April 2014

FINAL REPORT

SD 5-1 Air Quality Monitoring Plan - Meliadine Gold Project, Nunavut

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Report Number: Doc 375-1314280007 Ver 0
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REPORT

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Executive Summary

Agnico Eagle Mines Limited (AEM) is developing the Meliadine Gold Project (the Project), located approximately 25 kilometres (km) north from Rankin Inlet, and 80 km southwest from Chesterfield Inlet in the Kivalliq Region of Nunavut. Situated on the western shore of Hudson Bay, the Project site is located on a peninsula between the east, south, and west basins of Meliadine Lake (63°1′23.8" N, 92°13′6.42" W), on Inuit owned land.

This document presents a preliminary Air Quality Monitoring Plan (Plan) for the Project. This Plan and follow-up program is designed to be appropriate to the scale of the Project and the effects identified through the environmental impact assessment process. The predicted ambient air quality concentrations were considered in the design of an appropriate monitoring program and the development of mitigation and adaptive management strategies. These programs and strategies are intended to confirm the effectiveness of mitigation measures assumed in the Project, and in doing so, determine if alternative mitigation strategies are required to minimize emissions from the Project and their impacts.

The proposed monitoring program described in this Plan addresses the following components:

- regulatory considerations;
- scope of the program;
- goals of the program;
- air quality monitoring program;
- emissions monitoring program;
- input for mitigative and adaptive strategies; and
- annual report describing procedures for the preparation of annual reports and their ancillary components.

Based on the air quality assessment it is proposed that air quality monitoring be performed for particulates and NO_2. In addition, as meteorological data are a critical input to air dispersion models and emissions estimation, it is proposed a single real time meteorological station be installed at the site.

For each of the programs, AEM will assure that monitoring is conducted in accordance with the appropriate sampling reference methodologies. In addition standardized quality assurance/quality control (QA/QC) requirements will be followed. In siting the proposed stations, factors such as topography, infrastructure and power supply, and site accessibility will be considered.

AEM will provide annual reports summarizing the results of the air quality and meteorological monitoring programs summarizing the data collected during each year. In addition, AEM will report to appropriate federal programs where required.

This Plan has been prepared to a conceptual level appropriate for inclusion in the Project Environmental Impact Statement. Final details of the proposed program will be verified in consultation with the regulatory agencies during the permitting and detailed design process.

Study Limitations

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Abbreviation and Acronym List

AEM	Agnico Eagle Mines Limited
AENV	Alberta Environment
AMD	Alberta Air Monitoring Directive
CFR	Code of Federal Regulations
CH_4	Methane
CO_2	Carbon dioxide
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
EPA	Environmental Protection Agency
GHG	Greenhouse gas
Golder	Golder Associates Ltd.
NAAQO	National Ambient Air Quality Objectives
NAPS	National Air Pollution Surveillance Network
NIRB	Nunavut Impact Review Board
NO_2	Nitrogen dioxide
NPRI	National Pollutant Release Inventory
N_2O	Nitrous oxide
PM_{10}	Particles nominally smaller than 10 µm in diameter
$PM_{2.5}$	Particles nominally smaller than 2.5 µm in diameter
QA	Quality assurance
QC	Quality control
SSA	Site study area
SO_2	sulphur dioxide
TSP	total suspended particulate

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1.0 INTRODUCTION

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The proposed monitoring program described in this Plan addresses the following components:

- regulatory considerations;
- scope of the program;
- goals of the program;
- air quality monitoring program;
- emissions monitoring program;
- input for mitigative and adaptive strategies; and
- annual report describing procedures for the preparation of annual reports and their ancillary components.

The proposed program has been categorized into 3 distinct areas, as follows:

- Air Quality Monitoring;
- Meteorological Monitoring; and
- Mitigative and Adaptive Strategies.

A brief summary of the mitigation measures and the air monitoring program are summarized in the Sections below.

This Plan has been prepared to a conceptual level appropriate for inclusion in the Project Environmental Impact Statement (EIS). Final details of the proposed program will be verified in consultation with the regulatory agencies during the permitting and detailed design process. The Plan will be reviewed and updated on a regular basis as the Project proceeds into predevelopment, construction, operations, and closure.

