TECHNICAL MEMORANDUM

DATE June 27, 2017 **PROJECT No.** 1658927/6100/6130

TO Ryan Vanengen
Agnico Eagle Mines

CC

FROM Cameron McNaughton **EMAIL** csmcnaug@golder.com

COMMITMENT 7 – COMPARISON OF VAULT HAUL ROAD OBSERVATIONS OF ROAD DUST TO WHALE TAIL EIS HAUL ROAD PREDICTIONS

1.0 INTRODUCTION

During the Technical Meeting and Pre-hearing Conference, held in Baker Lake, Nunavut on April 28 to May 2, 2017 Agnico Eagle committed to use the dustfall monitoring stations on the Vault Pit Haul Road to validate and improve modelling of the Whale Tail haul road dust and provide results in the form of a technical memo (Commitment 7).

During the Technical Meeting, Environment and Climate Change Canada (ECCC) raised concern that the dispersion modelling based predictions related to road dust deposition along the Whale Tail haul road in the Whale Tail Environmental Impact Study (EIS) may not be conservative enough. This technical memorandum summarizes and compares the 2013 to 2016 Meadowbank dustfall monitoring data to the EIS air quality model predictions for the Whale Tail haul road.

2.0 DATA AND METHODS

2.1 Vault Haul Road Dustfall Observations

There are four dustfall monitoring stations at the Meadowbank Mine: DF-1, DF-2, DF-3, and DF-4. Monitoring station DF-4 is located 480 metres (m) northwest of the Vault haul road and approximately 1.2 kilometres (km) northeast of the Portage Rock Storage Facility at Meadowbank. Dustfall monitoring at DF-4 began March 15, 2012. However, haul trucks began transporting ore from the Vault Pit to Meadowbank in January 2014. Thus, analysis of the dust from the haul road is restricted to the 2014 to 2016 period. Beginning in 2013, dust suppression was applied to the Vault haul road and continues to be applied during the summer months.

2.2 Whale Tail Haul Road EIS Predictions

Road dust deposition along the Whale Tail haul road were predicted using the AERMOD air quality model and used results of a haul road traffic study (SNC 2015) to determine type, frequency, and speeds of vehicle traffic on the proposed haul road.

AERMOD includes two atmospheric deposition algorithms for particulate matter. Initially Method II was used to predict maximum 24-hr average dust deposition as a function of distance from the haul road. This quantity was multiplied by 30-days to compute the maximum monthly deposition rate in milligrams per square centimetre per 30-days (mg/cm^2/30-day). Input parameters for the Model II simulation are summarized as follows:

- particle geometric mean diameter = 5.0 μm; and
- fraction of particle mass emitted in the fine mode (i.e., less than 2.5 micrometers) = 3%.

The road dust particle size distribution is not known. However, Method II deposition is most appropriate when the size distribution is unknown and, a small fraction of the particles are predicted to be smaller than 10 μm in aerodynamic diameter. Since road dust is predicted to have a large proportion of particles larger than 10.0 μm, EIS reviewers pointed out that the simulation should be reevaluated using the Method I deposition algorithm. The simulation was re-run using Model I deposition and the following input parameters:

- particulate mass distribution of three groups: $PM_{<2.5}$, $PM_{2.5-10}$ and $PM_{>10}$;
- the mean diameter of the three mass groups: 0.05 μm , 5 μm, and 20 μm;
- the fractions of the three mass groups calculated from the estimated emission rates of $PM_{2.5}$, PM_{10}, and TSP: 3%, 24%, and 73%; and
- particle density = 1.0 g/cm^3 (grams per cubic centimeter).

Emissions of fugitive dust are mitigated along the Vault Haul road using chemical suppressants. Mitigation efficiency of chemical suppressants is typically assumed to be 80%. The Vault haul road is constructed from soapstone and has a higher silt content (9.3%) than esker material proposed for use as road-top material for the Whale Tail haul road (silt content = 6.1%). For comparison purposes, dust deposition along the Vault haul road has also been simulated using the higher silt content, assuming an 80% mitigation efficiency and keeping all other parameters equal while employing the Method I deposition algorithm.

RESULTS

Figure 1 summarizes annual time series of dust deposition observed at the DF-4 monitoring station from 2014 to 2016. As indicated, highest dust deposition rates occur in late spring to early fall (i.e., May to October). Table 1 summarizes simple statistics associated with dustfall observations at DF-4 from May to October in 2014, 2015, and 2016. These 17 data points were selected for comparison to the Whale Tail haul road predictions.

