Appendix 41

Meadowbank and Whale Tail 2022 Blast Monitoring Report

ANNUAL REPORT MEMORANDUM

Agnico Eagle Mines Ltd Meadowbank Complex
Environment Department

SUBJECT: 2022 Meadowbank and Whale Tail Blast Monitoring Report for the Protection of Nearby Fish Habitat

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1. Introduction and Objectives

In accordance with NIRB Project Certificate No.004 Condition 85 and Project Certificate No. 008 Condition 22, Agnico Eagle Meadowbank Complex developed a blasting program which complies with *The Guidelines for the Use of Explosives In or Near Canadian Fisheries Water*[1] (Wright and Hopky,1998) as modified by the DFO for use in the North and adhere to guidance provided in *Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies*[2] (Cott and Hanna, 2005). As a result, Agnico Eagle conducts monitoring to evaluate blast related peak particle velocity (PPV) and overpressure (IPC) to protect nearby fish bearing waters.

The detonation of explosives in or near water produces compressive shock waves that can cause significant impacts to the swim bladders of fish, rupture other internal organs and/or damage or kill fish eggs and larvae. In addition, the effects of the shock waves can be intensified in the presence of ice. Consequently, the Guidelines for the Use of Explosives in or Near Canadian Fisheries Water guidelines have been developed by DFO to protect fish and fish habitat from works or undertakings that involve explosives in or near fisheries waters. Guidance provided in Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies (Cott and Hanna, 2005) was also followed. It includes the following requirements:

1. No explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 100 kPa in the swim bladder of a fish; representatives from DFO requested that Agnico Eagle use a value of 50 kPa instead of 100 kPa; and

2. No explosive is to be detonated that produces a peak particle velocity greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank mine, it takes place between August 15 and June 30).

Peak particle velocity (PPV) and overpressure monitoring data was recorded throughout 2022 during blasting activities at Whale Tail, IVR, and IVR West Pits for the protection of fish. The locations of the blast monitoring stations on surface in 2022 at Whale Tail Mine are highlighted in Table 1 and Figure 1.

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[1] *Wright, D.G., and G.E.Hopky.Guidelines for the use of explosives in or near Canadian fisheries Water. 1998.Can. Tech.Rep. Fish.Aquat. Scie.2107: IV+34P.*
[2] *Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002 guidelines.*

Table 1: 2022 Surface Blast Monitoring Stations – Whale Tail Mine

Station	Easting	Northing
IVR Pit (Nemo Lake)	606,588	7,256,993
IVR Pit (Nemo Lake 2)	606,673	7,256,972
Whale Tail Pit (Mammoth Station 2)	605,945	7,255,169
Whale Tail Pit (Mammoth Station 3)	605,872	7,255,000

No blast monitoring was conducted at the Meadowbank mine site in 2022 as mining operations ceased in 2019.

