th percentile concentration. The line through the middle of the box represents the median, or 50th percentile concentration. The orange diamond represents the average concentration and the green circle represents the 90th percentile. On these figures, the whiskers extend up to the maximum, and down to the minimum concentration.

The 90th percentile of the 1-hour, 8-hour, and 24-hour measurements are typically used to represent the background air quality value when conducting an impact assessment as this value is exceeded only 10% of the time. The annual average concentration is used for annual background levels (Alberta Environment 2013) and based on the limited measurement data. The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred. Significant differences between the average and 75th percentile readings provide an indication that the background air quality is dominated by infrequent, but extreme events.

1.2.1 Fine Particulate Matter (PM$_{2.5}$)

Particulate emissions occur due to anthropogenic activities (such as industrial, transportation, and residential sources) and natural sources. Suspended particulate matter is classified based on its aerodynamic particle size, primarily due to the different health effects that can be associated with the particles of different diameters. In Ontario, PM$_{2.5}$ emissions have been demonstrating a steady decline over time, decreasing by approximately 16% from 2008 to 2017 (MECP 2017).While the maximum value of PM$_{2.5}$ may exceed the CAAQS, as shown on Figure 1, the standards are calculated as the 98th percentile of the annual monitored data averaged over three years of measurements. Table 3 lists the 24-Hour PM$_{2.5}$ ambient monitoring results calculated according to this methodology and Table 4 summarises the annual PM$_{2.5}$ concentrations for comparison against the CAAQS.

Figure 1: PM$_{2.5}$ Monitoring Data for 2014 through 2018

Table 3: Summary of 24-Hour PM$_{2.5}$ Monitoring Results for comparison to CAAQs of 27 µg/m³[(a)]

Years	24-Hour PM$_{2.5}$ [µg/m³]
	Kitchener
2014–2016	22.36
2015–2017	19.48
2016–2018	18.57

(a) CAAQS for PM$_{2.5}$ is the CWS for PM$_{2.5}$ which is based on the 98th percentile of the annual monitored data averaged over three years of measurements

Table 4: Summary of Annual PM$_{2.5}$ Monitoring Results for Comparison to the CAAQs of 8.8 µg/m$^{3(a)}$

Years	Annual PM$_{2.5}$ [µg/m^3]
	Kitchener
2014–2016	8.47
2015–2017	7.69
2016–2018	7.22

(b)   CAAQS for PM$_{2.5}$ is the CWS for PM$_{2.5}$ which is based on the annual monitored data averaged over three years of measurements.

The three-year annual and daily average CAAQs have not been exceeded at the Kitchener station within the monitoring period assessed.

1.2.2   NO$_x$ and NO$_2$ Concentrations

NO$_x$ is emitted in two primary forms: nitric oxide (NO) and nitrogen dioxide (NO$_2$). NO reacts with ozone in the atmosphere to create NO$_2$. The primary source of oxides of nitrogen (NO$_x$) in the region is the combustion of fossil fuels. Emissions of NO$_X$ result from the operation of stationary sources such as incinerators, boilers, and generators, as well as the operation of mobile sources such as vehicles and other equipment.

The annual mean concentrations of NO$_2$ in Ontario have decreased by 33% from 2008 to 2017 (MECP 2017). No exceedances of the 1-hour or 24-hour Ontario AAQC for NO$_2$ were recorded at the stations assessed between 2014 and 2018 (Figure 2). While the maximum 1-hour value of NO$_2$ may exceed the CAAQS, as shown on Figure 2, the standards are calculated as the 98th percentile of the daily maximum monitored data averaged over three years of measurements. Table 5 lists the 1-Hour NO$_2$ ambient monitoring results calculated according to this methodology.
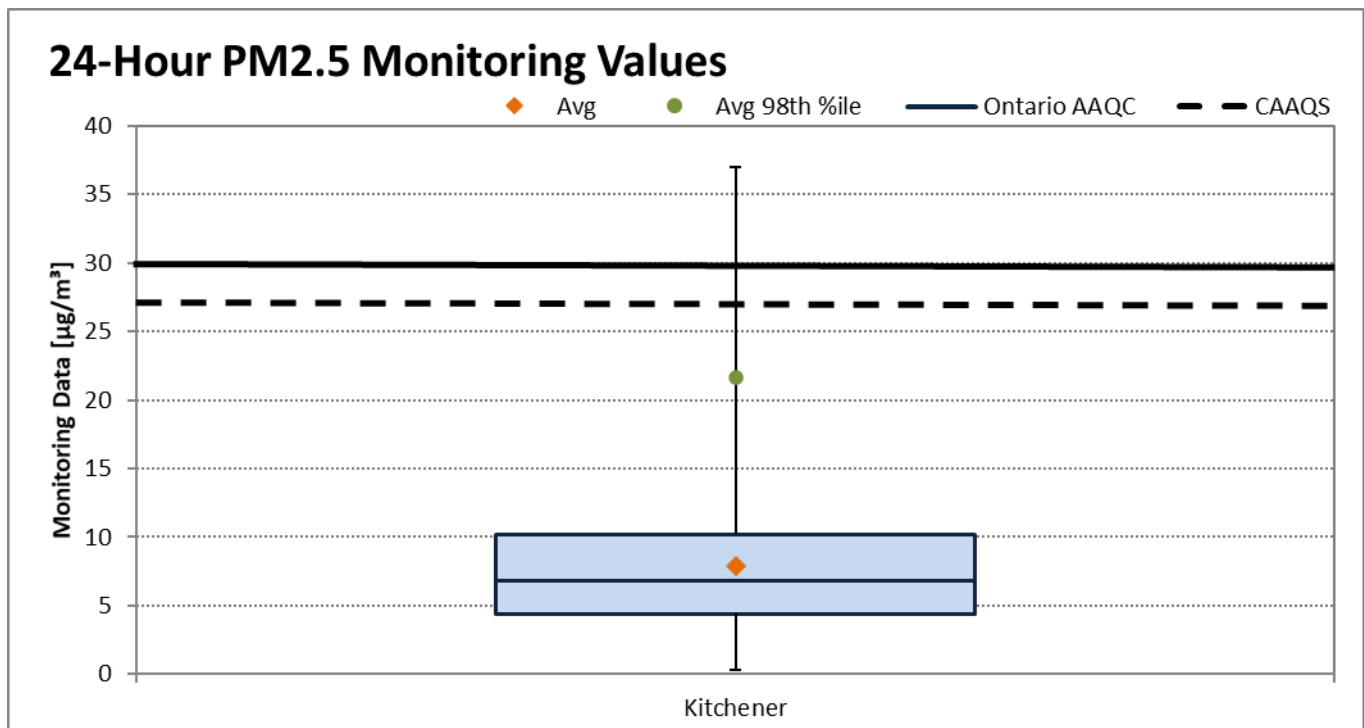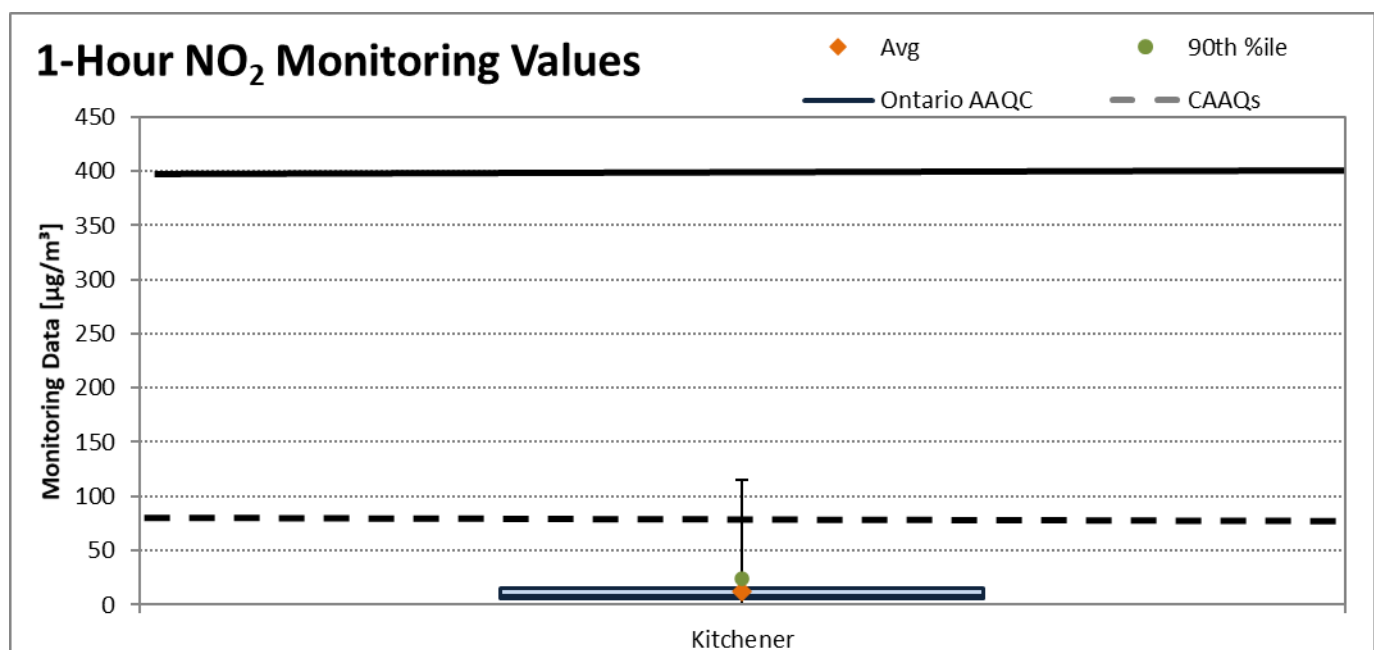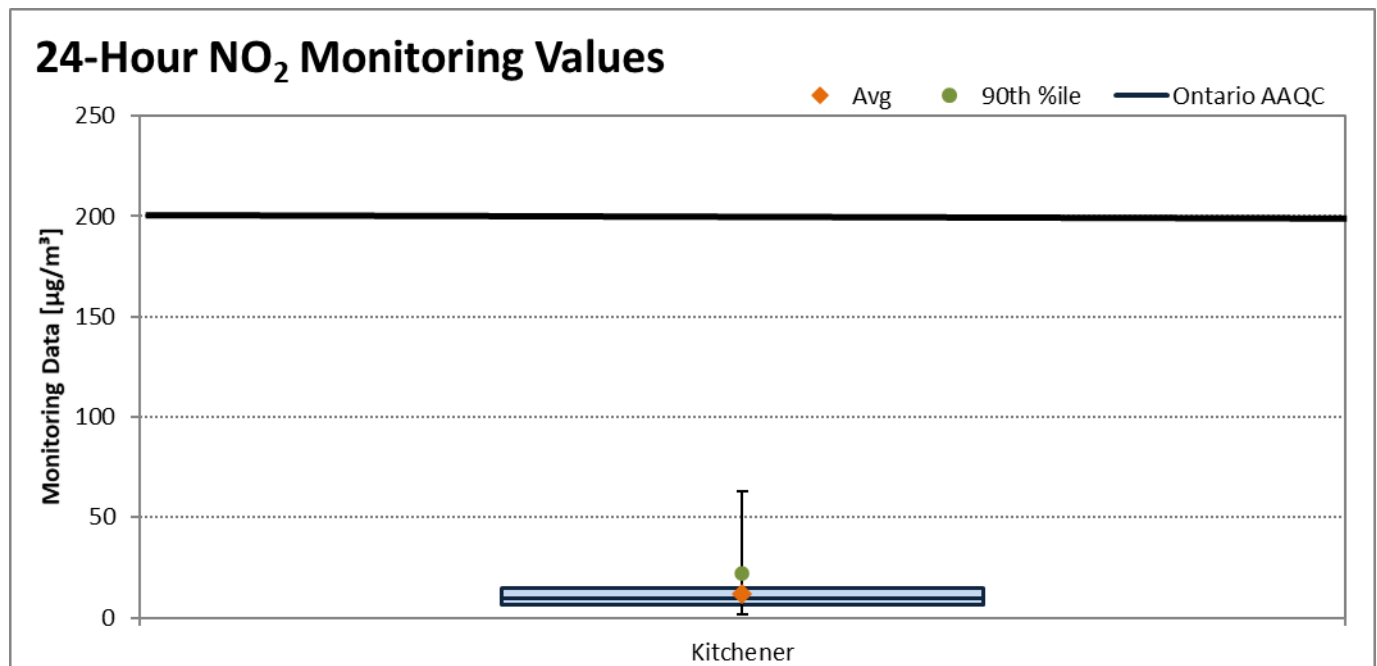
Figure 2: NO₂ Monitoring Data for 2014 through 2018

