GREENSTONE GOLD MINES

Hardrock Project

Air Quality Management and Monitoring Plan

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Table of Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviations

AAQC	Ambient Air Quality Criteria
AQMMP	Air Quality Management and Monitoring Plan
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CWS	Canada Wide Standards
EAC	Environmental Advisory Committees
EC	Environment Canada
ECA	Environmental Compliance Approval
EIS/EA	Environmental Impact Statement / Environmental Assessment
EMMPs	Environmental Management and Monitoring Plans
GGM	Greenstone Gold Mines GP Inc.
GHG	Greenhouse gas
LOM	Life of Mine
MECP	Ministry of Environment Conservation and Parks
MTO	Ministry of Transportation
NAAQO	National Ambient Air Quality Objectives
PDA	Project development area
TMF	tailings management facility
WRSA	waste rock storage areas

1 Introduction and Environmental Management and Monitoring Plan Overview

Greenstone Gold Mines GP Inc. (GGM) is committed to minimizing environmental effects through the implementation of mitigation measures, monitoring and adaptive management for the Hardrock Project (the Project) within Environmental Management and Monitoring Plans (EMMPs) for construction and operation. The Air Quality Management and Monitoring Plan (AQMMP) describes monitoring to address regulatory and permit requirements and outlines how monitoring results will be used to guide management decisions.

Through the EMMPs, the Project's environmental risks and opportunities are addressed in a comprehensive, systematic, planned and documented manner to meet the following objectives:

- The Project is carried out in compliance with existing legislation, consistent with federal and provincial guidelines, best practices, GGM corporate policies, and commitments made to Indigenous communities during project review
- Predictions of environmental effects identified in the environmental assessment are confirmed
- Measures to mitigate environmental effects are documented, their effectiveness assessed, and needs for further mitigation identified as needed
- Benefits from the Project are enhanced
- Reporting is structured to inform adaptive management and continual improvement

The EMMPs guide environmental management for the Project. They are being progressively refined as the Project moves - through permitting and construction. They will be updated based on continual improvement during operations, using an adaptive management approach.

An adaptive management process, including a framework for ongoing review of monitoring data and mine site performance, is used to identify whether further mitigation measures are needed. This process is described in Section 7.3.

2 Mine Overview

The Hardrock deposit will be mined as an open pit. The process plant will operate 365 days per year with a Life of Mine (LOM) of approximately 15 years. Mill operations will be variable up to a nominal maximum throughput of 30,000 tonnes per day (tpd) as conditions warrant. The overall Project development schedule will consist of the following main phases:

- Construction: Years -3 to -1, with early ore stockpiling commencing after the first year of construction.
- Operation: Years 1 to 15, with Year 1 representing a transition from construction to operation.

- Closure: Years 16 to 20 for Active Closure and Years 21 to 36 for Post-Closure.

Key mine components of the Project development area (PDA) are an open pit, waste rock storage areas (WRSAs), overburden storage areas, ore stockpile, ore crushing and mill feed ore storage activities, process plant, water management facilities, tailings management facility (TMF), power plant and associated infrastructure, and explosives facility. Ancillary Project components are buildings, service water supply and associated infrastructure, sewage and effluent treatment plants, site roads, watercourse crossings, realignments, and habitat compensation/offsets, onsite pipelines and piping, fuel and hazardous materials storage, aggregate sources, and temporary camp. Existing infrastructure currently located within the PDA will be relocated, including a portion of Highway 11, a Ministry of Transportation (MTO) Patrol Yard, and Hydro One Networks Inc. (Hydro One) facilities.

3 Purpose of the Air Quality Environmental Management and Monitoring Plan

The purpose of the AQMMP is to describe monitoring to address regulatory and permit requirements and outline how monitoring results will be used to guide management (e.g., implementation of additional mitigation measures), as follows:

- Describe requirements for routine management of sources of airborne dust during construction and operation
- Describe requirements for monitoring ambient air quality and meteorological conditions in and near the Hardrock site as the basis for assessing potential adverse air quality effects thatmay be attributable to the Project on surrounding areas
- Track air quality performance and provide feedback to the Environment Superintendent which may be used to refine the dust suppression program and other potentially significant air quality sources
- Describe requirements for provincial and federal air quality and emissionsreporting

The AQMMP applies only to the Hardrock Project activities and addresses only ambient air quality management issues. Workplace air quality and worker exposure assessments, controls, and mitigation measures will be addressed separately.

Greenhouse gas (GHG) related issues are addressed in the Greenhouse Gas Management Plan.

3.1 Performance Objectives

Objectives and targets are established to drive continuous improvement in environmental performance through the adaptive management process and are consistent with the overall strategic goals of the Project. Objectives are measurable (where possible), monitored, communicated, and updated as appropriate.

In support of GGM's overarching environmental objective (to work to prevent or mitigate any adverse environmental effects, meet or exceed regulatory requirements and strive to continually improve our environmental practices and performance), GGM has established performance objectives for the AQMMP that consider key Project interactions and compliance obligations. Air quality will be monitored in sensitive areas, which include residential areas and locations of (or protective of) traditional land use. The off-property air quality monitoring data will be compared to the following criteria:

- Federal and provincial air quality standards and objectives (discussed in Section 4)
- Environmental Compliance Approval (ECA) requirements (discussed in Section 4)

3.1.1 *Triggers and Thresholds for Action and Adaptive Management*

Triggers for further action within an adaptive management structure need to be robust (based on sufficient data to describe variability), reliable (easily and consistently measurable), and meaningful (reflect potential adverse effects on the environment). For the AQMMP, the trigger for adaptive management will be either:

- An exceedance of the federal or provincial objectives or standards.
- Frequently measured concentrations greater than 85% of the federal or provincial objectives or standards.

Adaptive management for air quality will be used as follows:

- To address situations in which the objectives or standards are exceeded; the process for responding to these events (reviewing causes, assessing the need for additional mitigation measures) is described in the Best Management Practices
- Guide the continual improvement process
- Incorporate changes to the management and monitoring plan related to introduction of new regulatory requirements, revised objectives or criteria, or updated best practices or technology.

Further information about the adaptive management process is provided in Section 7.3.

4 Scope

The AQMMP applies to Project infrastructure and management under the care and maintenance of GGM. It does not include components managed or maintained by third parties. This document covers the following:

- Geographic scope - area of the Project that will undergo changes through construction and/or operation to accommodate the advancement of Project, and associated monitoring

- Temporal scope - construction and operation phases
- Regulatory scope – applicable laws and regulations, described in Table 4-1.

The AQMMP applies to individuals working for or on behalf of GGM, including employees and contractors, who have a role and/or accountability for the development, implementation, and maintenance of this AQMMP. GGM will make reasonable efforts to use suitably qualified (licenced where applicable) contractors for the transport of materials, supplies and waste materials, with appropriate controls and management plans in place to reduce the likelihood of incidents during transport.

Table 4-1: Regulatory Requirements that Apply to Air Quality Management and Monitoring Plan

Type of Requirement	Relevant Act or Document	Details
Environmental Assessment Process Requirement	Federal Decision Statement Conditions	A decision statement was issued by the Canadian Environmental Assessment Agency under Section 54 of the *Canadian Environmental Assessment Act* on December 10, 2018 that outlined a series of conditions in which GGM must comply. This AQMMP addresses the following conditions: • 5.1 The Proponent shall develop, prior to construction and in consultation with Indigenous groups, measures to mitigate emissions of dust generated by the Designated Project, including dust from vehicles associated with the Designated Project on roads located within the project development area and dust generated during the transport of historical tailings, that take into account the standards and criteria set out in the Canadian Council of Ministers of the Environment's Canadian Ambient Air Quality Standards and Ontario's Ambient Air Quality Criteria. The Proponent shall submit these measures to the Agency before implementing them. The Proponent shall implement these measures during construction, operation and the first five years of decommissioning. • 5.2 The Proponent shall install prior to operation, and use during ore crushing and transfer, crushers with dust collection systems. • 5.3 The Proponent shall develop, prior to construction and in consultation with Indigenous groups and relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and to determine the effectiveness of the mitigation measures as it pertains to the adverse environmental effects on the health of

Table 4-1: Regulatory Requirements that Apply to Air Quality Management and Monitoring Plan

Type of Requirement	Relevant Act or Document	Details
		Indigenous Peoples of changes to air quality. As part of the follow-up program, the Proponent shall: ○ identify, as part of the development of the follow-up program, monitoring locations for air contaminants within areas used by Indigenous groups for traditional purposes or within areas representative of air quality in areas used by Indigenous groups for traditional purposes; ○ monitor, during construction, operation and the first five years of decommissioning, total suspended particulates, particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$) and nitrogen dioxide at the monitoring locations identified pursuant to condition 5.3.1, using as benchmarks the standards and criteria set out in the Canadian Council of Ministers of the Environment's Canadian Ambient Air Quality Standards and Ontario's Ambient Air Quality Criteria. The Proponent shall monitor total suspended particulates, fine particulate matter (PM2.5) and nitrogen dioxide at least monthly and shall monitor particulate matter (PM_{10}) in real-time; ○ monitor, at least annually during construction and for the first two years of operation, airborne benzene and benzo(a)pyrene at the monitoring locations identified pursuant to condition 5.3.1. The Proponent shall determine, in consultation with Indigenous groups and relevant authorities and based on the results of the monitoring, if additional monitoring is required after the first two years of operation and at what frequency this additional monitoring shall occur; and ○ monitor, during construction and for the first two years of operation, silt content on roads within the project development area. The Proponent shall determine, in consultation with Indigenous groups and relevant authorities and based on the results of the monitoring, if additional monitoring is required after the first two years of operation

Table 4-1: Regulatory Requirements that Apply to Air Quality Management and Monitoring Plan

Type of Requirement	Relevant Act or Document	Details
		and at what frequency this additional monitoring shall occur.
	Provincial Environmental Assessment Certificate Conditions	A Provincial Environmental Assessment Certificate was issued by the Ministry of the Environment, Conservation and Parks (MECP) in March 2019. This AQMMP addresses the following conditions: • 22.1 The Proponent shall prepare and implement, in consultation with the Ministry's Thunder Bay District Office, and to the satisfaction of the District Manager, an Ambient Air Monitoring and Reporting Plan for the Undertaking. • 22.2 The Ambient Air Monitoring and Reporting Plan shall, at minimum, include: a) An ambient air monitoring program which includes an appropriate number and location of sampling sites; b) A list of all potential emission sources; c) The proposed start date for and frequency of the ambient air monitoring and reporting to be carried out; and, d) The identification of the contaminants that shall be monitored. • 22.3 The Proponent shall submit the Ambient Air Monitoring and Reporting Plan to the District Manager a minimum of 90 days prior to the start of Construction or by such other date as agreed to in writing by the District Manager. • 22.4 The Proponent shall implement the Ambient Air Monitoring Program prior to the start of Construction or at such other time that may be determined by the District Manager and communicated to the Proponent in writing. • 22.5 The Proponent shall carry out the Ambient Air Monitoring Program until such time as the District Manager notifies the Proponent in writing that the Ambient Air Monitoring Program is no longer required. • 22.6 The District Manager may require changes to be made to the Ambient Air Monitoring and Reporting Plan and the Proponent shall make the changes and implement the plan in accordance with the required changes.
Regulatory Requirements	Federal	National Ambient Air Quality Objectives (NAAQOs) Canada Wide Standards (CWS) Canadian Ambient Air Quality Standards (CAAQS) (see Table 4-2)
	Provincial	Ambient Air Quality Criteria (AAQC)

Table 4-1: Regulatory Requirements that Apply to Air Quality Management and Monitoring Plan

Type of Requirement	Relevant Act or Document	Details
		(see Table 4-3)
	Environmental Compliance Approval Requirements	It is expected that the Environmental Compliance Approval (ECA) for the Project will contain specific terms and conditions regarding ambient monitoring, reporting, source testing, complaint resolution, etc. This section of the AQMMP will be updated upon receipt of the ECA to reflect the terms and conditions.
	Municipal Regulatory Requirements	There are no known local/municipal regulatory requirements related to air quality.

4.1 Regulatory Requirements

The AQMMP has been developed and implemented to comply with applicable legislative, regulatory, permit and other relevant obligations, outlined in the following sections.

4.1.1 *Federal Regulatory Requirements*

Federal air quality criteria applicable to the Project include: National Ambient Air Quality Objectives (NAAQOs) (Canada Gazette 1989), Canada Wide Standards (CWS) and the Canadian Ambient Air Quality Standards (CAAQS). The NAAQOs were established by the federal government in the early 1970s to protect human health and the environment by setting objectives for common air pollutants including: nitrogen dioxide, ozone, sulphur dioxide and total suspended particulates. The objectives are denoted as "Desirable", "Acceptable" and "Tolerable". The Federal Objectives are defined as follows:

- The Maximum Desirable Level is the long-term goal for air quality and provides a basis for anti-degradation policy for unpolluted parts of the country, and for the continuing development of control technology
- The Maximum Acceptable Level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being
- The Maximum Tolerable Level denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population

The CWS are based on intergovernmental agreements developed under the Canadian Council of Ministers of the Environment (CCME) Canada-wide Environmental Standards Sub-Agreement, which operates under the broader CCME Canada-wide Accord on Environmental Harmonization.

The CAAQS for $PM_{2.5}$ and ozone were developed through a collaborative process involving the federal, provincial and territorial governments and stakeholders, as directed by the CCME (CCME 2012). The CAAQSs have replaced the CWS for $PM_{2.5}$ and ozone. CAAQSs for $PM_{2.5}$ and ozone have been developed for years 2015 and 2020 as shown in Table 4-2. On October 3, 2016, the CCME announced a new CAAQS for SO_2 with effective dates of 2020 and 2025. These values are also shown in Table 4-2. New nitrogen dioxide (NO_2) CAAQS were published on November 3, 2017 and come into effect in 2020 and 2025. These levels may also apply to the Project, depending on how they are adopted in Ontario.

The NAAQOs, CWS and CAAQS applicable to the Project are listed in Table 4-2.

Table 4-2: Summary of Federal NAAQOs, CWS and CAAQSs

Pollutant and units (alternative units in brackets)	Averaging Time Period	Canada Wide Standards	Canadian Ambient Air Quality Standards	National Ambient Air Quality Objectives		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Sulphur Dioxide	1 hour	-	70 ppb [D] 65 ppb [E]	450 µg m^{-3}	900 µg m^{-3}	-
	24 hour	-	-	150 µg m^{-3}	300 µg m^{-3}	800 µg m^{-3}
	Annual	-	5 ppb [D] 4 ppb [E]	30 µg m^{-3}	60 µg m^{-3}	-
Nitrogen Dioxide	1 hour	-	60 ppb [F] 42 ppb [G]	-	400 µg m^{-3}	1,000 µg m^{-3}
	24 hour	-	-	-	200 µg m^{-3}	300 µg m^{-3}
	Annual	-	17 ppb [F] 12 ppb [G]	60 µg m^{-3}	100 µg m^{-3}	-
Total Suspended Particulate Matter (TSP)	24 hour	-	-	-	120 µg m^{-3}	400 µg m^{-3}
	Annual	-	-	60 µg m^{-3}	70 µg m^{-3}	-
$PM_{2.5}$	24 hour	30 µg m^{-3} [A]	28 µg m^{-3} [B] 27 µg m^{-3} [C]	-	-	-
	Annual	-	10.0 µg m^{-3} [B] 8.8 µg m^{-3} [C]	-	-	-

NOTES:

A CCME (2000), Canada-Wide Standards for Respirable Particulate Matter and Ozone, effective by 2010. The Respirable Particulate Matter Objective is referenced to the 98th percentile over three consecutive years; the Ozone Objective is referenced to the on 4th highest 8-hour average annual value, averaged over three consecutiveyears.

B CCME (2012), CAAQS for $PM_{2.5}$ and ozone for 2015. The 24-hour standard is referenced to the 98th percentile over three consecutive years, and the annual standard is referenced to the 3-hear average of the annual average concentration. The Ozone Objective is referenced to the on 4th highest 8-hour average annual value, averaged over three consecutive years.

C CCME (2012), CAAQS for $PM_{2.5}$ and ozone for 2020. The 24-hour standard is referenced to the 98th percentile over three consecutive years, and the annual standard is referenced to the 3-hear average of the annual average concentration. The Ozone Objective is referenced to the on 4th

highest 8-hour average annual value, averaged over three consecutive years.

D CCME (2016). CAAQS for SO_2 effective 2020. The 1-hour standard is referenced to the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations. The annual standard is the arithmetic average of 1- hour average SO_2 concentrations.

E CCME (2016). CAAQS for SO_2 effective 2025. The 1-hour standard is referenced to the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations. The annual standard is the arithmetic average of 1- hour average SO_2 concentrations.

F CCME (2017). CAAQS for NO_2 effective 2020. The 1-hour standard is referenced to the 3-year average of the annual 99th percentile of the NO_2 daily maximum 1-hour average concentrations. The annual standard is the arithmetic average of 1- hour average NO_2 concentrations.

G CCME (2017). CAAQS for NO_2 effective 2025. The 1-hour standard is referenced to the 3-year average of the annual 99th percentile of the NO_2 daily maximum 1-hour average concentrations. The annual standard is the arithmetic average of 1- hour average NO_2 concentrations.

Federal reporting is required annually to the National Pollutant Release Inventory (NPRI), which is mandatory under the *Canadian Environmental Protection Act, 1999* (CEPA 1999). For NPRI substances, the amount that was manufactured, processed, or otherwise used at the facility during each calendar year will have to be reported. Reports are required to be submitted to the NPRI for each calendar year by the end of May of the following year.

4.1.2 *Provincial Regulatory Requirements*

The provincial Ambient Air Quality Criteria (AAQC) relevant to the Project are prescribed in Ontario Regulation 419/05 (O. Reg. 419). The Project will be considered a new facility under O. Reg. 419 and, as such, the Schedule 3 standards will apply. Where no O. Reg. 419 Schedule 3 standards are available, Ontario AAQCs and Jurisdictional Screening Levels (JSL) are considered (MECP 2008a). Pertinent air quality objectives, guidelines, and standards are listed in Table 4-3 for criteria air contaminants (CACs). Proposed changes to AAQC in O. Reg. 419 were also considered and included in Table 4-3.

On December 31, 2021, the Toxics Reduction Act, 2009 will be repealed and its associated regulations revoked, ending the Toxics Reduction Program. Based on the current Project schedule, no reporting to the Toxics Reduction Program will therefore be required.

Table 4-3: Summary of Applicable Provincial Air Quality Standards

Contaminant	Chemicals Abstracts Services Number (CAS No.)	O. Reg. 419 – Schedule 3			Ontario AAQC		
		1-Hour (µg/m^3)	24-Hour (µg/m^3)	Other Time Period (µg/m^3)	1-Hour (µg/m^3)	24-Hour (µg/m^3)	Other Time Period (µg/m^3)
Sulphur dioxide	7446-09-5	100	-	10	100	-	10
Nitrogen oxides[A]	10102-44-0	400	200	-	400	200	
$PM_{2.5}$	N/A	-	-	-	-	27 [B-1]	8.8; annual [B-2]
PM_{10}	N/A	-	-	-	-	50 [B-3]	
TSP	NA	-	120	-	-	120	60: annual
Dustfall	N/A	-	-	-	-	-	7 g/m^2; 30-day 4.6 g/m^2; Annual geometric mean
Aluminum	7429-90-5	-	120[H]	-	-	-	-

Table 4-3: Summary of Applicable Provincial Air Quality Standards

Contaminant	Chemicals Abstracts Services Number (CAS No.)	O. Reg. 419 – Schedule 3			Ontario AAQC		
		1-Hour (µg/m³)	24-Hour (µg/m³)	Other Time Period (µg/m³)	1-Hour (µg/m³)	24-Hour (µg/m³)	Other Time Period (µg/m³)
Antimony	7440-36-0	-	25	-	-	25	-
Arsenic	7440-38-2	-	0.3 [D]	-	-	0.3	-
Barium	7440-39-3	-	10 [D]	-	-	10	-
Beryllium	7440-41-7	-	0.01	-	-	0.01	-
Bismuth	7440-69-9	-	-	-	-	-	-
Cadmium	7440-43-9	-	0.025 0.25 [E]	-	-	0.025	0.005; annual
Calcium	7440-70-2	-	-	-	-	-	-
Chromium (total)	7440-47-3	-	0.5 5 [E]	-	-	0.5	-
Cobalt	7440-48-4	-	0.1 [D]	-	-	0.1	-
Copper	7440-50-8	-	50	-	-	50	-
Lead	7439-92-1	-	0.5, 2 [E]	0.2; 30+ day	-	0.5	0.2(+) 30day
Lithium	7439-93-2	-	20	-	-	20	-
Magnesium oxide	1309-48-4	-	120	-	-	-	-
Manganese	7439-96-5	-	0.4	-	-	0.1 (Mn in $PM_{2.5}$), 0.2 (Mn in PM_{10}), 0.4 (Mn in TSP)	-
Mercury	7439-97-6	-	0.5	-	-	2 (Hg), 0.5 (Hg as alkyl compounds)	-
Molybdenum	7439-98-7	-	120 [D]	-	-	120	-
Nickel	7440-02-0	-	2 [E]	0.04; annual	-	0.1 (Ni in PM_{10}), 0.2 (Ni in TSP)	0.02 (Ni in PM_{10} - annual), 0.04 (Ni in TSP - annual)
Potassium	7440-09-7	-	8 [C]	-	-	-	-
Selenium	7782-49-2	-	10 [D]	-	-	10	-
Silver	7440-22-4	-	1	-	-	1	-
Strontium	7440-24-6	-	120 [D]	-	-	120	-
Thallium	7440-28-0	-	0.24 [C]	-	-	-	-
Tin	7440-31-5	-	10	-	-	10	-
Titanium	7440-32-6	-	120	-	-	120	-

Table 4-3: Summary of Applicable Provincial Air Quality Standards

Contaminant	Chemicals Abstracts Services Number (CAS No.)	O. Reg. 419 – Schedule 3			Ontario AAQC		
		1-Hour (µg/m³)	24-Hour (µg/m³)	Other Time Period (µg/m³)	1-Hour (µg/m³)	24-Hour (µg/m³)	Other Time Period (µg/m³)
Uranium	7440-61-1	-	1.5 [E]	0.03; annual	-	0.15 (U in PM_{10}), 0.3 (U in TSP)	0.03 (U in PM_{10} - annual), 0.06 (U in TSP - annual)
Vanadium	7440-62-2	-	2	-	-	2	-
Yttrium	7440-65-5	-	2.4 [C]	-	-	-	-
Zinc	7440-66-6	-	120	-	-	120	-
Benzene	71-43-2	_	100 [C]	0.45; annual	_	2.3	0.45
Benzo(a)pyrene	50-32-8	_	0.00005	0.00001; annual	_	0.00005	0.00001; annual

NOTES:

A The Schedule 3 standards for NOx are based on health effects of NO_2, as NO_2 has adverse health effects at much lower concentrations than NO. Therefore, the standard was compared to NO_2 in this report.

B-1 Canadian Ambient Air Quality Standards (CAAQS) for Respirable Particulate Matter and Ozone, effective by 2020 (CCME, 2012). The Respirable Particulate Matter Objective is referenced to the 98th percentile daily average concentration averaged over 3 consecutive years.