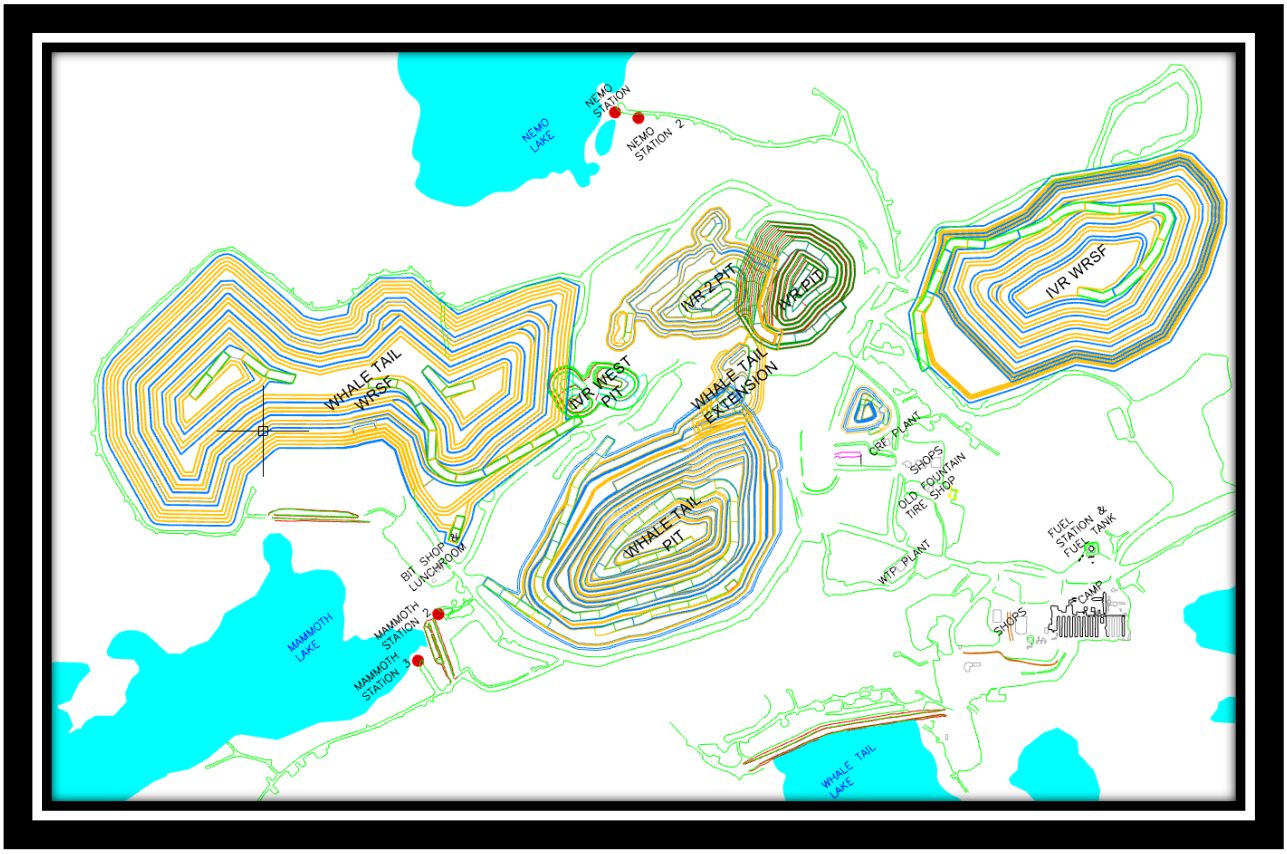

Figure 1 – Whale Tail Blast Monitoring Stations

2. Methods

2.1- Blast Monitoring

Blasts were monitored using Instantel's Minimate & Micromate Blaster which is fully compliant and is annually calibrated with the international Society of Explosives and Engineers performance specifications for blasting seismographs (Instantel, 2005). The Minimate & Micromate Blaster has three main parts: a monitor, a standard transducer (geophone) and a microphone. The monitor contains the battery and electronic components of the instrument. It also checks the two sensors to ensure they are functioning. The transducer measures ground vibration with a mechanism called a geophone [3].

This instrument measures transverse, vertical and longitudinal ground vibrations. Transverse ground vibrations agitate particles in a side-to-side motion. Vertical ground vibrations agitate particles in an up and down motion. Longitudinal ground vibrations agitate particles in a back-and-forth motion progressing outward from the event site (Instantel, 2005). The Minimate & Micromate Blasters calculate the PPV for each geophone and calculate the vector sum of the three axes. The result is the Peak Vector Sum (PVS) and is the resultant particle velocity magnitude of the event:

$$PVS = \sqrt{(T^2 + V^2 + L^2)}$$

Where:

T = particle velocity along the transverse plane
V = particle velocity along the vertical plane
L = particle velocity along the longitudinal plane

The transducer is installed as per the model specifications. All monitoring follows Agnico Eagle Blast Monitoring Program.