This report has been prepared in accordance with the “Study Limitations of This Report,” which are presented at the beginning of the report. The reader’s attention is specifically drawn to this information for reference during the use of this report.

1.1 Concordance with Project Guidelines

The purpose of this document is to address Guidelines issued by the Nunavut Impact Review Board (NIRB) for the Project (NIRB 2012), and specifically those relating to the preparation of an Air Quality Management Plan. Specific requirements set out in the guidelines relating to the preparation of the Plan are presented in Volume 1, Appendix 1.0-A.

2.0 AIR QUALITY MONITORING PROGRAM

The proposed air quality monitoring plan will address one of the most prominent issues for mining projects: the concentration of airborne particulate surrounding the major areas of activity and the deposition of those particles over time. The proposed program will use a combination of active and passive sampling methods.

Table 1 summarizes the recommended air quality follow-up monitoring programs. The recommendations identify that the air quality monitoring will focus on airborne particulates during the operations phase only because emissions during the construction phase will continuously change, both spatially and temporally.

Passive gaseous monitoring, specifically of nitrogen dioxide (NO_2) is proposed. No continuous monitoring is proposed for other gaseous compounds because of the relatively low levels of emissions and the low concentrations predicted in the air quality assessment. The particulate monitoring program will be implemented for the operations phase only.

Table 1: Summary of Monitoring Programs

Component	Project Phase	Program Objective	Suggested Frequency and Location of Monitoring
Air Quality	Operations Phase	• To verify that the TSP, PM_{10}, and $PM_{2.5}$ emission rates used in the assessment were reasonable, but conservative • To verify the predicted concentrations of TSP, PM_{10}, and $PM_{2.5}$ • To verify that the mitigation measures considered integral to the Project are being incorporated as planned, and are effective	• Development of fugitive dust management plan during operation activities • Installation of one continuous TSP/PM_{10} sampling unit (active) • Installation of a dust fall jars, as appropriate (passive) • Installation of one passive NO_2 monitor

2.1 Dynamic (Active) Particulate Monitoring

It is proposed that one dynamic continuous sampler for total suspended particulate (TSP), particles nominally smaller than 10 µm in diameter (PM_{10}), and particles nominally smaller than 2.5 µm in diameter ($PM_{2.5}$) be installed at the mine site. The specific location of the monitor will be determined in collaboration with Environment Canada and assuring that standard site criteria defined in the amended Air Monitoring Directive (Alberta Environment 1989), are followed. Specifically, consideration will be given to the following:

- site accessibility;
- power supply;
- effects of topography;
- local interferences (e.g., buildings);

- security;
- local meteorological conditions (wind speed);
- dispersion patterns as predicted within the FEIS Volume 5, Section 5.2; and
- location of potentially sensitive receptors.

Based on the above noted criteria, the proposed location is on the mine site east of the processing plant. The location of this station may need to be adapted in future based on changes in operations or monitoring methods.

As part of this program, AEM will retain an air quality specialist to assist in site selection, installation, and training of mine personnel in instrument operation, quality assurance/quality control, and reporting.

2.1.1 Monitoring Methods

Dynamic monitoring will be based on continuous sampling for TSP, PM_{10} and $PM_{2.5}$. The U.S. Environmental Protection Agency (EPA) has described standard methods for collection of PM air samples in Section 40 CFR Part 53 and 58 of U.S. Code of Federal Regulations (U.S. EPA 1997). It has been demonstrated that intermittent dynamic sampling (e.g., Partisols) are the most reliable for the proposed monitoring; however, the actual type of sampler (e.g., Partisol, BAM, TEOM) to be used at the mine site will be determined in consultation with the regulatory agencies.

The sampler will be sited specifically in accordance with the Alberta Air Monitoring Directive (AMD). The AMD siting methodology considers factors including air quality dispersion modelling results, dominant wind direction, terrain and obstacles, site accessibility, and the sensitivity of nearby receptors, and has been previously used for developing air monitoring programs in the far north. This methodology will be developed further by including site access and power supply parameters to guide the site selection process. The results will be compared with ambient air quality criteria for TSP, PM_{10}, and $PM_{2.5}$ to demonstrate that the facility emissions do not result in ground level concentrations in excess of those predicted in the environmental assessment.

