Appendix 53

Whale Tail Blasting Measurements

TECHNICAL MEMORANDUM

DATE 19 March 2020 **Project No.** 19124290-476-TM-Rev0

TO Robin Allard
Agnico Eagle Mines Limited

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WHALE TAIL PIT – BLASTING MEASURMENTS FROM AUGUST, SEPTEMBER, AND DECEMBER 2019

1.0 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) has retained Nuqsana Golder to assist with a program to measure noise and vibration from explosive blasting at the Whale Tail Pit for the Meadowbank Complex. The blast measurement study is to collect preliminary data per discussions with the Terrestrial Advisory Group (TAG) for the Meadowbank Complex in 2018 and 2019.

The initial goal of this program is to measure noise and vibration from explosive blasts conducted under both summertime and wintertime conditions. Once a sufficiently large number of measurements have been collected, measurement data will be used to establish site-specific relationships between noise/vibration levels and:

- blasting parameters (e.g., charge mass, burden depth)
- environmental conditions (e.g., air temperature, wind direction)
- propagation distances

This information will be further used for analysis of caribou behaviour response to explosive blasts in future studies.

This memorandum provides a summary of the first year of the basting measurement program. In particular, this memorandum:

- discusses parameters used to assess blasting noise and vibration
- describes equipment used to measure blasting noise and vibration
- identifies locations around the Whale Tail Pit where measurements were collected
- presents measurement data collected in August, September, and December 2019
- outlines planned future work

2.0 ASSESSMENT PARAMETERS

Blasting impacts are typically assessed using two different parameters:

- Peak Particle Velocity (PPV), which characterizes ground vibration (i.e., physical shaking of the ground as a result of an explosive blast). PPV values are usually measured in millimetres per second (mm/s).
- Peak Pressure Level (PPL), which characterizes airblast overpressure (i.e., movement of air as a result of an explosive blast). PPL values are usually measured in linear decibels (dBL).

Although PPL values are measured in decibels and are sometimes described informally as blasting “noise”, it is important to understand that airblast overpressure is experienced in a very different way than audible sound because the bulk of energy associated with an airblast occurs at very low frequencies (i.e., frequencies that are too low to be perceived as sound by the auditory system). Consequently, observers often report experiencing explosive airblast as a “gust of wind” rather than an audible phenomenon and it is not appropriate to compare audible sound levels to PPL values. For example, an audible sound level of 115 A-weighted decibels (dBA) would be perceived as extremely loud while a PPL of 115 dBL would be barely perceptible (and completely inaudible).

Most guideline limits on PPV and PPL from blasting are intended to protect against minor cosmetic damage to buildings and other structures. For example, the Environment Canada *Environmental Code of Practice for Metal Mines* (Environment Canada 2009) recommends that PPV be limited to 12.5 mm/s and PPL be limited to 128 dBL at nearby receptors.

There are very few guideline limits intended to address disturbance or annoyance from explosive blasting, but one document that is commonly referenced in blasting assessments is the Australian and New Zealand Environment Council (ANZEC) *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZEC 1990). To protect against impacts associated with annoyance, the ANZEC document recommends that PPV be limited to 5 mm/s and PPL be limited to 115 dBL at nearby receptors. Although these limits were established to address human annoyance, they also represent a reasonable starting point for an assessment of potential impacts to caribou (in the absence of wildlife-specific thresholds or limits).

3.0 MEASUREMENT EQUIPMENT

During the first year of the blasting measurement program, blasting measurements were collected using four Instantel Minimate units (Model No. 716A3001), which are owned and maintained by Agnico Eagle. The Minimate units make use of triaxial geophones to measure PPV and characterize ground vibration. All four Minimate units were outfitted with geophones. The Minimate units make use of linear microphones to measure PPL and characterize airblast overpressure. Only two of the four Minimate units were outfitted with linear microphones per available equipment.

A number of technical challenges arose as a result of using Agnico Eagle’s existing Minimate units during the first year of the blasting measurement program.

- PPL values for a given blast could only be measured at two locations, since only two of Agnico Eagle’s four Minimate units are outfitted with linear microphones. Ideally, PPL values could be measured simultaneously at four locations.
- Agnico Eagle’s Minimate units are configured to run on internal batteries. This limits the amount of time the units can log data before having to be recovered and recharged. During summertime conditions, the typical

battery life was found to be about two days; during wintertime conditions, the typical battery life was found to be even shorter. Ideally, the Minimate units could be configured to work with an external power source that would allow for deployments of a week (or longer) to log data from multiple blasts.