B-2 Annual Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2020. The Respirable Particulate Matter Objective is referenced to the 3-year average of the annual average concentrations.

B-3 AAQC for PM10 is an interim AAQC provided as a guide for decision making.

C Upper Risk Threshold

4.2 ECA Requirements

It is expected that the MECP Environmental Compliance Approval (ECA) for the Project will contain specific terms and conditions with respect to ambient monitoring, reporting, source testing, complaint resolution, etc. This section of the AQMMP will be updated upon receipt of the ECA to reflect the terms and conditions.

5 Roles and Responsibilities

All persons working for or on behalf of GGM, including employees and contractors, have a role in the successful implementation and maintenance of the AQMMP. Table 5-1 outlines roles and responsibilities for activities under this plan.

Table 5-1: Roles and Responsibilities

Role	Responsibility
Construction Manager (for construction phase) Mine Manager (for operation phase)	• Collaborate with the Environment Superintendent to plan and implement air quality effect management during construction activities. • Collaborate with the Environment Superintendent to plan and implement air quality effect management during operation phases. • Collaborate with the Environment Superintendent to provide air quality awareness and safety training to Project personnel and contractors.
Environmental Superintendent	• Collaborate with the Construction Manager and General Manager, as described above. • Collaborate with the Construction Manager and General Manager to communicate compliance obligations and provide training to employees and contractors related to EMMP. • Identify, document, track, and maintain up-to-date compliance obligations related to EMMP goals. • Complete reporting requirements.
Environmental Supervisor	• Organize and schedule monitoring activities. • Oversee implementation of monitoring activities by Environmental Monitors/Technicians.
Environmental Monitors/ Technicians	• Review and provide input into AQMMP. • Participate in implementation of mitigation measures and monitoring. • Provide input into any future revisions of the AQMMP and adaptive management as required. • Communicate results of monitoring to their community.
Environmental Advisory Committees (EAC)	• Review and provide input into AQMMP. • Provide input into any future revisions of the AQMMP and adaptive management as required. • Meet regularly and report EAC activities to the Implementation Committee.
Equipment Operator	• Comply with EMMP requirements as directed with Construction, Operation or Environment Superintendent.
Employees / Contractors	• Follow outlined compliance obligations related to AQMMP, including air quality reporting requirements.

5.1 Communication

5.1.1 *Notification of Exceedances to Triggers*

If the applicable air quality criteria are exceeded for one or more contaminants, GGM shall as soon as practicable, notify a provincial officer, as per Section 28(b) of O. Reg. 419/05 and investigate the root cause, as there may be several potential explanations for an exceedance (e.g. other emissions sources, instrument malfunction, field handling/laboratory analysis errors, etc.).

If it is determined that GGM was the likely cause, for example through review of facility operations during that period, then GGM will undertake appropriate corrective actions in accordance with requirements of Section 28 of O. Reg. 419/05.

5.2 Support

5.2.1 *Competence, Training and Awareness*

GGM requires that persons working under its management, including employees and contractors, have the knowledge, understanding, skills and abilities to complete work in a manner that protects the environment. The following actions will be established to provide worker competency, training and awareness:

- Personnel assigned to emissions mitigation activities are expected to have met the educational, work experience, responsibility, personal attributes and training requirements for their positions.
- Appropriate training will be provided to employees supporting the AQMMP, commensurate with their duties. Such training may consist of classroom lectures, workshops, teleconferences or on-the-job training.
- GGM will conduct an annual review of this EMP and appendices

6 Implementation of Mitigation Measures

6.1 General Approach

The AQMMP includes design and operational requirements for efficient control of emission sources and to reduce emissions. The technical solutions and measures adopted in the Plan are consistent with the best practices applicable to environmental protection. The Project will have multiple emissions sources which will have mitigation measures applied to them. This section of the AQMMP describes the management strategies, required controls, and operational requirements for the construction and operation phases of the Project.

6.2 Construction

The following significant emissions sources are associated with construction of the Project:

- Site preparation including timber harvesting, clearing and grubbing, overburden and soils stripping, stockpiling and management, grading, and blasting (if required)
- Open pit operation: material handling, equipment travel in the open pit, grading, drilling, blasting, mobile equipment, historical tailings storage (in the pit).
- Facilities construction: general construction activities, mobile equipment.

- TMF construction: material handling, equipment travel, site preparation, grading, mobile equipment.
- WRSA, ore, overburden and soils stockpiles: wind erosion, unloading, bulldozing, grading and mobile emissions.
- Ore, waste rock, overburden and soils haul roads: unpaved road dust and mobile equipment.
- Aggregate sources: material handling, portable crushing and mobile emissions.
- Construction access road: unpaved road dust and mobile equipment.
- Tailpipe emissions from mobile equipment.

6.2.1 *Emissions Mitigation and Management*

The following mitigation and management strategies will be utilized to control emissions during construction:

- Limit vehicle speeds
- Provide effective and timely equipment maintenance to keep mining equipment in good working condition
- Where possible, reduce haul routes to and within the PDA
- Maintain administrative controls, including a no idling policy to reduce mobile equipment and other-use vehicle emissions
- During construction, surficial debris, including stumps and other vegetation, will be rolled into appropriate soil stockpiles during clearing
- Use a temporary electrical grid connection to reduce the need for diesel generators

6.2.2 *Dust Mitigation and Management*

Water will be used on construction operations such as grading and bulldozing as required. The equipment operator will load haul trucks minimizing the drop distance between the bucket and the bed of the haul truck as much as possible.

The following mitigation and management strategies will be used to control dust from unpaved roads:

- Where possible, minimize haul routes to, and within, the Project

- Control fugitive dust emission from roadways, material handling and stockpiles by application of water sprays, chemical suppression, dust sweeping, wind breaks/shelters, gravel application, truck wheel washing stations, enclosure of dust sources, and other means. Over-application of water causing surface runoff should be avoided. Maintain the site roadways in good condition, with regular visual examination and maintenance to reduce loose dust on the roads. Enforce speed limits on on-site unpaved roads

Retain (and maintain) a buffer of existing vegetation on each side of internal unpaved haul roads where feasible Detailed construction dust mitigation measures are provided in the Construction Best Management Plan for Fugitive Dust presented in Appendix C.

6.3 Operation

The following significant emissions sources are associated with operation the Project:

- Site preparation including timber harvesting, clearing and grubbing, soil stripping, stockpiling and management, grading, and blasting (if required)
- TMF construction
- open pit operation: material handling (soils, overburden, ore and waste rock), mining fleet and equipment travel, drilling of holes for blasting, blasting
- truck loading and unloading (soils, overburden, ore and waste rock)
- unpaved road dust (haul roads from the pit to WRSA's, ore stockpile, TMF, historical tailings to TMF, etc.)
- waste rock and ore material transferring and handling on WRSAs and ore stockpile: loading, bulldozing, and grading
- WRSAs, overburden/soil storage areas and ore stockpile wind erosion
- tailpipe exhaust emissions from mobile equipment
- power plant: natural gas-fired engines
- diesel dewatering pumps
- ore crushing and transferring
- ore grinding
- mill materials and reagent handling

- process plant operation: cyanidation and detoxification, carbon regeneration, induction furnace
- TMF: truck unloading of waste rock, truck travel, and wind erosion of dry tailings.

The following activities have negligible potential for air emissions:

- Ball mill grinding – this is a wet process.
- Emissions from tailings pumped to the TMF as the tailings are in a slurry form and the contents are non-volatile.
- Mobile emissions from company vehicles and service trucks travelling within the PDA.
- Explosives Plant - raw materials used for explosives manufacturing will be in prill or liquid (solutions) form and non-volatile.
- Reagent, acid, caustic and fuel storage tanks – low volatility and usage.
- Aggregate crushing with a portable crushing plant. Aggregate crushing during operation is expected to occur for no more than two weeks per year and may be achieved with the primary or secondary crushers or with a portable crusher that may move throughout the PDA from year-to-year if aggregate crushing is required.
- Loading, transport and unloading of historical MacLeod and Hardrock tailings to the TMF, as the historical tailings will have a high moisture content (about 20%) or will be wetted prior to transport.

6.3.1 *Emissions Mitigation and Management*

The following gas and odour management control strategies for the process plant includes:

- Continually monitor pH of cyanide mixing / storage tanks to maintain alkaline solution
- Adhere to the International Code for Cyanide Management
- Use a scrubber on the induction furnace to control emissions. Check the operation of the scrubber daily and maintain the scrubber as per manufacturer specifications
- Kiln operators will regularly review the operational performance data of the kiln and associated equipment
- Criteria air contaminant emissions from mobile road and non-road equipment will be controlled through the application of the following practices:

- New mobile equipment onsite will meet applicable Transport Canada off-road vehicle emission requirements. Tier 4 emissions standards came into effect in 2018.
- Provide effective and timely equipment maintenance to keep the mining equipment in good working condition. Follow equipment manufacturer specifications for maintenance.
- Use low emissions/cleaner fuel alternatives to conventional fuels where practicable and the technology proven.

6.3.2 *Dust Mitigation and Management*

During operation, the following management strategies will be used:

- Use recycled or reclaimed water as much as possible based on water quality. Obtain water for use in Project operation, including truck washing, dust suppression, and drill water, from alternative sources to municipal water, where possible. Alternative sources may include, treated water from the Effluent Treatment Plant and surface water from Kenogamisis Lake.
- Use water on grading and bulldozing operations as required. Load haul trucks within the open pit using hydraulic shovels. The open pit will reduce dust emissions from the Project and, to further reduce fugitive dust from this activity, have the equipment operator minimize the drop distance between the bucket and the bed of the haul truck as much as possible
- Equip primary crusher with a dust collection system (baghouse or equivalent) to control fugitive emission during ore crushing
- Equip secondary crusher with a dust collection system (baghouse or equivalent) and protective covers, to control potential dust emissions during secondary crushing and ore transferring
- Enclose the mill feed ore storage area
- Equip high pressure grinding rolls (HPGR) with wet scrubbers (or equivalent) to control dust emissions from the grinding operations
- Use a wet scrubber (or equivalent) on the induction furnace to control emissions
- Apply water to historical tailings (as required) prior to transport to the TMF.
- Use a dust collector to control dust from the lime silo during loading. Use a dust collection system in the lime preparation area to control emissions from the lime storage tank
- Progressive reclamation of WRSA’s as they are closed during the operations phase

The following strategies will be used to control dust from unpaved roads during operations:

- Where possible, minimize haul routes to, and within, the Project
- Control fugitive dust emission control from roadways, material handling and stockpiles by application of water sprays, chemical suppression, dust sweeping, wind breaks/shelters, gravel application, truck wheel washing stations, enclosure of dust sources, and other means. The actual watering rate will vary, depending on surface moisture conditions and traffic levels, and will be triggered whenever the Operations Manager or water truck operator deem appropriate, based on visual observations of dust emissions and surface moisture content. Over-application of water causing surface runoff should be avoided. Maintain site roadways in good condition, with regular visual examination and maintenance to reduce loose dust on roads
- Supplement watering with the use of MECP approved dust suppressants, if needed. GGM will consult with the Environmental Advisory Committees and inform the MECP prior to use of a new dust suppressant.
- Enforce speed limits on on-site unpaved roads
- Maintain a buffer of existing vegetation on each side of internal unpaved haul roads where feasible
- Employ wind sheltering (wind screens or berms) along selected haul routes as required
- Wet or cover transported material (aggregate, borrow, or historical tailings). Over-application of water resulting in runoff from the vehicle should be avoided.

The following measures will be used to control dust from the TMF:

- Under very dry meteorological conditions dust may be generated from dried tailings. As needed, adjust tailings spigot discharge to provide adequate wetting of tailings to suppress dust generation
- Progressively restore TMF cells as cells are closed during the operations phase as described in the GGM Hardrock Project Mine Production Closure Plan

Detailed operations dust mitigation measures are provided in the Operations Best Management Plan for Fugitive Dust presented in Appendix B.

6.3.3 *Lighting Mitigation and Management*

Lighting fixtures used during the Project construction, operation and active closure phases will be designed to mitigate potential effects including:

- Specify construction lighting to use only as much lighting as is necessary for safe and efficient construction activities, and locate portable lighting equipment where, to the extent feasible, it is not visible at nearby receptors
- Follow widely accepted standards and guidelines for selection of exterior lighting systems, including directional lighting to limit light trespass and avoid glare. Incorporate proper shielding via the use of horizontal cut-off fixtures in the Project lighting plan (where practicable), and position portable lighting to limit visibility at surrounding residences
- Install light sensitive switches on road lights, so they do not operate during the day
- Most of the routes for haul trucks and service vehicles onsite will be shielded by topography and/or vegetation along their length, and no street lighting is currently planned for these areas
- In the detailed roadway design, leave tree cover in place where practicable to reduce the line-of-sight from receptors to the onsite roads.
- Implement lighting of the re-aligned Highway 11 according to current MTO standards.

6.4 Closure

Mitigation and monitoring activities associated with decommissioning, reclamation and rehabilitation during the closure phase are presented in the Closure Plan. Mitigation measures applicable to the construction phase would apply during active closure and it is anticipated that mitigation during the post closure phase will not be required.

7 Monitoring, Evaluation and Reporting

7.1 Monitoring, Measurement, Analysis and Evaluation

An ambient air quality monitoring program will be implemented to regularly sample air quality at key locations on and adjacent to the Project. The program is designed to measure the effectiveness of control measures, evaluate air quality at nearby receptors and verify compliance with ECA conditions, relevant regulatory standards, and corporate requirements. The air quality monitoring program will be in place during construction and will continue and be adjusted as needed through operation.

The basic air quality monitoring program will be comprised of a combination of high-volume air samplers (or equivalent), dust deposition gauges, passive samplers and real time particulate monitors. Air quality

monitoring stations will be installed to measure both the background (predominantly upwind) ambient particulate matter and that from Project operations. A meteorological monitoring station will be installed and maintained to provide real time and periodic meteorological data to assist in day-to-day operational measures and for data interpretation. The location/siting criteria for the meteorological tower will be reviewed with the MECP prior to installation and start of Project construction.

The air quality monitoring program is outlined in Table 7-1.

Table 7-1: Summary of Air Quality Compliance Monitoring Program

Parameter	Monitoring Method	Duration	Frequency	Location	Responsibility
TSP/metals Deposition	Dustfall jars	Dustfall - construction, operation and the first five years of decommissioning. Metals in Dustfall - first year of operation	Monthly	8 locations	Environmental Supervisor and Monitors
TSP/metals	High-volume air sampler or equivalent	Construction and the first five years of operation.	6-day intervals following the MECP provincial sampling schedule	Upwind / downwind (Rosedale Point and MacLeod Provincial Park)	Environmental Supervisor and Monitors
PM_{10}	Beta Attenuation Monitor (BAM) or equivalent	Construction, operation and the first five years of decommissioning	Continuous	Upwind / downwind (Rosedale Point and MacLeod Provincial Park)	Environmental Supervisor and Monitors
$PM_{2.5}$	BGI PQ-200 or equivalent	Construction, operation and the first five years of decommissioning	Monthly	Upwind / downwind (Rosedale Point and MacLeod Provincial Park)	Environmental Supervisor and Monitors
NO_2	Thermo Scientific Model 42iQ NO-NO2-NOx analyzer or equivalent	Construction, operation and the first five years of decommissioning	Continuous	Rosedale Point	Environmental Supervisor and Monitors
SO_2	Thermo Scientific Model 43iQ SO_2 analyzer or equivalent	Construction, operation and the first five years of decommissioning	Continuous	Rosedale Point	Environmental Supervisor and Monitors

Table 7-1: Summary of Air Quality Compliance Monitoring Program

Parameter	Monitoring Method	Duration	Frequency	Location	Responsibility
Benzene	Passive Sampler	Construction and first 2 years Operation	Monthly	Upwind / downwind (Rosedale Point and MacLeod Provincial Park)	Environmental Supervisor and Monitors
Benzo(a)pyrene	High-volume air sampler or equivalent	Construction and first 2 years Operation	Monthly	Upwind / downwind (Rosedale Point and MacLeod Provincial Park)	Environmental Supervisor and Monitors
Meteorology Wind speed Wind direction Temperature Rainfall Relative humidity	Meteorological tower	Construction, operation and the first five years of decommissioning	Continuous	Rosedale Point	Environmental Supervisor and Monitors

Further details of the air quality compliance monitoring program are provided in the Ambient Monitoring Plan in Appendix A. Within the Ambient Monitoring Plan, Sections A1 – A5 provide the necessary information to support the scope of the program and station siting. Once the monitoring program is implemented, reference to the following sections of the Ambient Monitoring Plan is required for ongoing operating protocols and requirements:

- Section A6 - Laboratory and Analytical Procedures
- Section A7 – Quality Assurance Procedures
- Section A8 – Accuracy Checks
- Section A9 – Real Time Dust Monitoring
- Section A10 – Reporting Requirements

7.2 Reporting

The form and frequency of follow-up reporting will be determined as the Project progresses through permitting; however, it is anticipated that those elements relevant to the AQMMP will be assembled into a formal report and made available to interested parties on an annual basis during construction and operation. Receiving, documenting and responding to communication from external interested parties, including complaints, will also form part of reporting under this Plan.

7.2.1 *Annual Summary Report*

An annual summary report of relevant activities and findings for the previous calendar year will be assembled and supplied to interested parties, including Indigenous communities. The summary report will be completed by June 30 of the following year and will include:

- A general description of the site activities occurring during the reporting year
- Summary of the ambient air quality measurements
- Summary of any complaints received, the identified cause, and responses taken by GGM
- Summary of any validated ambient air quality exceedances, their cause and the response by GGM
- Summary of any updates to the AQMP and reasons for the changes

7.2.2 *Ambient Air Quality*

Annual reports will be generated that include the results of the ambient monitoring program. Should a validated exceedance of an O.Reg.419/05 criteria occur, it will be reported. Annual reports include both a summary and analysis of the ambient monitoring program for the previous year as required by the MECP Operations Manual (MECP 2018). Annual reports are due to the MECP by May 15 of the year following the reporting year.

7.2.3 *NPRI*

On an annual basis the Project will be required to report to the NPRI, which is Canada's legislated inventory of pollutant releases (to air, water and land), disposals, and transfers for recycling. Reports to the NPRI are typically due on June 1 of the year following the reporting calendar year (e.g., the deadline for reporting to the NPRI for the 2018 calendar year is June 1, 2019. Updates to NPRI reporting requirements are published as NPRI Notices in the Canada Gazette. GGM will check for updates in the Canada Gazette annually (which can be searched for on the Environment and Climate Change Canada (ECCC) website).

The Project will be required to report the amount of each NPRI substance at the facility which was manufactured, processed or otherwise used at the facility during the year, if the quantities meet their respective reporting thresholds. Reporting is required for facilities where pit or quarry operations occur, regardless of the employee hours worked threshold of 20,000 hrs, which will be exceeded. The NPRI substances are grouped into five parts, each representing a different category of substance and with specific thresholds and reporting requirements.

7.2.4 *Air Quality Exceedance Reporting*

In the event of a measured and validated exceedance of a MECP air quality criteria, GGM shall as soon as practicable, notify a provincial officer, as per Section 28(b) of O. Reg. 419/05. Notification of an exceedance is normally accomplished by submitting a report to the MECP Spills Action Centre. Exceedance reporting will be required for any contaminant included in the Ambient Monitoring Plan (Appendix A). The exceedance reporting procedure and its linkage to the Adaptive Management Process is presented in Figure 7-1.

7.3 Adaptive Management Process for Continual Improvement

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning from their outcomes. Adaptive management provides the flexibility to address/accommodate new circumstances, to adjust monitoring, implement new mitigation measures, or modify existing measures.

GGM will identify and correct incidents with appropriate and lasting measures aimed to prevent reoccurrence and/or similar occurrences. The Adaptive Management Framework (Figure 7-2), provides a formalized approach to:

- Formally track and monitor activities
- Report and as needed investigate incidents, including non-conformance and non-compliance events
- Develop and implement corrective and preventive actions
- Continue monitoring and update relevant EMMPS

