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## VOLUME 4 - ATMOSPHERIC ENVIRONMENT

# Whale Tail Pit Project Meadowbank Division

**Submitted to:**
Nunavut Impact Review Board
Nunavut Water Board

REPORT

**Report Number: 1541520**

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# EXECUTIVE SUMMARY – VOLUME 4 ATMOSPHERIC ENVIRONMENT

Volume 4 of the Final Environmental Impact Statement for the Whale Tail Pit and Haul Road Project (the Project) addresses Guidelines issues by the Nunavut Impact Review Board, specifically those relating to effects to the Atmospheric Environment, including climate and meteorology, air quality, and noise and vibration. The effects assessment evaluates all Project phases, including construction, operations, and closure.

## Climate

The Climate and Meteorology section included a review of relevant documents, as well as Inuit Qaujimajatuqangit (IQ) observations from Inuit from Baker Lake. Climate change is a concern for Elders and land users because the unpredictability of weather conditions has resulted in a lack of confidence in using traditional knowledge to predict weather. Inuit are also concerned about the potential effects of climate change to vegetation, wildlife, fish, and other traditional resources.

Greenhouse gas (GHG) emissions from Nunavut are low due to its low population and low intensity of urban/industrial activities. Total average emissions from Nunavut from 2007 to 2011 were 434 kilotonnes of carbon dioxide equivalents per year (kt $CO_{2e}$/yr). Development of the Whale Tail Pit and emissions from traffic along the haul road to Meadowbank Mine are predicted to result in a 56% increase in GHG emissions for Nunavut. However, when compared to Canada's national emissions (714,000 kt $CO_2$e/yr), the Project contributes to a less than 0.05% increase in national GHG emissions.

The short duration of the proposed Project means that climate change related effects to the Project are likely negligible.

## Air Quality and Dust

Inuit depend upon their local environment for their social, cultural, and economic well-being, they are aware of changes to their environment, including air quality. Inuit have documented recent changes to air quality, and are concerned about the potential effects of these changes on their traditional land use activities and resources. Inuit Qaujimajatuqangit highlighted concerns about the effects of dust deposition on vegetation and the sensitivity of caribou, muskox, and other traditional resources to these potential effects. Potential effects of the Project on air quality and atmospheric deposition of dust were predicted and compared to national and territorial air quality guidelines as there are no standards that can be drawn explicitly from IQ.

Local Inuit requested that emissions of fugitive road dust be mitigated through the use of road watering and the application of chemical dust suppressants, and that the accumulation of dust be monitored. Agnico Eagle conducts local meteorology, air quality, and dustfall monitoring at their existing Meadowbank Mine and mitigation and monitoring opportunities at the proposed Project are similar to those at the existing Meadowbank Mine.

The dispersion model-predicted ground level concentrations of carbon monoxide (CO), $NO_2$, and sulfur dioxide ($SO_2$) were very low compared to the baseline and to their relevant ambient air quality standards. Predictions of $PM_{2.5}$ adjacent to the haul road were below Nunavut ambient air quality guidelines within 50 to 75 metres (m) from the haul road. Maximum annual TSP concentrations are predicted to exceed the ambient air quality standard (60 micrograms per cubic metre [$\mu g/m^3$]) within the first 100 to 300 m from the haul road. Predicted dust deposition rates are predicted to be below the BC dustfall standard within 300 m of the haul road. Annual dust deposition is predicted to be below the Ontario dustfall standard within 25 m from the haul road. These standards are considered to be the strictest dust deposition standards in Canada.

The effects of fugitive dust emissions on air quality adjacent to the haul road are limited in spatial extent and occur primarily on dry windy days in the summer. These effects are reversible in that fugitive dust will no longer affect air quality once the Whale Tail Pit is decommissioned and the haul road becomes inactive.

The effects of mining activities at the Whale Tail Pit on regional air quality are limited in spatial extent and occur primarily on dry windy days in summer. These effects are reversible in that emissions will no longer affect air quality once the Whale Tail Pit is decommissioned and the haul road become inactive. Based on an extrapolation of the monitoring results, the effects of an extension to the operations of the Meadowbank Mill and camp on regional air quality are considered low. Any potential effects are considered reversible in that emissions will no longer affect air quality once the Whale Tail Pit and Meadowbank Mill are decommissioned.

The All-Weather Access Road (AWAR) between the community of Baker Lake and the Meadowbank Mine is expected to remain active for a period of up to three years after the Whale Tail Pit operations commence. The significant distance between the AWAR and the Whale Tail operations and the expected limited use of the AWAR limits the potential for combined effects of emissions resulting from the ongoing use of the AWAR and the Whale Tail Pit operations. The most recent (2015) results of the Meadowbank dustfall monitoring program indicate that even in close proximity to the project operations, all samples but 1 out of the 48 collected, compared favourably with the Alberta guidance on dustfall for recreational and residential areas.

The results of this assessment indicate particulate matter and dustfall monitoring at the Whale Tail Pit and along the haul road to the Meadowbank Mine is warranted. The monitoring program will be based on the existing air quality and dustfall monitoring conducted at the Meadowbank Mine, and the dustfall monitoring program along the Meadowbank AWAR to Baker Lake.

Both IQ and scientific monitoring suggest that road watering and the application of chemical suppressants can reduce fugitive dust emissions.

## Noise and Vibration

Haul road construction noise levels for all periods are predicted to be less than the existing ambient noise level at the boundary of the Local and Regional Study Areas (LSA and RSA). The predicted values also indicate that there will be no low frequency noise (LFN) effect along the LSA boundary. Haul road operations noise levels are also predicted to be less than the existing ambient noise level in summertime and wintertime at the boundary of the RSA. Similarly, for all periods, haul road operations Project noise levels are predicted to be less than 35 A-weighted decibel (dBA) at the boundary of the LSA.

Pit Operations noise levels are predicted to be less than 30 dBA at the RSA boundary for both summertime and wintertime. Similarly, for all periods, pit operations noise levels are predicted to be less than the 30 dBA existing ambient noise level for most of the LSA boundary and are predicted to be less than 35 dBA along all areas of the LSA boundary. Summertime and wintertime pit operations cumulative noise levels are predicted to be less than the applicable AER Directive 038 PSL limit along the whole LSA boundary. There will be no LFN effect along the LSA boundary. At the LSA boundary airborne noise levels from Project blasting are predicted to be well below the NCP-119 standard.

The predicted setback distances from pit operations blasting activities required to achieve compliance with DFO peak particle velocity (vibration) and peak pressure level (noise) limits for the protection of spawning fish and fish habitat, are 700 m and 148 m for Fish Spawning areas and Fish Habitat, respectively. During pit operations, blasting will be carefully managed and monitored in the context of DFO limits and appropriate setbacks will be established so that noise and vibration from pit operations blasting do not affect fish spawning or general habitat.

Any potential effects associated with the primary pathways are captured in the assessment of potential effects to, and residual effect classifications for, other valued components, specifically in wildlife, birds, and fisheries.

Follow-up noise monitoring for the Project will be conducted in a way similar to monitoring currently being conducted as part of the Meadowbank Mine noise management plans. Annual monitoring will be conducted at four locations in the vicinity of the Project with locations being selected and adjusted as Project evolves If monitored noise levels exceed appropriate limits, Agnico Eagle will take appropriate actions to identify the specific cause of the exceedance and, if practical, to mitigate the relevant noise source.

# ᓇᐃᓈᖅᓯᒪᔪᖅ – ᐅᖃᓕᒫᒐᖅ 4 ᓯᓚᐅᑉ ᓯᓚᖃᖅᑎᑦᑑᑉ ᐊᕙᑎᖓ

ᐅᖃᓕᒫᒐᖅ 4 ᑭᖑᓪᓕᖅᐹᖅ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᕐᒧᑦ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᕐᒧᑦ ᐊᒻᒪ ᐅᓯᑲᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕐᑯᑎᒧᑦ ᐱᓕᕆᐊᕐᒧᑦ (ᐱᓕᕆᐊᖅ) ᐱᓕᕆᐊᖃᖅᑐᖅ ᒪᓕᒃᑕᐅᔫᒃᓴᓂᒃ ᐱᔾᔪᑕᐅᔪᓂᒃ ᓄᓇᕗᒻᒥ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᖃᒥᕐᖄᔾᒃᑯᓐᓄᑦ, ᐱᓗᐊᖅᑐᒥᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᖃᐅᔨᓴᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓯᓚᐅᑉ ᓯᓚᖃᖅᑎᑦᑑᑉ ᐊᕙᑎᖓᓂᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᓯᓚ ᐊᒻᒪ ᓯᓚᖃᖅᑎᑦᑐᖅ, ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓂᖓ, ᐊᒻᒪ ᓂᐱᖃᕐᓂᖅ ᐊᒪᓗ ᓴᔪᕋᓛᕐᓂᐅᔪᑦ. ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓃᑦ ᕿᒥᕐᕈᔪᑦ ᑕᒪᐃᓄᓗᒃᑖᖅ ᐱᓕᕆᐊᑉ ᓇᓃᓐᓂᓇᔭᖏᓐᓂᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᓴᓇᔭᐅᓂᖓ, ᐊᐅᓛᖅᑎᑦᑎᓂᖅ, ᐊᒻᒪ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᓂᖅ.

## ᓯᓚ

ᓯᓚ ᐊᒻᒪ ᓯᓚᖃᖅᑎᑦᑐᖅ ᐊᕝᒃᑐᖅᓯᒪᓂᕐᒥᑦ ᐃᓚᐅᔪᖅ ᕿᒥᕐᕈᓂᖅ ᑕᒪᑐᒨᖓ ᑎᑎᖅᑲᓂᒃ, ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ (IQ)-ᒥᑦ ᖃᐅᔨᔭᐅᔪᑦ ᐃᓄᖕᓂᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᐅᓂᑦ. ᓯᓚᐅᑉ ᐊᓯᔾᔨᕐᓂᖓ ᐃᓱᒪᓘᑕᐅᔪᖅ ᐃᓐᓇᓇᔭᐅᔪᓄᑦ ᐊᒻᒪ ᓄᓇᒥᒃ ᐊᑐᖃᑦᑕᖅᑐᓄᑦ ᓇᓗᓇᕐᓂᓇᔭᖕᒐᓄᑦ ᓯᓚᐅᑉ ᐊᓯᔾᔨᖃᑦᑕᕐᓂᖓ ᓇᓗᓂᖅᑕᖃᓕᖅᑎᑦᑎᔪᖅ ᐊᑐᖅᑕᐅᓂᖏᑦ ᐱᖅᑯᓯᒃᑯᑦ ᖃᐅᔨᒪᓂᓇᔭᐅᔪᑦ ᓇᓚᐅᑦᑎᓂᕐᒧᑦ ᓯᓚᒥᒃ. ᐃᓄᐃᑦ ᐃᓱᒫᓘᑎᖃᕐᒥᔪᑦ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓᓄᑦ ᐱᕈᖅᑐᓄᑦ, ᓂᕐᔪᑎᓄᑦ, ᐃᖃᓗᖕᓄᑦ, ᐊᒻᒪ ᐊᓯᖏᓐᓄᑦ ᐱᖅᑯᓯᓇᔭᐅᔫᒃᑯᑦ ᐱᕚᓪᓕᖃᑦᑕᖅᑐᓂᒃ.

ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᑦ ᓯᓚᒧᑦ (GHG) ᓄᓇᕗᒻᒥᑦ ᐊᑦᑎᒃᑑᔪᑦ ᐊᒥᓲᖏᓐᓂᖏᓐᓄᑦ ᐃᓄᖏᑦ ᓄᓇᕗᒻᒥᐅᑕᐃᑦ ᐊᒻᒪ ᐊᖏᓗᐊᖏᓪᓗᓂ ᐱᓕᕆᕚᓪᔪᐊᖑᖃᑦᑕᖅᑐᓂᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ. ᑲᑎᓗᒃᑖᖅᓗᒥᑦ ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᓄᑦ ᓈᓴᐅᑏᑦ ᓄᓇᕗᒻᒥᑦ 2007-ᒥᑦ 2011-ᒧᑦ 434 (KILOTONNES) ᑭᓗᑕᓐ-ᖑᓚᐅᖅᑐᑦ ᑳᐸᓐ ᑕᐃᔭᒃᓴᐃᑦ ᐊᔾᔨᐸᓗᒥᑦ ᐅᑭᐅᒥᑦ (kt $CO_{2e}$/yr). ᐱᕝᕙᓪᓕᐊᓂᖓ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᖅ ᐊᒻᒪ ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᑦ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᑦ ᐅᓯᑲᑦᑕᓂᕐᒧᑦ ᐊᑉᕐᑯᑎᒃᑯᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ 56%-ᒥᑦ ᐊᖏᓪᓕᒋᐊᕐᓂᐊᕐᓂᖓᓄᑦ GHG ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᑦ ᓄᓇᕗᒻᒧᑦ. ᑭᓯᐊᓂ, ᑕᐅᑐᖕᒑᖅᓗᒍ ᑲᓇᑕᒥᑦ ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᑦ (714,000 kt $CO_2e$/yr), ᐱᓕᕆᐊᖅ ᐃᑲᔪᐃᓯᒪᔪᖅ 0.05% ᑐᖖᒑᓂᑦ ᐊᖏᓪᓕᒋᐊᖅᑐᒥᒃ ᑲᓇᑕᐅᑉ GHG-ᓂᒃ ᐊᓂᐊᔪᖏᓐᓄᑦ.