Table 5: Summary of 1-Hour NO₂ Monitoring Results for Comparison to the CAAQs of 79 μg/m³ [a]

Years	24-Hour NO₂ [μg/m³]
	Kitchener
2014–2016	19.89
2015–2017	18.18
2016–2018	16.43

(a)   CAAQS for NO₂ is based on the 98th percentile of the daily maximum 1-hour monitored data averaged over three years of measurements.

1.2.3   Ozone (O₃)

Ground-level ozone is formed when NO_x and VOCs react in the presence of sunlight. Ground-level ozone exceeded the 1-hour AAQC at 16 stations in Ontario in 2016. The exceedances of ozone can be attributed to transboundary flow of contaminants from the United States (MECP 2017). A summary of the monitored O₃ concentrations are summarized on Figure 3. The maximum 1-hour concentration of O₃ at both stations was above the Ontario AAQC, however the 90th percentile was well below the Ontario AAQC.

Currently there is no 8-hour Ontario AAQC for O₃, but there is a Canada-wide Standard which has been used for comparison to the data. While the maximum 8-hour concentration of O₃ exceeds the standard at all three stations, compliance with the Canada-wide Standard is based on the fourth highest 8-hour value annually, averaged over a 3-year period. Table 6 presents a summary of the 3-year averaging methodology using 8-hour O₃ ambient monitoring results. The Canada-wide Standard has been exceeded at the station assessed.
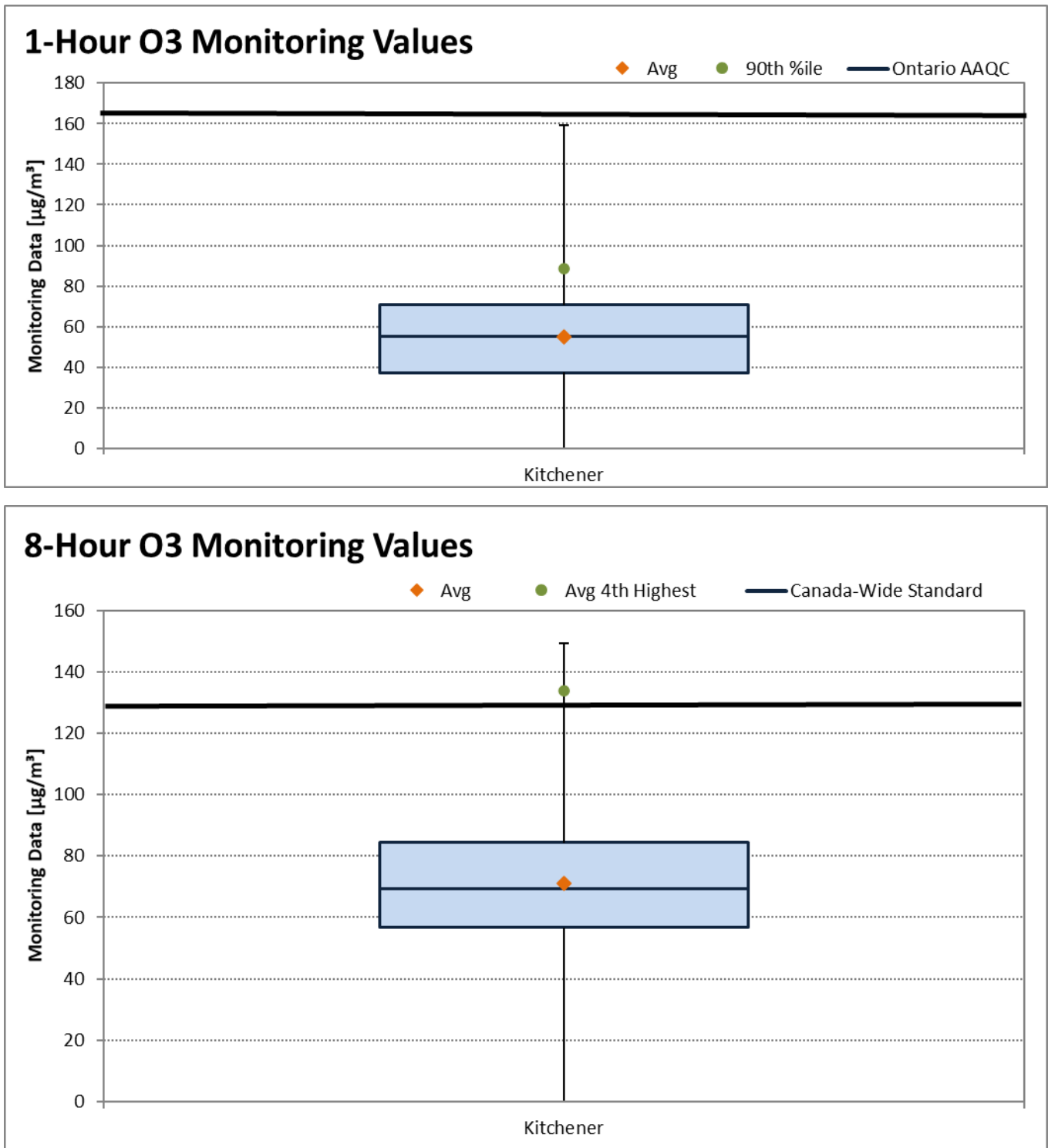
Figure 3: O3 Monitoring Data for 2014 through 2018