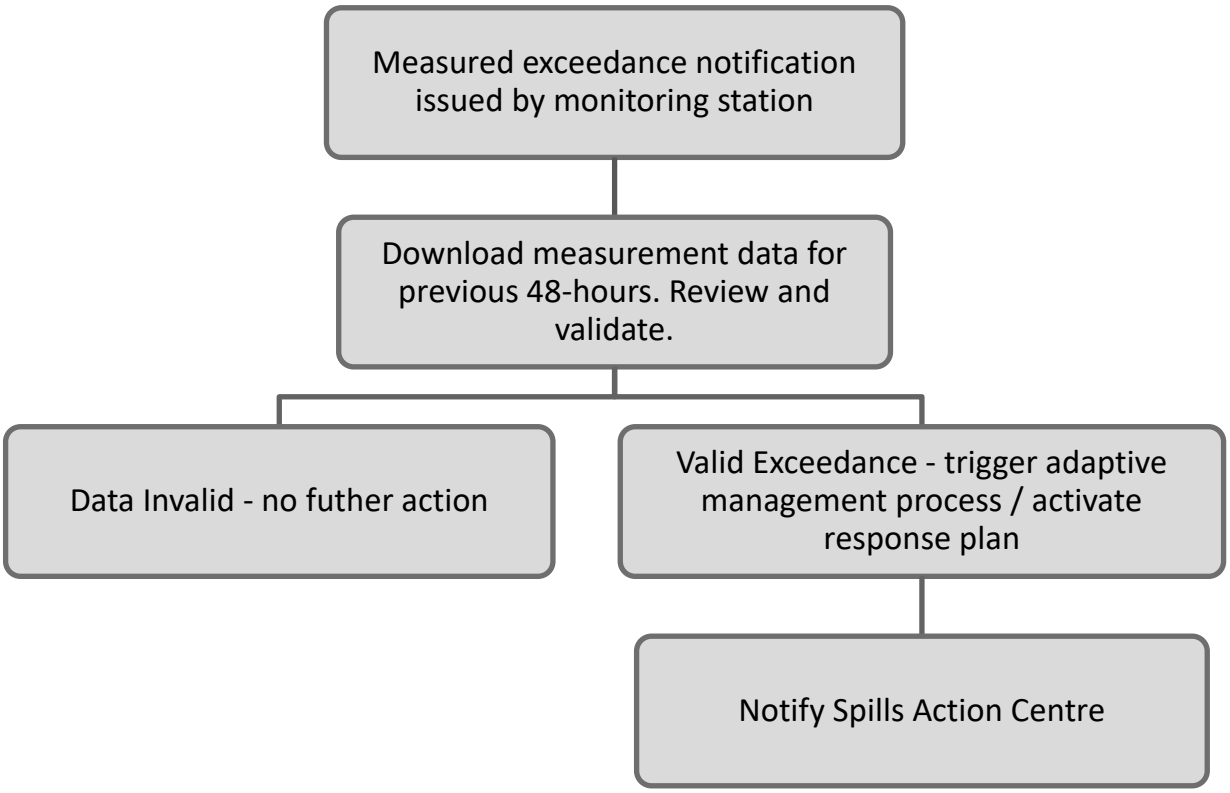

Figure 7-1: Hardrock Project Exceedance Reporting/Adaptive Management Process

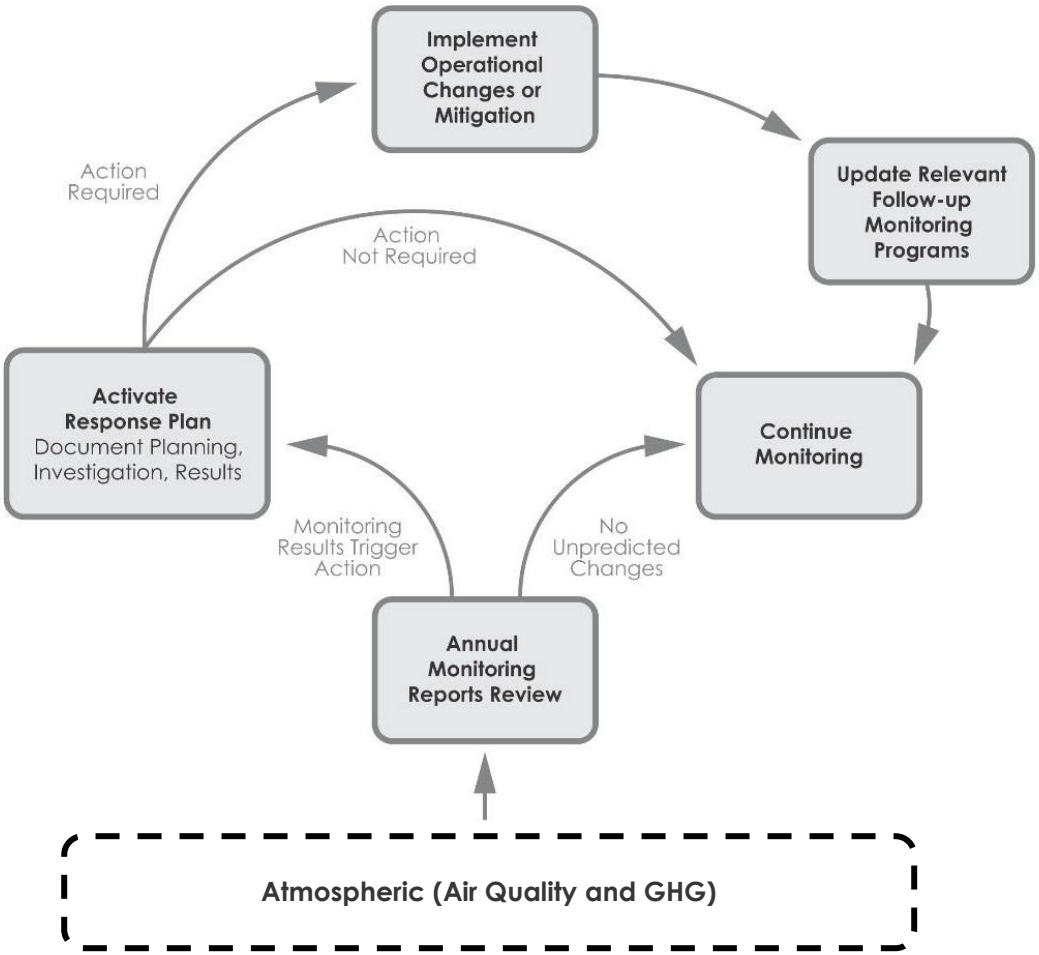

Figure 7-2: Hardrock Project Adaptive Management Framework

Corrective actions will be assigned as appropriate, including actions to prevent their reoccurrence. Corrective actions will vary according to the results of incident investigation and in consideration of other incidents related to the AQMMP. GGM is committed to the continual improvement of its environmental management and performance. As part of the GGM Adaptive Management Framework, the AQMMP will be assessed annually to verify implementation and the continued suitability, adequacy and effectiveness of the Plan. The review will identify elements of this AQMMP in need of revision and evaluate performance against established performance objectives.

8 REFERENCES

Canadian Council of Ministers of the Environment (CCME), (2007). Guidance Document on Achievement Determination. Canada-Wide Standards for Particulate Matter and Ozone. Revised (PN1391) (978-1-896997-74-2 PDF).

Canadian Council of Ministers of the Environment (CCME), (2012). Guidance Document on Achievement Determination. Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone (PN 1483) (978-1-896997-91-9 PDF).

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Ontario Ministry of the Environment, Conservations and Parks (MECP), (2018). Operations Manual for Air Quality Monitoring in Ontario, Operations Division, Technical Support Section, 2018, PIBS 6687e

APPENDIX A:
AMBIENT MONITORING PLAN (AMP)

Appendix A Ambient Monitoring Program

The following Ambient Monitoring Plan (AMP) summarizes the parameters to be monitored, location and frequency of monitoring, sampling and calibration, data acquisition and validation, reporting requirements, records management, and (when required) corrective and preventive action.

A.1 Introduction

A.1.1 Monitoring Objectives

An ambient monitoring and reporting program is a requirement laid out in the Provincial Minister's Notice of Approval to Proceed with the Undertaking, detailed in Condition 22 of the Notice of Approval (MECP, 2019).

The purposes of the ambient monitoring program will be to:

1. Quantify any measurable ground level concentrations resulting from emissions from the GGM Hardrock Project cumulative to local air quality
2. Monitor concentrations of selected GGM-related air contaminants in nearby residential areas
3. Monitor concentration of selected GGM-related air contaminants in Indigenous Traditional Land and Resource Use (TLRU) areas or at locations that will be protective of air quality in TLRU areas
4. Quantify background ambient levels of air contaminants in the area
5. Proactively assess the effectiveness and adaptively adjust mitigation measures to reduce off-site ambient air quality levels.

A.1.2 Project Description

The Project is in northern Ontario, approximately 275 kilometres (km) northeast of Thunder Bay, in the Municipality of Greenstone, Ward of Geraldton. The centroid coordinates of the proposed open pit are UTM- Easting, 504405, Northing 5502930 (NAD 83, UTM Zone 16 U). A site plan showing the layout of the Project site is presented in Figure A-1.

Key mine components of the Project development area include an open pit, waste rock storage areas (WRSAs), ore and overburden stockpiles, ore crushing and mill feed storage activities, ore milling and processing plant, water management facilities, tailings management facility (TMF), power plant and associated infrastructure, and explosives manufacturing plant and storage. Ancillary mine infrastructure includes mine operation buildings, service water supply and associated infrastructure, sewage and effluent treatment facilities, mine site roads, watercourse crossings, realignments, habitat compensation/offsets, onsite pipelines and piping, hazard materials storage, aggregate sources, and temporary camp.

Key project activities associated with the construction and operational phases as they pertain to atmospheric environment are described below.

Construction Phase

The construction phase will last approximately 30 months and includes the following activities:

- Site preparation including, clearing and grubbing, soil stripping, grading, and leveling of the site as required in preparation for foundations and buildings
- Soils and overburden (including potentially contaminated overburden/soils) management in accordance with the Soils Management Plan
- Relocation of a portion of the historical MacLeod tailings to temporary storage in the open pit
- Removal of existing infrastructure
- Watercourse crossings
- Goldfield Creek diversion
- Hwy 11 realignment
- Open pit development including the removal of topsoil, overburden and waste rock, drilling and blasting, and preproduction mining of ore
- Development and implementation of water management facilities (i.e., collection ponds and drainage ditches, temporary water treatment plant; sanitary sewage treatment plants; potable water infrastructure)
- Development of the overburden stockpiles and WRSAs
- Construction of the TMF
- Construction of the mill and initial commissioning during the final months of construction
- Physical construction of buildings and structures associated with the project, and installation of equipment associated with its operation
- Construction of linear facilities (e.g., roads, onsite pipelines and piping, power lines)
- Construction of ancillary facilities (e.g., fuel supply, storage and distribution); and
- Extraction from aggregate sources

Operation Phase

The operation phase includes the following activities:

- Operation of the open pit mine, which will include drilling, blasting, loading of ore and waste rock, and additional overburden stripping until the full extent of the open pit at surface is exposed
- Soils and overburden management in accordance with the Soils Management Plan
- Relocation of portions of the historical MacLeod tailings to the new TMF, including historical tailings temporarily stored in the open pit
- Hauling of ore to the milling and processing plant and waste rock to the WRSAs
- Ore processing which includes crushing and milling
- Tailings management, operation of the water management facilities, and onsite power generation

A.1.3 Site Characteristics

The Project is in northwestern Ontario, approximately 275 km northeast of Thunder Bay in the Municipality of Greenstone, Ward of Geraldton. The Project is generally centred at the intersection of Highway 11 and Michael Power Boulevard. Highway 11 currently traverses the Project property in an east-west direction. Michael Power Boulevard extends north from the Project area towards the community of Geraldton.

The lands surrounding the Project development area (PDA) include urban, rural, and recreational areas. The lands surrounding the east, south and west of the PDA are primarily natural areas including forests, wetlands and lakes. The lands to the north of the PDA are mostly urban residential, concentrated in the community of Geraldton. MacLeod Provincial Park is a recreation area located across the Central Basin of Kenogamisis Lake to the east of the PDA. Another recreational area is the Kenogamisis Golf Club, currently located within the PDA. The golf course property is owned by GGM, who leases the property to the municipality.

The topography of the PDA and surrounding area is relatively flat to gently rolling, with local relief up to 20 m above the surrounding area resulting in no distinct topographic features. Ground surface slopes from local topographic high areas, primarily bedrock outcrops, to low lying areas characterized by swamps and ponds with overall poor water drainage throughout the area. Ground elevations range from approximately 335 metres above mean sea level (m amsl) along the shoreline of Kenogamisis Lake and Barton Bay to 375 m amsl in the southwest area of the PDA.

A total of 313 air quality/human health and ecological risk assessment (HHERA) and 17 Traditional Land and Resource Use (TLRU) receptors were identified and examined in the environmental assessment (EA)

of the Project. These receptors included residences/residential areas, hospitals, schools, day cares, nursing homes, recreational areas and water bodies. The special receptors included some receptors located within the modelled property boundary used in the air quality assessment, such as potential new locations for a MTO yard, an OPP station, the Kenogamisis Golf Club and properties (including Rosedale Point residences) not owned by GGM. A listing of all special receptors can be found in Appendix A, Table A-1 of the Air Quality Technical Data Report (Stantec, 2017). Plots of the special receptors in proximity to the Project are shown in Figures A-2 to A-5.

A.1.4 Monitoring Period

Ambient monitoring for total suspended particulates, particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), dustfall, nitrogen dioxide and sulphur dioxide will be conducted during construction, operation and the first five years of decommissioning as per Condition 5.3 of the Federal EA Decision Statement. Monitoring for metals in TSP will be conducted during construction and the first five years of operation. Also following the Federal Decision, benzene and benzo(a)pyrene will be monitored during construction and for the first two years of operation. Metals in dustfall will be monitored for the first year of operation and the need for additional metals monitoring will be determined based on a review of the monitoring results for the one-year period in consultation with the MECP and Environmental Advisory Committees.

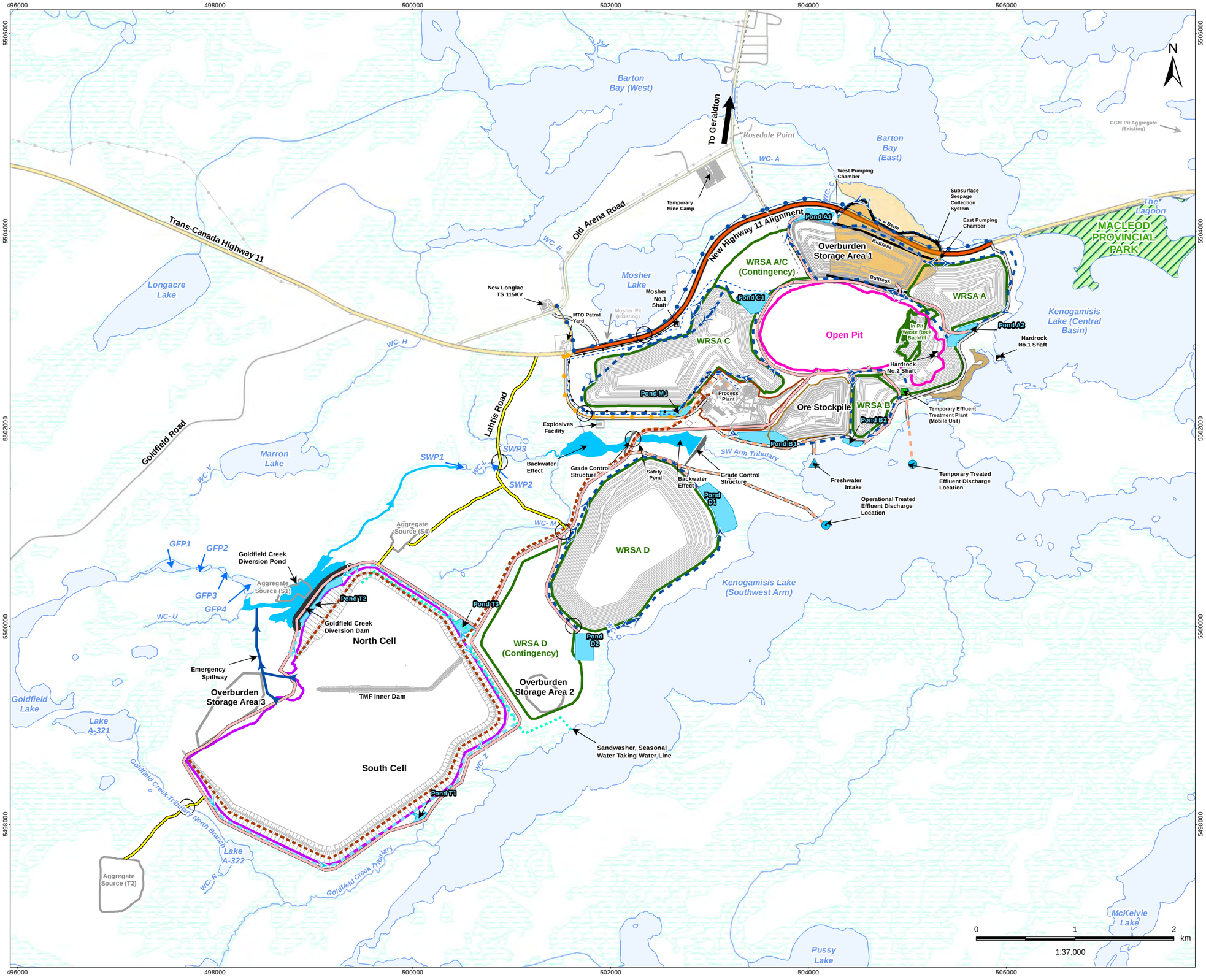
GGM may request modifications to the ambient air monitoring programme from the MECP if the monitoring data provides sufficient justification to change or discontinue monitoring. Changes to the monitoring program will be decided based on an annual review of the results of the monitoring program (following the adaptive management process) in consultation with the MECP.

A.1.5 Report Contents

The MECP's Operations Manual for Air Quality Monitoring in Ontario (MECP, 2018) (Operations Manual) requires a monitoring plan to include the following sections:

- Purpose or objectives of the monitoring program – Section A.1.1
- Expected duration of the monitoring program – Section A.1.4
- Identified and suspected air emission source(s) – Section A.1.2
- Identified and suspected receptors – Section A.1.3
- Number and location of monitoring sites (including meteorological sites) – Section A.3.3
- Air quality parameters to be monitored and monitoring frequency – Sections A.4.1, A.5.1, A.5.2
- Monitoring methods/instruments to be used – Section A.5

- Analytical methods/procedures – Section A.5, A.6
- Laboratory services support to be used – Section A.6
- Dispersion model to be used (if applicable) – N/A
- Quality Assurance and Quality Control (QA/QC) plan – Section A.7, A.8
- Data reporting procedures – Section A.10.



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Revised: 2020-01-21 By: dharvey

Stantec

Legend

Preliminary Site Plan

- Discharge Location
- Existing Mine Shaft
- Freshwater Intake
- Temporary Effluent Treatment Plan
- Watercrossing
- Access Road
- Construction Access Road
- Diversion Channel
- Emergency Spillways
- Haul Road
- Potable Water Pipeline
- Pipeline (Intake and Discharge)
- 44 kV Distribution Line
- 12.5 kV Distribution Line
- 115 kV Transmission Line
- Seepage Collection Ditch
- Subsurface Seepage Collection System
- Contact Water Collection Ditch
- Tailings Pipeline and 13.8 kV Distribution Line
- Water Line
- Aggregate Source
- Collection Ponds
- Open Pit- Full Extent
- Ore Stockpile
- Process Plant Area
- Tailings Management Facility
- Waste Rock Storage Area

Highway Realignment

- New Highway 11 Alignment

Existing Features*

- Highway
- Major Road
- Local Road
- Existing Power Line
- Existing Potable Water Pipeline
- Watercourse
- Provincial Park
- Waterbody
- Wetland (Eco-Site Based)

Historical Tailings Areas

- Historical Hardrock Tailings
- Historical MacLeod High Tailings
- Historical MacLeod Low Tailings

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.
* Existing Features have been removed in the PDA and do not reflect current conditions.

January 2020
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Client/Project

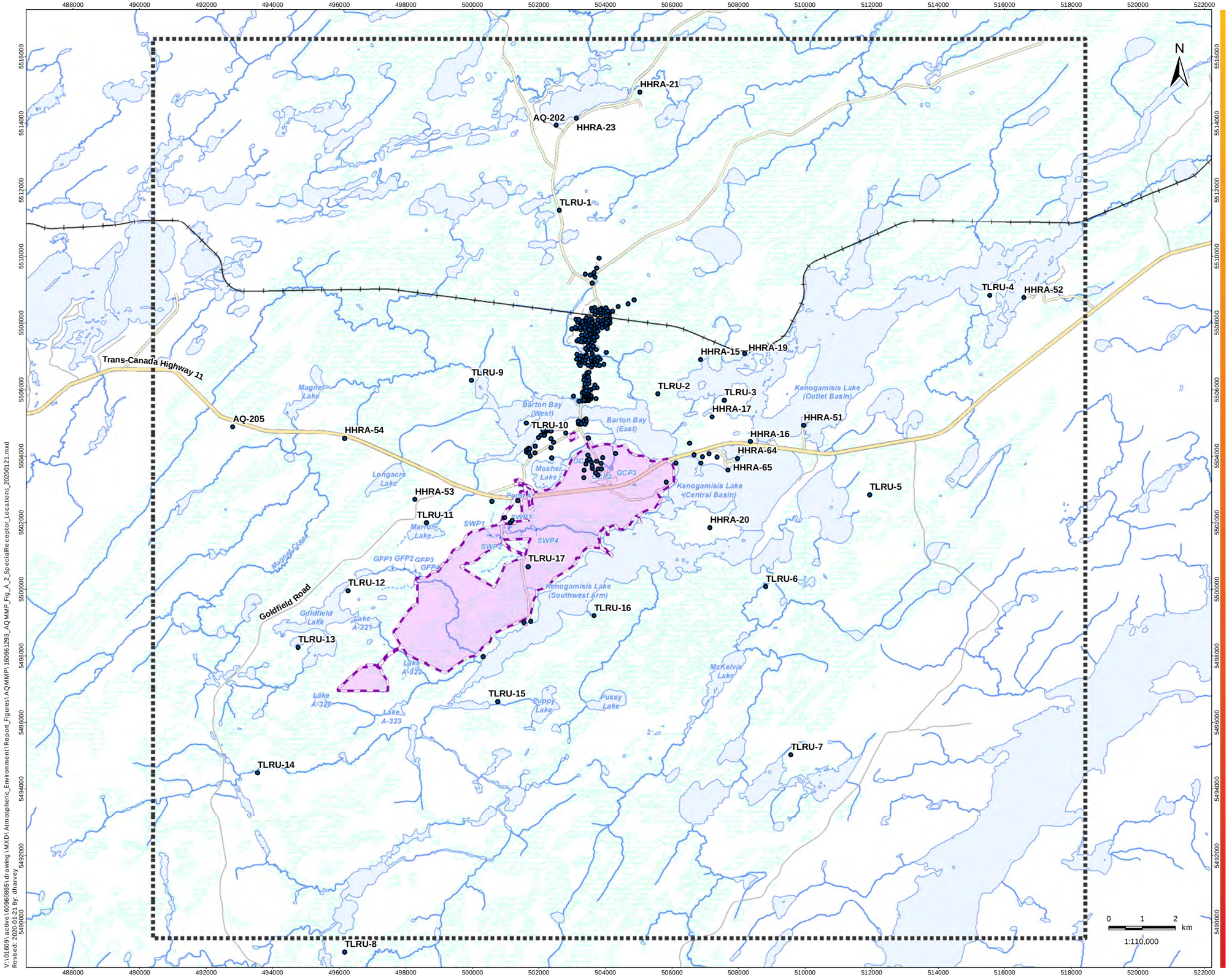
Greenstone Gold Mines GP Inc. (GGM)
Hardrock Project

Figure No.

A-1

Title

Site Plan



Legend

- Mapbook Tile Index
- Local Assessment Area
- Project Development Area
- Special Receptor Location

Existing Features

- Highway
- Major Road
- Local Road
- Railway
- Watercourse- Permanent
- Watercourse- Intermittent
- Waterbody
- Wetland (Eco-site Based)

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

January 2020
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Client/Project

Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-2

Title

Special Receptor Locations

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501500 502000 502500 503000 503500

5505000 5504500 5504000

N

Barton Bay (West)

Barton Bay (East)

TLRU-10

AQ-200 AQ-225 AQ-228 AQ-224 AQ-226 AQ-229 HHRA-49 AQ-244 AQ-231 AQ-243 AQ-198 AQ-199 HHRA-1

AQ-232 AQ-242 AQ-233 AQ-241 AQ-234 AQ-235

HHRA-48 HHRA-7 AQ-201 AQ-240 AQ-197 AQ-239 AQ-195 AQ-238 AQ-236 AQ-237

Old Arena Road

HHRA-8 HHRA-6

Mosher Lake

HHRA-30 AQ-22 AQ-21 AQ-23 AQ-24 AQ-25 AQ-16 AQ-26 AQ-19 AQ-27 AQ-17 HHRA-2 AQ-20 AQ-18

WC-A

HHRA-60 AQ-219 HHRA-9 AQ-218 AQ-217

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Revised: 2018-10-17 By: dharvey

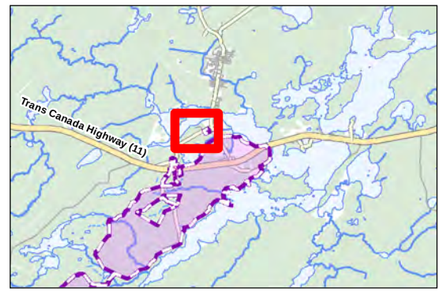
Stantec

Legend

- Project Development Area
- Special Receptor Location

Existing Features

- Highway
- Major Road
- Local Road
- Watercourse- Permanent
- Watercourse- Intermittent



Notes

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October 2018
160961293

Client/Project

Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-3

Title

Special Receptors
Near Rosedale Point

V:\01609\active\60960865\drawing\MXD\Atmospheric_Environment\Report_Figures\AQMMP\160961293_AQMMP_Fig_A_4_SpecialReceptors_Near_MacleodProvincialPark.mxd
Revised: 2018-10-17 By: dharvey

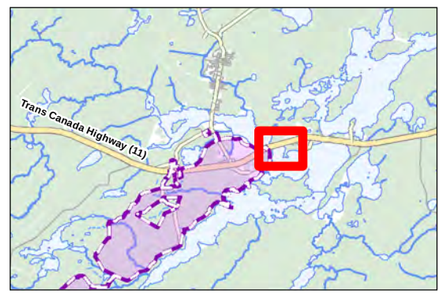
Stantec

Legend

- Project Development Area
- Special Receptor Location

Existing Features

- Highway
- Major Road
- Local Road
- Watercourse- Permanent
- Watercourse- Intermittent



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Client/Project

Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-4

Title

Special Receptors Near MacLeod Provincial Park

A.2 Summary of Dispersion Modelling Predictions

Dispersion model predictions are an aide in the siting of monitoring stations recommended by the United States Environmental Protection Agency (40 CFR, Part 58) (US EPA). A dispersion modelling study of emissions from GGM was completed as part of the approved environmental assessment for this project (Stantec 2017). This study examined emissions of about 58 different contaminants of potential concern including criteria air contaminants, metals, and PAHs. The maximum off-property ground-level concentrations due to emissions from GGM were estimated using the AERMOD dispersion model.