2.2- Data Analysis

In 2022, the engineering department continued the work established in 2021 of documenting blast patterns, sequences, and detonation results leading to both accurate material documentation and blast design optimization. In addition, procedures were reviewed, and a flow process was developed internally to optimize blast patterns from the planning to the design stages considering a radius of influence near surface blast monitoring stations.

The blast monitoring data was screened to ensure blast PPV and IPC monitoring results corresponded to a single blast event. Data is collected per each blast date and may include a composite of blast patterns. As a result, data may include multiple blast patterns that could have occurred during the same monitoring event (i.e., a single PPV and IPC value for 3 blast patterns). The data was screened to remove all redundant data points (such as replicate readings).

[3] *Instantel INC.2005.Minimate Blaster Operation Manual.*

2.3- Results, Discussion and Conclusions

PPV and IPC blast monitoring exceedances are presented in Table 2 and results in Table 4. Blast monitoring results are reviewed after each blast and a blast vibration mitigation (Investigation & Corrective Measures) plan begins immediately, if the vibrations or the overpressure exceeds the guidelines.

In 2022, 187 blasts were monitored at IVR. There were two (2) blasts exceeding the PPV concentration DFO limit of 13 mm/s and no blast (0) exceeding the IPC measurement DFO limit of 50kPa.

For Whale Tail, 186 blasts were monitored. There were no (0) PPV readings exceeding 13 mm/s and no blast (0) exceeding the IPC measurements DFO limit of 50 kPa.

Table 2: Whale Tail PPV and IPC exceedance 2018-2021

Year	PPV exceedance	IPC exceedance
2018	2	0
2019	8	0
2020	4	0
2021	0	0
2022	2	0
Total	**16**	**0**

A total of 2 PPV exceedances were recorded in 2022. The exceedances occurred on April 18th, 2022, and September 9th, 2022 (egg incubation period is from August 15 to June 30). The events were located at Nemo Lake Station following blast activities related to the IVR 2 pit:

- The exceedance on April 18th was recorded at the IVR Pit Nemo Lake Station corresponding to 5151MSV11 and 5144SUI28 with PPV reading of 17.27 mm/s and IPC of 20.21 kPa. Pattern 5151MSV11 contained six (6) holes detonated on the same delay. The exceedance was not reported to the DFO within the 72h due to a Health and Safety related event. To mitigate the probability of another exceedance, the corrective measures taken and the explanation of the delay in DFO notification are provided in the Appendix A. (20-HCAA-00275-2022-04-18)

- The exceedance on September 9th was recorded at IVR Pit Nemo Lake Station corresponding to 5130MSV08 and 5130MSV26 with PPV reading of 17.37 mm/s and IPC of 20.33 kPa. Pattern 5130MSV08 had three (3) holes detonated on the same delay. To mitigate the probability of another exceedance, the corrective measures taken are provided in the Appendix B. (20-HCAA-00275 2022-09-09)

As a result of DFO guideline exceedance in 2022, the mining team has deployed a number of controls to maintain compliance. In summary, these controls are as follows:

Control: Reinstalled Nemo monitoring station and added redundant data collection
Purpose: Reduce the risk of collecting faulty vibration data and improve theoretical modeling inputs by having multiple sources of comparison.

Control: Blast vibration theoretical model factor of safety increased
Purpose: Additional conservatism built into the vibration model, and internal trigger for pattern redesign (shape, size, hole diameter), in order to limit vibration. This will be regularly reviewed and updated as additional data is collected from the monitoring stations in an effort to improve modeling accuracy.

Control: Decreased blast pattern sizes in vibration sensitive areas
Purpose: Fewer pattern rows reduces the number of holes and charges on the same delay limiting the amount of energy released at the same time which limits vibration.

Control: Patterns with smaller hole diameters in vibration sensitive areas if needed
Purpose: Reduces the overall charge on the same delay limiting the amount of energy released at the same time which limits vibration.