2.1.2 Monitoring Frequency

Depending on the type of particulate sampler selected, the monitoring of TSP, PM_{10}, and $PM_{2.5}$ concentrations will be carried out at a minimum of every 6 days. This frequency aligns with the National Air Pollution Surveillance (NAPS) schedule, whereby a single 24-hour sample is collected every 6^{th} day.

Particulate sampling will be conducted year-round. However, sampling during extreme winter conditions (-20 degrees Celsius [°C] and colder) with the potential for blowing snow, which frequently occur during winter months, allows the possibility for snow to be drawn through the inlet resulting in a void sample and possible damage to the electronic components of the sampler. A small amount of data loss is expected during the winter, as ambient conditions exceed the normal operating range expected for the equipment being used. It is anticipated that climate-controlled shelters will be required to house the equipment to minimize this problem.

In addition, by operating on a 6-day cycle, different days are sampled each week, which allows for the monitoring of differing production intensities or other variations.

2.1.3 Data Analysis

The TSP, PM_{10}, and $PM_{2.5}$ data from the monitoring location will be analyzed for indications of air quality concerns (e.g., increasing trends or measured concentrations above the predictions with the FEIS or applicable ambient air standards). The results of this analysis will be presented in the annual air quality report (see Section 7.0).

To analyze for indications of air quality concerns, the TSP and $PM_{2.5}$ data from the station will be compared to the air assessment results (FEIS Volume 5, Section 5.2), Nunavut Standards (Nunavut 2011), and Canada-Wide standards (CCME 2000, 2001).

The analysis of spatial particulate trends will compare measured particulate concentrations to the relevant standards. There is the possibility that unusual events in the region (e.g., a dust storm transporting airborne particulate) could result in higher measured particulate concentrations at specific locations. Any such unusual event will be analyzed in conjunction with the on-site meteorological data to investigate the cause of the event.

The analysis of temporal trends will look for consistent trends in the measured particulate concentrations on an annual basis.

In addition to the annual trend analysis, ongoing visual observation at the site is one mechanism for identifying high dust events and triggering remedial actions. The potential cause(s) of the condition and the mitigation action available will be evaluated and implemented as appropriate.

2.2 Static (Passive) Particulate Monitoring

In addition to the dynamic monitoring, a static (passive) particulate monitoring (i.e., dust fall monitoring) program will be implemented for the mine site. It is proposed that static samplers for dustfall be installed at the following locations:

- one near the dynamic sampler;
- one sampler at the edge of the site study area (SSA; see FEIS Volume 5, Section 5.1)) in predominant upwind direction, and a second sampler at the edge of the SSA in the predominant downwind direction from the open pit areas that are actively being mined; and
- one along the primary haul route between the active open pit and the processing plant.

2.2.1 Monitoring Methods

Dustfall data will be collected using open vessels containing a purified liquid matrix. Particles are deposited and retained in the vessel, which are then sent to a laboratory where total and fixed dustfall are quantified. Total dustfall is everything that falls into the collection vessel, while fixed dustfall is the non-combustible subset.

Dustfall canisters will be used to collect ambient dustfall for analysis of deposition rates of dust. Unlike the continuous samplers, dustfall collection is a passive program that provides a measure of particulates that would be directly deposited onto vegetation, soil, and water in the vicinity of the Project.

2.2.2 Monitoring Frequency

Dustfall canisters are exposed in the field for a nominal period of 30 days. Dustfall sampling is done over this longer period to allow for a sufficient sample size for analysis. In this regard, it provides an indication of longer-term air quality trends.

2.2.3 Monitoring Parameters

The dustfall samples will be analyzed for the total and fixed dustfall collected over the sampling period. Ambient dustfall nominally includes particles large enough to settle out of the air column close to their point of generation.

2.2.4 Data Analysis

The dustfall rates measured at the dustfall stations will be analyzed for indications of increasing trends or measured concentrations above the applicable ambient air criteria, as well as spatial and temporal trends. The conclusions of this analysis will be presented each year in the annual report (see Section 7.0).