This section presents a brief overview of the dispersion modelling methods and results relevant to the siting of the ambient monitors. Additional details can be found in the Air Quality Technical Data Report prepared for the EA (Stantec, 2017).

A.2.1 Meteorological Modelling

As part of the dispersion modelling study, a five-year (2009 – 2013) meteorological dataset provided by the MECP based on upper air data from the International Falls station (located about 450 km southwest of the Project) and surface data from Geraldton Airport (elevation 348 m amsl) and processed using AERMET version 14134 was used in the modelling assessment. The meteorological data were processed by the MECP to reflect the land uses surrounding the proposed site.

A wind rose diagram is an efficient and convenient way of summarizing wind speed and directional data. The length of the radial barbs gives the total percent frequency of winds from the indicated direction, while the portions of the barbs of different widths indicate the frequency of associated wind speed categories. Figure A-5 summarizes the hourly winds for the GGM Hardrock site. The predominant winds are blowing from northwesterly and west to southerly directions.

A.2.2 Dispersion Modelling

The dispersion modelling assessment was conducted to predict the downwind concentrations of air contaminants emitted by the GGM Hardrock Project.

Contour plots showing the maximum predicted ground level concentrations of TSP and PM_{10} are presented in Figures A-6 to A-9 for Operation Phases 1 and 2. These figures show the highest TSP and PM_{10} concentrations are predicted to occur south of the open pit along the modelled property boundary on the shore of Kenogamisis Lake.

Construction emissions and predicted concentrations were less than those for operation.

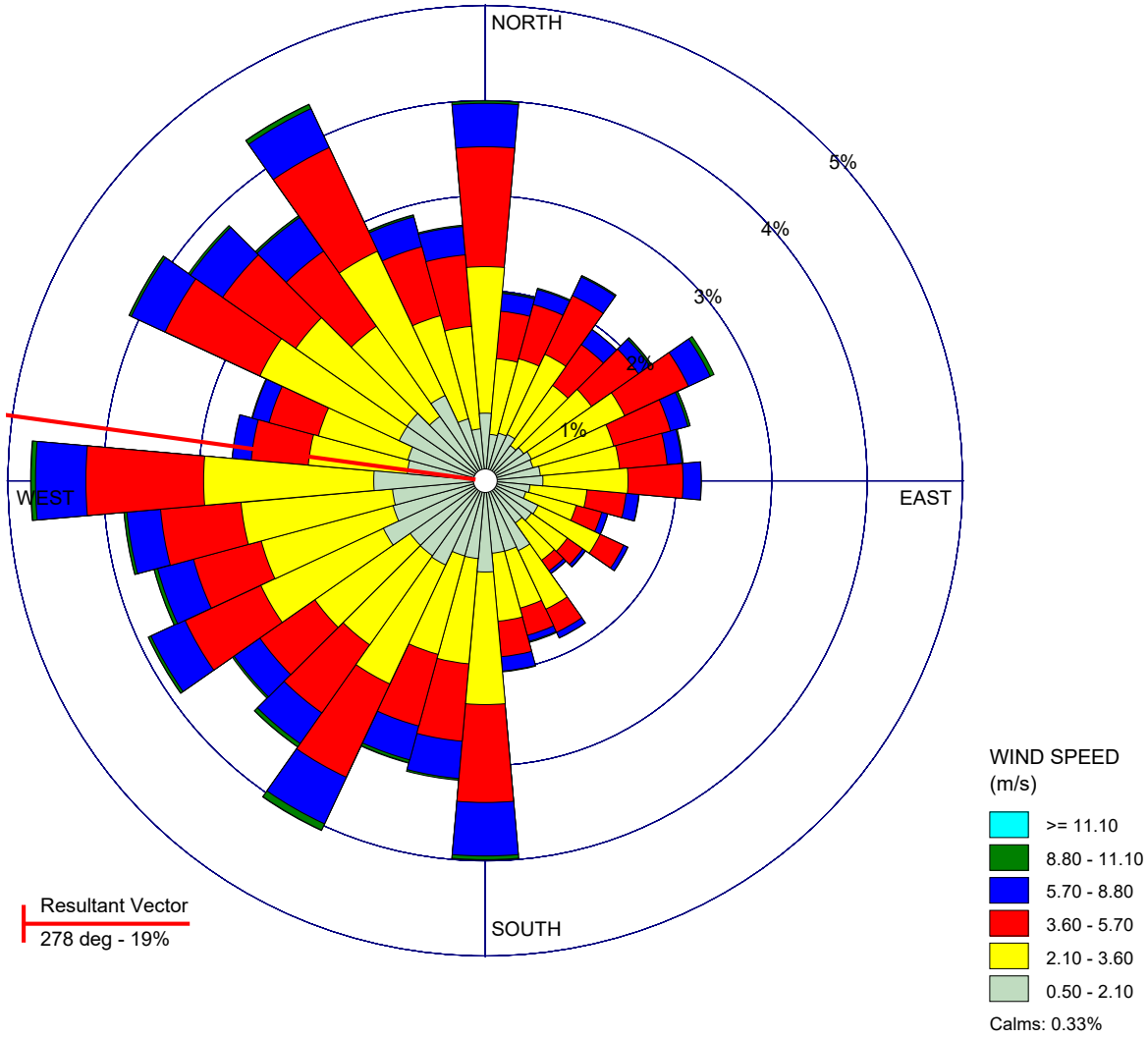
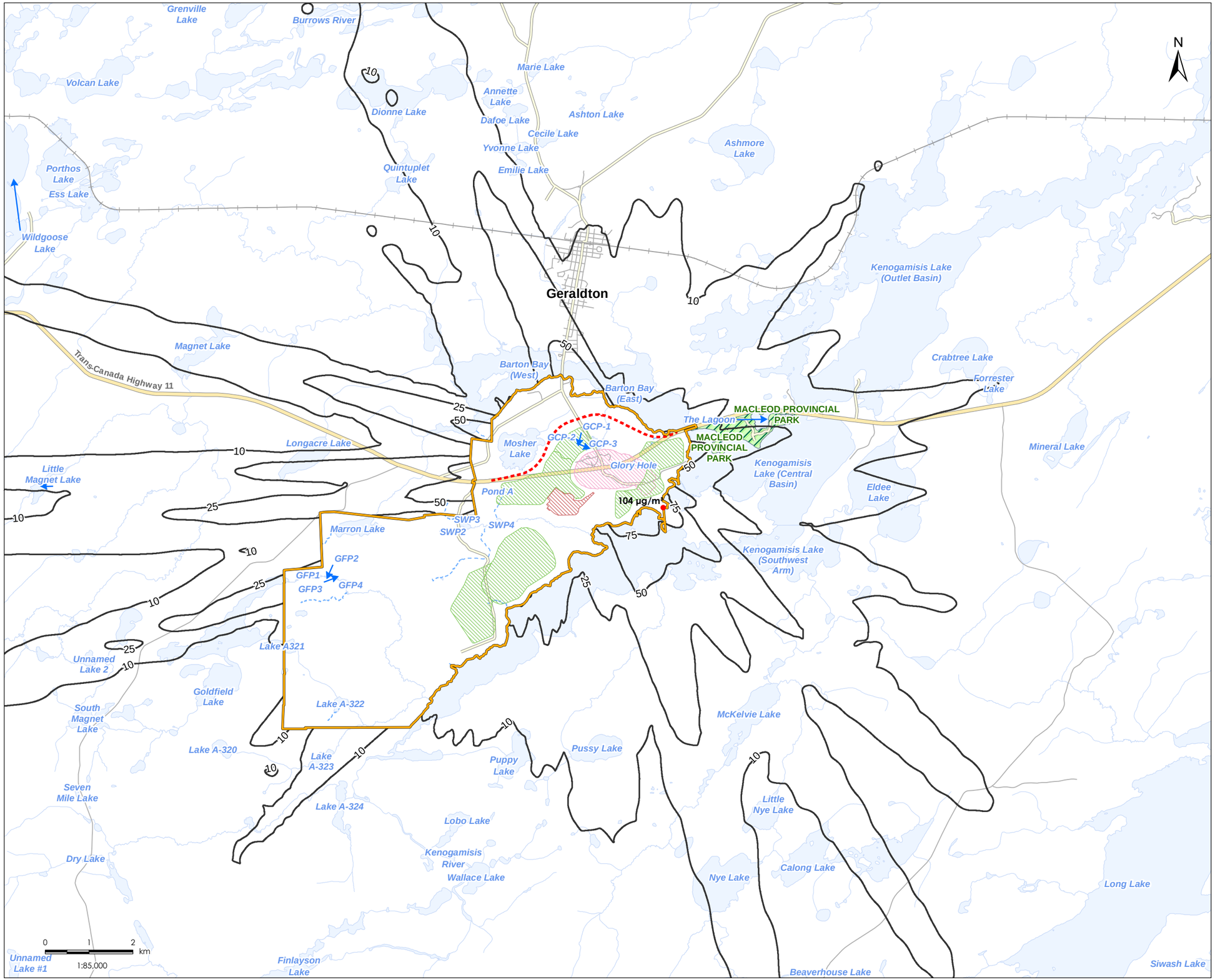


Figure A-5: Wind Rose Plot (2009-2013)



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Revised: 2020-01-21 By: dharvey

Stantec

Legend

- Location of Maximum Predicted Concentration
- Concentration Contour (µg/m³)
- Model Property Boundary
- Open Pit
- Process Plant Area
- Waste Rock Storage Area
- New Highway 11 Alignment
- Highway
- Major Road
- Local Road
- Watercourse - Permanent
- Watercourse - Intermittent
- Waterbody
- Provincial Park

Notes

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Client/Project

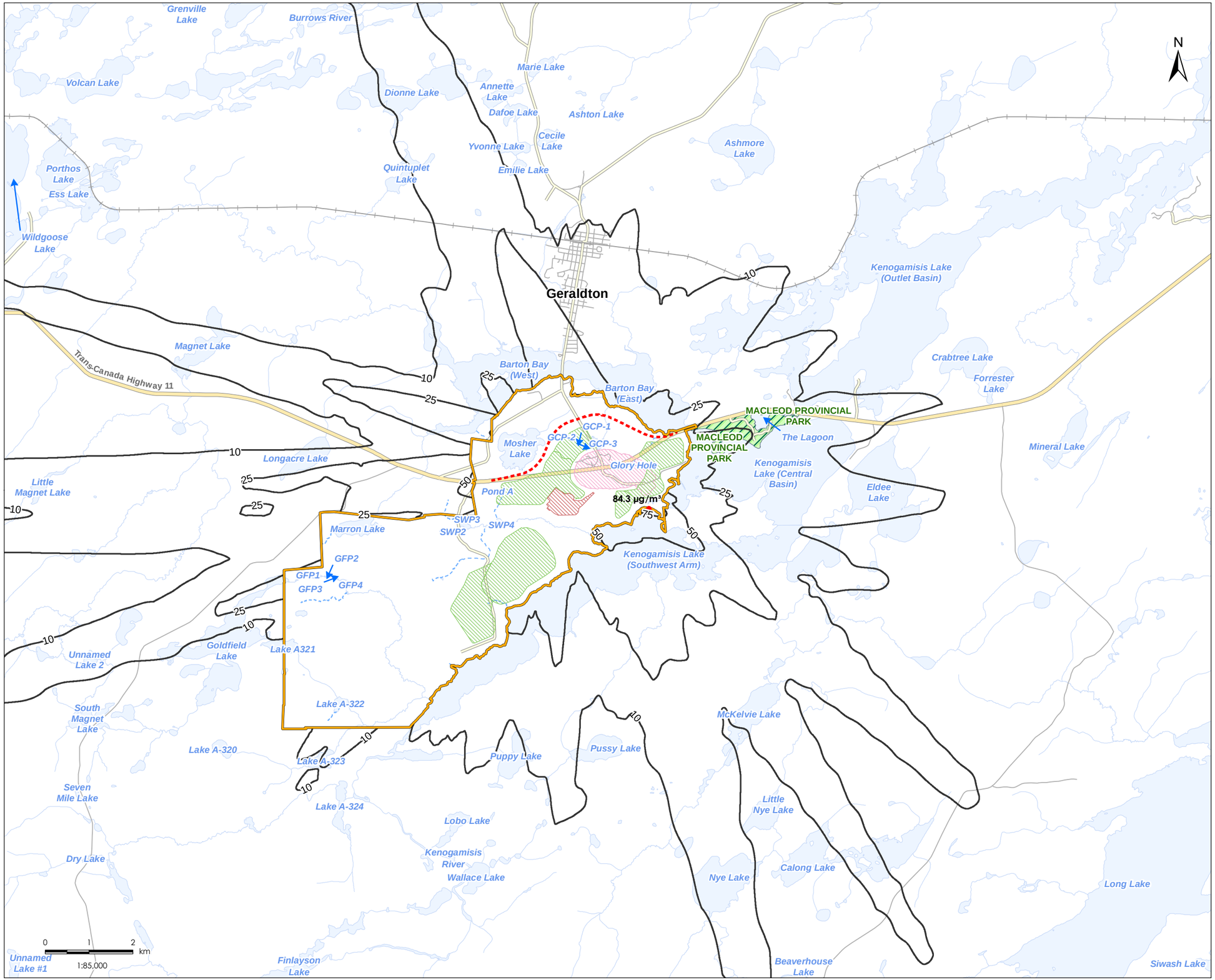
Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-6

Title

Maximum Predicted 24-Hour Average TSP Concentrations in the LAA (Mill Phase 1 Operating Scenario)



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Revised: 2020-01-21 By: dharvey

Stantec

Legend

- Location of Maximum Predicted Concentration
- Concentration Contour (µg/m³)
- Model Property Boundary
- Open Pit
- Process Plant Area
- Waste Rock Storage Area
- New Highway 11 Alignment
- Highway
- Major Road
- Local Road
- Watercourse - Permanent
- Watercourse - Intermittent
- Waterbody
- Provincial Park

Notes

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Client/Project

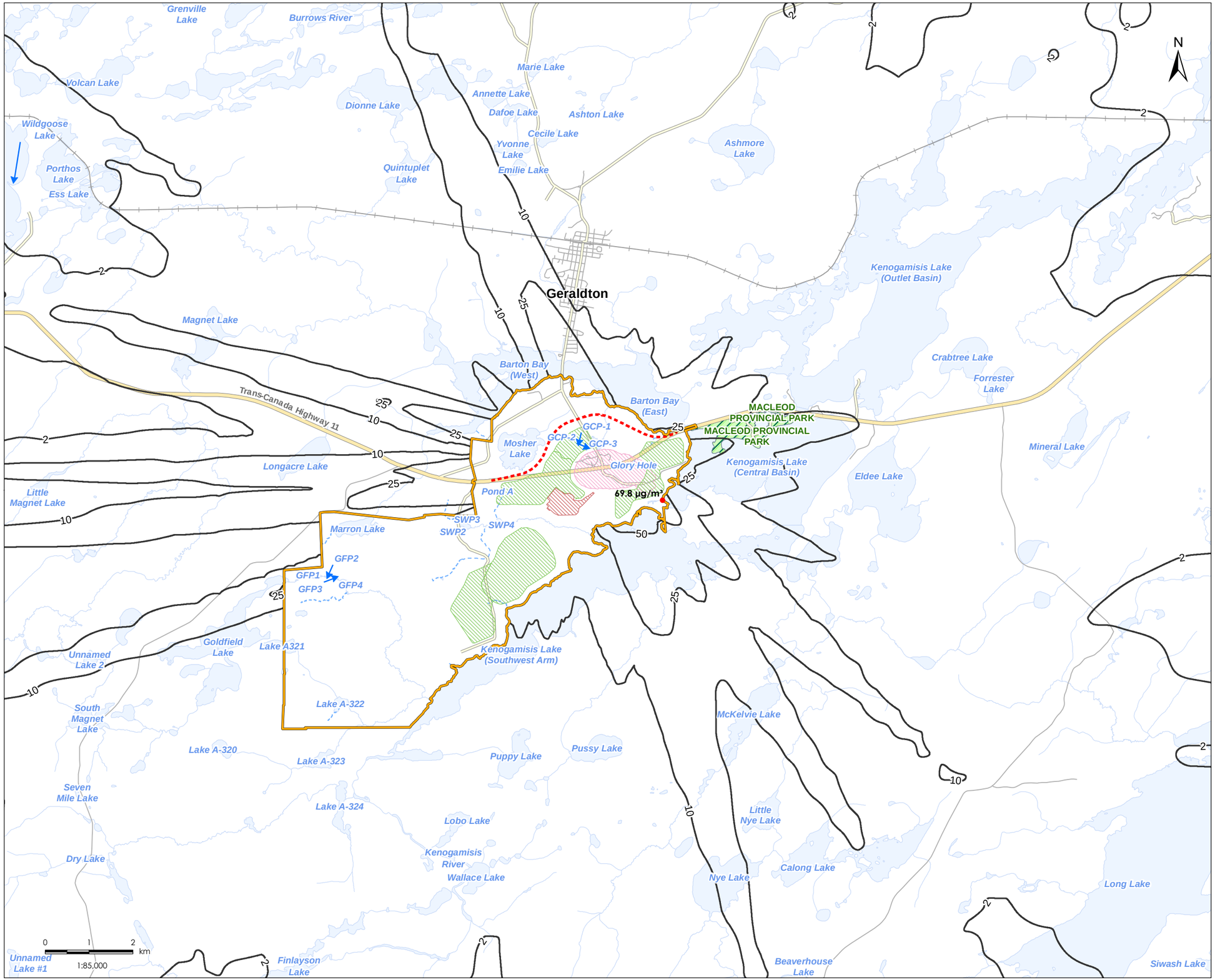
Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-7

Title

Maximum Predicted 24-Hour Average TSP Concentrations in the LAA (Mill Phase 2 Operating Scenario)



V:\01609\active\60960865\drawing\MXD\Atmospheric_Environment\Report_Figures\AQMMP\160961293_AQMMP_F_A6_A7_A8_A9_Concentrations_Fig_20200121.mxd
Revised: 2020-01-21 By: dharvey

Stantec

Legend

- Location of Maximum Predicted Concentration
- Concentration Contour (µg/m³)
- Model Property Boundary
- Open Pit
- Process Plant Area
- Waste Rock Storage Area
- New Highway 11 Alignment
- Highway
- Major Road
- Local Road
- Watercourse - Permanent
- Watercourse - Intermittent
- Waterbody
- Provincial Park

Notes

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Client/Project

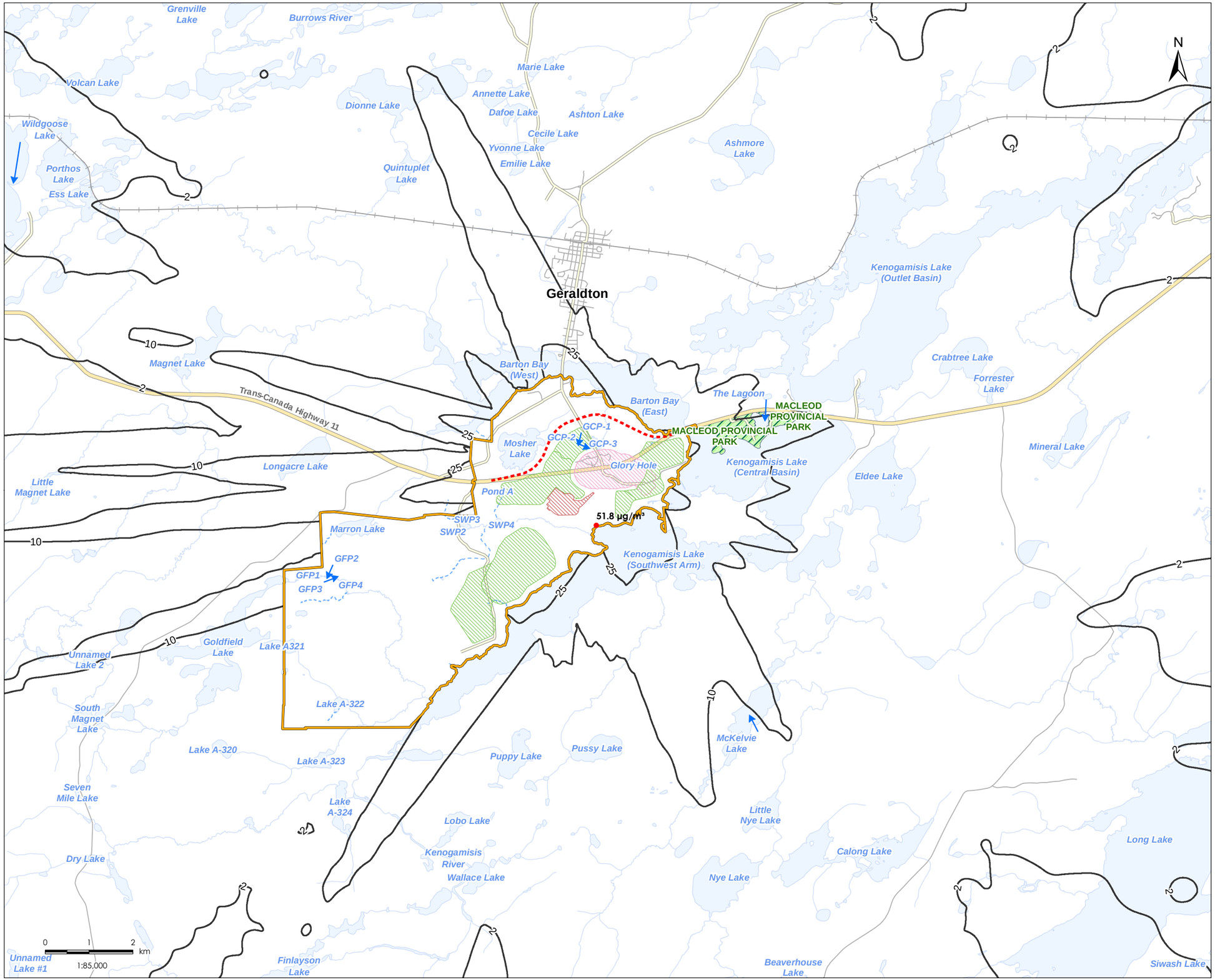
Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-8

Title

Maximum Predicted 24-Hour Average PM_{10} Concentrations in the LAA (Mill Phase 1 Operating Scenario)



V:\01609\active\60960865\drawing\MXD\Atmospheric_Environment\Report_Figures\AQMMP\160961293_AQMMP_F_A6_A7_A8_A9_ConcentrationsFig_20200121.mxd
Revised: 2020-01-21 By: dharvey

Stantec

Legend

- Location of Maximum Predicted Concentration
- Concentration Contour (µg/m³)
- Model Property Boundary
- Open Pit
- Process Plant Area
- Waste Rock Storage Area
- New Highway 11 Alignment
- Highway
- Major Road
- Local Road
- Watercourse - Permanent
- Watercourse - Intermittent
- Waterbody
- Provincial Park

Notes

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Client/Project

Greenstone Gold Mines GP Inc.
Hardrock Project

Figure No.