- Agnico Eagle's Minimate units are not protected by an outdoor case. As such, these units are susceptible to damage by adverse weather conditions and wildlife. This issue is exacerbated during wintertime conditions, when air temperatures routinely drop below -40^{0}C. Ideally, the Minimate units could be enclosed in rugged outdoor cases that would protect them from the elements.

Agnico Eagle and Nuqsana Golder are currently working to procure improved measurement equipment to address the technical challenges identified above (see Section 6 of this memorandum).

4.0 MEASUREMENT LOCATIONS

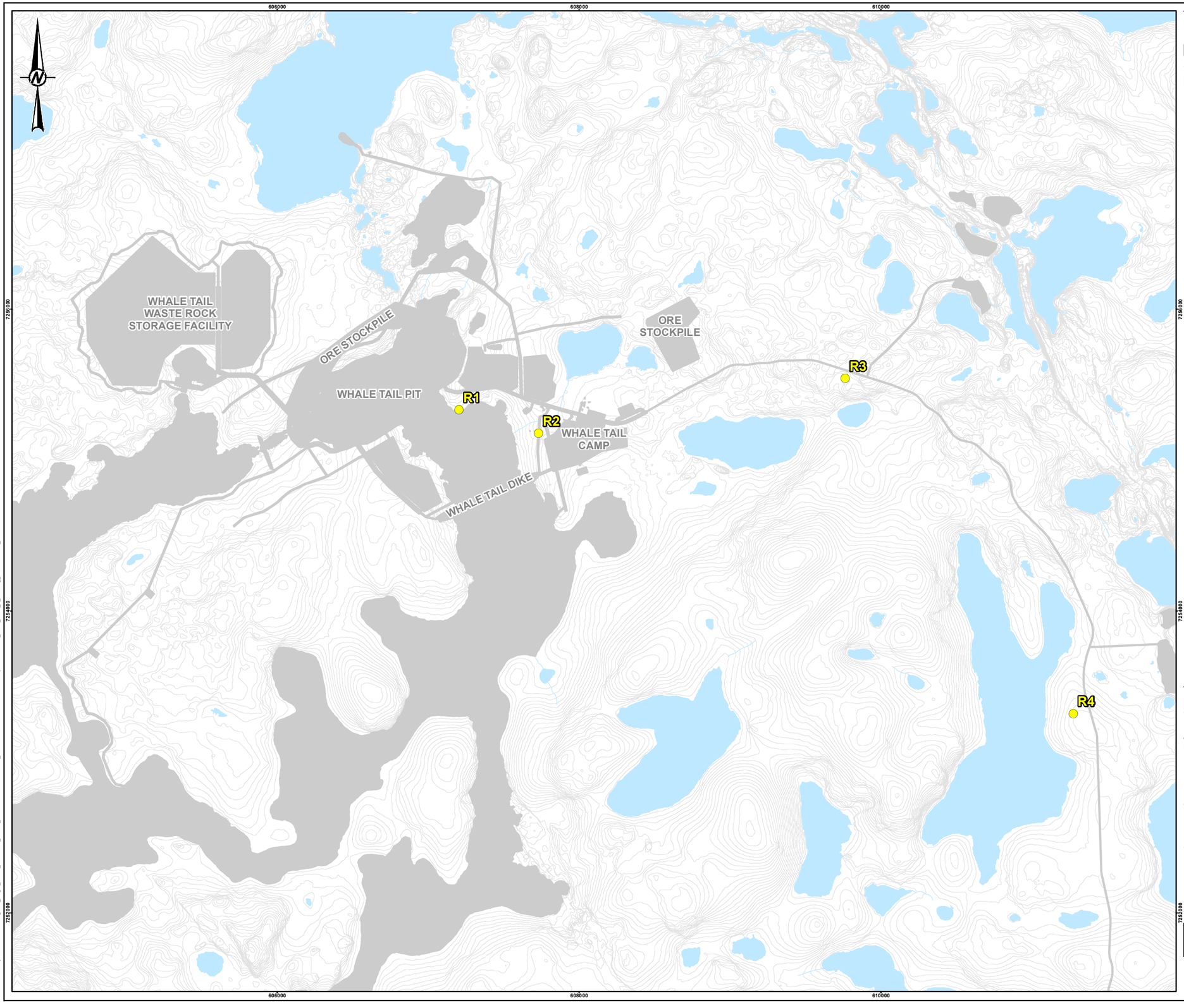
Because Agnico Eagle owns four Minimate units, it was possible to collect blasting measurements at four different locations. Because one of the primary goals of the measurement program is to establish a relationship between blasting noise/vibration levels and propagation distances (see Section 1 of this memorandum), measurements were collected at four different distances from the Whale Tail Pit. During the first year of the program, measurement locations were selected to be approximately downwind from the Whale Tail Pit based on prevailing wind conditions in the area. Because downwind conditions enhance noise propagation, measurement locations that are downwind from the Whale Tail Pit should capture maximum (or near-maximum) PPL values associated with in-pit blasting.