Table 6: Summary of 3-year average 8-Hour O$_3$ Monitoring Results for Comparison to the Canada-wide Standard

Years	8-Hour Ozone [µg/m³]
	Kitchener
2014–2016	130.33
2015–2017	129.28
2016–2018	129.77

1.3 Summary of Monitored Data

For the Kitchener station, monitoring data for the years 2014 through 2018 were summarized by indicator compound for the averaging period relevant to the AAQC. To provide an understanding of the variability of the monitoring data, the average, 75th percentile, 90th percentile, and maximum values are summarized in Table 7 and Table 10. As discussed in the previous section, the 90th percentile of the 1-hour, 8-hour, and 24-hour measurements are typically used to represent the background air quality value when conducting an impact assessment and the annual average concentration is used for annual background levels (Alberta Environment 2013). The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred.

Table 7: Summary of Air Quality at the Kitchener Station (2014 – 2018) in µg/m³ [a]

Indicator	Averaging Period	Average	75th	90th	Max
SPM	24-hour	26.40	34.03	46.67	123.33
	Annual	26.48	—	—	30.97
PM$_{10}$	24-hour	14.67	18.90	25.93	68.52
PM$_{2.5}$	24-hour	7.92	10.21	14.00	37.00
	Annual	7.94	—	—	9.29
NO$_2$	1-Hour	11.96	15.05	24.45	114.74
	24-Hour	11.95	14.81	22.26	63.01
	Annual	6.36	—	—	7.07
O$_3$	1-Hour	54.94	70.65	88.31	158.96
	8-Hour	71.04	84.39	100.09	149.15

(a) Data measured in parts per billion (ppb) or parts per million (ppm), were converted to µg/m³ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

APPENDIX B

Emission Calculations - Dance Pit

1.0   EXISTING PIT EMISSIONS

The Site is adjacent to an active pit (the Dance Pit) and Dabrowski Pit that are used to process approximately 3,300 tonnes of material per day. Aggregate material is extracted by loaders and taken to the crushing plant for processing and sizing. Material is stored in stockpiles and may be taken to the wash plant for cleaning before being hauled off-site for distribution. All equipment is located below grade in the pit, which is on average approximately 10 m deep. All activities operate for approximately 11 hours per day. Support activities include diesel power generation equipment.

Emission calculations are provided below for each of the main sources of emission at the existing Dance and Dabrowski Pits.

1.1   Crushing Plant and Wash Plant

The crushing plant and wash plant process approximately 300 tonnes of material per hour at the Dance Pit. Material is transferred by conveyor through primary and secondary crushing and screening equipment before being transferred to stockpiles. Material may later be transferred to the wash plant. Once material enters the wash plant, it is considered to be saturated and is not considered to be a source of particulate emissions.

Emission factors for crushing plant and wash plant equipment were obtained from US EPA AP-42 Chapter 11.19.2 – Crushed Stone Processing, Table 11.19.2-1 (U.S. EPA, 2006). Controlled emission factors were used if available as moisture is controlled through spray bars.

The following equation was used to calculate the emission rates for particulates:

$$\text{Emission Rate} \left[\frac{\text{g}}{\text{s}}\right] = \text{Emission Factor} \left[\frac{\text{kg}}{\text{Mg}}\right] \times \text{Hourly Throughput} \left[\frac{\text{tonne}}{\text{hour}}\right] \times \text{Conversion Factors}$$

The following is a sample calculation for the maximum daily SPM emission rate for the aggregate crushing activity:

$$\text{SPM Emission Rate} = 0.0006 \frac{\text{kg}}{\text{Mg}} \times 300 \frac{\text{tonne}}{\text{hour}} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ hr}}{3{,}600 \text{ s}}$$

$$\text{ER} = 5.00\text{E} - 02 \text{ g/ } s$$

A summary of the emission rates for all crushing plant equipment is provided in Table 1, and for relevant wash plant equipment in Table 2.

Table 1: Emission Rates from Crushing Plant

Source Description	Source Type	Maximum Capacity [Mg/hour]	SPM Emission Factor [kg/Mg]	SPM Emission Rate [g/s]	PM$_{10}$ Emission Factor [kg/Mg]	PM$_{10}$ Emission Rate [g/s]	PM$_{2.5}$ Emission Factor [kg/Mg]	PM$_{2.5}$ Emission Rate [g/s]
Feeder Loading	Truck Unloading	300	0.000008	6.67E-04	0.000008	6.67E-04	0.000008	6.67E-04
Jaw Crusher	Crushing	300	0.000600	5.00E-02	0.000270	2.25E-02	0.000050	4.17E-03
Conveyor Transfer	Transfer Point	300	0.000070	5.83E-03	0.000023	1.92E-03	0.000007	5.42E-04
Conveyor to Bin	Drop	300	0.000736	6.13E-02	0.000322	2.68E-02	0.000049	4.06E-03
Bin to Conveyor	Drop	300	0.000736	6.13E-02	0.000322	2.68E-02	0.000049	4.06E-03
Primary Screen	Screening	300	0.001100	9.17E-02	0.000370	3.08E-02	0.000025	2.08E-03
Conveyor Transfer	Transfer Point	100	0.000070	1.94E-03	0.000023	6.39E-04	0.000007	1.81E-04
Conveyor Transfer	Transfer Point	100	0.000070	1.94E-03	0.000023	6.39E-04	0.000007	1.81E-04
Drop to Stockpile	Drop	100	0.000736	2.04E-02	0.000322	8.94E-03	0.000049	1.35E-03
Conveyor Transfer	Transfer Point	200	0.000070	3.89E-03	0.000023	1.28E-03	0.000007	3.61E-04
Cone Crusher	Crushing	200	0.000600	3.33E-02	0.000270	1.50E-02	0.000050	2.78E-03
Secondary Screen	Screening	200	0.001100	6.11E-02	0.000370	2.06E-02	0.000025	1.39E-03
Transfer Point	Transfer Point	100	0.000070	1.94E-03	0.000023	6.39E-04	0.000007	1.81E-04
Surge Bin	Drop	100	0.000736	2.04E-02	0.000322	8.94E-03	0.000049	1.35E-03
Transfer Point	Transfer Point	100	0.000070	1.94E-03	0.000023	6.39E-04	0.000007	1.81E-04
Drop to Stockpile	Drop	100	0.000736	2.04E-02	0.000322	8.94E-03	0.000049	1.35E-03

GOLDER

Table 2: Emission Rates from Washing Plant

Source Description	Source Type	Maximum Capacity [Mg/hour]	SPM		PM$_{10}$		PM$_{2.5}$	
			Emission Factor [kg/Mg]	Emission Rate [g/s]	Emission Factor [kg/Mg]	Emission Rate [g/s]	Emission Factor [kg/Mg]	Emission Rate [g/s]
Unloading to Bin	Truck Unloading	150	0.000008	3.33E-04	0.000008	3.33E-04	0.000008	3.33E-04
Drop to conveyor	Drop	150	0.000736	3.07E-02	0.000322	1.34E-02	0.000049	2.03E-03
Conveyor Transfer	Transfer Point	150	0.000070	2.92E-03	0.000023	9.58E-04	0.000007	2.71E-04
Transfer to wash screen	Drop	150	0.000736	3.07E-02	0.000322	1.34E-02	0.000049	2.03E-03