A-9

Title

Maximum Predicted 24-Hour Average PM_{10} Concentrations in the LAA (Mill Phase 2 Operating Scenario)

A.3 GENERAL SITING CONSIDERATIONS

A.3.1 Scales of Representativeness

Proper siting of monitoring stations requires a precise specification of the monitoring objective, which usually includes a desired spatial scale of representativeness. The spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station through which the pollutant concentration is reasonably uniform. The goal in siting monitoring stations is to correctly match the spatial scale represented by the sample of monitored air with the monitoring objective of the station. The scales of representativeness of most interest for local air monitoring are:

- Microscale – defines concentrations in air volumes associated with area dimensions ranging from several metres up to about 100 m
- Middle Scale – defines the concentration typical of areas ranging in size from about 100 m to 0.5 km
- Neighbourhood Scale – defines concentrations within extended areas with relatively uniform land use with dimensions of 0.5 to 4.0 km
- Urban Scale – defines overall city-wide conditions with dimensions on the order of 4 to 50 km

US Consolidated Federal Regulations, Section 40, Part 58 (40CFR Part 58), (US EPA, 2010) provide guidelines on the scales of representativeness required for specific monitoring objectives. The objective of monitoring source impact is associated with micro, middle and neighbourhood scales. Monitoring for background concentrations requires neighbourhood or regional scales of representativeness. This monitoring plan has been developed to meet the objective of source impacts in the area. Based on this objective, the monitors would be situated to capture middle to neighbourhood scales of representativeness (hundreds of metres to 4 km). The dispersion modeling results show the maximum predicted concentrations occur within this range.

A.3.2 Siting Requirements

Table A.3-1 provides a summary of siting requirements listed in the MECP's Operations Manual (MECP, 2018) that will be followed as closely as possible for the siting of the monitoring stations; however, the location of the stations will be constrained to sites with adequate security (within a secured, fenced area), vehicle access, set-back from roadways, and access to power.

Table A.3-1: Summary of Siting Criteria for Ambient Monitors

Contaminant	Height Above Ground (metres)	Distance from Supporting Structure (metres)		MECP Recommended Criteria
		Vertical	Horizontal	
Total Suspended Particulate (TSP)	2 to 15	>1	>2	Greater than 20 metres from trees
				Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler
				Airflow must be unrestricted through an arc of at least 270 degrees
				No nearby furnace or incineration flues
				Distance from sampler to roadway > 20-25 m for sampler inlet heights of 2-5 m
Dustfall	3	-	-	No nearby unpaved roadways, parking lots, etc.
				Greater than 20 meters from obstacles (buildings, trees, terrain features)
				Unrestricted air flow in 3 of the 4 wind quadrants
				No nearby chimneys or flues that could emit coarse particulate (soot/coal)
				Avoid building wake wind effects from rooftop installations
PM_{10} (continuous sampler)	2 to 15	>1	>2	Greater than 20 metres from trees
				Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler
				Unrestricted air flow in 3 of the 4 wind quadrants
				> 5 m from chimneys with natural gas combustion emissions
				> 20 - 25 metres from major roadways
$PM_{2.5}$ (discrete sampler)	2 to 15	>1	>2	Greater than 20 metres from trees
				Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler
				Airflow must be unrestricted through an arc of at least 270 degrees
				No nearby furnace or incineration flues
				Distance from sampler to roadway > 25 m
				Sampler Inlet > 5 m from nearest natural gas combustion source.

Contaminant	Height Above Ground (metres)	Distance from Supporting Structure (metres)		MECP Recommended Criteria
		Vertical	Horizontal	
PAH/VOCs	3-15	>1	>2	Greater than 20 metres from trees
				Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler
				Airflow must be unrestricted through an arc of at least 270 degrees
				No nearby furnace or incineration flues
				Distance from sampler to roadway > 25 m
				Sampler Inlet > 5 m from nearest natural gas combustion source.
NOx	3-15	>1	>1	> 20 m from trees
				>10 m from street intersection
				2 – 10 m from roadways
SO_2	3-15	>1	>!	Greater than 20 metres from trees
				Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler
				Airflow must be unrestricted through an arc of at least 270 degrees
				No nearby furnace or incineration flues
Wind speed and Direction	≥ 10 m height above ground	-	-	> 1 building height (H) upwind of a building obstruction
				> 1.5 H above building roof for rooftop installation
				> 5-10 H downwind of building
				> 10 m above dense vegetative canopy
				> 2 tower side widths (D) for boom installations
Air Temperature	-	-	-	> 2 m height above ground
				Temperature sensor > 4 obstruction heights and > 30 m from large paved areas
				> 1 D for tower mast installations

A.3.3 Number of Monitors

US Consolidated Federal Regulations, Section 40, Part 58 (40CFR Part 58), Appendix D (US EPA, 2010) provides criteria for the basic air monitoring requirements, including the total number of monitoring sites that will serve specific data needs. EPA notes that the optimum size of a particular network involves trade-offs among data needs and available resources. The numbers of monitoring sites recommended in

Appendix D are based on population levels and contaminant being monitored. The relevant study area for the GGM Hardrock Project would cover the Municipality of Greenstone, which has a population of 4,636 (2006 census data). The contaminants considered in 40CFR Part 58, App D relevant to the Project is PM_{10}. For PM_{10} no more than two monitoring stations are required for low population urban areas (100,000-250,000), with no monitoring specified for populations less than 100,000.

Other considerations in setting the number of monitoring stations would be the presence of potentially health-sensitive receptors within the scales of representativeness identified in Section A3.1 (100's of metres to 4 km). The nearest hospital to GGM is located about 5.3 km from the centre of the pit to the north in the Town of Geraldton and outside the siting area of consideration. The nearest daycare centre identified in the EA is located about 5.2 km to the north, also outside of the siting area of interest. The nearest of three identified schools is located about 5.1 km from the site to north in Geraldton. All schools are located outside of the siting area of interest. As all these receptors are outside the siting area of consideration, monitoring at these locations would not be expected to provide useful information.

Further discussion on the number of monitoring stations is provided in Section A4.3.

A.4 CONTAMINANTS AND LOCATIONS FOR MONITORING

A.4.1 Contaminants to be Monitored

The main contaminant associated with mining activities is dust (particulate), which includes total suspended particulate matter (TSP), particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). TSP is a measure of the particles in the atmosphere that are too small to settle out quickly but remain suspended for significant periods of time. Generally, this means particles with an aerodynamic diameter of less than 44 µm. Although TSP is an excellent measure of the loading of particulate matter in the air, it does not necessarily reflect the health risks of particulate matter. Inhalable particulates (aerodynamic particles in the PM_{10} range) are trapped by the upper airways, and do not enter the lungs, while respirable particulates ($PM_{2.5}$) can make their way deep into the lungs and may become lodged there.

Other aspects related to the effects of dust generated by mining activities on human health derive from its chemical composition. Dust may contain metals such as arsenic, cadmium, cobalt, lead, manganese, nickel, vanadium, or zinc. The composition and relative concentrations of metals in dust/particulate will depend on its source (ore, waste rock, overburden, etc.).

The AQMMP focuses on the main contaminant of concern from mining activities, which is particulate matter. Dust generated at the site has not been identified as having contaminant levels that would cause health or environmental impacts or have a detrimental impact on flora or fauna near the Project. Minimization of Project particulate emissions will inherently reduce the impact of metals emissions in the surrounding area.

The monitoring program will be conducted to measure off property ambient air concentrations of the following contaminants:

- TSP
- PM_{10}
- $PM_{2.5}$
- Dustfall
- Metals in TSP
- Metals in Dustfall
- Nitrogen dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Benzene
- Benzo(a)pyrene (B(a)P)

Metals in dustfall are included in the monitoring program to address Indigenous community concerns. NO_2, $PM_{2.5}$, benzene and B(a)P are included to address Condition 5.3 of the Federal EA approval. SO_2 is included as it was identified during review to be required by the MECP. The following contaminants are not included in the ambient monitoring assessment based on the results of the Air Quality Technical Data Report (Stantec, 2017):

- Other criteria air contaminants –CO. The maximum predicted CO concentrations outside the modelled property boundary of this parameter were all below their assessed criteria.
- Volatile Organic Compounds (VOCs)/Polycyclic Aromatic Hydrocarbons (PAHs) other than benzene and benzo(a)pyrene. The maximum predicted concentrations outside the modelled property boundary of these parameters were all below their applicable criteria.

A.4.2 Monitoring Locations

Ambient air monitoring for TSP and metals, PM_{10}, $PM_{2.5}$, NO_2, benzene, B(a)P and dustfall will be conducted at three sites near the Hardrock Project property. The selected downwind locations take into account the following specific considerations:

- The dominant wind directions that could result in plume transport to nearby residential receptors are blowing from westerly to southerly directions, with northwesterly winds also frequent

- The monitor(s) should be situated to capture middle to neighbourhood scales of representativeness (hundreds of metres to 4 km)
- The dispersion modelling predicted that higher concentrations would occur near the Project
- Most of the residences are located north of the Site in the town of Geraldton. Locating a monitor in the Rosedale Point neighbourhood (closer to the Project than Geraldton) will be protective of air quality in Geraldton and in TLRU locations in northerly directions from the Project
- Locating a monitor near the west edge of Macleod Provincial Park will be protective of air quality in the park and east of the park, including TLRU locations in easterly directions from the Project

These selected sites will be:

- Station A (Upwind) - a site located in a predominantly upwind location from the Project (west of the TMF). The proposed site for this station is at the intersection of a hydro right of way and the TransCanada Highway to the east of Longacre Lake. Power for this station could be taken from a nearby power line/hydro pole.
- Station B (Downwind) – located in a downwind direction in the vicinity of the nearest residential area (the Rosedale Point neighborhood). The proposed site for this station is near the intersection of Michael Power Blvd and Old Arena Road in an open field. Power for this station could be taken from a nearby power line/hydro pole. The meteorological tower is also proposed to be installed at this location.
- Station C (Downwind) - located in a predominantly downwind direction near Macleod Provincial Park, which contains campgrounds and is considered sensitive to air quality. Two potential locations for this station have been identified. The first location (identified as Station C-1) is located near the entrance gate to the park. The second (Station C-2) is located within the park in an open area on the lake shore. Power for these locations could be taken from nearby power lines.

The approximate locations of the stations are shown in Figure A-10 and comparisons to the siting criteria are presented in Table A.4-1. Photos showing the approximate locations of Stations A, B and C-1 are presented in Figures A-11 to A-13.

The locations of the stations were determined considering the availability of power and the MECP siting requirements outlined in Table A.3-1. Station A is in an area where maximum TSP and PM_{10} concentrations are predicted to be low and winds blow from the Hardrock site towards this station infrequently. The siting for this station is not ideal with regards to unrestricted air flow; however, this should not be a serious issue for a monitoring station measuring background air quality and not sited to measure any specific emissions sources. The upwind area is mainly forested and open locations with power availability are limited. Stations B and C-1/C-2 are in areas where elevated TSP and PM_{10} concentrations are predicted by

the dispersion modelling as well as being in proximity to nearby residential areas. These locations are expected to meet the siting criteria presented in Table A.3-1.

These proposed locations will be used for the monitoring sites dependent on review and approval by the MECP and successful negotiations with the property owners. GGM will consult with Ontario Parks on the exact location of the monitor in MacLeod Provincial Park and understands that a research permit authorization from Ontario Parks will be required.

Dustfall and metals in dustfall measurements will be conducted at five additional locations:

- Station D – a site near a traditional land resource use (TLRU) area (receptor TLRU-16 in the Air Quality Technical Data Report(Stantec, 2017)). This location had the highest predicted total annual PM deposition of all the TLRU receptors modelled. The monitoring location is on the south shoreline of Kenogamisis Lake (South Arm) southeast of WRSA D. This location is accessible via boat only (no road access).

- Station E - along the south-east Project boundary to identify maximum downwind impacts. The proposed location is south-east of the Hardrock No. 1 Shaft on the isthmus extending into Kenogamisis Lake. The location is in the vicinity of the maximum predicted 24-hour average modelled property line TSP concentration during operation.

- Station F - within the Town of Geraldton to quantify dustfall in a populated area unaffected by dustfall from the Hardrock Project.

- Station G - north of the new Highway 11 alignment, near the southwest shore of Barton Bay (East) and on the location of the Historical Macleod Low tailings. The location is included to quantify dust fall levels over Barton Bay East due to emissions from the overburden storage area, open pit, WRSA C and the process plant. The station addresses Indigenous community concerns regarding dust fall onto Barton Bay for frequent southwesterly to southerly winds (see wind rose in Figure A-5).

- Station H - along the northwest shore of Kenogamisis Lake east of the TMF and south of the WRSA D contingency area. The location is included to quantify dust fall impacts onto the southwest arm of Kenogamisis Lake due to emissions from the TMF, Overburden Storage Area 2 and WRSA D. The station addresses Indigenous community concerns regarding dust fall onto Kenogamisis Lake for frequent southwesterly to northerly winds (see wind rose in Figure A-5).

The general locations for the proposed monitoring sites are presented in Table A.4-1.

The number and type of monitoring locations proposed in this AMP is commensurate with the scale of the Hardrock Project operations, the level of monitoring at other mine sites in Ontario and with consideration of the proximity of the Project to populated areas.

If repeated exceedances of a MECP AAQC are measured, the monitoring program may be changed to add monitoring at other stations. Any changes to the monitoring program will be discussed with the MECP and the Environmental Advisory Committees prior to implementation.

A summary of how the proposed ambient monitoring locations will meet the probe siting criteria for middle to neighbourhood scale ambient monitoring objectives is presented in Table A.4-2.

Table A.4-1: Proposed Monitoring Locations

Monitoring Location	Parameters Measured	UTM Zone	Easting (m)	Northing (m)	Predominantly Upwind (U) or Downwind (D)	Rationale for Location
A	PM_{10}/$PM_{2.5}$/TSP, metals/Dustfall, Benzene, and B(a)P	16 U	498485	5503647	U	Predominantly upwind station – located to the west of the TMF.
B	PM_{10}/$PM_{2.5}$/TSP, metals/Dustfall, NO_2, SO_2, Benzene, and B(a)P	16 U	503253	5504870	D	Predominantly downwind station located in the vicinity of the nearest residential area to the Project – the Rosedale neighborhood. This location will also provide a conservative estimate of exposure in the Town of Geraldton which is further removed from the Project.
C-1	PM_{10}/$PM_{2.5}$/TSP, metals/Dustfall, Benzene, and B(a)P	16 U	507095	5504201	D	Predominantly downwind station located near MacLeod Provincial Park. This location will also provide a conservative estimate of exposure at properties to the east of the park.
Or C-2	PM_{10}/$PM_{2.5}$/TSP, metals/Dustfall, Benzene, and B(a)P	16 U	507687	5503563		
D	Dustfall/metals	16 U	503483	5499354	D	Located in a predominantly downwind location, in the vicinity of the nearest Traditional Land and Resource use to the Project.
E	Dustfall/metals	16 U	505995	5502654	D	Located in a predominantly downwind location on the isthmus south-east of the Hardrock No. 1 Shaft along the south-west Project boundary, to capture off-property dustfall levels.
F	Dustfall/metals	16 U	503150	5505527	D	Located in a predominantly downwind location at the southern edge of the Town of Geraldton to provide an indication of dustfall levels in a populated area further away from the Project and estimate dustfall gradient with respect to dustfall at Station B.

Table A.4-1: Proposed Monitoring Locations

Monitoring Location	Parameters Measured	UTM Zone	Easting (m)	Northing (m)	Predominantly Upwind (U) or Downwind (D)	Rationale for Location
G	Dustfall/metals	16 U	504778	5504182	D	Quantifies dust fall levels over Barton Bay East due to emissions from the overburden storage area, open pit, WRSA C and the process plant
H	Dustfall/metals	16 U	501941	5499137	D	Quantifies dust fall impacts onto the southwest arm of Kenogamisis Lake due to emissions from the TMF, Overburden Storage Area 2 and WRSA D.

Table A.4-2: Comparison of Proposed Monitoring Locations to Probe Siting Criteria

Contaminant	MECP Spacing Criteria	Proposed Monitoring Station Location								
		A	B	C-1	C-2	D	E	F	G	H
TSP	a. 2 to 15 m above ground	>2	>2	>2	>2	-	-	-	-	-
	b. > 1 m vertically from support structure	>1	>1	>1	>1	-	-	-	-	-
	c. > 2 m horizontally from support structure	>2	>2	>2	>2	-	-	-	-	-
	d. Greater than 20 metres from trees	>20	>30	≥20	>50	-	-	-	-	-
	e. Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler	>2	>2	>2	>2	-	-	-	-	-
	f. Airflow must be unrestricted through an arc of at least 270 degrees	180	360	360	360	-	-	-	-	-
	g. No nearby furnace or incineration flues	N	N	N	N	-	-	-	-	-
	h. Distance from sampler to roadway > 20-25 m for sampler inlet heights of 2-5 m	10-15	15-20	>20	>20	-	-	-	-	-
Dustfall	a. 3 m above ground	3	3	3	3	3	3	3	3	3
	b. No nearby unpaved roadways, parking lots (separation distance depends on monitoring objectives)	N	N	N	N	N	N	N	N	N
	c. Greater than 20 meters from obstacles (buildings, trees, terrain features)	>20	>30	≥20	>50	>40	>75	>100	>60	>100
	d. Unrestricted air flow in 3 of the 4 wind quadrants	2 of 4	4 of 4	4 of 4	4 of 4	3 of 4	4 of 4	4 of 4	4 or 4	4 of 4
	e. No nearby chimneys or flues that could emit coarse particulate (soot/coal)	N	N	N	N	N	N	N	N	N
	f. Avoid building wake wind effects from rooftop installations	N/A	N/A	N/A	Y	N/A	N/A	N/A	N/A	N/A

Table A.4-2: Comparison of Proposed Monitoring Locations to Probe Siting Criteria

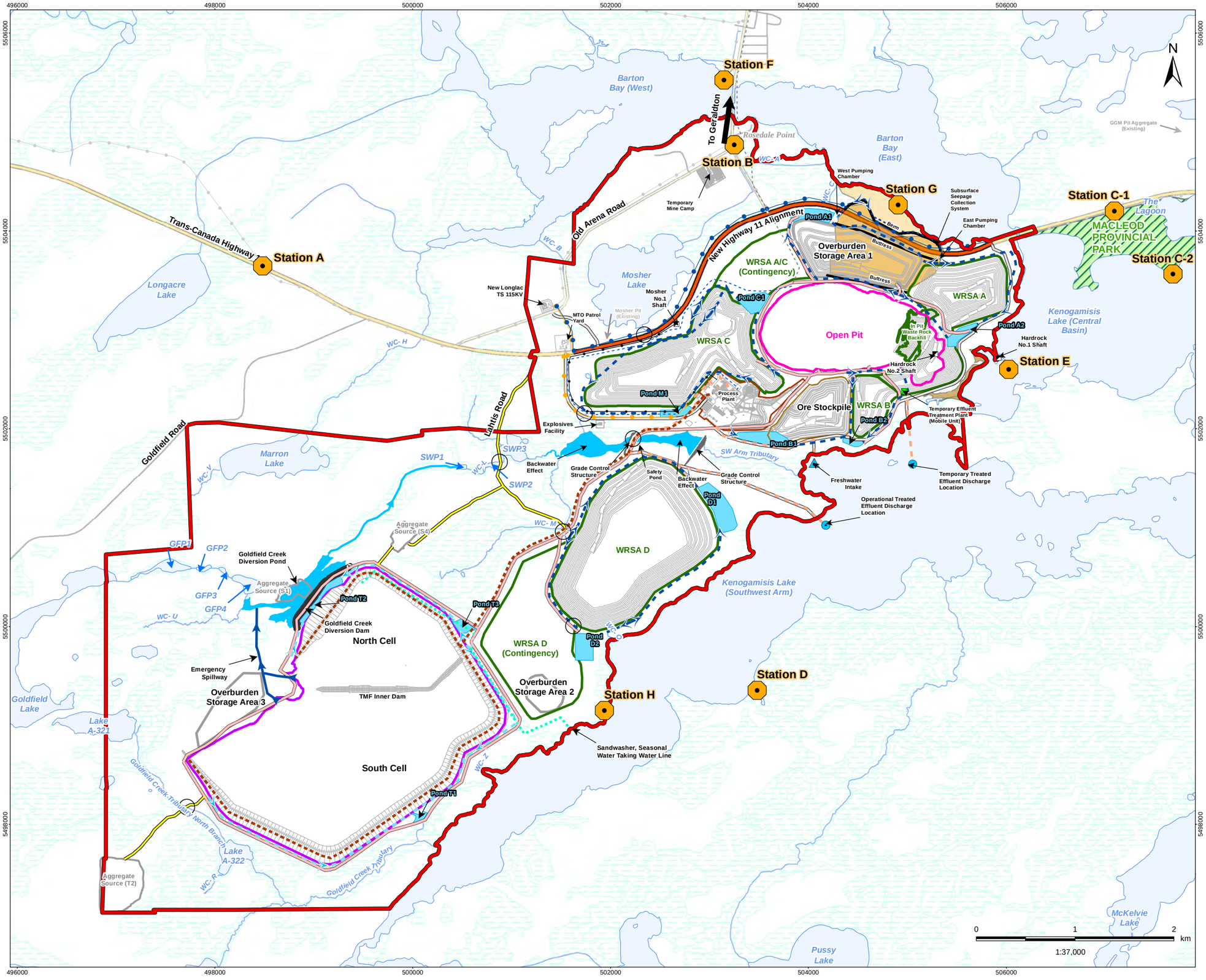
Contaminant	MECP Spacing Criteria	Proposed Monitoring Station Location								
		A	B	C-1	C-2	D	E	F	G	H
PM_{10}	a. 2 to 15 m above ground	>2	>2	>2	>2	-	-	-	-	-
	b. > 1 m vertically from support structure	>1	>1	>1	>1	-	-	-	-	-
	c. > 2 m horizontally from support structure	>2	>2	>2	>2	-	-	-	-	-
	d. Greater than 20 metres from trees	>20	>30	≥20	>50	-	-	-	-	-
	e. Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler	>2	>2	>2	>2	-	-	-	-	-
	f. Unrestricted air flow in 3 of the 4 wind quadrants	2 of 4	4 of 4	4 of 4	4 of 4	-	-	-	-	-
	g. > 5 m from chimneys with natural gas combustion emissions	>5	>5	>5	>5	-	-	-	-	-
	h. > 20 - 25 metres from major roadways	N/A [1]	N/A	N/A	N/A	-	-	-	-	-
$PM_{2.5}$	a. 2 to 15 m above ground	>2	>2	>2	>2	-	-	-	-	-
	b. > 1 m vertically from support structure	>1	>1	>1	>1	-	-	-	-	-
	c. > 2 m horizontally from support structure	>2	>2	>2	>2	-	-	-	-	-
	d. Greater than 20 metres from trees	>20	>30	≥20	>50	-	-	-	-	-
	e. Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler	>2	>2	>2	>2	-	-	-	-	-
	f. Airflow must be unrestricted through an arc of at least 270 degrees	180	360	360	360	-	-	-	-	-
	g. No nearby furnace or incineration flues	N	N	N	N	-	-	-	-	-
	h. Distance from sampler to roadway > 25 m	10-15	15-20	>20	>20	-	-	-	-	-
PAH	a. 3 to 15 m above ground	>3	>3	>3	>3	-	-	-	-	-