ᓇᐃᑦᑑᓇᔭᕐᓂᖓ ᐱᓕᕆᐊᖑᔪᒪᔪᖅ ᑐᑭᖃᖅᑐᖅ ᓯᓚᐅᑉ ᐊᓯᔾᔨᕐᓂᖓ ᐱᔾᔪᑎᖃᖅᑐᖅ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐱᓕᕆᐊᕐᒧᑦ ᐅᔾᔨᕐᓇᖅᑐᖕᒋᑦᑐᖅ.

## ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓂᖓ ᐊᒻᒪ ᐊᓂᖅᓵᖅᑐᖅᑕᕗᑦ

ᐃᓄᐃᑦ ᐊᑐᖅᑲᑦᑕᖅᑐᑦ ᖃᓂᑕᖏᓂᒃ ᐊᕙᑎᒋᔭᖏᓂᒃ ᐃᓅᖅᑎᒌᖕᓂᕐᒧᑦ, ᐱᖅᑯᓯᕐᒧᑦ, ᐊᒻᒪ ᐱᕈᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᖃᓄᐃᖏᑦᑎᐊᕐᓂᕐᒧᑦ, ᐅᔾᔨᕈᓱᒃᑐᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᓂᒃ ᐊᕙᑎᖓᓄᑦ, ᐃᓚᐅᑉᓗᓂ ᐊᓂᖅᓵᖅᑐᖅᑕᖏᑦᑕ ᖃᐅᔨᓂᖓᑦ. ᐃᓄᐃᑦ ᖃᐅᔨᓯᒪᔪᑦ ᓖᓐᓇᓵᖅ ᐊᓯᐊᖑᕐᓂᐅᔪᓂᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ, ᐊᒻᒪ ᐃᓱᒪᓘᑎᖃᖅᑐᑦ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐱᖅᑯᓯᒃᑯᑦ ᓄᓇᒥᒃ ᐊᑐᖃᑦᑕᖅᑕᖏᓐᓂᑦ ᐊᒻᒪ ᐱᕝᕕᖃᑦᑕᖅᑕᖏᓐᓂᑦ. ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᐃᓱᒪᓘᑕᐅᔪᒃ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᒃ ᐳᔪᖃᑖᑉ ᒥᒃᓵᓄᑦ ᐱᕈᖅᑐᓄᑦ ᐊᒻᒪ ᐃᒃᐱᒋᓴᕋᐃᓂᖏᓐᓄᑦ ᑐᒃᑐᐃᑦ, ᐅᒥᖕᒪᐃᑦ, ᐊᒻᒪ ᐊᓯᖏᑦ ᐱᖅᑯᓯᒃᑯᑦ ᐱᕚᓪᓕᖃᑦᑕᖅᑐᑦ ᑕᒪᒃᑯᓄᖓ ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓄᑦ. ᖃᐅᔨᓴᕐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓂᖃᕐᓂᖓᓄᑦ ᐊᒻᒪ ᓯᓚᖃᖅᑎᑦᑐᒧᐊᖅᑐᑦ ᐳᔪᖃᑏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓚᐅᖅᑐᑦ ᑲᓇᑎᒥᐅᖓᓂᑦ ᐊᒻᒪ ᓄᓇᕗᒻᒥᐅᖓᓂᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓂᖏᖕᒋᓐᓄᑦ ᒪᓕᒃᑕᐅᔫᒃᓴᐃᑦ ᐊᑐᖅᑕᐅᔪᖅᑕᖃᕐᒪᑦ ᓇᓗᓇᐃᖅᑕᐅᔪᖕᓇᖅᑐᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ.

ᓄᓇᓕᖕᒥᐅᑕᐃᑦ ᐃᓅᔪᑦ ᑐᒃᓯᕋᓚᐅᖅᑐᑦ ᐱᐅᖏᑦᑐᓂᒃ ᐊᓂᐊᔪᓂᒃ ᐊᑉᕐᑯᑎᒥᑦ ᐳᔪᖃᑖᒃ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑕᐅᖁᐸᓗᒍ ᐊᑐᕐᓗᑎᒃ ᐊᑉᕐᑯᑎᒥᒃ ᐃᒻᒥᖅᑐᐃᑲᑦᑕᕐᓂᒃᑯᑦ ᐊᑐᖅᑕᐅᑲᑦᑕᖅᑐᓂᒃ ᐳᔪᖃᑖᖃᓗᐊᖅᑕᐃᓕᑎᑦᑎᓂᕐᒥᒃ, ᐊᒻᒪ ᑲᑎᐸᓪᓕᐊᔪᑦ ᐳᔪᖃᑖᒃ ᖃᐅᔨᓯᐊᖅᑕᐅᑲᑦᑕᕐᓗᓂ. ᐊᓪᓃᖅᑯᑦ ᓯᓚᓕᓇᑲᑦᑕᖅᑐᑦ ᐃᓂᖃᕐᕕᒋᔭᖓᓂᑦ, ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᐅᔨᓂᓇᔭᖓᓂᑦ, ᐊᒻᒪ ᐳᔪᖃᑖᖑᒥᒃ ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑕᒪᒪᐅᔪᒥᒃ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᑦ ᐊᒻᒪ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓗᑎᒃ ᐊᒻᒪ ᖃᐅᔨᓯᐊᖃᑦᑕᖅᓗᑎᒃ ᐱᕕᖃᕐᓂᐅᔪᑦ ᐱᓕᕆᐊᖑᔪᒪᔪᒥᑦ ᐊᔾᔨᖃᕐᓗᑎᒃ ᑕᒪᒪᐅᔪᓂᒃ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᑦ.


AGNICO EAGLE
Golder Associates

ᓯᐊᒻᒪᒃᑕᐅᓂᖓ ᐋᖅᑭᐅᒪᔪᖅ-ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᓄᓇᒦᖓᔪᖅ ᑲᑎᓯᒪᔪᑦ carbon monoxide (CO), $NO_2$, ᐊᒻᒪᓗ sulfur dioxide ($SO_2$) ᐊᑦᑎᒃᑐᒻᒪᕆᐅᓚᐅᖅᑐᑦ ᑕᐅᑐᖕᒎᖅᔪᒋᑦ ᑮᓕᕐᔭᐅᔪᑦ ᐊᒻᒪᓗ ᐊᑦᔨᖏᓐᓂᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᐊᑐᖅᑕᐅᔪᓄᑦ. ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ PM2.5 ᓄᑦ ᐊᑭᐊᓃᑦᑐᑦ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᐅᑉ ᐊᑖᓃᓚᐅᖅᑐᑦ ᓄᓇᒥᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᒪᓕᒃᑕᐅᔫᒃᓴᖏᓐᓄᑦ 50-ᒥᑦ 75-ᒧᑦ ᒦᑕᓄᑦ (m) ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ. ᐊᖏᕋᒃᑯᑦ ᐊᕐᕋᒍᑕᒫᑦ TSP ᑲᑎᓯᒪᔪᑦ ᓇᓚᐅᑦᑖᒻᑕᐅᔪᑦ ᐅᖓᑕᐅᑦᑎᓂᐊᕐᓂᖏᓐᓄᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᓂᐃᓐᓂᖓᓄᑦ ᐊᖅᑐᖅᑕᐅᔪᒥᑦ (60 micrograms cubic ᒦᑕᑕᒫᑦ [ $^{3}$]g/m ᓯᕗᓪᓕᖅᐸᐅᔪᑦ 100-ᒥᑦ 300-ᒧᑦ ᒦᑕᓄᑦ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ. ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐳᔪᖃᑖᓄᑦ ᓈᓴᐅᑏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐊᑖᓐᓂᐊᕐᓂᖏᓐᓄᑦ BC ᐳᔪᖃᑖᖕᒧᑦ ᐊᑐᖅᓂᑕᐅᔪᓂᑦ 300 m ᒦᑕᓂᒃ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ. ᐊᕐᕋᒍᑕᒫᑦ ᐳᔪᖃᑖᒃ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᐊᑦᑎᖕᓂᖅᓴᐅᓂᖓᓄᑦ ᐋᑎᐅᖁᔪᒥᑦ ᐳᔪᖃᑖᖕᒧᑦ ᐊᑐᖅᑕᐅᔪᒥᑦ 25 m ᒦᑕᐅᑉ ᐃᓗᐊᓂᑦ ᐅᓯᒃᑲᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑕᐅᑉ ᐃᓗᐊᓂᑦ. ᑕᒪᒃᑯᐊ ᐊᑐᖅᑕᐅᔪᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐊᐅᓚᑕᐅᓪᓚᕆᖕᓂᖏᓐᓄᑦ ᐊᑐᖅᑕᐅᔪᓂᑦ ᑲᓇᑕᒥᑦ.

ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐳᔪᖃᑖᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑎᖕᓄᑦ ᐊᑭᐊᓂᑦ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎ ᑮᓕᖃᖅᑐᑦ ᑎᑭᐅᑎᓂᕐᒧᑦ ᐊᖓᔾᔪᖕᓂᕐᒧᑦ ᐊᒻᒪᓗ ᑕᐃᒪᐅᖃᑦᑕᓗᐊᖅᑐᑦ ᐸᓂᖅᑎᓪᓗᒍ ᐊᓄᓇᑐᔪᒥᑦ ᐊᐅᔭᒃᑯᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐅᑎᕈᖕᓇᖅᑐᑦ ᐳᔪᖃᑖᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᖖᓂᕐᓗᑎᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᓄᐃᓐᓂᓇᔭᖏᓐᓄᑦ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᖅ ᐊᑐᖅᑕᐅᔪᖕᓃᖅᐸᑦ ᐊᒻᒪᓗ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎ ᐊᑐᖅᑕᐅᔪᖕᓃᖅᐸᑦ.

ᐊᑐᖅᑯᒋᑦ ᕿᓂᖅᓴᐃᓂᕐᒧᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐅᐃᒍᒋᐊᖅᑕᐅᓂᖓᓄᑦ ᐊᐅᓐᖅᑎᑦᑎᓃᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᓯᖃᓪᓕᑎᓇᕝᕚᖕᒥᑦ ᐊᒻᒪᓗ ᓄᓇᓕᐊᓐᒥᑦ ᐊᓂᕌᖅᑐᖅᑕᑉᑕ ᖃᓄᐃᓐᓂᖓᓄᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᖓᓄᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐅᑎᖅᑎᑦᑐᖅᓇᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐱᐅᖏᑦᑐᑦ ᐊᓂᐊᔪᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᖖᓃᕐᓂᐊᕐᒪᑕᑦ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᓄᐃᓐᓂᖓᓄᑦ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᖅ ᐊᒻᒪᓗ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᐊᑐᖅᑕᐅᔪᖕᓃᖅᐸᑕ.

ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕿᑎᐅᔪᖅ (AWAR) ᐊᑯᓐᓂᖓᓃᑦᑐᖅ ᖃᒪᓂᑦᑐᐊᑉ ᐊᒻᒪᓗ ᐊᐳᖅᑎᓈᖅᑑᑉ ᓂᕈᐅᒋᔭᐅᔪᖅ ᐊᑐᖅᑕᐅᖕᒋᓇᕐᓂᐊᕐᓂᖓᓄᑦ ᐅᑭᐅᓄᑦ ᐱᖓᓱᓄᑦ ᑎᑭᓪᓗᒍ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᕐᒥᑦ ᐊᐅᓛᕐᓃᑦ ᓄᖅᑲᖅᑳᖅᑎᓪᓗᒍ. ᐅᖓᓯᖕᓂᖓ ᐊᑯᓐᓂᖏᓐᓂᑦ AWAR ᐊᒻᒪᓗ Whale Tail-ᒥᑦ ᐊᐅᓛᕐᓃᑦ ᐊᒻᒪᓗ ᓂᕈᐅᒋᔭᐅᔪᖅ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᐊᕐᓂᖓ AWAR ᑮᓕᖅᑲᖅᑎᑦᑎᔪᖅ ᑲᑎᒪᔪᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐱᐅᖏᑦᑐᓂᒃ ᐊᓂᐊᔪᓂᑦ ᐊᑐᖅᑕᐅᖏᓇᕐᓂᖓᓄᑦ AWAR ᐊᒻᒪᓗ Whale Tail-ᒥᑦ ᐊᐅᓛᕐᓂᐅᔪᓄᑦ. ᒫᓇᓵᖑᓛᖑᔪᖅ (2015) ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐳᔪᖃᑖᒥᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᖅ ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᖅ ᖃᓂᑦᑑᓕᓗᐊᕐᒥᑦ ᐱᓕᕆᐊᑉ ᐊᐅᓛᕐᓂᕆᔭᖓᑕ, ᐆᒃᑐᕋᖅᑕᐅᔪᓗᒃᑖᑦ ᑖᑉᑯᓇᓂ ᐆᒃᑐᕋᖅᑕᐅᔪᓂᑦ ᐊᑕᐅᓯᖅ ᐃᓚᐅᖕᒋᕐᔪᒧᑦ 48-ᖑᔪᓂᑦ ᑲᑎᑕᐅᔪᓂᑦ, ᐱᐅᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᐃᐋᐳᑕᐅᑉ ᒪᓕᒃᑕᐅᔫᒃᓴᖏᓐᓄᑦ ᐳᔪᖃᑖᒧᑦ ᐊᑐᖅᑕᐅᒥᐊᖅᑐᒥᑦ ᐊᒻᒪᓗ ᐊᖏᕐᕋᓇᔭᐅᔪᑦ ᐃᓂᖏᓐᓂᑦ.

ᖃᓄᐃᖓᓂᐅᔪᑦ ᖃᐅᔾᔭᐃᓂᕐᒥᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᒥᑭᔪᑯᓗᖕᓂᑦ ᐊᒻᒪᓗ ᐳᔪᖃᑖᒥᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᕐᒥᑦ ᐊᒻᒪᓗ ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐱᓕᕆᐊᖑᓯᒪᔪᖅ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᖅ ᐊᑐᕐᓂᐊᖅᑐᖅ ᑕᐃᒪᐅᔪᕐᒥᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑕ ᖃᓄᐃᓐᓂᖓᓄᑦ ᐊᒻᒪᓗ ᐳᔪᖃᑖᒧᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒥᒃ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ, ᐊᒻᒪᓗ ᐳᔪᖃᑖᖕᒥᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᖅ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐊᑉᕿᑎᒥᑦ ᖃᒪᓂᑦᑐᐊᕐᒧᖕᒐᐅᔪᒧᑦ.

ᑕᒪᕐᒥᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᐊᒻᒪᓗ ᐃᓕᓐᓂᐊᖅᓯᒪᓂᖃᕐᓂᒃᑯᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᓇᓗᓇᐃᖅᑐᖅ ᐊᑉᕿᑎᒥᒃ ᐃᒻᒥᖅᑐᐃᓂᖅ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᓂᖓ ᐳᔪᖃᑖᖃᓗᐊᖅᑕᐃᓕᑎᑦᑎᔩᑦ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᔪᖕᓇᖅᑐᑦ ᐳᔪᖃᑖᒥᒃ.

## ᓂᐱᖃᕐᓂᖅ ᐊᒻᒪᓗ ᓴᔪᕋᓛᖕᓂᐅᔪᖅ

ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎ ᓴᓇᔭᐅᓂᖓᓄᑦ ᓂᐱᖃᕐᓂᐅᑉ ᓇᓃᓐᓂᕆᔭᖓᓂᑦ ᑕᒪᐃᓐᓄᑦᑖᖅ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖏᓐᓄᑦ ᑕᐅᒪᐅᔪᒥᒃ ᓂᐱᖃᕐᓂᐅᔪᒥᒃ ᑮᓕᖓᓄᑦ ᖃᓐᓂᖅᓴᒥᑦ ᐊᒻᒪᓗ ᐅᖓᓯᖕᓂᖅᓴᒥᑦ ᖃᐅᔾᔭᐃᓂᐅᔪᓂᑦ (LSA ᐊᒻᒪᓗ RSA). ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᓈᓴᐅᑏᑦ ᓇᓗᓇᐃᖅᓯᖕᒥᔪᑦ ᐊᑦᑎᒃᑑᖓᔪᒥᒃ ᓂᐱᑕᖃᒃᔮᖕᒋᓐᓂᖓᓄᑦ (LFN) ᖃᓄᐃᖓᓕᖅᑎᑦᑎᔪᒥᒃ LSA-ᒥᑦ ᑮᓕᐅᔪᒧᑦ. ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ ᐊᐅᓛᕐᓂᐅᔪᒥᑦ ᓂᐱᖃᕐᓂᐅᑉ ᓇᓃᓐᓂᕆᔭᖏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᖕᒥᔪᑦ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖓᓄᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᓂᒃ ᐊᐅᔭᒧᑦ ᐊᒻᒪᓗ ᐅᑭᐅᖑᑎᓪᓗᒍ ᑮᓕᕐᔭᖓᓂᑦ RSA. ᐊᔾᔨᖓᓂᖓ, ᓇᓃᓐᓂᓗᒃᑖᖑᔪᓂᑦ, ᐅᓯᑦᑕᖕᓂᕐᒧᑦ ᐊᑉᕿᑎ ᐊᑐᖅᑕᐅᑎᓪᓗᒍ ᐱᓕᕆᐊᒥᑦ ᓂᐱᖃᕐᓂᐅᑉ ᓇᓃᓐᓂᕆᔭᖓᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖓᓄᑦ 35 (dBA)-ᒥᑦ ᑮᓕᕐᔭᖓᓄᑦ LSA.

ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ ᐊᐅᓛᕐᓂᕐᒧᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖓᓄᑦ 30 dBA-ᒥᑦ ᑭᒡᓕᕆᔾᔪᑎᒥᑦ RSA ᑕᒪᐃᓐᓄᑦ ᐊᐅᔾᔭᑯᑦ ᐊᒻᒪᓗ ᐅᑭᐅᒃᑯᑦ. ᑕᐃᒪᓐᓇᑦᑕᐅᖅ, ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ ᐊᐅᓛᖅᑎᑦᑎᓂᕐᒧᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᖅ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖓᓄᑦ 30 dBA ᑕᐃᒪᐅᔪᒥᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᒥᑦ ᑕᒪᐃᓄᓗᒃᑖᖅᖃᔾᔪᖅ ᑭᒡᓕᕆᔾᔪᑎᒥᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖓᓄᑦ 35 dBA-ᒥᑦ ᐃᓂᐅᔪᓗᒃᑖᓂᑦ LSA ᑭᒡᓕᕆᔾᔪᖓᓄᑦ. ᐊᐅᔾᔭᑯᑦ ᐅᑭᐅᒃᑯᓪᓗ ᐃᓗᑦᑐᖅᓯᒪᔪᒥᒃ ᐊᐅᓛᖅᑎᑦᑎᓂᕐᒥᑦ ᑲᑎᑉᐸᓪᓕᐊᔪᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖏᓐᓄᑦ ᐊᑐᖅᑕᐅᔾᔪᑎᐊᖃᖅᑐᒥᑦ AER ᒪᓕᒃᑕᐅᔫᖅᓴᒥᑦ 038 PSL-ᒧᑦ ᑭᒡᓕᐅᔪᒥᑦ ᑕᒪᓗᒃᑖᒧᑦ LSA ᑭᒡᓕᖃᖅᑎᑕᖓᓄᑦ. LFN-ᒥᒃ ᐱᔪᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖅᑕᖃᔅᔫᖏᑦᑐᖅ LSA ᑭᒡᓕᖃᖅᑎᑕᖓᓄᑦ. LSA ᑭᒡᓕᖃᖅᑎᑕᖓᓂᑦ ᓯᓚᒧᐊᖅᑐᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᑦ ᐱᓕᕆᐊᕐᒥᑦ ᖀᖅᑎᕆᓂᕐᒧᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᖕᓂᖅᓴᒃᓚᐅᓂᐊᕐᓂᖓᓄᑦ NCP-119-ᒥᑦ ᐊᑐᖅᑕᐅᔾᔪᑎᐊᓕᖕᒥᑦ.

ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᔪᖅ ᐅᖓᓱᖕᓂᐅᔪᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᕐᒥᑦ ᖃᖅᑎᕆᓂᕐᓂᑦ ᐱᔭᕆᐊᖃᖅᑐᖅ ᒪᓕᒋᐊᖃᕐᓂᕐᒧᑦ ᐃᖃᓗᓕᕆᔨᒃᑯᑦ ᓴᔫᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᓂᐱᖃᕐᓂᕐᒧᑦ ᑭᒡᓕᓕᐅᖅᓯᒪᔾᔭᖏᓐᓄᑦ ᒥᐊᓂᕆᓂᕐᒧᑦ ᒪᓐᓂᓕᐅᖅᑐᖅ ᐃᖃᓗᐃᑦ ᐊᒻᒪᓗ ᐃᓂᖏᑦ, 700 ᒦᑕᐅᔪᑦ ᐊᒻᒪᓗ 148 ᒦᑕᐅᑉᓗᑎᒃ ᐃᖃᓗᐃᑦ ᒪᓐᓂᓕᐅᕐᕕᖏᓐᓂᑦ ᐃᓂᖏᓐᓄᒡᓗ. ᐃᓗᑦᑐᖅᓯᒪᔪᕐᒥᑦ ᐊᐅᓛᕐᓂᐅᑎᒡᓗᒍ, ᖃᖅᑎᕆᓂᖅ ᐊᐅᓚᑕᐅᑎᐊᕐᓂᐊᖅᑐᖅ ᐊᒻᒪᓗ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓗᑎᒃ ᐃᖃᓗᓕᕆᔨᒃᑯᑦ ᑭᒡᓕᓕᐅᖅᓯᒪᔾᔭᖏᑦ ᐋᕿᒃᓯᒪᔾᔭᖏᒡᓗ ᓴᖅᑭᑕᐅᓗᑎᒃ ᓂᐱᖃᕐᓂᖅ ᐊᒻᒪᓗ ᓴᔫᑎᑦᑎᓂᖅ ᖄᖅᑎᕆᓂᕐᒥᑦ ᐱᔪᓂᒃ ᐊᒃᑐᖅᓯᓂᖃᔅᔫᖏᒻᒪᑕ ᒪᓐᓂᓕᐅᖅᑐᓂᒃ ᐃᓂᕆᔾᔮᖏᓐᓂᓪᓘᓐᓃᑦ.

ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᔪᑦ ᐊᑉᖁᑕᐅᓗᐊᖅᑐᓂᑦ ᖃᐅᔮᓴᐃᓂᕐᒦᑦᑐᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᑦ, ᐊᒻᒪᓗ ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑏᑦ ᐃᓂᓕᐅᖅᓯᒪᔪᑦ, ᐊᓯᖏᑦ ᐃᒃᐱᒋᓂᖅᕼᐅᔪᑦ ᐃᓚᒋᔾᔪᔪᑦ, ᐱᓗᐊᖅᑐᒥᑦ ᓂᕐᔪᑎᓂᑦ, ᑎᖕᒥᐊᓂᑦ, ᐊᒻᒪᓗ ᐃᖃᓗᖕᓂᑦ.

ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᕐᒧᑦ ᐱᓕᕆᐊᖑᓂᐊᖅᑐᖅ ᐊᔾᔨᒌᓗᒍ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᒫᓇᐅᔪᖅ ᐱᓕᕆᐊᖑᔪᑦ ᐃᓚᒋᔭᐅᑉᓗᓂ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᓂᑦ. ᐊᕐᖍᒍᑕᒫᖅ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒥᒃ ᐱᓕᕆᐊᖃᕐᓂᐊᖅᑐᑦ ᓯᑕᒪᓄᑦ ᐃᓂᐅᔪᓄᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐃᓂᐅᔪᑦ ᓂᕈᐊᖅᑕᐅᓗᑎᒃ ᐊᒻᒪᓗ ᐋᕿᒋᐊᖅᑕᐅᓗᑎᒃ ᐱᓕᕆᐊᖅ ᐱᕚᓪᓕᐊᓂᖓᓂᑦ. ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᓂᐱᖃᓂᐅᑉ ᓇᓃᓐᓂᕆᔭᖏᑦ ᐅᖓᑕᐅᑦᑎᒃᐸᑕ ᑭᒡᓕᐅᔪᓄᑦ, ᐊᓃᕈᒃᑯᑦ ᖃᓄᐃᓕᐅᕆᐊᕐᓂᐊᖅᑐᑦ ᐃᓕᑕᖅᓯᓂᕐᒧᑦ ᐱᔾᔪᑕᐅᔪᒥᒃ ᐅᖓᑕᐅᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ, ᓈᒻᒪᒃᐸᑦ, ᐊᖏᕈᐊᖏᕆᐊᖅᑎᓪᓗᒋᑦ ᓂᐱᖃᖅᑎᑦᑎᔪᖅ.