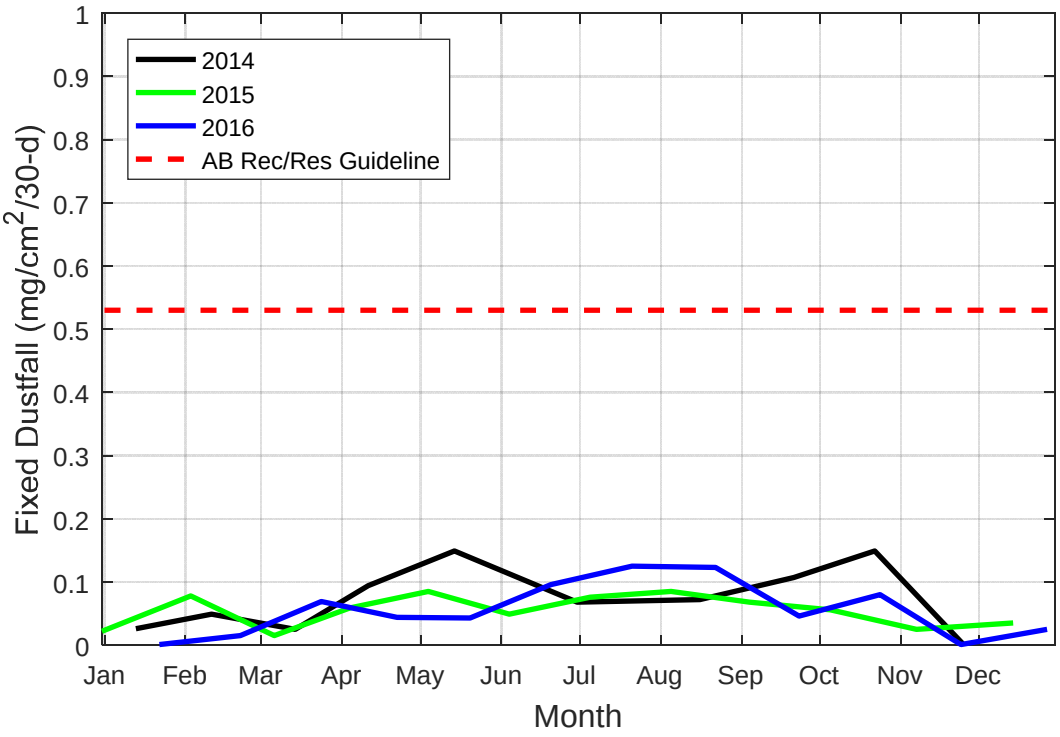

Figure 1: Time Series of Annual Dustfall Observations at Meadowbank Station DF-4

Table 1: Summary of May to October Dustfall Observations at Station DF-4

N	Mean (mg/cm²/30-day)	Median (mg/cm²/30-day)	Stdev (mg/cm²/30-day)	Min (mg/cm²/30-day)	Max (mg/cm²/30-day)
17	0.087	0.080	0.034	0.043	0.149

Figure 2 summarizes AERMOD model predictions for the Whale Tail and Vault haul roads. Figure 2 also includes May to October dustfall observations at DF-4 from 2014 to 2016, and results of temporary transect data from dustfall monitoring studies conducted by Agnico Eagle at Meadowbank in 2013 and 2014.

The Method I (solid black and green lines) and Method II (dashed black line) predictions from the AERMOD model include the addition of a presumed background rate of dust deposition of 0.072 mg/cm^2/30-day, based on dustfall observations collected 4 km from the Meadowbank Mine (Agnico Eagle 2015). The primary difference between the Model I and Model II predictions for the Whale Tail haul road, and without dust suppression, is the distance at which they predict compliance with the Alberta Recreational/Residential dustfall Guideline of 0.53 mg/cm^2/30-day. Method II predicts compliance at between 100 and 300 m from the proposed haul road. Method I predicts compliance at between 300 and 500 m from the proposed haul road.

Dustfall observations at DF-4 from May to October for 2014 to 2016 are included in Figure 2 as blue circles (Agnico Eagle 2015, 2016, 2017). These observations occur monthly and are collected at a distance of 480 m from the Vault Pit haul road. The Vault Pit haul road observations (green circles) include measurements at 50 m

downwind of the Vault road in 2013, and measurements 50 m and 600 m upwind, and 50 m downwind in 2014 (Agnico Eagle 2014, 2015).

Also included in Figure 2 (black squares) are 2014 observations from the Baker Lake to Meadowbank all-weather access road (AWAR). The AWAR is not a haul road, but observations in 2014 are extensive and the observations included in Figure 2 were collected along transects perpendicular to the road along road segments that had no application of dust suppressants.

Predictions for the Vault Haul road, assuming chemical dust suppression and using the Method I deposition algorithm (green line), are comparable to Whale Tail haul road predictions that assume no dust suppression and use the Method II algorithm. Both simulations predict compliance with the AB Recreational/Residential dustfall guideline between 100 and 300 m from the haul roads.