In compliment to the items listed above, each blast design is subject to an approval checklist, that includes a vibration review and tie-in consideration, completed by at minimum 2 qualified people (Designer, Approver). Blast direction to limit shockwave propagation towards sensitive areas is also considered in the design process.

Vibration prediction, or modeling, is also completed for each blast. The modeling is based in using historical seismograph data to help predict expected vibrations from blasts of similar size, location, and geometry. It is calibrated to overestimate vibration in order to maintain a factor of safety within the calculated values. Additionally, Agnico Eagle is also currently evaluating the implementation (partial or complete) of electronic blasting within open pit operations. This would increase the precision of the blast timing allowing for better control of vibration.

In 2022, for Whale Tail Pit, the average PPV was 3.36 mm/s with a maximum of 11.05 mm/s. For IVR Pit, the average PPV was 3.98 mm/s with a maximum of 17.37 mm/s.

As previously mentioned, corrective actions were implemented to minimize recorded PPVs, especially those within a radius of influence near fish stations to remain compliant during blasting operations into the future.

Table 4: Maximum and average PPV and IPC per year

Location	Parameters	2018	2019	2020	2021	2022
Whale Tail Pit	Max PPV (mm/s)	26.1	20.9	14.6	12.7	11.05
	Average PPV (mm/s)	4.5	2.16	0.98	1.6	3.36
	Max IPC (kPa)	30.54	24.46	17.09	14.90	12.93
	Average IPC (kPa)	5.01	2.23	1.19	1.40	3.93
IVR Pit	Max PPV (mm/s)	N/A	N/A	6.5	8.6	17.37
	Average PPV (mm/s)	N/A	N/A	0.67	1.22	3.98
	Max IPC (kPa)	N/A	N/A	7.59	10.10	20.33
	Average IPC (kPa)	N/A	N/A	0.81	1.20	4.66

APPENDIX A – April 18th, 2022 IVR Pit Blast Exceedance

AGNICO EAGLE
MEADOWBANK

April 27th, 2022

José Audet-Lecouffe
Senior Biologist
Fish and Fish Habitat Protection Program
Fisheries and Oceans Canada
301-5204 50th Ave (Franklin)
5204, 50th Avenue
Yellowknife, NT
X1A 1E2

Re: 20-HCAA-00275 – 2022-04-18 Agnico Eagle IVR Pit Blast Exceedance

Dear José Audet-Lecouffe,

Agnico Eagle Mines would like to notify Fisheries and Oceans Canada that on April 18th, 2022 an exceedance in the peak particle velocity (PPV) occurred during the blasting activities related to the Pit IVR-2 at the Meadowbank Complex. As such, please find below information in relation to this event.

As detailed in the Blast Monitoring Program, Agnico Eagle aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002. Those guidelines stipulated that:

- no explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 50 KPa; and
- no explosive is to be detonated that produces a peak particle velocity (PPV) greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank Complex, it takes place between August 15 and June 30).

Description of Event

On April 18th, 2022, patterns 5151MSV11 and 5144SUI28 were blasted in IVR-2. Analyze of the blast monitoring station data at Nemo Station (Figure 1) showed that the PPV was 17.27mm/s and IPC was 20.21 KPa.

As per the normal practices to minimize blast vibrations, the blast tie-in was designed to minimize the amount holes on the same delay.