The analysis of the fixed dustfall sampling results will include the comparison of the results with Alberta objectives since neither Nunavut nor the Northwest Territories have dustfall standards. Specifically, the off-site data will be compared to the Alberta Environment (AENV) recreational area guideline of 53 mg/100 cm^2/30 days (AENV 2005).

Analysis of spatial trends would include comparisons between the various passive stations. Unusual differences will trigger investigation and examination of mitigation measures. The analysis will also check for consistently increasing trends in the measured dustfall rates on an annual basis.

2.3 Passive Monitoring of Gaseous Compounds

It is recommended that that one passive ambient air monitor for NO_2 be installed and operated during the operation phase of the Project. Due the AEM's commitment to use low sulphur diesel and the resulting low level concentrations anticipated for other gaseous compounds, only NO_2 monitoring is recommended.

2.3.1 Monitoring Station Locations

The passive NO_2 monitor will be installed in accordance with the AMD, which accounts for siting the monitoring station in an offsite location predicted to experience elevated concentrations as determined by dispersion modeling within the FEIS (Volume 5, Section 5.2). It is intended that the proposed passive NO_2 monitoring station will be co-located with a dustfall station. Co-locating these stations serves 2 purposes. First, it will allow for the efficient collection of samples. Second, it will allow for the calculation of ambient secondary particulate (nitrate) concentrations if this information is required at a later date.

2.3.2 Monitoring Methods

A passive NO_2 sampler is proposed for this monitoring program. The monitors are suitable for this type of program as they require no electricity, and can be left unattended for extended periods. The sample media are

taken to the field and exposed in protective shelters that are mounted to a support pole or small tripod. The passive samplers will be exposed for a nominal period of 30 days before they are retrieved, replaced, and sent to the laboratory for analysis.

2.3.3 Monitoring Frequency

Passive samplers are exposed in the field for a nominal period of 30 days. As passive sampling is done over a longer period to allow for a sufficient sample size for analysis, it provides an indication of longer-term air quality trends.

Passive NO_2 monitoring is proposed for the operations phase of the Project. Should it be discovered that NO_2 concentrations are consistently less than predicted in the FEIS, or are static for the first few years of operation, the frequency of monitoring may be adjusted depending on the acceptability of this to the regulatory agencies.

No continuous monitoring is proposed for gaseous pollutants because of the relatively low concentrations in the ambient air as predicted by the CALPUFF dispersion model (FEIS Volume 5, Section 5.2).

2.3.4 Data Analysis

The ambient NO_2 concentrations measured at the passive station will be analyzed for indications of air quality concerns (e.g., increasing trends or measured concentrations above the predictions contained within the FEIS [Volume 5, Section 5.2], as well as spatial and temporal trends).

The analysis of the NO_2 sampling results will include the comparison of results with the National Ambient Air Quality Objectives (NAAQO) (Environment Canada 2010). However, since the passive sampling will be on a monthly basis and the NAAQOs have no monthly criteria, the annual average of the monthly data will be compared to annual NAAQO for NO_2.

The analysis of temporal trends will look for consistent, increasing trends in the measured NO_2 concentrations on an annual basis.

2.4 Summary of Air Monitoring Equipment

The air monitoring equipment required to fulfill the above listed monitoring activities are summarized in the table below.

Table 2: Summary of Air Monitoring Equipment

Sampling Type	Number of Units
Dynamic monitoring of TSP, PM_{10}, and $PM_{2.5}$	1
Static monitoring of dust fall	3
NO_2 Passive Sampler	1

3.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Quality Assurance (QA) refers to plans or programs that encompass a wide range of internal and external management and technical practices designed to ensure the collection of data of known quality that matches the intended use of the data. Quality Control (QC) is a specific aspect of QA that refers to the internal techniques used to measure and assess data quality). As QC procedures are variable and program-specific, the procedures have been summarized in this section on a program component basis.

Monitoring will involve the following steps:

- Collection;
- Preservation;
- Storage;
- Handling; and
- Analysis.

AEM will assure that monitoring is conducted in accordance with the sampling reference methodology. In addition to standardized quality assurance/quality control (QA/QC) requirements, such as instrument calibration, leak checks, inspection of data, and proper labelling of all sampling containers, quarterly field audits of samplers will be performed in accordance where possible with the sampler operating manual. Sampling instrument audits are an integral part of the QA/QC program. Filter changes will be performed by an appropriately trained Project technician, placed in the filter transport container, and sent to a certified laboratory for weight analysis in accordance with methodology requirements. Chain of custody and request for analysis will be filled and sent out with the filters package.