Table A.4-2: Comparison of Proposed Monitoring Locations to Probe Siting Criteria

Contaminant	MECP Spacing Criteria	Proposed Monitoring Station Location								
		A	B	C-1	C-2	D	E	F	G	H
	b. > 1 m vertically from support structure	>1	>1	>1	>1	-	-	-	-	-
	c. > 2 m horizontally from support structure	>2	>2	>2	>2	-	-	-	-	-
	d. Sampler Inlet > 5 m from nearest natural gas combustion source.	>100	>100	>100	>100	-	-	-	-	-
	e. Greater than 20 metres from trees	>20	>30	≥20	>50	-	-	-	-	-
	f. Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler	>2	>2	>2	>2	-	-	-	-	-
	g. Airflow must be unrestricted through an arc of at least 270 degrees	180	360	360	360	-	-	-	-	-
	h. No nearby furnace or incineration flues	N	N	N	N	-	-	-	-	-
	i. Distance from sampler to roadway > 25 m	10-15	15-20	>20	>20	-	-	-	-	-
	j. Sampler Inlet > 5 m from nearest natural gas combustion source.	>100	>100	>100	>100	-	-	-	-	-
NO_2	a. 3 to 15 m above ground		≥3			-	-	-	-	-
	b. > 1 m vertically from support structure		>1			-	-	-	-	-
	c. > 1 m horizontally from support structure		>2			-	-	-	-	-
	d. > 20 m from trees		>30			-	-	-	-	-
	e. >10 m from street intersection		>10			-	-	-	-	-
	f. 2 – 10 m from roadways		15-20			-	-	-	-	-
SO_2	a. 3 to 15 m above ground	-	≥3	-	-	-	-	-	-	-
	b. > 1 m vertically from support structure	-	>1	-	-	-	-	-	-	-

Table A.4-2: Comparison of Proposed Monitoring Locations to Probe Siting Criteria

Contaminant	MECP Spacing Criteria	Proposed Monitoring Station Location								
		A	B	C-1	C-2	D	E	F	G	H
	b. > 1 m vertically from support structure	>1	>1	>1	>1	-	-	-	-	-
	c. > 2 m horizontally from support structure	>2	>2	>2	>2	-	-	-	-	-
	d. Sampler Inlet > 5 m from nearest natural gas combustion source.	>100	>100	>100	>100	-	-	-	-	-
	e. Greater than 20 metres from trees	>20	>30	≥20	>50	-	-	-	-	-
	f. Distance from sampler to air flow obstacle, i.e., buildings, terrain features, must be >2x height of obstacle above the sampler	>2	>2	>2	>2	-	-	-	-	-
	g. Airflow must be unrestricted through an arc of at least 270 degrees	180	360	360	360	-	-	-	-	-
	h. No nearby furnace or incineration flues	N	N	N	N	-	-	-	-	-
	i. Distance from sampler to roadway > 25 m	10-15	15-20	>20	>20	-	-	-	-	-
	j. Sampler Inlet > 5 m from nearest natural gas combustion source.	>100	>100	>100	>100	-	-	-	-	-
NO_2	a. 3 to 15 m above ground		≥3			-	-	-	-	-
	b. > 1 m vertically from support structure		>1			-	-	-	-	-
	c. > 1 m horizontally from support structure		>2			-	-	-	-	-
	d. > 20 m from trees		>30			-	-	-	-	-
	e. >10 m from street intersection		>10			-	-	-	-	-
	f. 2 – 10 m from roadways		15-20			-	-	-	-	-
SO_2	a. 3 to 15 m above ground	-	≥3	-	-	-	-	-	-	-
	b. > 1 m vertically from support structure	-	>1	-	-	-	-	-	-	-



Legend

- Proposed Monitoring Station Location
- Model Property Boundary

Preliminary Site Plan

- Discharge Location
- Existing Mine Shaft
- Freshwater Intake
- Temporary Effluent Treatment Plan
- Watercrossing
- Access Road
- Construction Access Road
- Diversion Channel
- Emergency Spillways
- Haul Road
- Potable Water Pipeline
- Pipeline (Intake and Discharge)
- 44 kV Distribution Line
- 12.5 kV Distribution Line
- 115 kV Transmission Line
- Seepage Collection Ditch
- Subsurface Seepage Collection System
- Contact Water Collection Ditch
- Tailings Pipeline and 13.8 kV Distribution Line
- Water Line
- Aggregate Source
- Collection Ponds
- Open Pit- Full Extent
- Ore Stockpile
- Process Plant Area
- Tailings Management Facility
- Waste Rock Storage Area

Highway Realignment

- New Highway 11 Alignment

Existing Features*

- Highway
- Major Road
- Local Road
- Existing Power Line
- Existing Potable Water Pipeline
- Watercourse
- Provincial Park
- Waterbody
- Wetland (Eco-Site Based)

Historical Tailings Areas

- Historical Hardrock Tailings
- Historical MacLeod High Tailings
- Historical MacLeod Low Tailings

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.
* Existing Features have been removed in the PDA and do not reflect current conditions.

February 2020
160961223

Client/Project

Greenstone Gold Mines GP Inc. (GGM)
Hardrock Project

Figure No.

A-10

Title

Proposed Monitoring Station Locations

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Revised: 2020-02-18 By: dharvey

Figure A-11: View of Approximate Location for Station A

Figure A-12: View of Approximate Location for Station B

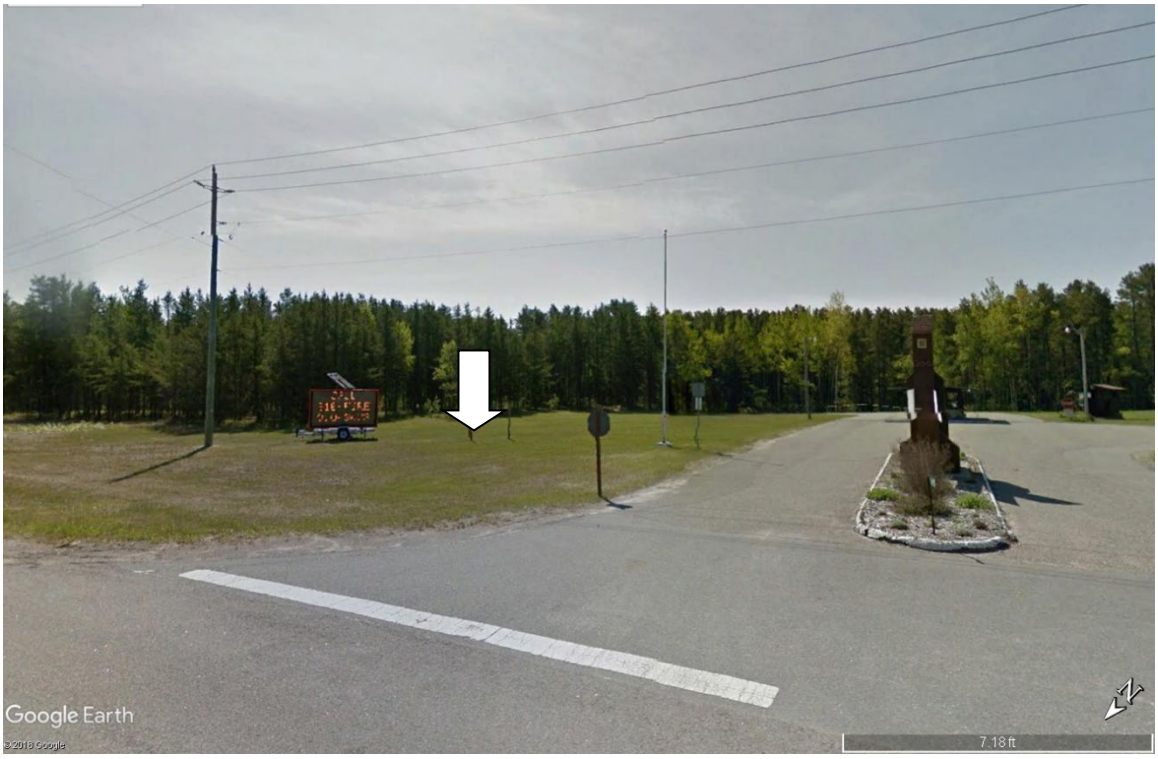


Figure A-13: View of Approximate Location for Station C-1

Figure A-14: View of Approximate Location for Station D

Figure A-15: View of Approximate Location for Station E

Figure A-16: View of Approximate Location for Station F

Figure A-17: View of Approximate Location for Station G

Figure A-18: View of Approximate Location for Station H

A.5 INSTRUMENTATION AND DATA ACQUISITION

The measurement program at selected monitoring sites will include continuous monitors for PM_{10} and meteorology and non-continuous monitors for TSP and metals, $PM_{2.5}$, NO_2, SO_2, Benzene, B(a)P and dustfall. Monitoring will be conducted per the methods and analysis recommended by the MECP Operations Manual (MECP, 2018). The following sections detail the continuous and non-continuous monitors proposed for the sampling program.

A.5.1 Continuous Ambient Monitors for Particulate Matter (PM_{10})

Each continuous PM_{10} sampler will consist of a Beta Attenuation Monitor (BAM) 1020 (or equivalent). The sampler uses beta ray attenuation to measure particulate concentrations.

Principle of Operation:	Beta Ray Attenuation
Range:	1 mg (1000 µg) default setting. Settable from 0.1 mg to 10 mg
Measurement Cycle Time:	1 hour

Each monitor will be contained in a heated/airconditioned enclosure and equipped with a cellular modem to allow remote downloading of the unit's memory on an hourly basis.

A.5.2 Continuous Ambient Monitor for Nitrogen Dioxide (NO_2)

The continuous NO_2 sampler will be a Thermo Scientific Model 42iQ NO-NO2-NOx analyzer or equivalent.

Principle of Operation:	Chemiluminescence
Range:	0 – 20 ppm default setting.
Measurement Cycle Time:	1 hour

The monitor will be contained in a heated/airconditioned enclosure and equipped with a cellular modem to allow remote downloading of the unit's memory on an hourly basis.

A.5.3 Continuous Ambient Monitor for Sulphur Dioxide (SO_2)

The continuous SO_2 sampler will be a Thermo Scientific Model 43iQ SO_2 analyzer or equivalent.

Principle of Operation:	Pulsed Fluorescence
Range:	0 – 100 ppm default setting.
Measurement Cycle Time:	1 hour

The monitor will be contained in a heated/airconditioned enclosure and equipped with a cellular modem to allow remote downloading of the unit's memory on an hourly basis.

A.5.4 Non-Continuous Ambient Monitors

Total Suspended Particulates (TSP) and Metals

Total suspended particulate matter (TSP) will be collected onto pre-weighed, conditioned Teflon coated glass fibre filters for a 24-hour period using a Tisch Environmental TE-5170 volumetric-flow high volume sampler (or equivalent) measuring TSP. This monitor operates by continuously drawing a sample of ambient air through a filter onto which particulate matter is deposited. The filters will be subsequently weighed for particulate loading and analysed using the Atomic Emission Spectroscopy/Inductively Coupled Plasma (AES/ICP) technique to determine metals content. Analysis of the TSP/metals samples will be conducted by a Canadian Assurance for Laboratory Accreditation (CALA) accredited laboratory following MECP guidance. The sampling schedule will correspond with the MECP's province-wide ambient sampling schedule (one sample taken every six days).

The list of metals to be analysed is: Aluminum (Al), Cadmium (Cd), Phosphorus (Ph), Antimony (Sb), Chromium (Cr) (Total), Selenium (Se), Boron (B), Cobalt (Co), Silver (Ag), Thallium (Tl), Lead (Pb), Tin (Sn), Arsenic (As), Vanadium (V), Barium (Ba), Manganese (Mn), Zinc (Zn), Beryllium (Be), Nickel (Ni), Bismuth (Bi), Zirconium (Zr), Magnesium (Mg), Copper (Cu), Strontium (Sr), Iron (Fe), Thallium (Tl), Molybdenum (Mo), Uranium (U), Titanium (Ti).

Dustfall

Dustfall will be measured using standard dustfall jars - open-topped cylinders 18.5 inches in height and 6 inches in diameter. The Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter, ASTM D1739-98) will be employed to conduct the sampling and analysis procedures. The dustfall jars will be supported at a height of approximately 3 m above ground level. The duration of each dustfall sample collection period will be 30 days ± 3 days with sample changeover occurring as close as possible to the beginning of each month. The same list of metals as for TSP sampling will be analyzed.

$PM_{2.5}$

$PM_{2.5}$ will be collected onto pre-weighed, conditioned 47-mm Teflon filters for a 24-hour period using a BGI- PQ200 sampler (or equivalent) measuring $PM_{2.5}$. This monitor operates by continuously drawing a sample of ambient air through a cyclone (that allows only $PM_{2.5}$ to pass) and then through a filter onto which the $PM_{2.5}$ is deposited. The filters will be subsequently weighed for particulate loading by a Canadian Assurance for Laboratory Accreditation (CALA) accredited laboratory following MECP guidance. The sampling schedule will overlap with the MECP's province-wide ambient sampling schedule with one sample taken every 30 days.

Benzene

Benzene will be measured using passive samplers such as the SKC EPA 325 Passive TD Tube for benzene (or equivalent). Passive sampling relies on the unassisted molecular diffusion of gaseous agents through a diffusive surface onto an adsorbent. After sampling, the adsorbed analytes are desorbed off the adsorbent by solvent or thermal desorption. Passive sampling will be conducted following manufacturers specifications and MECP guidance. Samples will be collected on a monthly basis with sample times ranging from 24-hours to 30-days depending on sampler sensitivity and ambient levels of each contaminant.

Benzo(a)Pyrene

B(a)P will be collected with Tisch Environmental TE-1000 mass-flow high volume air samplers (or equivalent). The samplers will be located on the roof of the instrumentation shelters to meet the required MECP siting characteristics. Each sampler is equipped with a dual chambered sampling module to contain a Teflon-coated glass fibre filter and a Poly-Urethane Foam (PUF) cartridge. B(a)P will be collected for a 24-hour period at 30-day intervals.

The samples will be submitted to a CALA accredited laboratory. B(a)P will be analyzed using Gas Chromatography/Mass Spectrometry (GC/MS) as per the protocols defined by US EPA Compendium Method TO-13A.

A.5.5 Meteorological Tower

GGM will operate a meteorological tower at Station B. The tower instrumentation will measure horizontal wind speed, wind direction, ambient temperature, relative humidity, barometric pressure, and rainfall. The meteorological sensors will be mounted on a tower. The proposed meteorological equipment will be:

- Wind Speed/Wind Direction: R.M. Young 05305-L (or equivalent)
- Temperature: Campbell Scientific Model 107 (or equivalent)
- Relative Humidity: Campbell Scientific Model HMP60 (or equivalent)
- Atmospheric Pressure: Campbell Scientific Model CS106 (or equivalent)
- Rainfall: R.M. Young 52202-L (or equivalent)
- Data Logger Campbell Scientific CR-300 (or equivalent)

A.6 LABORATORY ANALYTICAL PROCEDURES

Samples will be obtained and analyzed following US EPA reference or equivalent methods, as per the MECP Operations Manual (MECP, 2018). The contaminants to be assessed by laboratory analytical procedures and their laboratory reference methods are listed in Table A.6-1.

Table A.6-1: Summary of Laboratory Reference Methods

Contaminant	Laboratory Reference Method
Total Suspended Particulate (TSP)	US EPA Manual Reference Method: 40 CFR Part 50, Appendix B
Dustfall	Settleable Particulate Matter, ASTM D1739-98
Metals	Compendium Method IO-3 with Atomic Emission Spectroscopy/Inductively Coupled Plasma (AES/ICP)
Benzo(a)pyrene	Gas Chromatography/Mass Spectrometry (GC/MS) following US EPA Method TO-13A
Benzene	Manufacturer Specifications
$PM_{2.5}$	US EPA Manual Reference Method: 40 CFR Part 50, Appendix B

Samples will be sent to a Canadian Association for Laboratory Accreditation (CALA) certified laboratory for analysis.

A.7 QUALITY ASSURANCE PROCEDURES

A.7.1 Operator Requirements

Appropriate training will be provided to employees supporting the AMP, commensurate with their duties, such as the technicians operating the ambient sampling equipment, etc. Such training may consist of classroom lectures, workshops, teleconferences or on-the- job training.

The operation and maintenance of the monitoring program will include the following general provisions:

- Field activities will be recorded in standardized field notes. Hi-vol data sheets will include initial and flow measurements for each sample
- Chain of custody forms will be completed and submitted along with exposed samples to the CALA laboratory used for analysis
- Original containers will be used when submitting filters for analysis to avoid cross- contamination of samples, which will be recorded in the chain of custody forms
- Training records for personnel involved in the project will be maintained

A.7.2 Instrumentation Calibration and Maintenance

Samplers will be bench-tested and calibrated prior to their installation in the field. If required, the samplers will be re-calibrated once installed, before their first use. On-going calibration of the samplers will follow the recommended calibration schedule listed in the MECP Operations Manual (MECP, 2018). Equipment maintenance will be carried out following the manufacturer recommended schedule.

A.8 Accuracy Checks for Analysis Techniques

Travel and field blank samples will be submitted to the CALA accredited laboratory to confirm the accuracy of the analytical techniques used for TSP/metals/$PM_{2.5}$ / Benzene and B(a)P sampling. Blank samples will account for about ten percent (10%) of total submitted samples.

A.8.1 Sample Collection and Transportation

Samples will be properly handled such that there is no contamination. For filters, this entails the use of surgical gloves to avoid contamination. Samples will be carefully removed from the monitoring device by a trained operator, and placed in sealed, non-reactive containers. Filters will be placed in a folder and envelope, while dustfall containers will be placed in cases for protection from breakage, contamination, or loss during transportation.

Quality records for sample collection will be maintained. The quality record will include at least the following parameters:

- Station ID
- Station name/location
- Filter/canister/sampler ID
- Sample start date/time
- Sample end date/time or elapsed time
- Date/time sample collected
- Technician name
- Meteorological conditions during sampling
- Comments on visual examination of filters/canisters prior to and after sampling

A.9 Data Review and Validation

Data collected from the continuous and non-continuous monitors will be screened for suspicious data including outliers, instrumentation drift and missing data following MECP protocols given in the MECP Operations Manual (MECP, 2018). In general, the Operations Manual states that at a minimum, the required rate of recovery of valid data for both continuous non-continuous monitors is 75% (both seasonally and annually), with target recovery rates of greater than 90%.

A.10 REAL TIME DUST MONITORING

An automated software system will be used to download the most recent hourly and rolling 24-hour average PM_{10} data from the continuous PM_{10} monitors on an hourly basis. Current weather data (including wind speed, wind direction and relative humidity) from the meteorological tower will also be downloaded at hourly intervals. These data will be made available to appropriate GGM personnel for use in proactively assessing the efficiency of dust mitigation measures currently being employed and the need for additional measures to be implemented.

Protocols for adaptive management based on the real time dust monitoring are discussed in the fugitive dust best management plan (Appendix B, Section 8).

A.11 REPORTING REQUIREMENTS

Both quarterly and annual reports will be generated that include the results of the ambient monitoring program. The quarterly reports will follow a standardized format and will include the following statistical information as required by the MECP (MECP, 2018):

- For Continuous Monitors:
    - Arithmetic Mean
    - Monthly Arithmetic Mean
    - Maximum for averaging period used for comparison to statutory or regulatory limits
    - Maximum 24-hour, or another averaging period as appropriate
    - Percentage of valid hours
- For Non-Continuous Monitors:
    - Number of valid samples
    - Percentage of valid data

- Period arithmetic mean
- Period geometric mean (TSP only)
- Maximum 24-hour value
- Maximum monthly value
- Sampling dates (start and end)

In addition, should a validated exceedance of O.Reg.419/05 criteria occur, it will be reported as per Section 28(b) of O. Reg. 419/05. For quarterly report submissions, continuous and non-continuous data will be submitted electronically (Excel format) with the report. Edit logs for continuous and non-continuous monitors will be provided in the quarterly reports.

Annual reports will follow a similar format to the quarterly reports and will include both a summary and analysis of the AMP of the previous year. In addition to the required sections as detailed for the quarterly report, the annual report will include the following:

- A map showing the location of emitting sources, property boundaries, major structures on site and monitoring stations. Also included on the map will be a distance scale, north arrow and marked locations of nearby significant receptors
- A summary of overall operations, e.g., summary of parameters monitored and equipment/model numbers, frequency of site visits and calibrations, confirmation of data backups and/or archiving, list of problems that resulted in significant losses of data along with remedial actions
- A summary of audits and audit outcomes
- Summary statistics, including:
    - Annual arithmetic mean
    - Annual geometric mean (TSP only)
    - Maximum 1-hour concentration (continuous data only)
    - Maximum 24-hour concentration
    - Number of valid hours or sampling periods
    - Percent of valid data
- A summary of exceedances of O.Reg.419/05 or other applicable criteria for each applicable averaging period and the number of times exceedances occurred

- An analysis of exceedances evaluated by wind speed/direction data for source contribution assessment
- A comparison to historical data collected at the monitoring station.
- Further requirements for both the quarterly and annual reports can be found in the MECP Operations Manual (MECP, 2018)

The quarterly and annual reports and data collected from the monitoring program will be made available to the MECP per the requirements of the MECP Operations Manual (MECP, 2018). GGM will make the monitoring data, quarterly and annual reports accessible to the public upon request in a timely manner.

A.12 REFERENCES

Ontario Ministry of the Environment, Conservations and Parks (MECP). (2018). Operations Manual for Air Quality Monitoring in Ontario, Operations Division, Technical Support Section, 2018, PIBS 6687e

Ontario Ministry of the Environment, Conservations and Parks (MECP). (2019). Environmental Assessment Act, Section 9, Notice of Approval to Proceed with the Undertaking, Greenstone Gold Mines, EA-02-10

US Consolidated Federal Regulations, Section 40, Part 58 (40CFR Part 58). Title 40: Protection of Environment, Part 58-Ambient Air Quality Surveillance, Subpart G-Federal Monitoring Appendix E to Part 58 – Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

Stantec Consulting Ltd. (Stantec). 2017. Technical Data Report – Hardrock Project: Atmospheric Environment. Prepared by Stantec Consulting Ltd.