GOLDER

1.2   Stockpiles

Material is currently stored in stockpiles before and after processing on the Dance Pit. The U.S. EPA AP-42 emission factors from U.S. EPA Control of Open Fugitive Dust Source (EPA-45/3-88-008), September 1988, Page 4-17 were used to calculate the fugitive dust emissions associated with the storage piles. The following predictive emissions equation was used in determining the emission factors for material handling:

$$EF = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{f}{15}\right) \times scaling\ factor \times (1 - control\ efficiency)$$

Where:

EF .... = particulate emission factor (kg/ha/day),
s .... = silt loading (%)
f .... = percent of time the wind speed is greater than 5.4 m/s (%),
Scaling factor .... = a scaling factor for particulate (See Table 3), and

Control efficiency=reduction of fugitive dust emissions due to implementation of a BMP for fugitive dust.

Table 3: Stockpile Scaling Factors

Size Range	k
SPM	1
PM$_{10}$	0.5
PM$_{2.5}$	0.075

The percent of time the wind speed is greater than 5.4 m/s was obtained from the MECP pre-processed meteorological data (1996-2000) used for the dispersion modelling assessment.

The following is a sample calculation for the SPM emission factor for emissions that will occur from one of the stockpiles. The silt content for overburden of 7.5% from Table 13.2.4-1 of the U.S. EPA AP-42 Section 13.2.4 was used.

$$EF = 1.9 \times \left(\frac{7.5}{1.5}\right) \times \left(\frac{19.5}{15}\right) \times 1$$
$$EF = 12.13 \frac{kg}{ha - day}$$

The following is a sample calculation for the SPM emission rate for one of the stockpiles. A control efficiency of 80% was selected to represent the implementation of a fugitive dust BMPP.

$$ER = EF \times A \times \frac{1\ ha}{10,000\ m^2} \times \frac{1\ hr}{3,600\ s} \times \frac{1,000\ g}{1\ kg} \times \frac{1\ day}{24\ hr} \times (1 - control\ efficiency)$$

Where:

EF .... = particulate emission factor (kg/ha/day)
A .... = Exposed area (m^2)
Control efficiency =reduction of fugitive dust emissions due to implementation of a BMP for fugitive dust

$$\text{ER} = 12.13 \frac{\text{kg}}{\text{ha} - \text{day}} \text{ x } 1{,}350 \text{ m}^2 \times \frac{1 \text{ ha}}{10{,}000 \text{ m}^2} \times \frac{1 \text{ hr}}{3{,}600 \text{ s}} \times \frac{1{,}000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ day}}{24 \text{ hr}} \times (1 - 80\%)$$

$$\text{ER} = 3.79\text{E} - 03 \text{ g/ s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above and are summarised in Table 4.

Table 4: Emission Rates from Stockpiles

Storage Pile ID	Exposed Area [m²]	Silt Content [%]	Emission Factors [kg/ha/day]			Emission Rates [g/s]		
			SPM	PM₁₀	PM₂.₅	SPM	PM₁₀	PM₂.₅
Stock1	1,350	7.50	12.13	6.06	0.91	3.79E-03	1.89E-03	2.84E-04
Stock2	5,000	7.50	12.13	6.06	0.91	1.40E-02	7.02E-03	1.05E-03
Stock3	3,375	7.50	12.13	6.06	0.91	9.47E-03	4.74E-03	7.11E-04
Stock4	1,950	7.50	12.13	6.06	0.91	5.47E-03	2.74E-03	4.11E-04
Stock5	7,500	7.50	12.13	6.06	0.91	2.11E-02	1.05E-02	1.58E-03

1.3   Vehicles – Paved Road Dust

Vehicles enter and exit the Dance Pit along a paved stretch of road that is approximately 135 m long. Up to 5 shipping trucks enter the site in any one hour (i.e. 10 trips). The U.S. EPA AP-42 emission factors from Chapter 13.2.1 – Paved Roads (January 2011) were used to calculate the fugitive dust emissions from paved roadways. The following predictive emissions equation was used to calculate the fugitive dust emission factor for paved roads:

$$\text{EF} = (k(sL)^{0.91} \times (W)^{1.02}) \, (1 - \text{control efficiency})$$

Where:

EF .... = particulate emission factor (having units matching the units of k),
k .... = particle size multiplier for particle size range and units of interest (see Table 5),
sL .... = road surface silt loading (g/m²) assumed to be 8.2 (as per U.S. EPA AP-42 Section 13.2.1-3, silt loading for Quarries),
W .... = average weight (tons) of the vehicles traveling the road, and
control efficiency... = reduction of fugitive dust emissions due to implementation of a BMP for fugitive dust.

Table 5: Particle Size Assumptions for Paved Road Dust

Size Range	k
SPM	3.23
PM_{10}	0.62
$PM_{2.5}$	0.15

The following is a sample calculation for SPM for the predictive emission factor for vehicles that will travel along the main site access road. It was estimated that the trucks have an average weight of 58.3 tons. A control efficiency of 90% was selected to represent the implementation of a fugitive dust BMPP practices.

$$EF = (3.23 \times (8.2)^{0.91} \times (58.3)^{1.02})(1 - 90\%)$$

$$EF = 138.49 \text{ g/VKT}$$

The following is a sample calculation for the SPM emission rate for vehicles travelling along the same paved road segment:

$$ER = \frac{138.49 \text{ g}}{VKT} \times \frac{1.35 \text{ VKT}}{hour} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.09 \text{ g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above and are summarised below in Table 6.

Table 6: Emission Rates from Paved Roads

Description	Maximum VKT/hour	Average weight [tonnes]	Average weight [tons][1]	Emission Rates		
				SPM [g/s]	PM_{10} [g/s]	$PM_{2.5}$ [g/s]
Main Site Access to Weigh Scale	1.35	52.9	58.3	0.052	0.010	0.002

1.4   Vehicles – Unpaved Road Dust

Roads within the Dance Pit are unpaved. Traffic within the Dance Pit includes the following:

- Up to 5 Shipping Trucks travelling from the paved entrance road to the crushing plant/wash plant per hour (i.e. 10 trips);

- One Front End Loader at the Screening / Crushing Plant;

- One Front End Loader at the Wash Plant; and

- Haul Trucks travelling between the crushing plant/ extraction face;

The predictive equation in U.S. EPA AP-42 Chapter 13.2.2 – Unpaved Roads (November 2006) was used to calculate the fugitive dust emissions from unpaved roadways. The equation accounts for a control efficiency for the implementation of dust control measures. The equation is as follows:

$$EF = \left(k \left(\frac{s}{12} \right)^a \times \left(\frac{W}{3} \right)^b \times 281.9 \right) (1 - \text{control efficiency})$$

Where:

EF .... = particulate emission factor (g/VKT)

k .... = empirical constant for particle size range (pounds (lbs) per vehicle mile travelled (VMT)) (see Table 7)

s .... = road surface silt content (%) assumed to be 4.8% (as per U.S. EPA AP-42 Section 13.2.2 for Sand and Gravel Processing Plant Roads)

W .... = average weight (tons) of the vehicles traveling the road,

a .... = empirical constant for particle size range (dimensionless) (see Table 7)

b .... = empirical constant for particle size range (dimensionless) (see Table 7)

281.9................... = conversion from pounds per vehicle miles travelled to grams per vehicle kilometres travelled

control efficiency... = reduction of fugitive dust emissions of 90% due to implementation of a fugitive dust best management practice plan (BMPP)

Table 7: Particle Size Assumptions for Unpaved Road Dust

Size Range	k (lb/VMT)	a	b
SPM	4.9	0.7	0.45
PM$_{10}$	1.5	0.9	0.45
PM$_{2.5}$	0.15	0.9	0.45

The following is a sample calculation for SPM for the emission factor for the loader that operates at the crushing plant. It was estimated that the loaders will have an average weight of 62.1 tons. A control efficiency of 90% was selected to represent the implementation of a BMPP which will include road watering and a speed limit.

$$EF = \left(4.9\left(\frac{4.8}{12}\right)^{0.7} \times \left(\frac{62.1}{3}\right)^{0.45} \times 281.9\right)(1 - 90\%)$$

$$EF = 284.4 \text{ g/VKT}$$

The following is a sample calculation for the SPM emission rate for Loaders travelling along the same unpaved road segment:

$$ER = \frac{284.4 \text{ g}}{\text{VKT}} \times \frac{4.54 \text{ VKT}}{\text{hour}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.36 \text{ g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above and presented in Table 8, below. The location of the haul trucks will depend on where material is being extracted. Emission rates were therefore prepared based on extraction occurring in either Area 1, Area 2 or Area 3.