3.1.1 Total Suspended Particulate, PM_{10}, and $PM_{2.5}$ Monitoring

QA/QC procedures for the dynamic particulate monitoring program include the following:

- Travel blanks (laboratory prepared samples that travel with the samples but are not exposed to the atmosphere) will be used;
- Samplers will be calibrated and maintained annually;
- An accredited laboratory will be used for pre-sample preparation and determining sample weights;
- Samples will be collected by appropriately trained personnel consistent with detailed written operating instructions from qualified personnel (i.e., a professional air quality specialist);
- Qualified personnel will interpret the flow data and confirm ambient particulate concentrations based on laboratory results; and
- Data will be downloaded by appropriately trained personnel consistent with detailed written operating instructions from qualified personnel.

3.1.2 Dustfall Monitoring

QA/QC procedures for the dustfall monitoring program include the following:

- Travel blanks (laboratory prepared samples that travel with the samples but are not exposed to the atmosphere) will be used;
- An accredited laboratory will be used for pre-sample preparation and analysis;
- Samples will be collected by appropriately trained personnel consistent with detailed written operating instructions from qualified personnel; and
- Qualified personnel will calculate ambient dustfall deposition rates based on laboratory results.

3.1.3 Passive NO_2 Monitoring

- Travel blanks (laboratory prepared samples that travel with the samples but are not exposed to the atmosphere) will be used;
- An accredited laboratory will be used for pre-sample preparation and analysis;
- Samples will be collected by appropriately trained personnel consistent with detailed written operating instructions from qualified personnel; and
- Qualified personnel will interpret ambient NO_2 concentrations based on laboratory results.

4.0 METEOROLOGICAL MONITORING

Meteorological data are a critical input to air dispersion models and emissions estimation that will be required throughout the life of the Project. These data will allow for site-specific meteorological conditions to be included in emissions and modelling assessments, which can assist in developing trends.

A summary of the proposed meteorological monitoring program is provided in the table below.

Table 3: Summary of Monitoring Programs

Component	Project Phase	Program Objective	Suggested Frequency and Location of Monitoring
Meteorological Data	Construction and Operations Phase	• Installation of appropriate on-site meteorological station to collect relevant data that can assist to support ongoing study at the site	• real time sampling

A single monitoring station will be installed at the site and installed to meet international meteorological installation standards. When siting the station, factors such as topography, infrastructure and power supply, and site accessibility will be considered. The proposed monitoring equipment includes the following:

- wind monitor;
- temperature probe and related appurtenances;
- net radiometer sensor and related appurtenances;

- measurement and control module and related appurtenances;
- module housing;
- solar panel;
- rechargeable battery;
- station tower and related appurtenances;
- rainfall and snowfall gauge; and
- software.

It is proposed that the tower continuously measure the following parameters:

- wind speed at 10 m above the ground;
- wind direction at 10 m above the ground;
- temperature at 2 m above the ground;
- solar radiation at 2 m above the ground; and
- total precipitation at 2 m above the ground.

Data will be analyzed by a qualified technician and a summary of meteorological data included in the annual report (see Section 7.0). Discussion of extreme events will be included as part of the report.

5.0 REGULATORY REVIEW

In addition to the monitoring programs, AEM has committed that the Project will meet CCME emission requirements for boilers and heaters, fuel storage tanks, and waste incinerators. These requirements are summarized as follows:

- National Emission Guidelines for Commercial/Industrial Boilers and Heaters (CCME 1998a): This documents sets out the emission limits from boilers and heaters. The limits are frequently referenced by regulatory agencies as targets that need to be achieved for approval and permit compliance.
- Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks (CCME 1995): This document is intended to provide consistency in controlling volatile organic compound emissions from fuel storage tanks.
- Canada-Wide Standards for Dioxins and Furans (CCME 2001): This document sets out the emission limits from incinerators. Emission limits are expressed as a concentration in the exhaust gas exiting the stack of the facility and will be met using generally available incineration and emission control technology and waste diversion. An emission concentration limit of 80 pico-grams of International Toxic Equivalency Quotients per cubic metre (pg I-TEQ/m3) is applicable to the Project for hazardous waste and sewage sludge incineration.