# SOMMAIRE DE GESTION – VOLUME 4 – L'ENVIRONNEMENT ATMOSPHÉRIQUE

Le Volume 4 de l'Énoncé des incidences environnementales du Projet de gisement Whale Tail et de route de transport (le Projet) traite des directives et lignes directrices émises par la Commission du Nunavut chargée de l'examen des répercussions, plus particulièrement celles relatives aux effets sur l'environnement atmosphérique, dont le climat et la météorologie, la qualité de l'air, ainsi que le bruit et les vibrations. L'évaluation des effets s'attarde à évaluer toutes les phases du Projet, incluant la construction, les opérations et la fermeture.

## Le climat

La section sur le climat et la météorologie inclut un examen des documents pertinents, ainsi que des observations sur l'Inuit Qaujimajatuqangit (IQ) de la part d'Inuits de Baker Lake. Les changements climatiques sont une source d'inquiétude pour les aînés et les utilisateurs des terres puisque l'imprévisibilité des conditions climatiques a mené à un manque de confiance envers l'usage des connaissances traditionnelles pour prévoir la température. Les Inuits sont également concernés par les effets potentiels des changements climatiques sur la végétation, la faune, le poisson et les autres ressources traditionnelles.

Les émissions de gaz à effet de serre (GES) du Nunavut sont faibles en raison de sa population restreinte et de la faible intensité de ses activités urbaines/industrielles. Les émissions moyennes totales du Nunavut de 2007 à 2011 étaient de 434 kilotonnes d'équivalent de dioxyde de carbone par an (kt $CO_{2e}$/an). Le développement du gisement Whale Tail et des émissions engendrées par la circulation le long de la route de transport vers la mine Meadowbank devrait mener à une augmentation de 56 % des émissions de GES pour le Nunavut. Cependant, lorsque comparé aux émissions nationales du Canada (714 000 kt $CO_2$e/an), le Project contribue à une augmentation de moins de 0,05 % des émissions canadiennes de GES.

La courte durée du Projet proposé signifie que les effets du Projet associés aux changements climatiques sont susceptibles d'être négligeables.

## La qualité de l'air et la poussière

Les Inuits dépendent de leur environnement local pour leur mieux-être social, culturel et économique. Ils sont conscients des changements subits par leur environnement, dont la qualité de l'air. Les Inuits ont documenté de récents changements à la qualité de l'air et se questionnent sur les effets potentiels de ces changements sur leurs activités et leurs ressources en lien avec l'utilisation traditionnelle de la terre. L'Inuit Qaujimajatuqangit met en relief des questionnements au sujet des effets des dépôts de poussière sur la végétation et la sensibilité du caribou du bœuf musqué et d'autres ressources traditionnelles à ces effets potentiels. Les effets potentiels du Projet sur la qualité de l'air les dépôts atmosphériques de la poussière ont été prévus et comparés aux directives nationales et territoriales sur la qualité de l'air étant donné u'il n'existe pas de normes pouvant être tirées explicitement des IQ.

Les Inuits locaux ont demandé que les émissions fugitives de poussière de route soient atténuées par l'arrosage des routes et l'application de contrôles chimiques de la poussière, et que l'accumulation de poussière soit surveillée. Agnico Eagle procède à la surveillance locale de la météorologie, de la qualité de l'air et des retombées de poussières à la mine Meadowbank et les possibilités d'atténuation et de surveillance du Projet proposé sont similaires à celles de la mine actuelle de Meadowbank.

Les concentrations au niveau du sol prédites par modélisation de la dispersion du monoxyde de carbone (CO), $NO_2$ et du dioxyde de soufre ($SO_2$) étaient très faibles comparées aux données de base et leurs normes pertinentes en matière de qualité de l'air ambiant. Les prévisions de $MP_{2,5}$ adjacentes à la route de transport se situaient en deçà des directives de qualité de l'air ambiant du Nunavut entre 50 et 75 mètres (m) à partir de la route de transport. Les concentrations de MPT annuelles maximales devraient dépasser la norme de qualité de l'air ambiant (60 microgrammes par mètre cube [$\mu g/m^3$]) à l'intérieur des premiers 100 à 300 m de la route de transport. Les taux de dépôt de poussière prévus devraient se situer en deçà de la norme de retombées de poussières de la C.-B. à l'intérieur des 300 m de la route de transport. Le dépôt annuel de poussière devrait se situer en deçà de la norme de retombées de poussières de l'Ontario à l'intérieur de 25 m à partir de la route de transport. Ces normes sont considérées comme les normes canadiennes les plus sévères en matière de dépôt de poussière.

Les effets des émissions fugitives de poussière sur la qualité de l'air à proximité de la route de transport sont limités dans l'espace et se produisent principalement en été, lors de journées venteuses et sèches. Ces effets sont réversibles et cette poussière fugitive cessera d'affecter la qualité de l'air une fois que la fosse Whale Tail sera déclassée et que la route de transport ne sera plus active.

Les effets des activités minières du gisement Whale Tail sur la qualité de l'air de la région sont limités dans l'espace et se produisent principalement en été, lors de journées venteuses et sèches. Ces effets sont réversibles et ces émissions cesseront d'affecter la qualité de l'air une fois que la fosse Whale Tail sera déclassée et que la route de transport ne sera plus active. En se basant sur une extrapolation des résultats de surveillance, les effets d'un prolongement des opérations de l'usine et du campement de Meadowbank sur la qualité de l'air de la région sont considérés comme faibles. Tout effet potentiel est considéré comme réversible et ces émissions cesseront d'affecter la qualité de l'air une fois que la fosse Whale Tail et l'usine de Meadowbank seront déclassées.

La route d'accès praticable par tous les temps (AWAR) entre la collectivité de Baker Lake et l'usine de Meadowbank devrait demeurer active pour une période allant jusqu'à 3 ans après le début des opérations de la fosse Whale Tail. La distance importante entre l'AWAR et les opérations de Whale Tail, ainsi que l'utilisation limitée envisagée de l'AWAR limitent le potentiel d'effets combinés des émissions résultant de l'usage continu de l'AWAR et des opérations de la fosse Whale Tail. Les résultats les plus récents (2015) du programme de surveillance des retombées de poussières de Meadowbank indiquent que même à proximité restreinte des activités du Projet, tous les échantillons sauf 1 sur les 48 qui ont été recueillis, ont pu être comparés favorablement aux directives de l'Alberta sur les retombées de poussières dans les zones récréatives et résidentielles.

Les résultats de cette évaluation indiquent que la surveillance des matières particulaires et des retombées de poussières autour de la fosse Whale Tail et le long de la route de transport jusqu'à la mine Meadowbank est garantie. Le programme de surveillance sera basé sur la surveillance actuelle de la qualité de l'air et des retombées de poussières autour de la mine de Meadowbank, ainsi que sur le programme de surveillance des retombées de poussières le long de l'AWAR de Meadowbank jusqu'à Baker Lake.

Autant la surveillance scientifique que celle des IQ suggèrent que l'arrosage des routes et l'application de contrôles chimiques de la poussière peuvent réduire les émissions de poussière fugitives.

## Le bruit et les vibrations

Les niveaux de bruit de la construction de la route de transport pour toutes les périodes devraient être plus faibles que le niveau de bruit ambiant actuel à la limite des zones d'étude locale et régionale (ZEL et ZER). Les valeurs prévues indiquent également qu'il n'y aura pas d'effets causés par le bruit à basse fréquence (BBF) le long de la frontière de la ZEL. Les niveaux de bruit des activités de la route de transport devraient également être plus faibles que le niveau de bruit ambiant actuel en été et en hiver à la frontière de la ZER. De même, pour toutes les périodes, les niveaux de bruit du Projet associés aux activités de la route de transport devraient être en deçà de 35 décibels de gamme A (dBA) à la limite de la ZEL.

Les niveaux de bruit des activités de la fosse devraient être en deçà de 30 dBA à la limite de la ZER, autant en été qu'en hiver. De même, pour toutes les périodes, les niveaux de bruit des activités de la fosse devraient être plus faibles que le niveau de bruit ambiant actuel de 30 dBA pour la plupart des limites de la ZER et de moins de 35 dBA le long de tous les secteurs de la limite de la ZEL. Les niveaux de bruit cumulatifs des activités de la fosse en été comme en hiver devraient se situer en deçà de la directive AER applicable (limite de 038 PSL) le long de la totalité de la frontière de la ZEL. Il n'y aura pas d'effet BBF le long de la frontière de la ZEL. À la limite de la ZEL, les niveaux de bruit aérien de l'abattage par explosion du Projet devraient se situer bien en deçà de la norme NCP-119.

Les distances de retrait prévues pour les activités d'abattage par explosion de la fosse nécessitent de se conformer aux limites de vitesse de crête des particules (vibration) et de pic de pression (bruit) du MPO en matière de protection des poissons en frai et de l'habitat des poissons. Ces distances de retrait sont respectivement de 700 m et de 148 m pour les aires de frai des poissons et l'habitat des poissons. Au cours des opérations de la fosse, l'abattage par explosion sera prudemment géré et surveillé dans le contexte des limites du MPO et des distances de retrait appropriées seront établies afin que le bruit et la vibration provenant de l'abattage par explosion de la fosse n'affectent pas la reproduction des poissons ou leur habitat général.

Tout effet potentiel associé aux trajectoires primaires est saisi dans l'évaluation des effets potentiels, ainsi que la classification des effets résiduels, sur d'autres composantes valorisées, particulièrement au niveau de la faune, des oiseaux et des poissons.

Un suivi de la surveillance du bruit du Projet sera effectué d'une manière demeurant similaire à la surveillance présentement en cours dans le cadre des plans de gestion du bruit de la mine Meadowbank. Il sera procédé à une surveillance annuelle sur quatre emplacements à proximité du Projet. Ces emplacements seront sélectionnés et modifiés au fur et à mesure de l'évolution du Projet. Si les niveaux de bruit enregistrés excèdent les limites appropriées, Agnico Eagle prendra les mesures nécessaires pour identifier la cause spécifique du dépassement des limites et, dans la mesure du possible, atténuer la source du bruit.

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## LIST OF ACRONYMS

| | |
|---|---|
| ACIA | Arctic Climate Impact Assessment |
| AER | Alberta Energy Regulator |
| AWAR | all-weather access road |
| CAC | criteria air contaminants |
| CO | carbon monoxide |
| DFO | Fisheries and Oceans Canada |
| FEIS | Final environmental impact statement |
| FTPCCCEA | Federal/Provincial Territorial Committee on Climate Change & Environmental Assessment |
| GHG | greenhouse gas |
| GHGRP | Greenhouse Gas Emissions Reporting Program |
| Golder | Golder Associates Ltd. |
| $H^+$ | hydrogen ion |
| IPCC | Intergovernmental Panel on Climate Change |
| IQ | Inuit Qaujimajatuqangit |
| ISEE | International Society of Explosives Engineers |
| ISO | International Organization for Standardization |
| LFN | Low Frequency Noise |
| LSA | Local Study Area |
| NAD | North American Datum |
| $NH_3$ | ammonia |
| NIA | noise and vibration impact assessment |
| NIRB | Nunavut Impact Review Board |
| $NO_2$ | nitrogen dioxide |
| NO | nitrogen monoxide |
| NPRI | National Pollutant Release Inventory |
| OMOE | Ontario Ministry of Environment |
| PM10 | particulate matter smaller than 10.0 micrometres in aerodynamic diameter |
| PM2.5 | particulate matter smaller than 2.5 micrometres in aerodynamic diameter |
| PPL | Peak Pressure Level |
| PPV | Peak Particle Velocity |
| PSL | Permissible Sound Level |
| Rmax | maximum predicted Project noise level |
| RSA | Regional Study Area |
| $SO_2$ | sulfur dioxide |
| the Project | Whale Tail Pit and Haul Road |
| TSP | total suspended particulate matter |

## LIST OF UNITS

| | |
|---|---|
| % | percent |
| +/- | plus or minus |
| < | less than |
| > | greater than |
| °C | degrees Celsius |
| dB | decibel |
| dBA | A-weighted decibel |
| dBC | C-weighted decibel |
| dBZ | unweighted or linear decibels |
| $g/m^2/yr$ | grams per square metres per year |
| eq $H^+/m^2/yr$ | equivalent hydrogen per square meters per year |
| hr | hour |
| kg-N/ha/yr | kilograms of nitrogen per hectare per year |
| km | kilometre |
| kt $CO_2e/yr$ | kilotonnes of carbon dioxide equivalents per year |
| $mg/cm^2/30days$ | milligram per square centimetre per 30 days |
| $mg/dm^2/day$ | milligrams per squared decimetre per day |
| m | metre |
| mm | millimetre |
| mm/s | millimetres per second |
| ppb | parts per billion |
| ppbv | parts per billion, volumetric |
| ppmv | parts per million, volumetric |
| t $CO_{2e}/yr$ | tonnes of carbon dioxide equivalents per year |
| t/d | tonnes per day |
| $\mu g/m^3$ | micrograms per cubic metre |

# 4.0 ATMOSPHERIC ENVIRONMENT

## 4.1 Introduction

The purpose of this section is to address the Guidelines issued by the Nunavut Impact Review Board (NIRB) for the Meadowbank Mine (Cumberland 2005a), and specifically those relating to the impact of the Whale Tail Pit and Haul Road Project (the Project) on weather and climate, air quality, and noise and vibration. Volume 2, Appendix 2-B list the specific requirements set out in the guidelines, and relating to the baseline and impact assessment of these components.