APPENDIX B:
OPERATION BEST MANAGEMENT PLAN (BMP) FOR FUGITIVE DUST

Appendix B Operation Best Management Plan (BMP) For Fugitive Dust

B.1 Introduction

B.1.1 Report Contents

This best management plan (BMP) for fugitive dust was prepared by Stantec Consulting Limited on behalf of Greenstone Gold Mines GP Inc. (GGM, the Proponent) for their proposed Hardrock Project (the Project). The Project components include an open pit, ore processing facilities including crushing plants and an ore milling and processing plant, waste rock storage areas (WRSAs), tailings management facility (TMF), natural gas-fueled power plant, and other associated buildings and processes.

This BMP meets Ontario Ministry of the Environment, Conservation and Parks (MECP) requirements (as specified in MECP guideline document Procedure for Preparing an Emission Summary and Dispersion Modelling Report ver. 4.0, Appendix F (MECP 2018), which at a minimum are:

- Identification of the sources of fugitive dust emissions within the facility
- Review of the composition and size range of the fugitive dust
- Description of how fugitive dust will be controlled from each identified source
- A schedule by which the plan will be implemented
- Description of how the plan will be implemented, including training of facility personnel
- Description of inspection and maintenance procedures
- Description of methods of monitoring and record keeping verifying compliance with the plan

B.1.2 Project Description

The Project is in northern Ontario, approximately 275 kilometres (km) northeast of Thunder Bay, in the Municipality of Greenstone, Ward of Geraldton. The centroid coordinates of the proposed open pit are UTM- Easting, 504405, Northing 5502930 (NAD 83, UTM Zone 16 U). A site plan showing the layout of the Project site is presented in Figure 1.

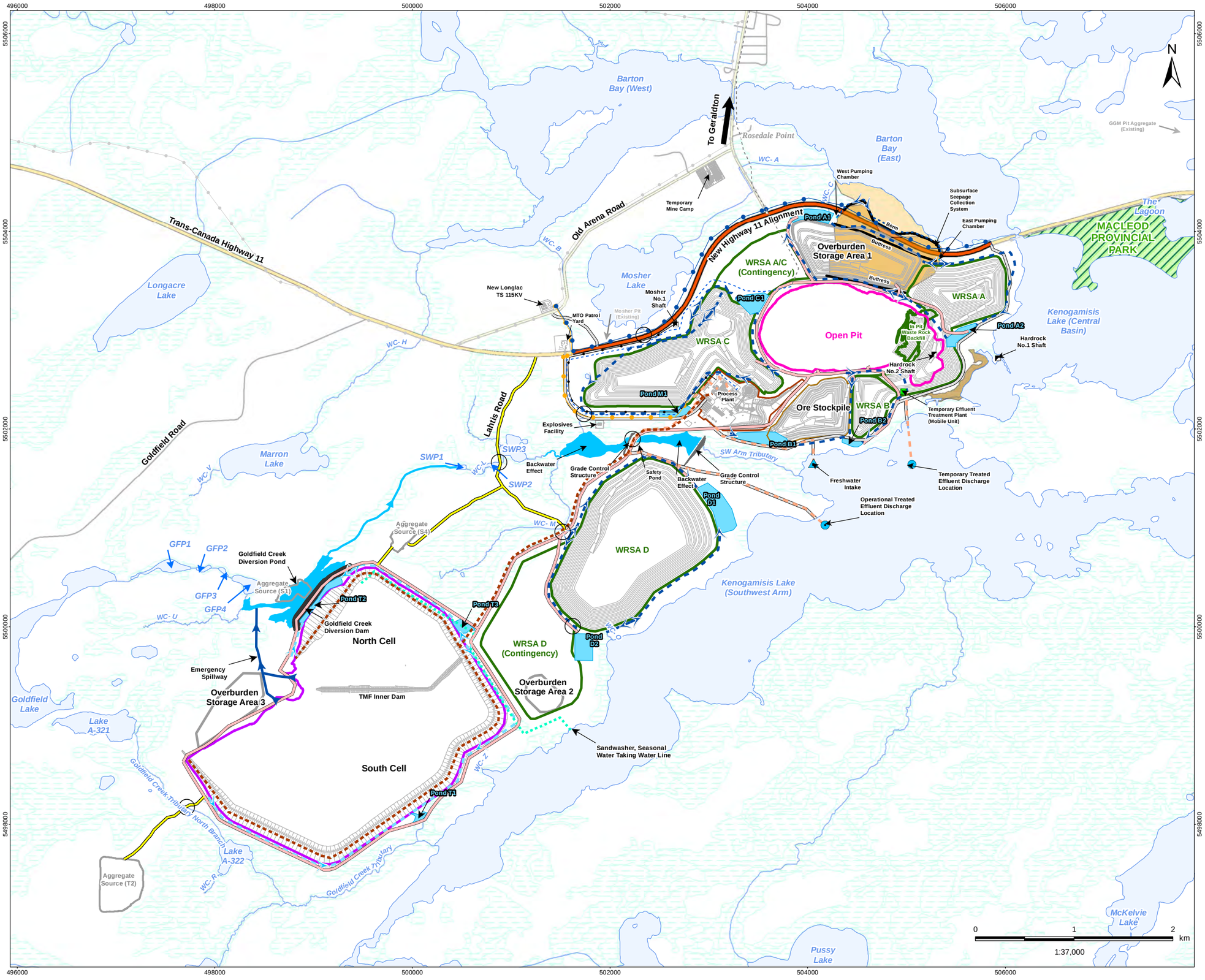
Key mine components of the Project development area include an open pit, waste rock storage areas, ore and overburden stockpiles, ore crushing and mill feed storage activities, ore milling and processing plant, water management facilities, tailings management facility, power plant and associated infrastructure and explosives manufacturing plant and storage. Ancillary mine infrastructure includes mine operation buildings, service water supply and associated infrastructure, sewage and effluent treatment facilities,

mine site roads, watercourse crossings, realignments, and habitat compensation/offsets, onsite pipelines and piping, hazard materials storage, aggregate sources, and temporary camp.

Key project activities associated with the operational phase as they pertain to the atmospheric environment are described below:

The operation phase includes the following activities:

- Operation of the open pit mine, which will include drilling, blasting, loading of ore and waste rock, and additional overburden stripping until the full extent of the open pit at surface is exposed
- Management of contaminated soils/overburden in accordance with the Soils Management Plan
- Relocation of portions of the historical MacLeod tailings to the new TMF, including historical tailings temporarily stored in the open pit
- Hauling of ore to the milling and processing plant and waste rock to the WRSAs
- Ore processing which includes crushing and milling
- Tailings management, operation of the water management facilities, and onsite power generation



Stantec

Legend

Preliminary Site Plan

- Discharge Location
- Existing Mine Shaft
- Freshwater Intake
- Temporary Effluent Treatment Plan
- Watercrossing
- Access Road
- Construction Access Road
- Diversion Channel
- Emergency Spillways
- Haul Road
- Potable Water Pipeline
- Pipeline (Intake and Discharge)
- 44 kV Distribution Line
- 12.5 kV Distribution Line
- 115 kV Transmission Line
- Seepage Collection Ditch
- Subsurface Seepage Collection System
- Contact Water Collection Ditch
- Tailings Pipeline and 13.8 kV Distribution Line
- Water Line
- Aggregate Source
- Collection Ponds
- Open Pit- Full Extent
- Ore Stockpile
- Process Plant Area
- Tailings Management Facility
- Waste Rock Storage Area

Highway Realignment

- New Highway 11 Alignment

Existing Features*

- Highway
- Major Road
- Local Road
- Existing Power Line
- Existing Potable Water Pipeline
- Watercourse
- Provincial Park
- Waterbody
- Wetland (Eco-Site Based)

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- Historical Hardrock Tailings
- Historical MacLeod High Tailings
- Historical MacLeod Low Tailings

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2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

* Existing Features have been removed in the PDA and do not reflect current conditions.

July 2019
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HP-MG003-EV-217-0001_0

Client/Project

Greenstone Gold Mines GP Inc. (GGM)
Hardrock Project

Figure No.
1-2

Title

Optimized Site Plan (Current as of May 2019)

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Revised: 2019-07-31 By: dharvey

B.2 Source Identification

B.2.1 Fugitive Dust - Composition

The composition of the fugitive dust is expected to be the same at that of the ore, waste rock or overburden excavated at the site. A summary of the metals content of these sources is presented in Table B.2-1.

Table B.2-1: Summary of Fugitive Dust Composition

Metal	Composition (Weight %)			
	Ore	Waste Rock (Average of 7 lithologies)	Overburden	Tailings
Ag	3.2E-05	2.1E-05	3.1E-04	2.4E-05
Al	1.3E+00	1.8E+00	4.5E+00	5.3E+00
As	6.6E-02	1.0E-02	9.6E-03	9.5E-02
Ba	1.0E-02	1.1E-02	4.1E-02	4.1E-02
Be	5.1E-05	5.1E-05	8.3E-05	1.0E-04
Bi	2.3E-04	2.4E-04	5.3E-06	1.5E-05
Ca	2.8E+00	2.4E+00	6.9E+00	3.1E+00
Cd	5.2E-05	5.2E-05	1.9E-05	2.3E-05
Co	1.6E-03	2.1E-03	8.8E-04	1.6E-03
Cr	4.8E-03	7.7E-03	3.1E-03	1.2E-02
Cu	3.0E-03	4.9E-03	2.8E-03	8.5E-03
Hg	2.5E-06	2.5E-06	7.8E-06	5.0E-06
K	3.3E-01	3.0E-01	1.7E+00	1.6E+00
Li	1.4E-03	3.1E-03	1.3E-03	1.6E-03
Mg	1.4E+00	1.7E+00	1.7E+00	2.0E+00
Mn	5.2E-02	6.3E-02	5.9E-02	6.2E-02
Mo	1.1E-04	1.1E-04	9.3E-05	1.9E-04
Ni	4.0E-03	5.8E-03	2.8E-03	5.5E-03
Pb	5.6E-04	6.7E-04	1.8E-02	8.3E-04
Sb	5.7E-04	4.9E-04	9.1E-05	5.9E-04
Se	2.0E-04	1.3E-04	7.8E-05	3.1E-04
Sn	7.1E-05	5.2E-05	5.9E-05	1.6E-04
Sr	1.3E-02	1.0E-02	2.1E-02	1.8E-02
Ti	3.6E-06	5.2E-06	1.5E-01	1.7E-01
Tl	2.1E-04	2.1E-04	2.6E-05	2.5E-05
U	9.7E-05	6.8E-05	9.3E-05	9.4E-05
V	3.4E-03	4.9E-03	4.2E-03	9.3E-03
Y	4.0E-04	5.0E-04	8.3E-04	6.2E-04
Zn	4.9E-03	6.2E-03	7.3E-03	7.3E-03

B.2.2 Fugitive Dust - Silt and Moisture Content

Construction Phase Sampling Results

The particle size distribution, surface silt loading and moisture content will be quantified during construction for the following areas in the Project:

- Haul Road – Open Pit
- Haul Road – Open Pit to WRSA A
- Haul Road - Open Pit to WRSA D
- Haul Road - Open Pit to ore stockpile
- Haul Road – Historical Tailings to TMF

Templates for summarizing results of the construction sampling are presented in Tables B.2.2 and B.2.3.

Table B.2-2: Template for Summary of Road Dust Sampling – Moisture Content

ID	Location	Moisture Content (%)		
		Uncontrolled	Controlled	½ Control
S-1	Haul Road – Open Pit			
S-2	Haul Road – Open Pit to WRSA A			
S-3	Haul Road - Open Pit to WRSA D			
S-4	Haul Road - Open Pit to ore stockpile			
S-5	Haul Road – Historical Tailings to TMF			

Table B.2-3: Template for Summary of Road Dust Sampling – Silt Loading

ID	Location	Silt Loading (%)		
		Uncontrolled	Controlled	½ Control
S-1	Haul Road – Open Pit			
S-2	Haul Road – Open Pit to WRSA A			
S-3	Haul Road - Open Pit to WRSA D			
S-4	Haul Road - Open Pit to ore stockpile			
S-5	Haul Road – Historical Tailings to TMF			

Figure B-2: Summary of Road Dust Sampling – Particle Size Distributions

Operation Phase Silt and Moisture Content Sampling

Locations

Confirmatory silt and moisture content sampling will be conducted at the same haul route locations measured during the construction phase:

- Haul Road – Open Pit
- Haul Road – Open Pit to WRSA A
- Haul Road - Open Pit to WRSA D
- Haul Road - Open Pit to ore stockpile
- Haul Road – Historical Tailings to TMF

Three additional locations will be sampled during operation:

- WRSA A
- WRSA D
- Ore stockpile

These locations were not sampled during the construction phase as the sampling was conducted prior to these sources being established.

Timing

Sampling will be conducted within three months of the start of Project operation or in the summertime (dependent on the operation start-date).

Sampling during operation will be conducted at six-month intervals for a period of two years from start of operation. If the results of the operation sampling for the haul routes vary significantly over the two-year period, then continuation of the sampling at locations and frequencies to be determined in consultation with the MECP will be considered.

Methods

Testing and analysis will be conducted following the protocols specified in US EPA AP-42 Appendix C-1 (Procedures for Sampling Surface/Bulk Dust Loading) and Appendix C-2 (Procedures for Laboratory Analysis of Surface/Bulk Dust Loading Samples). The number of samples collected will follow the guidelines specified in these documents.

Three samples will be collected at each of the areas noted above. Samples will be taken:

- Immediately prior to any dust control measure being applied (i.e. minimum control efficiency);
- Immediately following dust control measures being applied (maximum control efficiency);
- At 1/2 times between applications.

The results of the surface sampling will be used to refine road watering/sweeping schedules. The measured moisture contents can be associated with a control efficiency by use of Figure 6-1 in US EPA AP-42, Chapter 6. It is essential that samples be collected during periods with active traffic on the road.

If necessary, based on this site-specific analysis, the fugitive dust control measures specified in the Operation BMP will be updated in-order to achieve the required control efficiencies.

B.2.3 Fugitive Dust Emissions Sources

Operation Emissions

The following sources of fugitive dust emissions to the air were identified based on the process descriptions and data supplied by GGM:

- Open pit operation: material handling, equipment travel in the pit, grading, drilling, blasting
- Truck loading and unloading (waste rock, ore, soils and overburden)
- Waste rock, ore, overburden and soil stockpiles: wind erosion, unloading, bulldozing, and grading
- Ore, waste rock, overburden/soils and historical tailings haul routes; unpaved road dust
- Ore crushing
- Ore transferring/conveying operations
- Ore grinding
- Tailings management facility: truck unloading of historical tailings, unpaved road dust, and wind erosion of dry tailings
- Lime kiln and lime preparation area.

Summary of Emissions Sources

Based on the review presented in Section B2.2.1 and B2.2.2, the following fugitive dust emissions sources were identified and included in this BMP:

- Storage pile wind erosion
- Unpaved road dust
- Drilling and blasting
- Truck loading/unloading on piles
- Grading/Bulldozing
- Various processing operations fugitive sources

B.3 Fugitive Dust Control Measures for Each Source

B.3.1 Drilling and Blasting

Drill rigs will be equipped with a dust shroud on the drill and a wet suppression (spray) system. Equipment operators will ensure that the shroud and water sprays are in place and operating prior to conducting drilling.

Daily weather forecasts will be used to assist in scheduling blasts so that times when wind speeds are elevated, and winds are directed toward nearby residential areas, can be avoided if possible.

B.3.2 Grading and Bulldozing

Water sprays will be utilized on grading and bulldozing operations. Watering will be conducted on an as-needed basis. Water will be applied anytime visible dust emissions are noted by the equipment operators.

B.3.3 Truck Loading/Unloading on Piles

Loading of haul trucks will be performed using hydraulic shovels. To minimize fugitive dust from this activity, the drop distance between the bucket and the bed of the haul truck will be minimized by the equipment operator as much as possible.

Trucks dumping on the waste rock piles will be controlled using water spays and surface wetting. Waste rock and fine materials will be spread on individual dump platforms rather than down a dump face.

B.3.4 Truck Unloading to Primary Crusher

Trucks unloading to the primary crusher (two trucks may dump at the same time) will be enclosed (at a minimum on 3-sides of the drop point and the top). The integrity of the enclosure will be checked by operating personnel on a weekly basis.

B.3.5 Primary and Secondary Crushers

The primary and secondary crushers will be fully enclosed, and each equipped with a baghouse. The dust collectors shall be maintained as per manufacturer requirements and its operation checked daily.

B.3.6 Ore Transfer/Conveying

All conveyor transfer (drop) points will be enclosed. The integrity of the enclosure will be checked by operating personnel on a weekly basis.

B.3.7 Crushed Ore Stockpile

The crushed ore stockpile will be fully enclosed. The integrity of the enclosure will be checked by operating personnel on a weekly basis.

B.3.8 High Pressure Grinding Rolls

A wet scrubber or equivalent will be used to control emissions at the HPGR. The scrubber shall be maintained as per manufacturer requirements and its operation checked daily.

B.3.9 Lime Silo

A dust collector will be used to control dust from the lime silo during loading. The dust collector shall be maintained as per manufacturer requirements and its operation checked daily.

B.3.10 Lime Preparation

A wet scrubber will be used in the lime preparation area to control any emissions from the lime storage tank. The scrubber shall be maintained as per manufacturer requirements and its operation checked daily.

B.3.11 Unpaved Haul Roads

The following measures will be used to control dust from unpaved roads:

- A maximum speed limit of 65 km/h will be enforced on all on-site unpaved roads
- A 10-20 m buffer of existing vegetation shall be maintained on each side of internal unpaved haul roads where feasible
- Wind sheltering (wind screens or vegetation buffers) may be employed along selected haul routes as required

- Unpaved road surfaces will be watered once every 1-2 hours or as required (depending on weather conditions)

- A sufficient water supply will be available on site to allow the water truck(s) to apply sufficient water each hour to fully wet the road surface, or as required. The actual watering rate will vary, depending on surface moisture conditions and traffic levels, and will be triggered whenever the Environment Superintendent or water truck operator deem appropriate, based on visual observations of dust emissions and surface moisture content or as specified in the BMP. A sample water schedule is provided in Table B.4-1. In this table, water frequencies for an application intensity of 1 l/m^2 are provided for haul road sections that include vegetation or wind barrier sheltering as well as unsheltered road sections. Input data for these calculations are provided in Table B.4-2.

- Watering may be supplemented with the use of MECP approved chemical dust suppressants

- Sprinkler systems may be considered / employed on areas of high traffic

- Binding agents or hardening of road surfaces may be utilized as required

B.3.12 Storage Pile Wind Erosion

The following measures will be used to control dust from waste rock, overburden and soils stockpile wind erosion:

- Data from a meteorological tower (equipped with wind speed, wind direction, temperature and relative humidity measurement instrumentation) will be reviewed during operating hours.

- As required, water will be applied to the active area of the piles during periods of high winds, when visual observations of dust emissions occur or whenever the Environment Superintendent or water truck operator deem appropriate.

B.3.13 Tailings Management Facility

Under certain meteorological conditions dust can be generated from dried tailings. In dry (and windy) conditions the spigot lines should be continually moved around the TMF to ensure adequate wetting of the tailings to suppress dust generation. The tailings spigot discharge may be adjusted to provide adequate wetting of the tailings to suppress dust generation.

Progressive restoration of the TMF cells will be conducted as cells are closed during the operation phase.

B.4 Implementation Schedule

This BMP will be implemented upon start of operation at the Project.

Table B.4-1: Sample Watering Schedule

Haul Road	Required Watering Control Efficiency (%)				Application Frequency (Hours)			Water Amount (L)			
	Wind Sheltering	Vegetation Sheltering	Unsheltered	Application Intensity (L/m2)	Wind Sheltering	Vegetation Sheltering	Unsheltered	Wind Sheltering	Vegetation Sheltering	Unsheltered	Total
Pit Haul Road	87.5	85.7	90.0	1	1.9	2.1	1.5	321683.7	0.0	0	321684
Pit to waste storage A	87.5	85.7	90.0	1	9.0	10.3	7.2	30735.4	0.0	77962	108698
Pit to waste storage B	87.5	85.7	90.0	N/A	-	-	-	-	-	-	0
Pit to waste storage C	87.5	85.7	90.0	N/A	-	-	-	-	-	-	0
Pit to waste storage D	87.5	85.7	90.0	1	2.9	3.3	2.3	76496.9	83668.5	89406	249571
Pit to overburden pile	87.5	85.7	90.0	1	40.4	46.2	32.3	4553.4	0.0	16313	20866
Pit to ore stockpile	87.5	85.7	90.0	1	20.2	23.1	16.2	3642.7	0.0	6750	10393
Ore stockpile to primary crusher	87.5	85.7	90.0	1	16.2	18.5	12.9	9106.8	0.0	12195	21301
Pit to primary crusher	87.5	85.7	90.0	1	40.4	46.2	32.3	1821.4	0.0	4235	6056
Tailings management area	87.5	85.7	90.0	1	40.4	46.2	32.3	0.0	9960.5	22363	32323
Historical tailings to TMF	87.5	85.7	90.0	1	40.4	46.2	32.3	0.0	9960.5	27588	37548
Daily Water Application Rate (m3/day)	-	-	-	-	-	-	-	448.0	93.6	234.4	776.1
Number of Water Truck Loads/Day	-	-	-	-	-	-	-	25	5	13	42.6

Application frequencies calculated based on US EPA/625/5-87/022, Equation 5-2.
Water truck capacity of 18200 L assumed.

Table B.4-2: Haul Road Information

Haul Road	Total Distance (m)	Distance with Wind Sheltering (m)	Distance with Vegetation Sheltering (m)	Unsheltered Distance (m)
Pit Haul Road	2,820	2,820	-	0
Pit to waste storage A	4,544	1,500	-	3,044
Pit to waste storage B	801	-	-	801
Pit to waste storage C	2,229	2,000	-	229
Pit to waste storage D	3,822	1,200	1,500	1,122
Pit to overburden pile	3,866	1,000	-	2,866
Pit to ore stockpile	993	400	-	593
Ore stockpile to primary crusher	1,657	800	-	857
Pit to primary crusher	1,144	400	-	744
Tailings management area	6,429	-	2,500	3,929
Historical tailings to TMF	7,347	-	2,500	4,847
Total	35,652	10,120	6,500	19,032

B.5 Implementation and Training

A current version of the BMP will be maintained at the mine administration building. The Environment Superintendent will be responsible for the implementation of the BMP and confirming all on-site personnel are adequately trained. Formal training will be conducted for all relevant new mine staff and a refresher training will be conducted once every two years or as the BMP is updated.

The Environment Superintendent will maintain overall responsibility for confirming that the requirements of the BMP are followed. The Environment Superintendent may delegate responsibilities to the appropriate staff (managers or operators) as required. The Environment Superintendent will conduct an annual review of the BMP and update the requirements on an annual basis.