Table 8: Emission Rates from Unpaved Road

Description	Maximum VKT/hour	Average Weight [tonnes]	Average weight [tons][1]	Emission Rates [g/s]		
				SPM	PM_{10}	$PM_{2.5}$
Shipping Trucks – Paved Road to Crushing Plant	12.46	52.9	58.3	9.56E-01	2.44E-01	2.44E-02
Loaders – Crushing/Washplant to shipping	4.54	56.4	62.1	3.59E-01	9.14E-02	9.14E-03
Haul Trucks – Area 1 to Crushing	4.11	55.2	60.9	3.22E-01	8.21E-02	8.21E-03
Haul Trucks – Area 2 to Crushing	5.02	55.2	60.9	3.93E-01	1.00E-01	1.00E-02
Haul Trucks – Area 3 to Crushing	7.83	55.2	60.9	6.13E-01	1.56E-01	1.56E-02

GOLDER

1.5   Diesel Combustion

Three generators are used to provide power to the crushing plant and wash plant on the Dance Pit. Crank case emission factors and load factors for non-road Engine Modelling (US EPA, 2010) were used to calculate the exhaust emissions from the two generators. A load factor of 1.0 was assumed to comply with Tier 3 emission standards.

The following predictive emissions equation was used to calculate the combustion emission rates for the generators:

$$ER = EF \times \text{engine horsepower rating} \times \text{load factor} \times \frac{1\ hr}{3,600\ s}$$

Where:

ER =.................... emission rate (g/s)
EF =.................... emission factor (g/hp-hr).

The following is a sample calculation for the SPM emissions for one of the generators:

$$ER = \frac{0.15\ g}{hp - hr} \times 690\ hp \times 1.00 \times \frac{1\ hr}{3,600\ s}$$

$$ER = 2.88E - 02\ g/s$$

The emissions rates for NOx, PM$_{10}$ and PM$_{2.5}$ were calculated using the same equation and are summarised in Table 9, below.

Table 9: Emission Rates from Stationary Combustion

Contaminants	Emission Factor [g/hp-hr]	Emission Rate [g/s]		
		Gen 1 - 690 HP	Gen 2 - 470 HP	Gen 3 -670 HP
SPM	0.15	2.88E-02	1.95E-02	2.79E-02
PM$_{10}$	0.15	2.88E-02	1.95E-02	2.79E-02
PM$_{2.5}$	0.15	2.88E-02	1.95E-02	2.79E-02
NOx	3.00	5.75E-01	3.91E-01	5.58E-01

1.6   Non-Road Vehicles – Exhaust Emissions

Emission rates for non-road vehicles were calculated using the non-road module of the US EPA Motor Vehicle Emission Simulator (MOVES).The emission factors developed for the loaders and trucks are provided in Table 10 and are based on model years of 2014 and 2016 respectively.

GOLDER

Table 10: Emission Factors Calculated Using NONROAD module of MOVES

Compound	Emission Factor (g/HP-hr)	
	Loader	Haul Trucks
SPM	0.07	0.03
PM_{10}	0.07	0.03
$PM_{2.5}$	0.07	0.03
NO_X	0.91	0.36

The following predictive emissions equation was used to calculate the combustion emission rates for vehicles used in the existing pit operation:

$$ER = EF \times \text{engine horsepower rating} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

Where:

ER =.................... emission rate (g/s)
EF =.................... emission factor (g/hp-hr).

The following is a sample calculation for the SPM emissions for one of the loaders:

$$ER = \frac{0.07 \text{g}}{\text{hp} - \text{hr}} \times 380 \text{ hp} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

$$ER = 5.23E - 03 \text{ g/s}$$

The emissions rates for NOx, PM_{10} and $PM_{2.5}$, were calculated using the same equation and are presented below in Table 11. The emission rates for non-road vehicles were calculated for all three loaders and haul trucks. Emission calculations assume all equipment is operating at the same time.

Table 11: Emission Rates from Non-Road Vehicles

Vehicle ID	# of units	Power (HP)	SPM (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)	NOx (g/s)
Loaders	2	555	1.05E-02	1.05E-02	1.02E-02	1.35E-01
Haul Trucks	2	510	4.97E-03	4.97E-03	4.82E-03	5.99E-02

1.7 On-Road Vehicles – Exhaust Emissions

Emission factors for the current operations vehicle exhaust for on-road vehicles were obtained using the U.S. EPA's MOVES model.

The emission factors developed for the trucks are provided in Table 12.

GOLDER

Table 12: Emission Factors for Shipping Trucks Calculated Using MOVES

Compound	Emission Factor (g/VKT)
SPM	1.32
PM_{10}	1.32
$PM_{2.5}$	0.91
NO_X	13.18

The following predictive emissions equation was used to calculate the tailpipe emission rates for existing pit vehicles travelling on paved roads:

$$ER = EF \times VKT/hour \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

Where:

ER =.................... emission rate (g/s)
EF =.................... emission factor (g/VKT)
VKT/hour=........... 13.81 VKT/hour (Paved and unpaved total)

The following is a sample calculation for SPM emissions from shipping trucks.

$$ER = \frac{1.32 \text{ g}}{VKT} \times \frac{13.81 \text{ VKT}}{hour} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

$$ER = 5.06E - 03 \text{ g/s}$$

NOx, PM_{10} and $PM_{2.5}$, were calculated using the same equation and are summarised in Table 13.

Table 13: Emission Rates from Shipping Trucks

Compound	Emission Rate [g/s]
SPM	5.06E-03
PM_{10}	5.06E-03
$PM_{2.5}$	3.49E-03
NO_X	5.06E-02

GOLDER

1.8   Material Handling

Material is transferred from stockpiles to shipping trucks by loaders.

Predictive emission factors for particulate emissions were developed using equations (USEPA 2006). The following predictive emissions equation was used in determining the emission factors for material handling:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:

EF .... = particulate emission factor (kg/Mg)
k .... = particle size multiplier for particle size range (see Table 14)
U .... = mean daily wind speed (3.69 m/s)
M .... = moisture content of material (percent) (%).

Table 14: Particle Size Assumptions Material Transfer

Size Range	k
SPM	0.8
PM$_{10}$	0.35
PM$_{2.5}$	0.053

The following is a sample calculation for the SPM emission factor from the material handling of aggregate. A mean wind speed of 3.69 m/s is used below for illustration purposes although the emissions in the model were varied on an hour by hour basis, depending on the corresponding wind speed data record in the meteorological dataset. A moisture content of 4.8% was assumed.

$$EF = 0.74 \times 0.0016 \times \frac{\left(\frac{3.69}{2.2}\right)^{1.3}}{\left(\frac{4.8}{2}\right)^{1.4}}$$

$$EF = 0.00074 \frac{kg}{Mg}$$

The following is a sample calculation for the SPM emission rate for a material handling rate of 300 tonnes/hour.

$$ER = \frac{0.00074 \text{ kg}}{Mg} \times \frac{300 \text{ Mg}}{day} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}}$$

$$ER = 0.06 \frac{g}{s}$$

The emission rates of PM$_{10}$ and PM$_{2.5}$ were calculated as presented above.

Table 15: Emission Rates - Extraction and Material Handling

Source Description	Maximum Capacity [Mg/hour]	Emission Factors [kg/Mg]			Emission Rates [g/s]		
		SPM	PM_{10}	$PM_{2.5}$	SPM	PM_{10}	$PM_{2.5}$
Drop from Loader	300	7.37E-04	3.22E-04	4.88E-05	6.13E-02	2.68E-02	4.06E-03

1.9 Summary of Emissions from the Dance Pit Operation

Table 16 summarizes the emission rates for each activity at the Dance Pit and the percentage that each source contributes to the overall emissions from the existing Site. Crystalline Silica emissions from fugitive sources were estimated using published data on the ratios of Crystalline Silica in PM_{10} (Richards et al, 2009), equivalent to 13.7%.The largest sources of particulate matter are from the crushing plant and unpaved roadways.