Volume 4 includes a discussion on valued components (VCs), incorporation of Inuit Qaujimajatuqangit (IQ), description of the study areas, and an assessment of direct effects to changes to weather and climate, air quality, and noise and vibration in the study area. The effects assessment evaluates all Project phases, including construction, operations, and closure.

### 4.1.1 Volume Structure

- **Section 4.1:** Introduction
- **Section 4.2:** Climate and Meteorology
- **Section 4.3:** Air Quality
- **Section 4.4:** Noise and Vibration

### 4.1.2 Valued Components

**Table 4.1-1: Valued Components of the Atmospheric Environment**

| Valued Component | Rational |
|---|---|
| Weather and Climate | ■ Greenhouse gas emissions from the Project can contribute to climate change.<br>■ Climate change will affect weather in the Kivalliq region.<br>■ Community elders are concerned about climate change and recent unpredictability in weather (Volume 7, Appendix 7-A). |
| Air Quality | ■ Combustion emissions from mobile and stationary equipment have the potential to affect air quality.<br>■ Fugitive dust emissions from mining activities at the Whale Tail Pit have the potential to affect air quality<br>■ Fugitive road dust emitted from the haul road has the potential to affect air quality.<br>■ Community elders are concerned about the effects aerial deposition of fugitive dust may have on other VCs; for example, soil quality, water quality, flora and fauna (Volume 7, Appendix 7-A). |
| Noise and Vibration | ■ Noise and vibration were included as a VC in the EIS prepared for the Meadowbank Gold Project (Cumberland 2005a; Cumberland 2005b).<br>■ Community elders are concerned about Project noise effects on birds (Volume 7, Appendix 7-A).<br>■ Hunters and trappers are concerned about Project noise effects on wildlife, especially caribou (Cumberland 2005c).<br>■ Increased ambient noise levels resulting from Project noise emissions can result in effects to humans and wildlife.<br>■ Ground vibration and airborne noise resulting from Project blasting can result in effects to humans and wildlife. |

VC = valued component; EIS = Environmental Impact Statement.

## 4.1.3 Spatial and Temporal Boundaries

### *4.1.3.1 Weather and Climate*

The spatial boundary associated with the weather and climate VC is considered to be the Kivalliq region of Nunavut. The temporal boundary for existing weather and climate is the Environment Canada 30-year climate normal data from 1981 to 2010 for the Baker Lake meteorological station. Temporal boundaries for the assessment of potential effects related to climate change are considered up to year 2100.

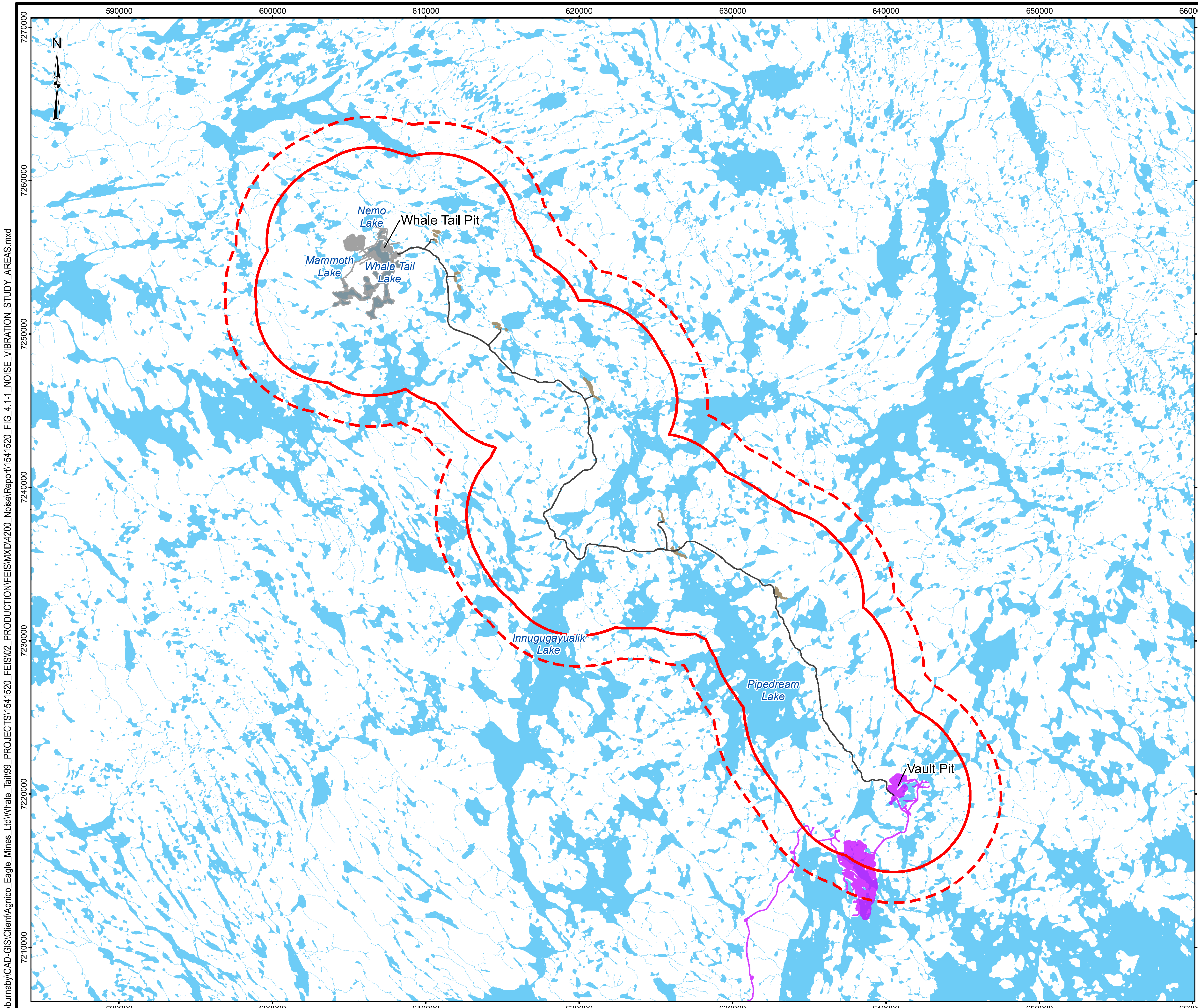
### *4.1.3.2 Air Quality*

The spatial boundary for the assessment of potential effects of the Project on regional air quality is a 60 kilometre (km) by 60 km domain centered on the Whale Tail Pit. For the purpose of assessing the potential effects of the haul road on air quality, a representative 1-km length of the haul road was modelled, and air quality predictions were calculated as a function of distance from the haul road. The meteorological data used to perform the air quality modelling was the 2005 to 2009 data from the Environment Canada meteorology station located at Baker Lake. For the purpose of conservatively assessing Project-related emissions on air quality, the peak emissions year for the Project (2020) was used in the assessment.

### *4.1.3.3 Noise and Vibration*

For the purposes of the assessment of potential effects of the proposed Project on noise and vibration the temporal boundary for construction, operations, and closure of the Project is about seven years. This includes one year construction, three to four years operations, and two years closure (Volume 3, Section 3.3.2).

The Local Study Area (LSA) and Regional Study Area (RSA) for the Project noise and vibration impact assessment (NIA) were selected for consistency with the noise and vibration study areas used in the Meadowbank Final Environmental Impact Statement (FEIS) (Cumberland 2005a; Cumberland 2005b). The LSA was established as a buffer surrounding the Project footprint at a distance of 5 km and the RSA was established as a buffer surrounding the Project footprint at a distance of 7 km (Figure 4.1-1). The Project footprint was taken to include the Whale Tail Pit and associated waste piles, power plant, ore crushing facility, Water Treatment Plant, and haul road. Noise and vibration levels were predicted for a grid of receptors covering the LSA and RSA and for a discrete receptor corresponding to the most impacted location on the LSA boundary.




**LEGEND**

- NOISE AND VIBRATION LOCAL STUDY AREA
- NOISE AND VIBRATION REGIONAL STUDY AREA

WHALE TAIL

- BORROW SOURCE
- INFRASTRUCTURE
- PROPOSED HAUL ROAD

MEADOWBANK

- INFRASTRUCTURE/ALL WEATHER ROAD
- WATERCOURSE
- WATERBODY


**REFERENCE**

1. WHALE TAIL INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON DECEMBER 21, 2015.
2. MEADOWBANK INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON NOVEMBER 12, 2015.
3. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
4. INSET MAP DATA OBTAINED FROM ESRI

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

5 0 5

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

## NOISE AND VIBRATION STUDY AREAS FOR PIT OPERATIONS

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT | | 1541520 | FILE No. |
| DESIGN | VY | 01 Mar. 2016 | SCALE AS SHOWN REV. 0 |
| GIS | CDB | 01 Mar. 2016 | |
| CHECK | JR | 06 May 2016 | **FIGURE 4.1-1** |
| REVIEW | LY | 06 May 2016 | |

## 4.2 Climate and Meteorology

### 4.2.1 Incorporation of Inuit Qaujimajatuqangit

Within the context of climate change (and meteorology), indigenous observations and perspectives offer insights into the nature and extent of environmental change, and in terms of the significance of changes for those peoples whose cultures are built on an intimate connection with the Arctic landscape (ACIA 2005).

To incorporate IQ into the climate and meteorology section of the FEIS Amendment, the following documents were reviewed:

- Arctic Climate Impact Assessment, Chapter 3: The Changing Arctic: Indigenous Perspectives (ACIA 2005).
- Unikkaaqatigiit: Putting the Human Face on Climate Change, Perspectives from Nunavut Communities (Communities of Arctic Bay, Kugaaruk and Repulse Bay 2005).
- Public Information Meeting Summary Report September 4, 2014 for the NIRB's monitoring of Agnico Eagle Mines Ltd.'s Meadowbank Gold Project (NIRB 2014).
- Public Information Meetings Summary Report, September 9 – September 11, 2015. Created for the NIRB's Monitoring of Agnico Eagle Mines Ltd.'s Meadowbank Gold Mine Site (NIRB 2015).
- Back River Project Final Environmental Impact Statement: Volume 4: Atmospheric Environment and references therein (Sabina 2015).
- Whale Tail Inuit Qaujimajatuqangit Baseline Report and references therein (Volume 7, Appendix 7-A).

#### *4.2.1.1 Existing Environment and Baseline Information*

Inuit from Baker Lake have observed changes in weather and climate over the years (Volume 7, Appendix 7-A). Several of these observations were stated by Elders during the Traditional Knowledge (TK) workshop in 2014 and during a follow-up consultation meeting in 2016, including:

> *" Water levels everywhere have dropped"*
>
> *"Speaking of water, there used to be more moisture on the ground. The land is now very dry."*
>
> *" The lake level is lower, and there is less water in the rivers." The summers are longer, the weather has changed. In the 1960s and earlier, the summers were much shorter."*
>
> *"We used to be able to make good snow shelters, but now there is often not enough snow or the right kind of snow to make a shelter".*
>
> *" …noticed that the ice isn't safe anymore. There are many spots with thin ice and open water, even in the winter. It is dangerous to travel now, because we can't rely on safe ice. We used to be able to travel at night in the springtime when the snow was hard. Now, we can't do this reliably, because it often doesn't refreeze at night."*
>
> *"When there is snow, it is not the same consistency as in the past. It is harder than usual, with more layers, and is not good for making snow blocks. It is not as easy to make an igloo as it was in the past".*
>
> *"Nothing is as expected"*

*“There is less snow on the south sides of the hills now, and a change in the direction of the winds that bring the snow. We sued to be able to tell the way to go by the drifts of the snow, but no longer can do that”.*

*“The shrubs growing on the land now seem to be growing more and getting larger than in the past”*

*“The berries are not growing right today. They are not developing right and don’t get ripe when we expect them to ripen. Sometimes there are very few berries.”*

*“There are now abrupt changes in the weather, extremes, spring going from thaws to cold, summers with cold phases, then hot, droughts, more storms, but sometimes shorter storms, the storms following one after the other”.*

Climate change is  a concern for Elders and land users because the unpredictability of weather conditions has resulted in a lack of confidence in using traditional knowledge to predict weather, which has implications for the safety of land users during harvesting and other activities.  Inuit are also concerned about the potential impacts of climate change to vegetation communities and wildlife habitat, and to fish, wildlife and other traditional resources that they depend on. The current impact of climate change on vegetation (wildlife habitat) is summarized as part of the existing environment in Volume 5, Section 5.4.2.