B.6 Inspection and Maintenance Procedures

The following inspection and maintenance procedures will be carried out at the site:

- Regular (minimum twice daily) visual inspection of the haul roads and storage piles
- Regular inspection and maintenance of the baghouses and wet scrubber systems
- Regular inspection and maintenance of the water truck(s) and water cannons as appropriate
- Regular inspection and maintenance of the meteorological tower (as per instrumentation manual requirements)

B.7 Monitoring, Record Keeping and Reporting

B.7.1 Monitoring

Air quality monitoring stations will be installed to measure both the background ambient particulate matter and that from the Project. The number and location of the ambient monitoring stations are discussed in Appendix A.

A meteorological tower will be installed at the site. The location/siting criteria for the meteorological tower is discussed in Appendix A.

B.7.2 Record Keeping

The following quality records will be maintained and kept on-site:

- A current version of this BMP
- Record of twice daily visual inspections

- Water truck application record (including water application rate, times and locations)
- Water truck(s) maintenance record
- Baghouse and wet scrubber maintenance records
- Visible dust observation record
- Complaint record (including date/time, description of complaint, weather conditions at the time of the complaint, site operation, corrective actions taken and notifications)
- Personnel training records

Standardized forms for the above quality records will be prepared prior to start of Project operation. The forms will include specifics on amounts of water applied for each operation.

B.8 Real Time Monitoring and Adaptive Dust Management

Hourly and rolling 24-hour average PM_{10} measurements will be remotely downloaded from the continuous PM_{10} monitors on an hourly basis.

When the rolling 24-hour average PM_{10} concentration at a downwind monitor (based on the wind direction at the time of the measurements) are measured to be greater than 40 µg/m^3 (80% of the MECP 24-hour average interim ambient air quality criteria of 50 µg/m^3), the Environment Superintendent will be notified and shall investigate the cause of the dust generation and take appropriate actions to reduce dust emissions from the site if required.

When rolling 24-hour average PM_{10} concentrations greater than 50 µg/m^3 are measured at a downwind monitor (based on the wind direction at the time of the measurements) the Environment Superintendent shall:

- Investigate the cause of the dust generation
- Develop/implement additional appropriate mitigation measures to reduce dust emissions from the site. These additional measures will consider the various optional mitigation measures detailed in Section B.3 and be approved by the Environment Superintendent
- Notify the Plant Manager of the additional mitigation measures to be implemented and if there are any expected impacts on site operations
- Review the ambient PM_{10} measurements at the appropriate monitoring location on an hourly basis and continue to mitigate or reduce on-site operations as practicable until the rolling 24-hour average PM_{10} level at the monitor is below 50 µg/m^3

- Note that in some instances background ambient PM_{10} levels (due to sources other than the Project) may be elevated above the MECP PM_{10} criteria, which would be evidenced by rolling 24-hour average PM_{10} levels exceeding 50 µg/m^3 at all stations simultaneously. In these instances, mine site operations should be minimized as much as practicable and the Site Manager notified.

- Should the exceedance be determined to be a valid measurement, provide notification to the MECP (see Section 7.2.4 of the AQMMP).

The trigger and action levels will be regularly reviewed through GGM's adaptive management process and revised as required to prevent exceedances of the MECP PM_{10} Guideline in the community.

B.9 References

Ministry of the Environment, Conservation, and Parks (MECP). 2018. Guideline A-10: Procedure for Preparing an Emission Summary and Dispersion Modelling Report, Ver 4 (PIBs 3614e03).

Stantec Consulting Ltd. (Stantec). 2017. Technical Data Report – Hardrock Project: Atmospheric Environment. Prepared by Stantec Consulting Ltd.

U.S. EPA. 1987. User's Guide – Emission Control Technologies and Emission Factors for Unpaved Road Fugitive Emissions. UEPA/625/5-87/022, September 1987.

U.S. EPA. 2006. Emissions Factors & AP 42 (Fifth Edition), Volume 1: Stationary Point and Area Sources, Chapter 13.2.2: Unpaved Roads.

APPENDIX C:
CONSTRUCTION BEST MANAGEMENT PLAN (BMP) FOR FUGITIVE DUST

Appendix C Construction Best Management Plan (BMP) For Fugitive Dust

C.1 Introduction

C.1.1 Report Contents

This best management plan (BMP) for fugitive dust was prepared by Stantec Consulting Limited on behalf of Greenstone Gold Mines GP Inc. (GGM, the Proponent) for their proposed Hardrock Project (the Project). The Project components include an open pit, ore processing facilities including crushing plants and an ore milling and processing plant, waste rock storage areas (WRSAs), tailings management facility (TMF), natural gas-fueled power plant, and other associated buildings and processes.

This BMP meets Ontario Ministry of the Environment, Conservation and Parks (MECP) requirements (as specified in MECP guideline document Procedure for Preparing an Emission Summary and Dispersion Modelling Report ver. 4.0, Appendix F (MECP 2018) which at a minimum are:

- Identification of the sources of fugitive dust emissions within the facility
- Review of the composition and size range of the fugitive dust
- Description of how fugitive dust will be controlled from each identified source
- Schedule by which the plan will be implemented
- Description of how the plan will be implemented, including training of facility personnel
- Description of inspection and maintenance procedures
- Description of methods of monitoring and record keeping to verify compliance with the plan.

C.1.2 Project Description

The Project is in northern Ontario, approximately 275 kilometres (km) northeast of Thunder Bay, in the Municipality of Greenstone, Ward of Geraldton. The centroid coordinates of the proposed open pit are UTM- Easting, 504405, Northing 5502930 (NAD 83, UTM Zone 16 U). A site plan showing the layout of the Project site is presented in Figure C- 1.

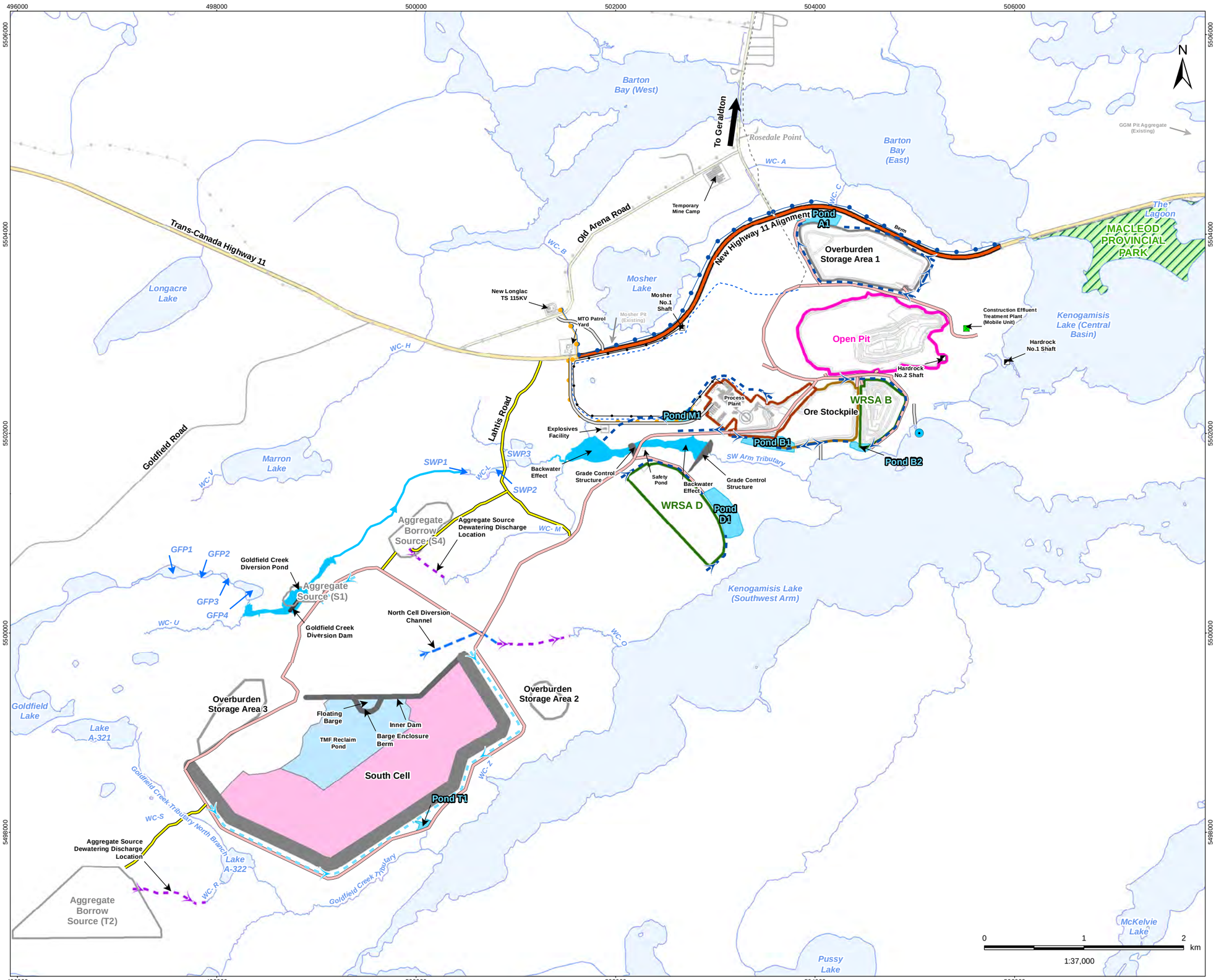
Key mine components of the Project development area include an open pit, waste rock storage areas, ore and overburden stockpiles, ore crushing and mill feed storage activities, ore milling and processing plant, water management facilities, tailings management facility, power plant and associated infrastructure, and explosives manufacturing plant and storage. Ancillary mine infrastructure includes mine operation buildings, service water supply and associated infrastructure, sewage and effluent treatment facilities,

mine site roads, watercourse crossings, realignments, and habitat compensation/offsets, onsite pipelines and piping, hazard materials storage, aggregate sources, and temporary camp.

Key project activities associated with the construction as they pertain to the atmospheric environment are described below.

The construction phase will last approximately 30 months and includes the following activities:

- Site preparation including, clearing and grubbing, soil stripping, grading, and leveling of the site as required in preparation for foundations and buildings
- Soils and overburden (including potentially contaminated overburden/soils) management in accordance with the Soils Management Plan
- Relocation of a portion of the historical MacLeod tailings to temporary storage in the open pit
- Removal of existing infrastructure
- Watercourse crossings
- Goldfield Creek diversion
- Hwy 11 realignment
- Open pit development including the removal of topsoil, overburden and waste rock, drilling and blasting, and preproduction mining of ore
- Aggregate pit development and portable rock crushing
- Development and implementation of water management facilities (i.e., collection ponds and drainage ditches, temporary water treatment plant; sanitary sewage treatment plants; potable water infrastructure)
- Development of the soils/overburden stockpiles and WRSAs
- Construction of the TMF
- Construction of the mill and initial commissioning during the final months of construction
- Physical construction of buildings and structures associated with the project, and installation of equipment associated with its operation
- Construction of linear facilities (e.g., roads, onsite pipelines and piping, power lines)
- Construction of ancillary facilities (e.g., fuel supply, storage and distribution); and
- Extraction from aggregate sources



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Revised: 2020-01-21 By: dharvey

Stantec

Legend

Preliminary Site Plan

- Existing Mine Shaft
- Construction Effluent Treatment Plant (Mobile Unit)
- Construction Treated Effluent Discharge Loccation
- Contact Water Collection Ditch
- Proposed Overland Flow
- Access Road
- Construction Access Road
- Diversion Channel
- Haul Road
- Potable Water Pipeline
- 44 kV Distribution Line
- 12.5 kV Distribution Line
- 115 kV Transmission Line
- Seepage Collection Ditch
- Collection Pond
- Aggregate Source
- Process Plant Area
- Open Pit
- Ore Stockpile
- Overburden Storage
- Waste Rock Area

Highway Realignment

- New Highway 11 Alignment

Existing Features*

- Highway
- Major Road
- Local Road
- Existing Power Line
- Existing Potable Water Pipeline
- Watercourse
- Provincial Park
- Waterbody

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

* Existing Features have been removed in the PDA and do not reflect current conditions.

January 2020
160961111

Client/Project

Greenstone Gold Mines GP Inc. (GGM)
Hardrock Project

Figure No.

C-1

Title

Site Plan - End of Construction Phase

C.2 Source Identification

C.2.1 Composition and Size Range of the Fugitive Dust

The composition of the fugitive dust is expected to be the same at that of the ore, waste rock or overburden excavated at the site. A summary of the metals contents of these sources is presented in Table C.2-1.

Table C.2-1: Summary of Fugitive Dust Composition

Metal	Composition (Weight %)			
	Ore	Waste Rock (Average of 7 lithologies)	Overburden	Tailings
Ag	3.2E-05	2.1E-05	3.1E-04	2.4E-05
Al	1.3E+00	1.8E+00	4.5E+00	5.3E+00
As	6.6E-02	1.0E-02	9.6E-03	9.5E-02
Ba	1.0E-02	1.1E-02	4.1E-02	4.1E-02
Be	5.1E-05	5.1E-05	8.3E-05	1.0E-04
Bi	2.3E-04	2.4E-04	5.3E-06	1.5E-05
Ca	2.8E+00	2.4E+00	6.9E+00	3.1E+00
Cd	5.2E-05	5.2E-05	1.9E-05	2.3E-05
Co	1.6E-03	2.1E-03	8.8E-04	1.6E-03
Cr	4.8E-03	7.7E-03	3.1E-03	1.2E-02
Cu	3.0E-03	4.9E-03	2.8E-03	8.5E-03
Hg	2.5E-06	2.5E-06	7.8E-06	5.0E-06
K	3.3E-01	3.0E-01	1.7E+00	1.6E+00
Li	1.4E-03	3.1E-03	1.3E-03	1.6E-03
Mg	1.4E+00	1.7E+00	1.7E+00	2.0E+00
Mn	5.2E-02	6.3E-02	5.9E-02	6.2E-02
Mo	1.1E-04	1.1E-04	9.3E-05	1.9E-04
Ni	4.0E-03	5.8E-03	2.8E-03	5.5E-03
Pb	5.6E-04	6.7E-04	1.8E-02	8.3E-04
Sb	5.7E-04	4.9E-04	9.1E-05	5.9E-04
Se	2.0E-04	1.3E-04	7.8E-05	3.1E-04
Sn	7.1E-05	5.2E-05	5.9E-05	1.6E-04
Sr	1.3E-02	1.0E-02	2.1E-02	1.8E-02
Ti	3.6E-06	5.2E-06	1.5E-01	1.7E-01
Tl	2.1E-04	2.1E-04	2.6E-05	2.5E-05
U	9.7E-05	6.8E-05	9.3E-05	9.4E-05
V	3.4E-03	4.9E-03	4.2E-03	9.3E-03
Y	4.0E-04	5.0E-04	8.3E-04	6.2E-04
Zn	4.9E-03	6.2E-03	7.3E-03	7.3E-03

The particle size distribution, surface silt loading and moisture content will be quantified during construction for the following haul routes in the Project:

- Haul road in the open pit
- Haul roads between the open pit and WRSAs A and D
- Haul road between the open pit and the ore stockpile
- Haul road from historical tailings to TMF

Testing and analysis will be conducted following the protocols specified in US EPA AP-42 Appendix C-1 (Procedures for Sampling Surface/Bulk Dust Loading) and Appendix C-2 (Procedures for Laboratory Analysis of Surface/Bulk Dust Loading Samples). The number of samples collected will follow the guidelines specified in these documents. Sampling will be conducted within three months of the start of Project construction in the summertime.

Three samples will be collected at each of the areas noted above. Samples will be taken:

- Immediately prior to any dust control measure being applied (i.e. minimum control efficiency)
- Immediately following dust control measures being applied (maximum control efficiency)
- At 1/2 time between applications

The results of the surface sampling will be used to refine road watering/sweeping schedules. The measured moisture contents can be associated with a control efficiency by use of Figure 6-1 in US EPA AP-42, Chapter 6. It is essential that samples be collected during periods with active traffic on the road. If necessary, based on this site-specific analysis, the fugitive dust control measures specified in the BMP will be updated in-order to achieve the required control efficiencies.

The results of the construction surface sampling will be incorporated into the Operation BMP and the mitigation measures updated as required based on this information.

C.3 Fugitive Dust Emissions Sources

C.3.1 Construction Emissions

The following potential sources of fugitive dust emissions to the air were identified based on the process descriptions and data supplied by GGM for the construction phase. The following emissions sources were identified:

- Open pit operation: material handling, equipment travel in the pit, grading, drilling, blasting

- Highway 11 construction: general construction activities
- Facilities construction: general construction activities
- TMF construction: material handling, equipment travel, site preparation, grading
- Waste rock, ore, overburden and soils stockpiles: wind erosion, unloading, bulldozing, and grading
- Ore, waste rock, overburden, soils and historical tailings haul routes; unpaved road dust
- Aggregate sources: material handling
- Construction access road: unpaved road dust

C.4 Fugitive Dust Control Measures for Each Source

C.4.1 Drilling and Blasting

Drill rigs will be equipped with a dust shroud on the drill and a wet suppression (spray) system. Equipment operators will ensure that the shroud and water sprays are in place and operating prior to conducting drilling.

Daily weather forecasts will be used to assist in scheduling blasts so that times when wind speeds are elevated, and winds are directed toward nearby residential areas, can be avoided if possible.

C.4.2 Grading and Bulldozing

Water sprays will be utilized on grading and bulldozing operations. Watering will be conducted on an as-needed basis. Water will be applied anytime visible dust emissions are noted by the equipment operators.

C.4.3 Truck Loading/Unloading on Piles

Loading of haul trucks will be performed using hydraulic shovels. To minimize fugitive dust from this activity, the drop distance between the bucket and the bed of the haul truck will be minimized (<1.5m) by the equipment operator or as much as possible.

Trucks dumping on the waste rock piles will be controlled using water spays and surface wetting. Waste rock and fine materials will be spread on individual dump platforms rather than down a dump face.

C.4.4 Unpaved Haul Roads

The following measures will be used to control dust from unpaved roads:

- A maximum speed limit of 50 km/h will be enforced on all on-site unpaved roads.
- A 10-20 m buffer of existing vegetation shall be maintained on each side of internal unpaved haul roads where feasible.
- Wind sheltering (wind screens or vegetation buffers) may be employed along selected haul routes as required.
- Unpaved road surfaces will be watered as required (depending on weather conditions).
- A sufficient water supply will be available on site to allow the water truck(s) to apply sufficient water each hour to fully wet the road surface, or as required.
- The actual watering rate will vary, depending on surface moisture conditions and traffic levels, and will be triggered whenever the Environment Superintendent or water truck operator deem appropriate, based on visual observations of dust emissions.
- Watering may be supplemented with the use of MECP approved chemical dust suppressants.
- Sprinkler systems may be considered / employed on areas of high traffic.
- Binding agents or hardening of road surfaces may be utilized as required.

C.4.5 Storage Pile Wind Erosion

The following measures will be used to control dust from waste rock, ore, overburden and soils stockpile wind erosion:

- Data from a meteorological tower (equipped with wind speed, wind direction, temperature and relative humidity measurement instrumentation) will be reviewed during operating hours.
- As required, water will be applied to the active area of the piles during periods of high winds, when visual observations of dust emissions occur or whenever the Environment Superintendent or water truck operator deem appropriate.

C.4.6 Tailings Management Facility

Under certain meteorological conditions dust can be generated from dried tailings. In dry (and windy) conditions the spigot lines should be continually moved around the TMF to ensure adequate wetting of the tailings to suppress dust generation. The tailings spigot discharge may be adjusted to provide adequate wetting of the tailings to suppress dust generation.

C.5 Implementation Schedule

This BMP will be implemented upon start of construction of the Project.

C.6 Implementation and Training

A current version of the BMP will be maintained at the construction office. The Environment Superintendent will be responsible for the implementation of the BMP and ensuring all construction personnel are adequately trained. Formal training will be conducted for all relevant new construction staff and a refresher training will be conducted as the BMP is updated.

The Environment Superintendent will maintain overall responsibility for ensuring that the requirements of the BMP are followed. The Environment Superintendent may delegate responsibilities to the appropriate construction staff (managers or operators) as required. The Environment Superintendent will conduct an annual review of the BMP and update the requirements on an annual basis.

C.7 Inspection and Maintenance Procedures

The following inspection and maintenance procedures will be carried out at the site:

- Regular (minimum twice daily) visual inspection of the haul roads and storage piles;
- Regular inspection and maintenance of the water truck(s) and water cannons as appropriate; and,
- Regular inspection and maintenance of the meteorological tower and ambient monitoring stations (as per instrumentation manual requirements).

C.8 Monitoring, Record Keeping and Reporting

C.8.1 Monitoring

Air quality monitoring stations will be installed to measure both the background ambient particulate matter and that from the Project. The number and location of the ambient monitoring stations are discussed in Appendix A.

A meteorological tower will be installed at the site. The location/siting criteria for the meteorological tower is discussed in Appendix A.

C.8.2 Record Keeping

The following quality records will be maintained and kept on-site:

- A current version of this BMP

- Record of twice daily visual inspections
- Water truck application record (including water application rate, times and locations)
- Water truck(s) maintenance record
- Visible dust observation record
- Complaint record (including date/time, description of complaint, weather conditions at the time of the complaint, site operations, corrective actions taken and notifications)
- Personnel training records

Standardized forms for the above quality records will be prepared prior to start of Project operation. The forms will include specifics on amounts of water applied for each operation.

C.9 Real Time Monitoring and Adaptive Dust Management

Hourly and rolling 24-hour average PM_{10} measurements will be remotely downloaded from the continuous PM_{10} monitors on an hourly basis.

When the rolling 24-hour average PM_{10} concentration at a downwind monitor (based on the wind direction at the time of the measurements) are measured to be greater than 40 µg/m^3 (80% of the MECP 24-hour average interim ambient air quality criteria of 50 µg/m^3), the Environment Superintendent shall be notified and shall investigate the cause of the dust generation and take appropriate actions to reduce dust emissions from the site if required.

When rolling 24-hour average PM_{10} concentrations greater than 50 µg/m^3 are measured at a downwind monitor (based on the wind direction at the time of the measurements) the Environment Superintendent shall:

- Investigate the cause of the dust generation
- Develop/implement additional appropriate mitigation measures to reduce dust emissions from the site. These additional measures will consider the various optional mitigation measures detailed in Section C.3 and be approved by the Environment Superintendent
- Notify the Construction Manager of the additional mitigation measures to be implemented and if there are any expected impacts on construction operations
- Review the ambient PM_{10} measurements at the appropriate monitoring location on an hourly basis and continue to mitigate or reduce on-site operations as practicable until the rolling 24-hour average PM_{10} level at the monitor is below 50 µg/m^3

Note that in some instances background ambient PM_{10} levels (due to sources other than the Project) may be elevated above the MECP PM_{10} criterion, which would be evidenced by rolling 24-hour average PM_{10} levels exceeding 50 µg/m^3 at all stations simultaneously. In these instances, construction operations should be minimized as much as practicable and the Construction Manager notified

C.10 References

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U.S. EPA. 2006. Emissions Factors & AP 42 (Fifth Edition), Volume 1: Stationary Point and Area Sources, Chapter 13.2.2: Unpaved Roads.

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