Measurement locations targeted during the first year of the blasting program are listed in Table 1. A map showing these same measurement locations is presented in Figure 1.

Table 1: Blasting Measurement Locations

Location Identification Code	Universal Transverse Mercator Coordinates[(a)] [Zone 14]		Description
	Easting [m]	Northing [m]	
R1	607205	7255333	Approximately 500 metres from the edge of the Whale Tail Pit
R2	607732	7255179	Approximately 1 kilometre from the edge of the Whale Tail Pit
R3	609764	7255543	Approximately 3 kilometres from the edge of the Whale Tail Pit
R4	611274	7253321	Approximately 5 kilometres from the edge of the Whale Tail Pit

[(a)] General measurement locations were selected to be downwind from the blast site (based on prevailing wind conditions in the area). Specific measurement locations were selected in the field after considering local ground conditions and site access limitations.



LEGEND

- BLASTING MEASUREMENT LOCATION
- APPROVED INFRASTRUCTURE
- WATERCOURSE
- WATERBODY

0 500 1,000

1:25,000 METRES

REFERENCE(S)

1. INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM NATURAL RESOURCES CANADA. DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

CLIENT [redacted]

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

BLASTING MEASUREMENT LOCATIONS

CONSULTANT [redacted]

YYYY-MM-DD	2020-03-18
DESIGNED	VY
PREPARED	CDB
REVIEWED	CLT
APPROVED	JR

PROJECT NO.	CONTROL	REV.	FIGURE
19124290	6000/6020	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25mm

PATH: Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\9_PROJECTS\19124290\2_PRODUCTION\6000\MXD\6020\Report\19124290_6000_6020_1_Blasting_Measurement_Locations.mxd PRINTED ON: 2020-03-18 AT: 2:28:28 PM

5.0 MEASUREMENT DATA

During the first year of the program, blasting data was measured during August, September, and December 2019. Table 2 provides a summary of the PPV and PPL values measured for each blasting event.

Measurement data in Table 2 indicates that all 12 blasts measured during the first year of the program resulted in PPV values well-below the 12.5 mm/s damage threshold (Environment Canada 2009) and well-below the 5 mm/s annoyance threshold (ANZEC 1990), even for the measurement location 500 metres from the edge of the Whale Tail Pit (R1). This suggests that ground vibration from blasting is unlikely to result in annoyance at nearby receptors.

Measurement data in Table 2 also indicates that all but one of the 12 blasts measured during the first year of the program resulted in PPL values below the 128 dBL damage threshold (Environment Canada 2009), even for the measurement location 500 metres from the edge of the Whale Tail Pit (R1). This suggests that airblast overpressure from blasting is unlikely to result in damage to nearby structures. Seven of the 12 blasts measured during the first year of the program resulted in PPL values above the 115 dBL annoyance threshold (ANZEC 1990) at the measurement location 500 metres from the edge of the Whale Tail Pit (R1). This suggests that airblast overpressure may result in annoyance impacts at receptors in close proximity to the blast site.

Future PPL measurements at more distant locations (i.e., R2, R3, and R4) should help to characterize the maximum distance to which PPL-related annoyance impacts may extend.