#### 4.2.1.2 Valued Component Selection

Several concerns about the effects of climate change on traditional land use activities and resources have been raised by Baker Lake Elder and land users during the TK workshop in 2014 and during follow-up consultation meetings in 2015 and 2016. Concerns related to climate change affecting traditional land use activities and resource use (Volume 7, Appendix 7-A) include:

- Warmer temperatures during the late summer resulting in a delayed and shorter caching period.
- The sporadic freeze-thaw cycle causing spots of thin ice and open water on the land, and resulting in a decreased ability to access resources, dangerous travel conditions, and loss of traditional travel routes.
- Lower water levels in rivers and lakes have made them more difficult to navigate over the past five years.
- Less rain and vegetation growth has resulted in a reduction in feeding areas for wildlife and traditional plant harvesting areas.
- A decline in the health of caribou due to less food availability, and in the quality of caribou meat and skin.
- Changes in caribou habitat and range, shifts in their migration patterns, and increased occurrence of starving and drowning.
- Lower water levels resulting in decreased fish populations and fish health, and changes to spawning runs.
- An overall reduction in species available for hunting, fishing, and gathering activities.

The effects of the Project on weather and climate cannot be measured (FTPCCCEA 2003), therefore climate was not selected as a VC; however, given that climate change has been described as one of the most significant environmental issues facing Inuit communities, and due to their close ties with the land and resources, IQ perspectives related to climate change and concerns raised have been incorporated into this assessment where appropriate.

#### *4.2.1.3 Impact Assessment*

The impacts of climate change have the potential to affect a wide range of environmental, social and economic systems of value to Inuit, as indicated by the observations and changes experienced by Baker Lake traditional land users.

Climate change is a global issue caused by emissions of greenhouse gases (GHG). The contribution of the Project, and total GHG emissions from Nunavut (less than 0.5 million metric tonnes per year), are negligible compared to the magnitude of global GHG emissions (approximately 45,000 million metric tonnes per year). It is not possible to measure the effects of the Project on climate (FTPCCCEA 2003), as compared to observing the effects of global climate change on the Kivalliq region. Consequently, this assessment quantifies Project-related greenhouse gas emissions and puts them into regional context by comparing them to GHG emissions from all of Nunavut.

#### *4.2.1.4 Mitigation and Monitoring*

Traditional harvesters have stated that they have had to adapt their land use patterns based on climate change. Warmer temperatures during the late summer have resulted in land users delaying the caching period by a month due to meat rotting, and a shorter caching period for hunters. Shifts in caribou migration patterns and caribou availability have caused harvesters to shift their harvesting patterns (Volume 7, Appendix 7-A). Monitoring of weather is conducted regionally by Environment Canada and is predicted to continue indefinitely as a means of monitoring long-term trends in regional climate.

### 4.2.2 Existing Environment and Baseline Information

The Project is located in Canada's Northern Arctic ecozone. This region includes most of Canada's Arctic Archipelago and northern regions of continental Nunavut and the Northwest Territories. This ecoregion is classified as a polar desert and is characterized by long cold winters and short cool summers. Extreme winter cold, low precipitation and persistent drying winds make this one of the harshest climates in Canada (McGill University 2016; University of Guelph 2016).

Environment Canada operates a meteorological monitoring station at Baker Lake, approximately 125 km from the Project. Long-term (1981 to 2010) meteorological records from the Baker Lake A meteorology station record average daily air temperatures in June to September of approximately 7 degrees Celsius (°C), with October to May average daily air temperatures of -20.6°C. Total annual precipitation at Baker Lake is low, averaging just 273 millimetres (mm) per year, most of which falls as rain in May through October. Winds are predominantly from the northwest and exceed 20 kilometres per hour more than 25 percent (%) of the time.

Meteorological data from 2004 to 2009 for the Baker Lake meteorological station were used as input to the air quality dispersion model used to assess potential Project-related effects to air quality. A detailed description of the existing regional weather and climate near the Project are included in Volume 4, Appendix 4-A.

Inuit and the scientific community have identified the Arctic as a region already experiencing climate change. However, these changes are caused by historic and contemporary greenhouse gas emissions that predominantly occur outside of Nunavut. It is now generally accepted that the existing weather and climate in the Kivalliq region from 1981 to 2010 is different than past weather and climate, and the historical periods included in Inuit oral traditions.

The IQ is supported by independent observations by the scientific community, for example the following (Hinzman et al. 2005):

*New extreme and seasonal surface climatic conditions are being experienced, a range of biophysical states and processes influenced by the threshold and phase change of freezing point are being altered, hydrological and biogeochemical cycles are shifting, and more regularly human sub-systems are being affected.*

### 4.2.3 Climate and Project Interactions

Pathway analysis is provided in Volume 3, Section 3.4. Primary pathways that require further effects analysis to determine the environmental significance from the Project are provided below. Pathways determined to have no linkage or those that are considered secondary are not predicted to result in environmentally significant effects are provided in Volume 3, Appendix 3-C, Table 3-C-1.

Changes to weather and climate have the potential to affect environmental, social and economic systems of value to the Inuit and other regional stakeholders. Project-related emissions of GHGs have the potential to contribute to climate change. However, the Federal/Provincial Territorial Committee on Climate Change & Environmental Assessment (FTPCCCEA) stated that "…the contribution of an individual project to climate change cannot be measured" (FTPCCCEA 2003). Consequently there is no assessment endpoint for climate. Greenhouse gas emissions from the Project are calculated as a measurement endpoint and compared to emissions from Nunavut to put the Project-related emissions into better context (see Section 4.2.3.1).

#### *4.2.3.1 Effects of the Project on Climate*

Greenhouse gas emissions from the Project can contribute to climate change, even though the contribution of any one Project to global climate change cannot be measured (FTPCCCEA 2003). Facilities in Canada that emit greater than 50,000 tonnes of carbon dioxide equivalents per year (t $CO_{2e}$/yr) are required to quantify and report their emissions to Canada's Greenhouse Gas Emissions Reporting Program (GHGRP).

As part of this assessment, Project-related emissions of GHGs were calculated using methods consistent with the GHGRP. These emissions estimates were then compared to the GHGRP reporting threshold (50,000 tonnes), to total emissions from Nunavut, and to Canada's national GHG emissions estimates. The total emissions for Nunavut and Canada are calculated from the 5-year average of emissions from 2007 to 2011 (Environment Canada 2013).

Table 4.2-1 summarizes predictions of greenhouse gas emissions for the Project for the peak year of production (i.e., 2020). Table 4.2-2 summarizes predictions from the Project plus those from the existing Meadowbank Mill and camp. As indicated, emissions are expected to exceed 50,000 tonnes per year. Therefore the Project will continue to report their annual emissions to Environment Canada's GHGRP. Greenhouse gas emissions from Nunavut are low due to its low population and low intensity of urban/industrial activities. Total average emissions from Nunavut from 2007 to 2011 were 434 kilotonnes $CO_2$e/yr (kt $CO_{2e}$/yr; Table 4.2-1). Development of the Whale Tail Pit and emissions from traffic along the haul road to Meadowbank Mine are predicted to result in a 56% increase in GHG emissions for Nunavut. Throughput for the Meadowbank Mill is predicted to be 15% to 20% lower than current throughput when processing ore from the Whale Tail Pit. Therefore the current GHG emissions rate of 180 kt $CO_{2e}$/yr is considered a conservative estimate for the future Meadowbank Mill (Table 4.2-1).

When compared to Canada's national emissions (714,000 kt $CO_2$e/yr), the Project contributes to a less than 0.05% increase in national GHG emissions.

**Table 4.2-1: Greenhouse Gas Emissions Summary for the Project**

| Emissions Source | Greenhouse Gas Emissions (kt $CO_{2e}$) | Project Emission as a Proportion of Nunavut and Canadian Emissions (%) |
|---|---|---|
| Off-road exhaust | 52.8 | — |
| On-road exhaust | 4.4 | — |
| Power plant | 4.1 | — |
| Camp heater | 2.9 | — |
| **Project Total[a]** | **64.2** | **—** |
| **Nunavut Total[b]** | **434** | **14.8** |
| **Canadian Total[b]** | **714,000** | **<0.01** |

[a] Project total includes emissions from the Whale Tail Pit and the Haul Road.

[b] 2007 to 2011 average (Environment Canada 2013).

kt$CO_{2e}$ = kilotonnes of carbon dioxide equivalents; % = percent; < = less than.

**Table 4.2-2: Greenhouse Gas Emissions Summary for the Project and the Meadowbank Mill**

| Emissions Source | Greenhouse Gas Emissions (kt $CO_{2e}$) | Project plus Meadowbank Emission as a Proportion of Nunavut and Canadian Emissions (%) |
|---|---|---|
| Whale Tail[a] | 64.2 | — |
| Meadowbank mill | 180 | — |
| **Project plus Meadowbank Total** | **244** | **—** |
| **Nunavut Total[b]** | **434** | **56** |
| **Canadian Total[b]** | **714,000** | **<0.04** |

[a] Project total includes emissions from the Project.

[b] 2007 to 2011 average (Environment Canada 2013).

Kt $CO_{2e}$ = kilotonnes of carbon dioxide equivalents; % = percent; < = less than.

### *4.2.3.2 Effects of Climate Change on the Project*

The climate in the Arctic is changing faster than at mid-latitudes (ACIA 2005; IPCC 2014). The most recent set of climate model projections (CMIP5) predict an Arctic-wide year 2100 multi-model mean temperature increase of +13°C in late fall and +5°C in late spring under the Intergovernmental Panel on Climate Change (IPCC)'s "business as usual scenario" (RCP8.5). IPCC climate change mitigation scenario RCP4.5 results in a year 2100 multi-model Arctic wide prediction of +7°C in late fall and +3°C in late spring (Overland et al. 2013). The effects of changes of this magnitude to terrestrial, aquatic and marine ecosystems, social and economic systems of the Arctic are an active area of research (e.g., NASA ABoVE[1]). However, the short duration of the proposed Project mean that climate change related effects to the Project are likely negligible.

[1] http://above.nasa.gov/

### 4.2.4 Monitoring and Follow-up

Environment Canada currently conducts long-term monitoring of weather and climate in the Kivalliq region of Nunavut. There are currently no plans to conduct supplementary meteorological monitoring at the Project.

# 4.3 Air Quality

## 4.3.1 Incorporation of Inuit Qaujimajatuqangit

To incorporate IQ into the air quality section of the FEIS Amendment, the following documents were reviewed:

- Unikkaaqatigiit: Putting the Human Face on Climate Change, Perspectives from Nunavut Communities (Communities of Arctic Bay, Kugaaruk and Repulse Bay 2005).
- Public Information Meeting Summary Report September 4, 2014 for the NIRB's monitoring of Agnico Eagle Mines Ltd.'s Meadowbank Gold Project (NIRB 2014).
- Public Information Meetings Summary Report, September 9 – September 11, 2015. Created for the NIRB's Monitoring of Agnico Eagle Mines Ltd.'s Meadowbank Gold Mine Site (NIRB 2015).
- Back River Project Final Environmental Impact Statement: Volume 4: Atmospheric Environment and references therein (Sabina 2015).
- Whale Tail Inuit Qaujimajatuqangit Baseline Report and references therein (Volume 7, Appendix 7-A).

### *4.3.1.1 Existing Environment and Baseline Information*

Since the Inuit depend upon their local environment for their social, cultural, and economic well-being, they are aware of changes to their environment, including air quality. Inuit have documented recent changes to air quality, and are concerned about the potential effects of these changes on their traditional land use activities and resources (Agnico Eagle 2014a; Volume 7, Appendix 7-A and references therein), and this IQ is incorporated into Section 4.3.2.

### *4.3.1.2 Valued Component Selection*

Local Inuit who use the Project study area have identified air quality and the effects of atmospheric deposition as a topic of concern during the 2014 TK workshop and follow-up consultation meetings in 2015 and 2016. Specific concerns related to dust include potential effects on:

- wildlife habitat and wildlife foraging behaviour;
- fish and fish habitat;
- water quality;
- caribou habitat, vegetation, and on plants that caribou rely on for foraging;
- meat caches located near the road; and
- the cumulative effects of dust.