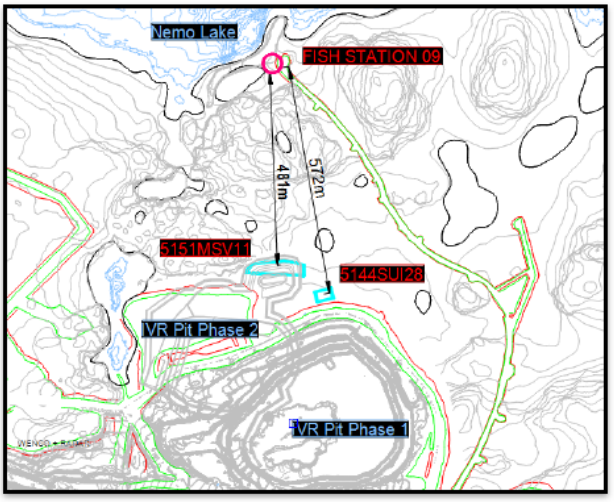

Figure 1: Nemo Lake Blast monitoring station vs blast patterns

Investigation of Exceedance

The blast patterns 5151MSV11 and 5144SUI28 were small in terms of dimension (60,000 tonnes combined) compared to the usual sizes of mass blast patterns (200,000 tonnes plus). The smaller size of the blasts was to help minimize the blast vibrations.

The Blast patterns were designed with the normal drill bit diameter of 6.5inches similar to all other mass blast patterns in the pit.

The distance between the blast pattern 5151MSV11 and Nemo Lake is the shortest one we had to date.

The delay between the event (April 18th) and the reporting (April 27th) is caused by a review in our operating procedure following an event that resulted in an explosion of one of our blast monitors in the hand of an employee. We had to make sure manipulation of the monitor was safe.

Corrective Measures

To minimize the risk of another exceedance, here are the corrective measure that will be implemented:

- The northern part of IVR 2 should be drilled using 4.5" to decrease the explosives load per delay.
- Patterns in IVR-2 will be smaller in size than other mass blasts in IVR-1 and Whale Tail Pit.
- Add a new verification item to our Drill & Blast checklist consisting of validating the vibrations prior to approval to determine if 4.5" or 6.5" is to be used.

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Should you have any questions or require further information, Agnico Eagle remains available at your convenience.

Regards,

Agnico Eagle Mines Limited – Meadowbank Complex

Alexandre Lavallee
Alexandre.lavallee@agnicoeagle.com
Environment and Critical Infrastructures Superintendent

APPENDIX B – September 9th, 2022 IVR Pit Blast Exceedance

September 12th, 2022

José Audet-Lecouffe
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Fisheries and Oceans Canada
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Yellowknife, NT
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20-HCAA-00275 2022-09-09 Agnico Eagle IVR Pit Blast Exceedance

Dear José Audet-Lecouffe,

Agnico Eagle Mines would like to notify Fisheries and Oceans Canada that on September 9th, 2022 at 6:15AM an exceedance in the peak particle velocity (PPV) occurred during the blasting activities related to the Pit IVR- 2 at the Meadowbank Complex. As such, please find below information in relation to this event.

As detailed in the Blast Monitoring Program, Agnico Eagle aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002. Those guidelines stipulated that:

- no explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 50 KPa; and
- no explosive is to be detonated that produces a peak particle velocity (PPV) greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank Complex, it takes place between August 15 and June 30).

Description of Event

On September 9th, 2022, patterns 5130MSV26 and 5130MSV08 were blasted in IVR-2, subsequently. Analysis of the blast monitoring station data at Nemo Station (Figure 1) showed that the PPV was 17.37mm/s and IPC was 20.3 KPa.

As per the normal practices to minimize blast vibrations, the blast tie-in was designed to minimize the amount holes on the same delay.