GOLDER

Table 16: Emission Summary for Dance Pit Emissions by Source

Source Identifier	Source Description	Emission Data				
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]	Percentage of Overall Emissions [%]
4	Crushing Plant	SPM	N/A	4.38E-01	24	13%
		PM_{10}	N/A	1.76E-01	24	17%
		$PM_{2.5}$	N/A	2.49E-02	24	12%
		Crystalline silica	14808-60-7	2.41E-02	24	19%
5	Wash Plant	SPM	N/A	6.46E-02	24	2%
		PM_{10}	N/A	2.81E-02	24	3%
		$PM_{2.5}$	N/A	4.67E-03	24	2%
		Crystalline silica	14808-60-7	3.86E-03	24	3%
6	Stockpiles	SPM	N/A	5.38E-02	24	2%
		PM_{10}	N/A	2.69E-02	24	3%
		$PM_{2.5}$	N/A	4.04E-03	24	2%
		Crystalline silica	14808-60-7	3.69E-03	24	3%

GOLDER

Source Identifier	Source Description	Emission Data				
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]	Percentage of Overall Emissions [%]
7	Paved Road Dust	SPM	N/A	5.19E-02	24	2%
		PM_{10}	N/A	9.97E-03	24	<1%
		$PM_{2.5}$	N/A	2.41E-03	24	1%
		Crystalline silica	14808-60-7	1.37E-03	24	1%
8	Unpaved Road Dust	SPM	N/A	2.64E+00	24	78%
		PM_{10}	N/A	6.74E-01	24	65%
		$PM_{2.5}$	N/A	6.74E-02	24	33%
		Crystalline silica	14808-60-7	9.24E-02	24	72%
9	Power Generation Equipment	SPM	N/A	7.62E-02	1, 24	2%
		PM_{10}	N/A	7.62E-02	1, 24	7%
		$PM_{2.5}$	N/A	7.62E-02	1, 24	38%
		NOx	10102-44-0	1.52E+00	1, 24	86%

GOLDER

Source Identifier	Source Description	Emission Data				
		Contaminant	CAS No.	Maximum Emission Rate [g/s]	Averaging Period [hours]	Percentage of Overall Emissions [%]
10	Nonroad Vehicles - Exhaust Emissions	SPM	N/A	1.54E-02	1, 24	<1%
		PM_{10}	N/A	1.54E-02	1, 24	1%
		$PM_{2.5}$	N/A	1.50E-02	1, 24	7%
		NOx	10102-44-0	1.95E-01	1, 24	11%
11	Paved Road Vehicles - Exhaust Emissions	SPM	N/A	5.06E-03	1, 24	<1%
		PM_{10}	N/A	5.06E-03	1, 24	<1%
		$PM_{2.5}$	N/A	3.49E-03	1, 24	2%
		NOx	10102-44-0	5.06E-02	1, 24	3%
12	Material Handling	SPM	N/A	6.13E-02	24	2%
		PM_{10}	N/A	2.68E-02	24	3%
		$PM_{2.5}$	N/A	4.06E-03	24	2%
		Crystalline silica	14808-60-7	3.68E-03	24	3%

GOLDER

APPENDIX C

Air Dispersion Modelling Parameters

1.0   DISPERSION MODELLING

The likely environmental effects for the air quality indicators were evaluated with the aid of the AERMOD dispersion model (Version 19191) developed by the United States Environmental Protection Agency (U.S. EPA).

The selection of this model was based on the following capabilities:

■   has a technical basis that is scientifically sound, and is in keeping with the current understanding of dispersion in the atmosphere;

■   applies formulations that are clearly delineated and are subjected to rigorous independent scrutiny;

■   makes predictions that are consistent with observations;

■   is recognized by federal and provincial regulators as one suitable for use;

■   evaluates the various source configurations and indicator compounds associated with the Site;

■   the terrain surrounding the Site is relatively simple and can be addressed by the terrain features of the model;

■   allows for the use of localised meteorological data; and

■   long range transport of compounds is not anticipated.

More specifically, AERMOD is recognized by federal and Ontario regulators as one of the regulatory default dispersion models and is suitable to model construction activities, waste disposal operations, and fugitives.

AERMOD consists of the model and two pre-processors; the AERMET meteorological pre-processor and the AERMAP terrain pre-processor. The following approved dispersion model and pre-processors were used in the assessment:

■   AERMOD dispersion model (v. 19191); and

■   AERMAP surface pre-processor (v. 11103).

1.1   Model Development

The AERMOD dispersion modelling system was developed by the U.S. EPA as a replacement to the long-standing Industrial Source Complex (ISC) model, as the model recommended by the U.S. EPA for regulatory applications in the United States. This model has also been adopted in Ontario as the regulatory model recommended for permitting and regulatory applications (MECP 2017). The model is generally based on Gaussian plume dispersion theory (U.S. EPA 2004), but also incorporates a series of specific algorithms to reflect current understanding of dispersion theory (U.S. EPA 2004).

1.2   Model Calibration

Regulatory dispersion models do not readily lend themselves to modification to incorporate site-specific characteristics in the equations themselves. However, the model does require site-specific meteorological data to operate. Digital terrain data for the site and surrounding area are also required inputs to the AERMAP pre-processor and used to characterize how the local topography could affect the dispersion of air contaminants. Building heights are required inputs to assess building downwash using the BPIP pre-processor.

1.3 Model Validation

Part of the rigorous process used by the U.S. EPA prior to adopting AERMOD as a regulatory model
(U.S. EPA 2004) was a significant peer review process to confirm that the model could accurately predict
ground-level concentrations when compared to monitoring data (U.S. EPA 2003, 2004).

1.4 Model Uncertainty and Sensitivity

Dispersion models employ assumptions that simplify the random processes associated with atmospheric motions
and turbulence. While this simplification limits the model's ability to replicate individual events, the strength of the
model lies in the ability to predict overall values for a given set of meteorological conditions. The process
undertaken by the U.S. EPA ensured that the model predictions can be relied on as reasonable estimate of the
likely concentrations. AERMOD is based on known theory and proven to reliably produce repeatable results.
To limit the uncertainty associated with emissions input to the model, conservative assumptions were made where
practical (Table 1). Finally, five years of meteorological data are used as an input to the model so that a full range
of possible meteorological conditions is evaluated.

Table 1: Reliability Summary for the AERMOD Dispersion Model

Model Name	Developer	Use in Assessment	Development	Calibration	Validation	Uncertainty and Sensitivity
AERMOD (Version 19191)	United States Environmental Protection Agency	Predict air quality concentrations and deposition	AERMOD was developed to replace the long-standing ISC model as the model recommended by the U.S. EPA. AERMOD is based on Gaussian plume dispersion theory (U.S. EPA 2004) that has been used for more than 30 years. The application of specific algorithms has been updated to reflect current understanding of dispersion theory (U.S. EPA 2004).	Regional meteorological data was used in the modelling (Section 1.5.1). Digital terrain data for the site and surrounding area input to the model (Section 1.5.2).	AERMOD has been adopted by the U.S EPA as it is preferred and recommended dispersion model (U.S. EPA 2005). Prior to adoption, the U.S. EPA completed a rigorous review of the model performance (U.S. EPA 2003, 2005).	AERMOD is based on known theory and proven to reliably produce repeatable results. Uncertainty associated with emissions is managed by making conservative assumptions. Model predictions are sensitive to fluctuations in the meteorology, which can be managed by using a five-year data set. Five years of data should include the full range of possible meteorological conditions.

1.5 Model Inputs

To predict ambient air concentrations with the aid of AERMOD, a series of inputs are required that parameterize the sources of emissions as well as their transport. These inputs can be grouped into categories:

■ Dispersion meteorological data;

■ Terrain and receptors;

■ Building downwash; and

■ Emissions and source configurations.

Each of these input categories are discussed separately in the following sections.