Due to these concerns, air quality was assessed as a VC. Specifically, the air quality portion of the assessment examines the effects of the Project on air quality, and the atmospheric deposition of acidic gases and windblown fugitive dust.

#### 4.3.1.3 Impact Assessment

Inuit Qaujimajatuqangit highlighted concerns about the sensitivity of caribou and muskox to losses of vegetation habitat (habitat quantity) and changes in vegetation habitat quality (habitat quality) because of dust deposition. Concerns were also raised related to the effects of dust on other traditional resources and activities that Inuit depend on. Potential effects of the Project on air quality and atmospheric deposition were predicted and compared to national and territorial air quality guidelines as there are no standards that can be drawn explicitly from IQ. The results of the air quality modelling were used to assess the impacts to vegetation in wildlife in Volume 5, to water quality and fish and fish habitat in Volume 6.

#### 4.3.1.4 Mitigation and Monitoring

Local Inuit requested that emissions of fugitive road dust be mitigated through the use of road watering and the application of chemical dust suppressants, and that the accumulation of dust be monitored over time (NIRB 2015a; Agnico Eagle 2016b, 2016c, 2016d). In response to local Inuit concerns, and as a NIRB requirement (Project Certificate No. 004; Condition 71), Agnico Eagle conducts local meteorology, air quality, and dustfall monitoring at their existing Meadowbank Mine (e.g., Agnico Eagle 2013a; Agnico Eagle 2015).

Mitigation and monitoring opportunities at the proposed Project are similar to those at the existing Meadowbank Mine. Public consultation with local Inuit indicates that they expect mitigation and monitoring strategies employed at the proposed Project to be similar to those employed at the Meadowbank Mill.

### 4.3.2 Existing Environment and Baseline Information

Since the Arctic is far from large mid-latitude sources of urban/industrial air pollution, it is often viewed as a pristine environment with excellent air quality. In fact, the Western Arctic is subject to seasonal reductions in air quality due to Arctic Haze (Shaw 1995; Quinn et al. 2007), long-range transport of Asian air pollution and mineral dust (McNaughton et al. 2011), and long-range transport of smoke from boreal forest fires (Forster et al. 2001; Warneke et al. 2009).

Other jurisdictions in Canada have published background concentrations of criteria air contaminants (CACs) that are used to assess Project-related changes to air quality. There are no published background air quality values available for Nunavut. To quantify existing air quality in the Kivalliq Region, this assessment undertook a comprehensive analysis of available air quality measurements in Arctic Canada, including results of the 2008 NASA ARCTAS[2] airborne field campaign. The methods and results of this analysis are summarized in Volume 4, Appendix 4-A.

Table 4.3-1 summarizes background concentrations of CACs used in this assessment. These background concentrations are added to air quality model predictions of maximum concentrations of CACs that result from emissions generated during the operations of the Project. The maximum plus background concentrations are then compared to the relevant Nunavut or Canadian ambient air quality guidelines or standards.

[2] https://espo.nasa.gov/arctas

**Table 4.3-1: Summary Statistics for Criteria Air Contaminants**

| Compound (units) | Averaging Period | Percentile | Background Concentrations used in the FEIS Amendment | Air Quality Standard |
|---|---|---|---|---|
| CO (ppmv) | 1-hr | 90th | **0.3** | 13 |
| | 8-hr | 90th | **0.3** | 5 |
| $NO_2$ (ppbv) | 1-hr | 90th | **5.0** | 159 |
| | 24-hr | 90th | **4.5** | 106 |
| | Annual | 50th | **1.9** | 24 |
| $O_3$ (ppbv) | 1-hr | 90th | **17.3 – 30.6[a]** | 82 |
| | 8-hr | 90th | | 63 |
| $SO_2$ (ppbv) | 1-hr | 90th | **1.0** | 172 |
| | 24-hr | 90th | **1.0** | 48 |
| | Annual | 50th | **0.1** | 8 |
| $PM_{2.5}$ (µg/m$^3$) | 24-hr | 90th | **6.6** | 28 |
| | Annual | 50th | **3.6[b]** | 8.8 |

[a] Indicated values are the range in monthly average concentrations used as input for the conversion of $NO_2$ to NO in the air quality model.

[b] Geometric average (median or 50th percentile) of 5-years of 24-hr average concentrations after removing zeros and hourly concentrations above the 97.6th percentile.

CO = carbon monoxide; $NO_2$ = nitrogen dioxide; NO = nitrogen monoxide; $SO_2$ = sulfur dioxide; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometres in aerodynamic diameter; $O_3$ = ozone; ppbv = parts per billion, volumetric; ppmv = parts per million, volumetric; µg/m$^3$ = micrograms per cubic metre; FEIS = Final Environmental Impact Statement.

In general, air quality in the Kivalliq region is good. However, IQ has documented recent changes to air quality (Communities of Arctic Bay, Kugaaruk and Repulse Bay 2005; Agnico Eagle 2014a; Sabina 2015; Volume 7, Appendix 7-A and references therein).

The Arctic is subject to seasonal reductions in air quality as a result of episodic events (e.g., boreal forest fires), seasonal changes in solar insolation (polar winter versus polar summer), and weather patterns that favour transport of mid-latitude pollution into the Arctic (e.g., spring time “Arctic haze” events). An example of seasonal changes in air quality is presented in Figure 4.3-1, which pools 10-years of 24-hour average observational data collected at the Sir John Franklin and Norman Wells National Air Pollution Surveillance stations from 2005 to 2009 (see Volume 4, Appendix 4-A for more details).

Elevated ambient concentrations of nitrogen dioxide ($NO_2$) in winter (Figure 4.3-1; top panel) are primarily due to wintertime buildup of $NO_2$ in the absence of sunlight responsible for $NO_2$’s photo-chemical destruction. In general, elevated spring and summer concentrations of particulate matter smaller than 2.5 micrometres in aerodynamic diameter ($PM_{2.5}$; Figure 4.3-1; bottom panel) are due to meteorology that favours transport of mid-latitude air pollution to the Arctic in spring, and transport of smoke from boreal forest fires to the Arctic in summer. For the 10-years of daily average $NO_2$ presented in Figure 4.3-1, background concentrations of $NO_2$ reach values 5% to 10% of the 24-hour Nunavut air quality standard (106 parts per billion, volumetric [ppbv]). Average $PM_{2.5}$ concentrations can reach 25% of the 24-hour air quality standard (28 micrograms per cubic metre [µg/m$^3$]).

During episodic events, $PM_{2.5}$ concentrations can meet or even exceed the Nunavut air quality standards. These events, while infrequent, could result in air quality monitoring observations at the proposed Whale Tail Pit and the Meadowbank Mine that exceed the Nunavut air quality standard. The primary cause of such observed air quality exceedances may not be mining operations related to the Project, but natural or man-made events beyond Agnico Eagle's control.

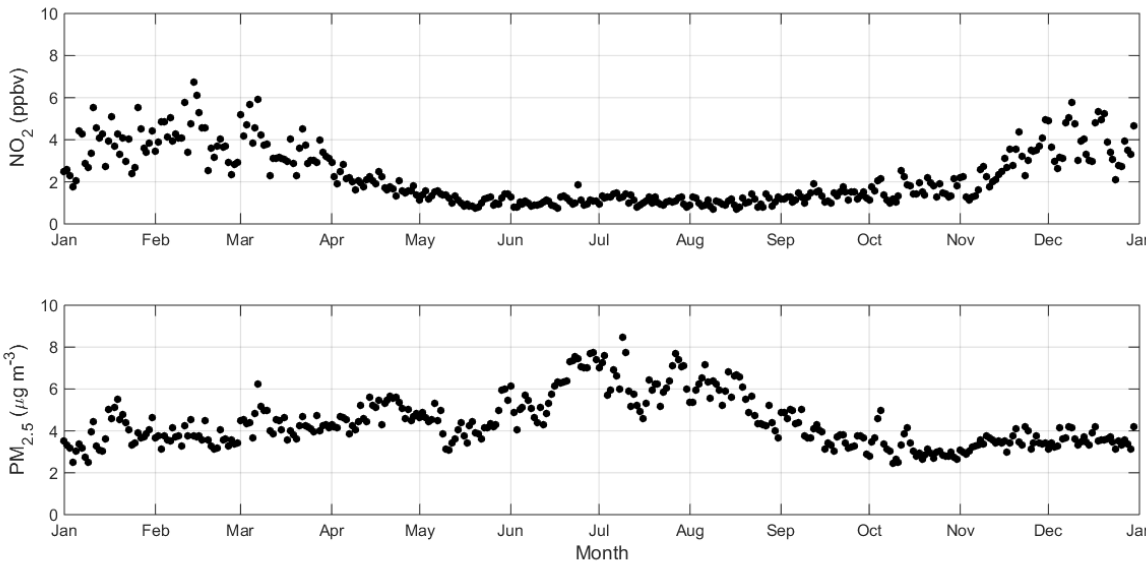



*Figure 4.3-1: Ten-year (2005 to 2009) Average 24-hour $NO_2$ (top) and $PM_{2.5}$ (bottom) Concentrations Observed at Sir John Franklin (NWT) and Normal Wells (NWT) National Air Pollution Surveillance Stations*

## 4.3.3 Potential Project-related Effects Assessment

Inuit Qaujimajatuqangit and professional scientific opinion were used to identify potential Project related effects to air quality. These pathways are summarized in Volume 3, Appendix 3-C, Table 3-C-1. Primary pathways include the following:

1) Traffic along the proposed haul road from the Whale Tail Pit to the existing Meadowbank Mine has the potential to generate combustion emissions and fugitive road dust that can affect air quality.

2) Mining operations at the Whale Tail Pit have the potential to produce combustion emissions and fugitive dust that can affect air quality.

3) Extension of Meadowbank Mill and Camp Operations have the potential to produce combustion emissions and fugitive dust that can affect air quality.

Traffic on the haul road during construction and decommissioning of the Whale Tail Pit, in addition to construction and decommissioning of the Whale Tail Pit, also have the potential to affect air quality. However, the emissions intensity from construction and decommissioning activities is much lower than the intensity of air emissions, including fugitive dust, during the Project's operations phase. This assessment considers emissions during the Project's operations phase (specifically year 2020, the peak year of mining activity) to be a conservative estimate of the maximum potential Project related to effects to air quality. Therefore emissions from construction and decommissioning are considered secondary pathways and are not explicitly assessed.

Project related air emissions have the potential to deposit to local terrestrial, aquatic, and marine ecosystems. Atmospheric deposition of acidic gases and fugitive dust therefore have the potential to affect soil and water quality, local flora and fauna, and the Inuit communities that depend on these resources for their cultural, social, and economic well-being. This air quality assessment includes quantification of these air emissions and predictions of the spatial patterns of their regional atmospheric deposition. These results are discussed in the following sections and were used in the effects assessment for other valued ecosystem components (e.g., water quality, soils, human health).

#### *4.3.3.1 Effects of Haul Road on Air Quality*

To evaluate potential effects of the haul road on air quality, this assessment undertook the following:

1) Quantification of baseline concentrations of CACs in the Kivalliq Region of Nunavut (see Volume 4, Appendix 4-A).

2) Calculation of CAC emissions from the following haul road sources (see Volume 4, Appendix 4-B):

    a. exhaust from vehicles operating on the haul road; and

    b. un-paved road dust from the haul road.

3) Air quality dispersion modelling of a representative 1 km section of the haul road oriented northeast to southwest was used to predict the following (See Volume 4, Appendix 4-C):

    a. maximum plus background concentrations of CAC as a function of distance from the haul road; and

    b. maximum dust deposition as a function of distance from the haul road.

The model predicted ground level concentrations of carbon monoxide (CO), $NO_2$, and sulfur dioxide ($SO_2$) were very low compared to the baseline and to their relevant ambient air quality standards (see Volume 4, Appendix 4-C). Predictions of $PM_{2.5}$ adjacent to the haul road were below Nunavut ambient air quality guidelines within 50 to 75 metres (m) from the haul road. Thus, the focus of the assessment is the potential effects of total suspended particulate matter (i.e., fugitive dust) on air quality adjacent to the haul road.

Table 4.3-2 summarizes maximum predicted total suspended particulate (TSP) concentrations as a function of distance from the haul road. Figure 4.3-2 plots predicted TSP concentrations as a function of distance from the haul road. In the near field, maximum TSP concentrations adjacent to the road are predicted to exceed the 24-hour average ambient air quality standard (Figure 4.3-2; red line = 120 $\mu g/m^3$) at distances of up to 1,500 m from the haul road. Maximum annual TSP concentrations are predicted to exceed the ambient air quality standard (60 $\mu g/m^3$) only within the first 100 to 300 m from the haul road.