- Environmental Guideline for the Burning and Incineration of Solid Waste (Nunavut 2012): This document sets out practices, methods and limits with respect to the combustion of solid waste in Nunavut. The guideline includes a specific limit of 80 picograms of International Toxic Equivalency Quotients per cubic metre (pg I-TEQ/m^3), which is consistent with the CCME limit above. The guideline also sets a limit of 20 micrograms per cubic metre (µg/m^3).

An Incinerator Management Plan for the Project is included in the FEIS as SD 2-12.

6.0 MITIGATIVE AND ADAPTIVE STRATEGIES

Design aspects, operational measures, and other mitigation measures have been incorporated into the current Project plans, which will minimize associated air emissions. Mitigation measures that will be applied to the Project can be classified into 3 stages:

- Design Based Mitigation;
- General Mitigation; and
- Activity Specific Mitigation.

Through its Project design, AEM has identified a series of best management practices that will be employed to minimize potential air quality changes. For example, within the Project, design specifications, such as the purchase of vehicles that meet Tier III emission standards, have been incorporated. Other mitigation will include the development of general mitigation practices, such as routine maintenance and housekeeping programs, as well as activity specific mitigation, such as incinerator management programs (see SD 2-12 Incineration Management Plan) and fugitive dust best management practices (e.g., SD 2-7 Ore Storage Management Plan, Section 5.3; SD 2-8 Mine Waste Management Plan, Sections 4.5 and 5.7; SD 2-9 Roads Management Plan, Section 2.5; SD 2-10 Borrow Pits and Quarries Management Plan, Section 7.3). In relation to the Project, AEM will take into consideration the 3 stages of mitigation, as outlined above, and develop emission reduction plans and consider pollution prevention and best management practices where required.

7.0 REPORTING

AEM will provide an annual air quality report that summarizes the air quality monitoring and air emissions data collected during each year. In addition, AEM will report annual emission estimates to the National Pollutant Release Inventory (NPRI) and Greenhouse Gas (GHG) emissions to the appropriate federal program.

The following items are included in a typical particulate monitoring report:

- Concentration standards for the facility;
- Type of monitoring test conducted;
- Monitoring locations;
- Instrumentation used;

- Weather conditions during ambient quality survey (monthly weather reports);
- Time and duration of monitoring, including dates;
- Results of monitoring at each monitoring location (daily for concentrations in $\mu g \cdot m^{-3}$);
- Annual arithmetic mean, statistical analysis, and graphs;
- Measurement error analysis (statistical and systematic errors);
- Sampler audit report;
- QA/QC data;
- Statement outlining compliance or non-compliance with the limit;
- Discussion of the reason for non-compliance when concentration exceedances are found; and
- Strategies to be used to manage air quality exceedance.

An annual report summarizing and analyzing the emissions and ambient monitoring information will be submitted to the Government of Nunavut and Environment Canada. The report will include the following:

- The particulate monitoring report containing items identified above;
- Emissions tracking data for NO_2, sulphur dioxide (SO_2), and greenhouse gases (carbon dioxide [CO_2], methane [CH_4] and nitrous oxide [N_2O]) based on annual fuel consumption, composition, and emission factors;
- A summary of a fugitive dust abatement measures and pollution prevention strategies undertaken in the reporting year;
- Contingency/response actions taken to respond to increasing trends or exceedances of emission estimates used in the EIS;
- Comparison of annual emission estimates, ambient air quality, and deposition monitoring results to previous years, and the estimates given in the EIS dispersion modeling (Volume 5, Section 5.2);
- Analysis of emissions and ambient air quality trends and effectiveness of strategies employed to minimize emissions; and
- Responses (initiated and planned) to issues (e.g., data loss, equipment failure, extreme weather, negative trends in air quality predictions).

8.0 CLOSURE

We trust that the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact us

Yours very truly,

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Tracy Hodges
Air Quality Specialist

ORIGINAL SIGNED

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