Table 2: Blasting Measurements

Blast Date and Time	Ground Vibration; Peak Particle Velocity [mm/s]				Airblast Overpressure; Peak Pressure Level [dBL]			
	R1	R2	R3	R4	R1	R2	R3	R4
25-Aug-2019; 12:37:28	2.11	1.06	0.22	0.13	113.5	110.2	n/a[(a)]	n/a[(a)]
28-Aug-2019; 12:40:16	1.29	0.66	n/a[(a)]	n/a[(a)]	115.2	n/a[(a)]	n/a[(a)]	n/a[(a)]
30-Aug-2019; 12:33:12	1.03	0.59	n/a[(a)]	n/a[(a)]	127.4	n/a[(a)]	n/a[(a)]	n/a[(a)]
3-Sep-2019; 12:39:14	2.15	1.08	n/a[(a)]	n/a[(a)]	106.0	n/a[(a)]	n/a[(a)]	n/a[(a)]
4-Sep-2019; 12:33:42	1.54	0.81	n/a[(a)]	n/a[(a)]	103.5	n/a[(a)]	n/a[(a)]	n/a[(a)]
8-Sep-2019; 12:40:37	n/a[(a)]	0.87	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]
9-Sep-2019; 12:39:01	n/a[(a)]	0.63	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]
21-Dec-2019; 18:31:23	1.07	n/a[(a)]	n/a[(a)]	n/a[(a)]	121.6	n/a[(a)]	n/a[(a)]	n/a[(a)]
23-Dec-2019; 12:45:22	0.56	n/a[(a)]	n/a[(a)]	n/a[(a)]	126.3	n/a[(a)]	n/a[(a)]	n/a[(a)]
25-Dec-2019; 12:45:19	1.30	n/a[(a)]	n/a[(a)]	n/a[(a)]	132.0	n/a[(a)]	n/a[(a)]	n/a[(a)]
26-Dec-2019; 12:45:12	3.31	n/a[(a)]	n/a[(a)]	n/a[(a)]	116.9	n/a[(a)]	n/a[(a)]	n/a[(a)]
28-Dec-2019; 12:44:16	1.19	n/a[(a)]	n/a[(a)]	n/a[(a)]	117.6	n/a[(a)]	n/a[(a)]	n/a[(a)]

[(a)] Measurement data not available for this blast.

6.0 IMPROVEMENTS AND FUTURE WORK

Agnico Eagle and Nuqsana Golder are currently working to procure improved measurement equipment to address the technical challenges identified in Section 3 of this memorandum, for a setup of four Minimate units to be deployed on site.

Each unit will be equipped with linear microphones to measure PPL values. Each unit will be equipped with multiple external batteries, which can be exchanged and charged without recovering the unit itself. This will allow for extended deployments of multiple weeks duration to capture dozens of individual blasts. Each of the four new units will be able to collect full waveform data for individual blasts, as well as histogram data over extended monitoring periods. This histogram data will help characterize baseline conditions in the area (i.e., PPV and PPL levels absent the contribution from explosive blasting). Each unit will be enclosed in a rugged outdoor case, which will provide protection from the elements during extended deployments and harsh weather conditions. In addition, each unit will be equipped with a small wind turbine, which will power an electric heater to maintain temperatures inside the enclosure within a reasonable operating range during wintertime conditions. Reduced protection and solar panels may be employed during summertime conditions.

The second year of blasting measurements will commence as soon as the new equipment is delivered and has been appropriately tested by Nuqsana Golder personnel. Agnico Eagle and Nuqsana Golder expect the second year of blasting measurements can commence in the third quarter (Q3) 2020. Initial deployment of the new measurement equipment will be completed under the supervision of a Nuqsana Golder technical expert. The equipment will then be maintained by Agnico Eagle environmental technicians and data will be downloaded regularly for analysis by Nuqsana Golder. After equipment deployment in Q3 2020, it is expected that blasting measurements will be collected more-or-less continuously throughout the remainder of 2020. Results of the second year of blasting measurements will be summarized in a memorandum in 2021.

7.0 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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https://golderassociates.sharepoint.com/sites/110051/project files/5 technical work/03_blasting/summary tech memo - 2020/rev0/19124290-476-tm-whaletail-blastmonitoring-rev0.docx

REFERENCES

ANZEC (Australian and New Zealand Environment Council). 1990. *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration.*

Environment Canada. 2009. *Environmental Code of Practice for Metal Mines.*