At distances greater than 300 m, all dustfall observations are below all of the AERMOD model predictions. At distances less than 100 m, observations adjacent to the Vault haul road can exceed the Vault haul road predictions. This can occur for several reasons, including but not limited to the following:

- actual dust suppressant mitigation efficiencies less than 80%;
- variable road silt content;
- differences in haul road traffic types, weights, and volumes; and
- deposition of very large particles (i.e., >40 μm), which are not simulated by AERMOD.

Predictions of dustfall at distances of less than 100 m should be considered highly uncertain due to the potential for deposition of very large particles. For example, 10 μm particles can become suspended in air and have the potential to travel 100's to 1000's of metres from their source. A 100 μm particle will not remain suspended and has the potential to travel only 10's to 100's of metres. However, it requires the deposition of one thousand, 10 μm particles to equal the mass deposited by a single 100 μm particle (mass being proportional to diameter cubed). So although dust deposition rates at 50 to 100 m from the haul road are uncertain and can be high, deposition rates beyond approximately 300 to 500 m are predicted to be below the AB guideline values, regardless of which emissions scenario is being considered.

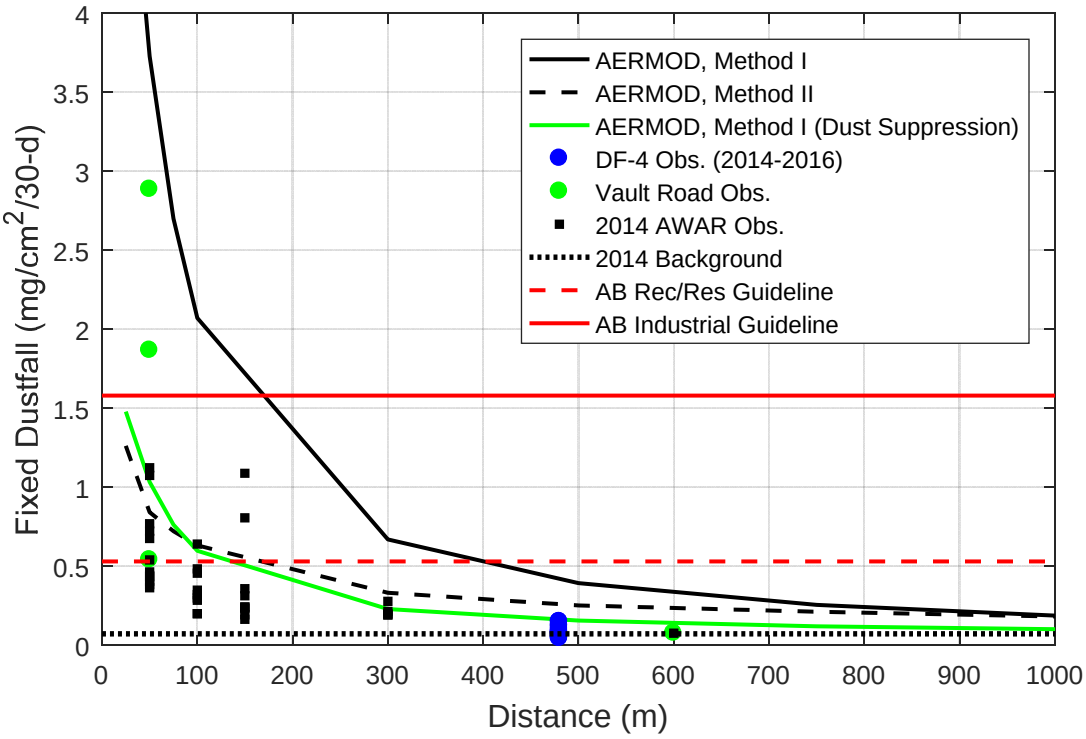

Figure 2: Summary of Road Dust Observations from Vault Pit Haul Road and the AWAR to Meadowbank and, Model Predictions for the Whale Tail Haul Road

3.0 CONCLUSIONS

ECCC reviewers of the Whale Tail Project EIS raised concerns about the conservatism associated with predictions of road dust being generated along the proposed Whale Tail haul road. This memorandum compared EIS predictions using two different air quality model algorithms to observations from the existing Meadowbank Mine. The observations include the following:

- ongoing monitoring at a fixed location 480 m from the Vault Pit haul road (i.e., DF-4);
- 2013 and 2014 dustfall measurements along transects perpendicular to the Vault Pit haul road; and
- 2014 dustfall measurements along transects perpendicular to the Baker Lake to Meadowbank AWAR.

The analysis presented here indicates that AERMOD modelling of dust from the haul road is conservative compared to the observations and, compliance with AB residential/recreational guideline will likely be attained at distances of between 300 to 500 m, or as near as 100 to 300 m.

4.0 CLOSURE

We trust this meets your needs, if you have any questions or concerns, feel free to contact the undersigned.

Regards,

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