1.5.1 Dispersion Meteorological Data

The MECP, as well as other agencies, recommends that five years of hourly data be used in the model to cover a wide range of potential meteorological conditions (MECP 2017). In this assessment, the AERMOD model was run using a MECP pre-processed five-year dispersion meteorological dataset (i.e. surface and profile files), in accordance with paragraph 1 of s.13(1) of O.Reg.419/05. As the Site is located in the West Central MECP Region – Hamilton, Niagara, Guelph, the meteorological dataset for London, Crops is used. The data set covers the period of January 1996 to December 2000.

1.5.2 Terrain and Modelling Receptors

Terrain elevations have the potential to influence air quality and odour concentrations at individual receptors, therefore surrounding terrain data is required when using regulatory dispersion models in both simple and complex terrain situations (U.S. EPA 2004). Digital terrain data is used in the AERMAP pre-processor to determine the base elevations of receptors, sources and buildings. AERMAP then searches the terrain height and location that has the greatest influence on dispersion for each receptor (U.S. EPA 2004). This is referred to as the hill height scale. The base elevation and hill height scale produced by AERMAP are directly inserted into the AERMOD input file.

1.5.2.1 Digital Terrain Data

Digital terrain data was obtained from the MECP. Sources located in the pit were modelled at final elevation (approximately 10m below grade).

1.5.2.2 Model Receptors

Receptors were identified based on the locations of surrounding residences. A 1km x 2 km receptor grid at 20m resolution was placed over the residential area immediately east of the Site to represent residences within the neighbouring subdivision and discrete receptors were placed at residences located along Cedar Creek Road.

1.5.3 Source Configurations

Sources were modelled using a combination of point, area and volume sources. Source parameters are provided in the following tables:

Table 2: Volume Source Parameters

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
1	Loader Drop to Bin (Extraction)	0.830	2.721	3	NOx	N/A
					TSP	6.13E-02
					PM_{10}	2.68E-02
					$PM_{2.5}$	4.06E-03
					Crystalline silica	3.68E-03
1A	Truck Loading (Extraction)	1.395	1.581	3.4	NOx	N/A
					TSP	4.17E-03
					PM_{10}	4.17E-03
					$PM_{2.5}$	4.17E-03
					Crystalline silica	5.71E-04
2	Feeder Loading/Jaw Crusher	1.163	2.326	2.5	NOx	N/A
					TSP	5.07E-02
					PM_{10}	2.32E-02
					$PM_{2.5}$	4.83E-03
					Crystalline silica	3.18E-03

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
3	Conveyor Transfer	0.233	0.349	1.5	NOx	1
					TSP	5.83E-03
					PM_{10}	1.92E-03
					$PM_{2.5}$	5.42E-04
					Crystalline silica	2.63E-04
4	Bin	0.233	0.698	1.5	NOx	N/A
					TSP	1.23E-01
					PM_{10}	5.37E-02
					$PM_{2.5}$	8.13E-03
					Crystalline silica	7.36E-03
5	Primary Screen	1.163	2.326	2.5	NOx	N/A
					TSP	9.17E-02
					PM_{10}	3.08E-02
					$PM_{2.5}$	2.08E-03
					Crystalline silica	4.23E-03

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
6	Conveyor Transfer	0.233	0.349	1.5	NOx	N/A
					TSP	1.94E-03
					PM_{10}	6.39E-04
					$PM_{2.5}$	1.81E-04
					Crystalline silica	8.76E-05
7	Conveyor Transfer	0.233	0.349	1.5	NOx	N/A
					TSP	1.94E-03
					PM_{10}	6.39E-04
					$PM_{2.5}$	1.81E-04
					Crystalline silica	8.76E-05
8	Drop to Stockpile	0.233	1.395	3	NOx	N/A
					TSP	2.04E-02
					PM_{10}	8.94E-03
					$PM_{2.5}$	1.35E-03
					Crystalline silica	1.23E-03

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
9	Conveyor Transfer	0.233	0.349	1.5	NOx	N/A
					TSP	3.89E-03
					PM_{10}	1.28E-03
					$PM_{2.5}$	3.61E-04
					Crystalline silica	1.75E-04
10	Cone Crusher/Secondary Screen	1.163	2.326	2.5	NOx	N/A
					TSP	9.44E-02
					PM_{10}	3.56E-02
					$PM_{2.5}$	4.17E-03
					Crystalline silica	4.88E-03
11	Conveyor Transfer	0.233	0.349	1.5	NOx	N/A
					TSP	1.94E-03
					PM_{10}	6.39E-04
					$PM_{2.5}$	1.81E-04
					Crystalline silica	8.76E-05

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
12	Surge Bin drop	0.233	0.698	1.5	NOx	N/A
					TSP	2.04E-02
					PM$_{10}$	8.94E-03
					PM$_{2.5}$	1.35E-03
					Crystalline silica	1.23E-03
13	Conveyor Transfer	0.233	0.349	1.5	NOx	N/A
					TSP	1.94E-03
					PM$_{10}$	6.39E-04
					PM$_{2.5}$	1.81E-04
					Crystalline silica	8.76E-05
14	Drop to Stockpile	0.233	1.395	3	NOx	N/A
					TSP	2.04E-02
					PM$_{10}$	8.94E-03
					PM$_{2.5}$	1.35E-03
					Crystalline silica	1.23E-03

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
15	Washplant feed	1.163	2.326	2.5	NOx	N/A
					TSP	3.33E-04
					PM_{10}	3.33E-04
					$PM_{2.5}$	3.33E-04
					Crystalline silica	4.57E-05
16	Conveyor to washplant	1.163	2.326	2.5	NOx	N/A
					TSP	2.92E-03
					PM_{10}	9.58E-04
					$PM_{2.5}$	2.71E-04
					Crystalline silica	1.31E-04
17	Washplant feed Drop	1.163	2.326	2.5	NOx	N/A
					TSP	3.07E-02
					PM_{10}	1.34E-02
					$PM_{2.5}$	2.03E-03
					Crystalline silica	1.84E-03

GOLDER

Modelling ID	Source Description	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
18	Conveyor to washplant	1.163	2.326	2.5	NOx	N/A
					TSP	3.07E-02
					PM_{10}	1.34E-02
					$PM_{2.5}$	2.03E-03
					Crystalline silica	1.84E-03
19	Loader to Haul Trucks	0.830	2.721	3.75	NOx	N/A
					TSP	6.13E-02
					PM_{10}	2.68E-02
					$PM_{2.5}$	4.06E-03
					Crystalline silica	3.68E-03

GOLDER

Table 3: Area Source Parameters

Modelling ID	Source Description	Area [m³]	Orientation [º]	Release Height [m]	Contaminant	Emission Rate [g/s]	Emission Rate [g/s/m²]
A1	Stockpile 1	1350	21	3	NOx	N/A	—
					TSP	3.79E-03	2.81E-06
					PM_{10}	1.89E-03	1.40E-06
					$PM_{2.5}$	2.84E-04	2.11E-07
					Crystalline silica	2.60E-04	1.92E-07
A2	Stockpile 2	5000	-11	3	NOx	N/A	—
					TSP	1.40E-02	2.81E-06
					PM_{10}	7.02E-03	1.40E-06
					$PM_{2.5}$	1.05E-03	2.11E-07
					Crystalline silica	9.62E-04	1.92E-07
A3	Stockpile 3	3375	-41	3	NOx	N/A	—
					TSP	9.47E-03	2.81E-06
					PM_{10}	4.74E-03	1.40E-06
					$PM_{2.5}$	7.11E-04	2.11E-07
					Crystalline silica	6.50E-04	1.92E-07

GOLDER

Modelling ID	Source Description	Area [m³]	Orientation [⁰]	Release Height [m]	Contaminant	Emission Rate [g/s]	Emission Rate [g/s/m²]
A4	Stockpile 4	1950	8	3	NOx	N/A	—
					TSP	5.47E-03	2.81E-06
					PM_{10}	2.74E-03	1.40E-06
					$PM_{2.5}$	4.11E-04	2.11E-07
					Crystalline silica	3.75E-04	1.92E-07
A5	Stockpile5	7500	-13	3	NOx	N/A	—
					TSP	2.11E-02	2.81E-06
					PM_{10}	1.05E-02	1.40E-06
					$PM_{2.5}$	1.58E-03	2.11E-07
					Crystalline silica	1.44E-03	1.92E-07
A6	Hanson Pit	90,000	-15	2.5	NOx	N/A	—
					TSP	7.75E-01	8.61E-06
					PM_{10}	2.39E-01	2.66E-06
					$PM_{2.5}$	1.66E-01	1.84E-06
					Crystalline silica	3.28E-02	3.64E-07