93, Rue Arseneault, suite 202 Val-d'or, Québec, Canada
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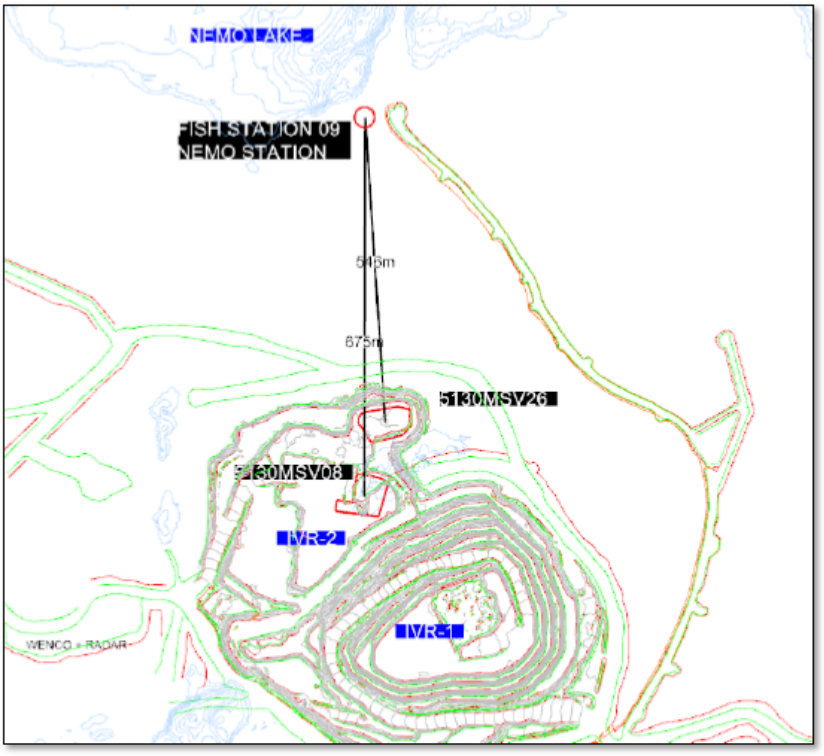

Figure 1: Nemo Lake Blast monitoring station vs blast patterns

Investigation of Exceedance

The blast patterns 5130MSV26 and 5130MSV08 were small in terms of dimension (89,000 tonnes each) compared to the usual sizes of mass blast patterns in IVR- and Whale tail Pit (200,000 tonnes plus). The smaller size of the blasts was to help minimize the blast vibrations by minimizing the blast row length, thus decreasing the amount of holes on the same delay.

The event was analyzed within the first 24 hours, and observed to be at a Peak Particle Velocity of 17.37mm/s and an Instantaneous Pressure Change of 20.3kPA.

Since the last exceedance in April 2022, Agnico Eagle has successfully estimated and monitored 88 blasts at Nemo Station. The theoretical model, with a built-in safety factor to ensure no recorded vibrations exceeds the estimated PPV, was estimating 12.05mm/s for the 5130MSV26 and 12.78mm/s for the 5130MSV08. The large difference between the model that purposefully overestimates the PPV and the recorded one indicates the exceedance likely comes from the instrument itself or the way the geophone was installed.

In addition to the previous corrective measures following the last exceedance in April 2022, a second monitoring station was installed at Nemo Station to have redundancy in the measures to help mitigate the risk of a faulty reading due to poor installation or no event recordings (malfunctioning seismograph). Unfortunately, the second monitoring station for Nemo Lake was recently dismantled for a modification needed at the Freshwater intake Pump Station. The second station was intended to be reinstalled following the completion of the works, estimated to be completed on September 15th.

Lastly, since the last exceedance, awareness and education of the adequate techniques to install a seismograph has been done, with a large emphasis on properly tightening the geophone to the ground via a bolt. However, it is suspected that leaving the bolted geophone with the exposed connections in the environment could also be a cause of the seismograph misreading blast vibrations.

Corrective Measures

To minimize the risk of another exceedance, here are the corrective measure that will be implemented:

- Purchase of 5 new seismographs. This was scheduled for 2023, but will be expedited to this year. This will reduce likelihood of equipment malfunction.
- The second Nemo Station will be reinstalled and all monitoring stations are to be identified with adequate signage.
- The geophones will either be installed in an enclosed and water proof space or brought inside after each use to eliminate the risk of poor connectors contact.
- Until the new seismographs come in and are tested, the safety factor will be increased in the blast vibration model so that the scaled distance relationship formula overestimate to an extent that the estimated PPV of blasts 5130MSV26 and 5130MSV08 is above the recorded value.

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Should you have any questions or require further information, Agnico Eagle remains available at your convenience.

Regards,

Agnico Eagle Mines Limited – Meadowbank Complex

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