GOLDER

Table 4: Point Source Parameters

Modelling ID	Source Description	Exit Temperature [⁰C]	Stack Diameter [m]	Exit Flow Rate [m³/s]	Release Height [m]	Contaminant	Emission Rate [g/s]
P1	Generator 1	500	0.5	9.82	3.5	NOx	5.75E-01
						TSP	2.88E-02
						PM_{10}	2.88E-02
						$PM_{2.5}$	2.88E-02
						Crystalline silica	N/A
P2	Generator 2	500	0.5	9.82	3.5	NOx	3.91E-01
						TSP	1.95E-02
						PM_{10}	1.95E-02
						$PM_{2.5}$	1.95E-02
						Crystalline silica	N/A
P3	Generator 3	500	0.5	9.82	3.5	NOx	5.58E-01
						TSP	2.79E-02
						PM_{10}	2.79E-02
						$PM_{2.5}$	2.79E-02
						Crystalline silica	N/A

GOLDER

Table 5: Line Volume Source Parameters

Modelling ID	Source Description	Length [m]	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
L1	Loader at Extraction face	30	4.451	3.26	3.50	NOx	5.60E-02
						TSP	1.08E-01
						PM_{10}	3.05E-02
						$PM_{2.5}$	6.48E-03
						Crystalline silica	3.65E-03
L2	Paved Entrance (Shipping Trucks)	135	8.372	2.965	3.19	NOx	4.94E-03
						TSP	5.24E-02
						PM_{10}	1.05E-02
						$PM_{2.5}$	2.75E-03
						Crystalline silica	1.37E-03
L3	Unpaved Entrance Road (Shipping Trucks)	1246	8.372	2.965	3.19	NOx	4.56E-02
						TSP	9.61E-01
						PM_{10}	2.48E-01
						$PM_{2.5}$	2.75E-02
						Crystalline silica	3.34E-02

GOLDER

Modelling ID	Source Description	Length [m]	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
L4	Extraction area (Area 1) to crushing plant	281	4.386	2.918	3.14	NOx	5.99E-02
						TSP	3.27E-01
						PM$_{10}$	8.70E-02
						PM$_{2.5}$	1.30E-02
						Crystalline silica	1.13E-02
L5	Loaders – crushing plant to shipping	52	4.451	3.26	3.50	NOx	1.35E-01
						TSP	3.69E-01
						PM$_{10}$	1.02E-01
						PM$_{2.5}$	1.93E-02
						Crystalline silica	1.25E-02
L6	Extraction area (Area 2) to crushing plant	343	4.386	2.918	3.14	NOx	5.99E-02
						TSP	3.98E-01
						PM$_{10}$	1.05E-01
						PM$_{2.5}$	1.48E-02
						Crystalline silica	1.37E-02

GOLDER

Modelling ID	Source Description	Length [m]	Initial Lateral Dimension [m]	Initial Horizontal Dimension [m]	Release Height [m]	Contaminant	Emission Rate [g/s]
L7	Extraction area (Area 3) to crushing plant	515	4.386	2.918	3.14	NOx	5.99E-02
						TSP	6.18E-01
						PM_{10}	1.61E-01
						$PM_{2.5}$	2.05E-02
						Crystalline silica	2.14E-02

1.5.4   Special Modelling Considerations

The site operates between the hours of 7 am and 6pm, therefore emissions from all activities within the site were modelled only occurring during those hours. Similarly, plant operations are typically significantly reduced during winter months and processing activities were assumed to operate at 65% capacity during the months of December to March.

Emission rates that rely on the hourly windspeed were modelled using variable emissions by wind speed. This allows for the use of the actual wind speeds in the meteorological data file to be used for the emission rates and avoids over-conservatism in the calculations and modelling of emissions from material handling activities. Emission rates for these sources were entered into the model using an hourly emission file.

1.6   Model Options

This section describes the modelling parameters used in the modelling assessment.

1.6.1   Options Used in the AERMOD Model

The options used in the AERMOD model are summarized in Table 6.

Table 6: Options Used in the AERMOD Model

Modelling Parameter	Description	Used in Concentration Modelling?
DFAULT	Specifies that regulatory default options will be used.	Yes
CONC	Specifies that concentration values will be calculated.	Yes
DEPOS	Total deposition flux values will be calculated	No
OLM	Specifies that the non-default Ozone Limiting Method for NO_2 conversion will be used.	No, NO_2 will be converted post processing, as described in Section 1.7.2
DDEP	Specifies that dry deposition will be calculated.	No, concentration values are therefore greater than if this parameter was selected
WDEP	Specifies that wet deposition will be calculated.	No, concentration values are therefore greater than if this parameter was selected
FLAT	Specifies that the non-default option of assuming flat terrain will be used.	No, the model will use elevated terrain as detailed in the AERMAP output.
NOSTD	Specifies that the non-default option of no stack-tip downwash will be used.	No
AVERTIME	Time averaging periods calculated.	1-hr, 24-hr, annual

Modelling Parameter	Description	Used in Concentration Modelling?
URBANOPT	Allows the model to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions.	No
URBANROUGHNESS	Specifies the urban roughness length (m).	No
FLAGPOLE	Specifies that receptor heights above local ground level are allowed on the receptors.	No

1.7   Post-Processing

Most air quality concentration results are output directly from the model, however there are certain parameters, including averaging periods less than 1 hour and conversion of NO_2 using existing regional ozone concentrations that require post-processing. These post-processing methods are described in the following sections.

1.7.1   Time Average Conversions

The smallest time scale that AERMOD predicts is a 1-hour average value. There are instances when criteria are based on different averaging times, and in these cases the following conversion factor, recommended by the MECP for conversion from a 1-hour averaging period to the applicable averaging period less than 1-hour could be used (MECP 2017). An example is given below for converting from a 1-hour averaging period to a 10-minute averaging period:

$$F = \left(\frac{t_1}{t_0} \right)^n$$

$$= \left(\frac{60}{10} \right)^{0.28}$$

$$= 1.65$$

Where:

 F ...... =   the factor to convert from the averaging period t_1 output from the model (MECP assumes AERMOD predicts true 60-minute averages) to the desired averaging period t_0 (assumed to be 10-minutes in the example above), and

 N ...... =   the exponent variable; in this case the MECP value of n = 0.28 is used for conversion.

For averaging periods greater than 1-hour, the AERMOD output was used directly.

1.7.2 Conversions of NO_x to NO_2

Emissions of oxides of nitrogen (NO_x) were used as inputs to the AERMOD model. Ambient NO_2 concentrations can be calculated from modelled NO_X values using the Ozone Limiting Method (Cole and Summerhays 1979) provided the background ozone concentration is available. The 1-hour, 24-hour and annual NO_2 concentrations were calculated using the 90th percentile of the eight-hour ground-level ozone concentrations presented in Appendix A.

1.8 Conservatism in Modelling Approach

Table 7 outlines the areas where conservatism was assumed in the modelling approach which results in an assessment that is not likely to under-predict the air quality associated with the Site.

Table 7: Areas of Conservatism in Modelling Approach

Area	Conservatism
All operations were modelled to be occurring simultaneously	The modelling assessment includes all operations occurring simultaneously at maximum capacity for 11 hours per day, 7 days per week. This is unlikely to occur in practice.
The longest haul road lengths were selected	The haul road emission rates were calculated for each extraction area using the maximum distance between the extraction area and stockpiles. This will not be the case for much of the staged extraction that occurs at the Site.
Extraction	Extraction activities were modelled occurring at the limit of extraction for each area, closest to receptors to identify the maximum predicted concentrations. In reality, the extraction area will move and will only occur at the extraction limit in each area for a short period of time
Unpaved Roads	It was assumed that all material would be hauled from the extraction area to the crushing plant. Material will be transported by either haul trucks or a conveyor
Deposition	The effects of particulate deposition within the pit were not simulated in the modelling. This will result in higher predicted concentrations.

It is assumed that the conservative emission rates, when combined with the conservative operating conditions and conservative dispersion modelling assumptions description herein, are not likely to under predict the modelled concentrations at each of the identified receptors.

GOLDER

golder.com