**Table 4.3-2: Maximum Total Suspended Particulate Concentrations Function of Distance from the Haul Road**

| Distance (m) | 24-hr (µg/m³) | Annual (µg/m³) |
|---|---|---|
| 25 | 1740 | 172 |
| 50 | 1330 | 118 |
| 75 | 1170 | 91.4 |
| 100 | 1040 | 73.5 |
| 300 | 498 | 26.7 |
| 500 | 358 | 15.4 |
| 750 | 254 | 9.7 |
| 1,000 | 213 | 6.4 |
| 1,500 | 92.4 | 3.2 |
| 2,000 | 52.7 | 1.9 |

m = metre; µg/m³ = micrograms per cubic metre.

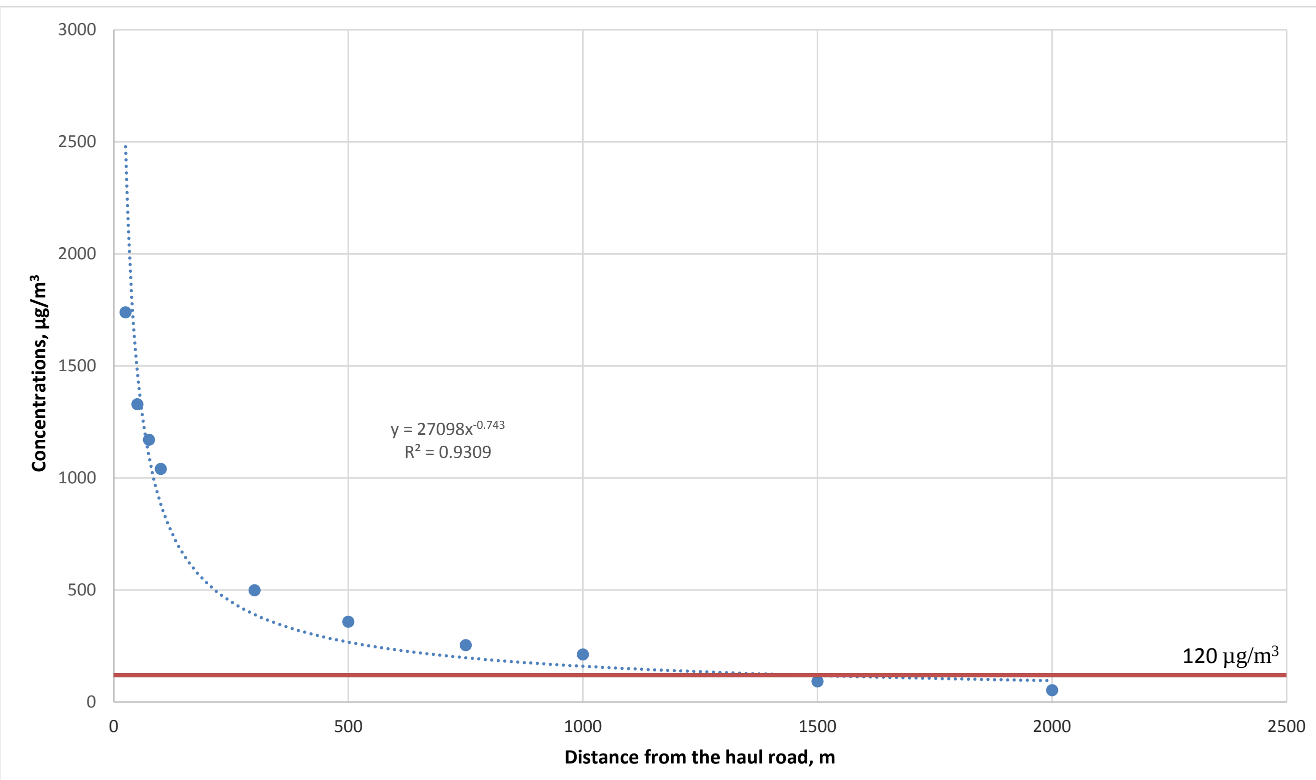



*Figure 4.3-2: Total Suspended Particulate Concentrations as a Function of Distance from the Haul Road*

Table 4.3-3 summarizes maximum predicted dust deposition as a function of distance from the haul road. Figure 4.3-3 plots predicted dust deposition as a function of distance from the haul road. Predicted dust deposition rates are compared to the British Columbia and Ontario standards as they are the most stringent among the Provinces of AB, BC, and ON (see Volume 4, Appendix 4-C). The British Columbia lower monthly dust fall standard for mining is 1.7 milligrams per squared decimetre per day ($mg/dm^2/day$). This value corresponds to deposition rates of 0.51 milligram per square centimetre per 30 days ($mg/cm^2/30days$). The Ontario annual dust fall standard is 4.6 $g/cm^2/30$-days which is equivalent to 0.46 $mg/cm^2/30days$. Maximum predicted monthly dustfall is predicted to be below the BC dustfall standard within 300 m of the haul road. Annual dust deposition is predicted to be below the Ontario dustfall standard within 25 m from the haul road.

Included in Figure 4.3-3 are the observed dust deposition rates at upwind and downwind dustfall monitoring stations along the Meadowbank Mine Vault haul road (Agnico Eagle 2015). Meadowbank road bed material is predicted to have a higher silt content (silt = 9.3%; Cumberland 2005) than esker material being considered as construction material for the Whale Tail Pit haul road (silt = 6.1%; Englobe 2015). Fugitive road dust emissions are very sensitive to road bed silt content. Therefore direct comparison between the predictions for the Whale Tail haul road and the observations from the Meadowbank haul road is not appropriate. However, Whale Tail haul road predictions appear comparable to the Meadowbank observations and lend confidence to the predictions presented in this assessment.

**Table 4.3-3: Maximum Dust Deposition as a Function of Distance from the Haul Road**

| Distance (m) | Monthly ($mg/cm^2/30days$) | Annual ($mg/cm^2/30days$) |
|---|---|---|
| 25 | 1.19 | 0.15 |
| 50 | 0.77 | 0.10 |
| 75 | 0.65 | 0.07 |
| 100 | 0.56 | 0.05 |
| 300 | 0.26 | 0.02 |
| 500 | 0.18 | 0.01 |
| 750 | 0.14 | 0.01 |
| 1000 | 0.11 | 0.00 |
| 1500 | 0.07 | 0.00 |
| 2000 | 0.05 | 0.00 |
| Dust fall criteria | 0.51 | 0.46 |

m = metre; $mg/cm^2/30days$ = milligram per square centimetre per 30 days.

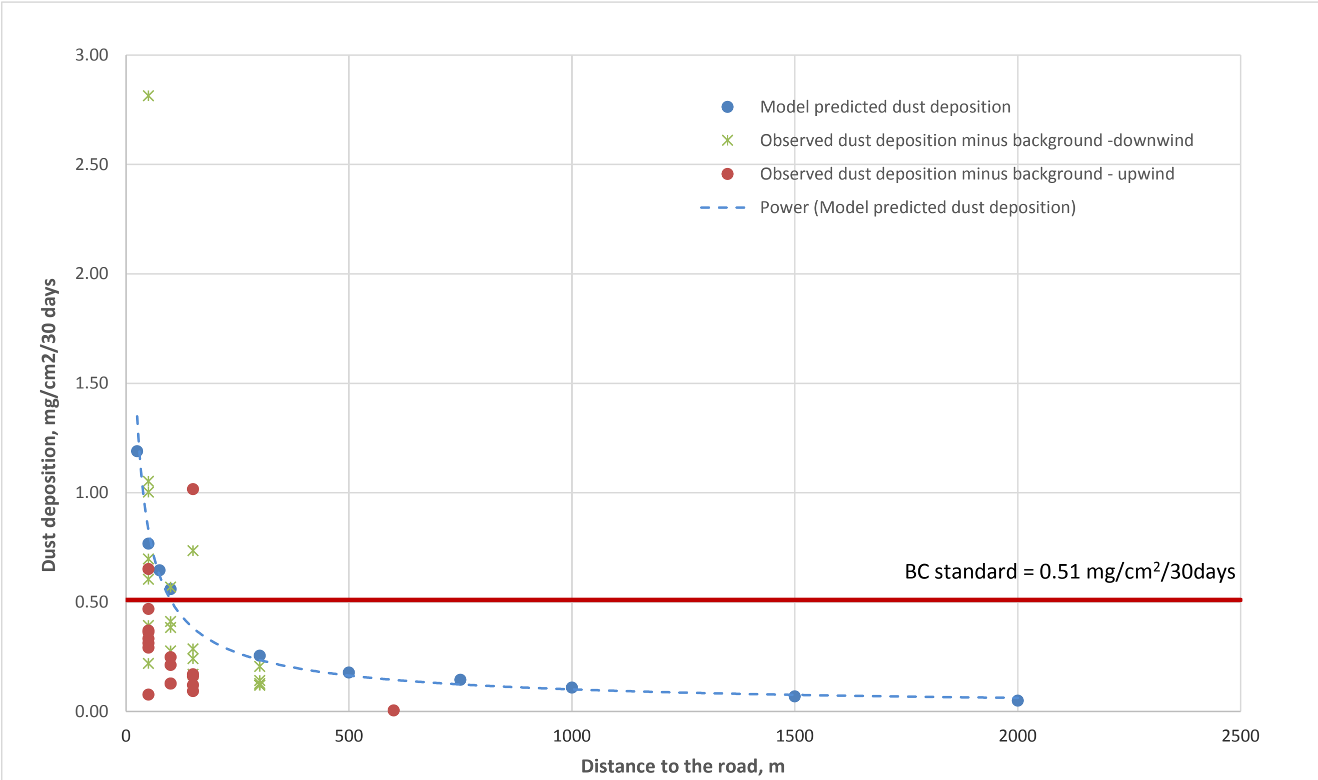



*Figure 4.3-3: Predicted (this assessment) and Observed (Meadowbank Mine) Dust Deposition as a Function of Distance from Mine Haul Roads*

The effects of fugitive dust emissions on air quality adjacent to the haul road are limited in spatial extent and occur primarily on dry windy days in the summer. These effects are reversible in that fugitive dust will no longer affect air quality once the Whale Tail Pit is decommissioned and the haul road becomes inactive. Atmospheric deposition of fugitive dust also has the potential to affect soil and water quality, and flora and fauna that the Inuit depend upon for their social, cultural, and economic well-being. Dust deposition results were used in the assessment of effects to soil, water quality, and human health and are discussed in Sections 5.3, 6.4, and Volume 3, Appendix 3-B, respectively. Results of this assessment indicate rates of atmospheric deposition are below relevant dustfall standards within 300 metres from the haul road. Analysis of the geochemistry of the locally-sourced haul road material does not indicate that the dust being deposited has the potential to affect soil and water quality (Golder 2014).

### 4.3.3.2 Effects of the Whale Tail Pit on Air Quality

To evaluate potential effects of the Whale Tail Pit on air quality, this assessment undertook the following:

1) Quantification of baseline concentrations of CAC in the Kivalliq Region of Nunavut (see Volume 4, Appendix 4-A).

2) Calculation of CAC emissions from the following sources (see Volume 4, Appendix 4-B):

    a. Whale Tail Pit activities, including:

i. in pit drilling and blasting;

ii. in pit material handling;

iii. un-paved road dust from the pit; and

iv. exhaust from off-road equipment operating in the pit;

b. wind erosion from ore pad and waste storage pile;

c. stationary combustion emissions from the camp heating and camp power; and

d. un-paved road dust and vehicle exhaust from the section of haul road within the Property boundary.

3) Air quality dispersion modelling to predict maximum plus background concentrations of CAC at the Property boundary (see Volume 4, Appendix 4-C).

Table 4.3-4 summarizes the background CAC concentrations, predicted maximum plus background concentrations near the Project, and ambient air quality criteria for Nunavut. Air quality modelling results predict the occurrence of maximum plus background concentrations of particulate matter smaller than 10.0 micrometres in aerodynamic diameter ($PM_{10}$) and TSP above the Nunavut air quality guidelines outside the Property boundary. For $PM_{10}$, the worst year of the 5-year simulation includes a single $PM_{10}$ exceedance. For TSP, the worst year of the 5-year simulation includes three 24-hour TSP exceedances. Figure 4.3-4 illustrates the predicted spatial distribution of maximum plus background 24-hour average TSP concentrations. As indicated, the region where the maximum plus background TSP concentrations are predicted to exceed the air quality criteria over a 24-hour period is small.

Air quality modelling also included an evaluation of maximum plus background concentrations of CACs at important local cultural or human health receptors. Predicted concentrations of all CAC were below their relevant ambient air quality standards at all of these local receptors.

The effects of mining activities at the Whale Tail Pit on regional air quality are limited in spatial extent and occur primarily on dry windy days in summer. These effects are reversible in that emissions will no longer affect air quality once the Whale Tail Pit is decommissioned and the haul road become inactive.

**Table 4.3-4: Summary Statistics for Criteria Air Contaminants**

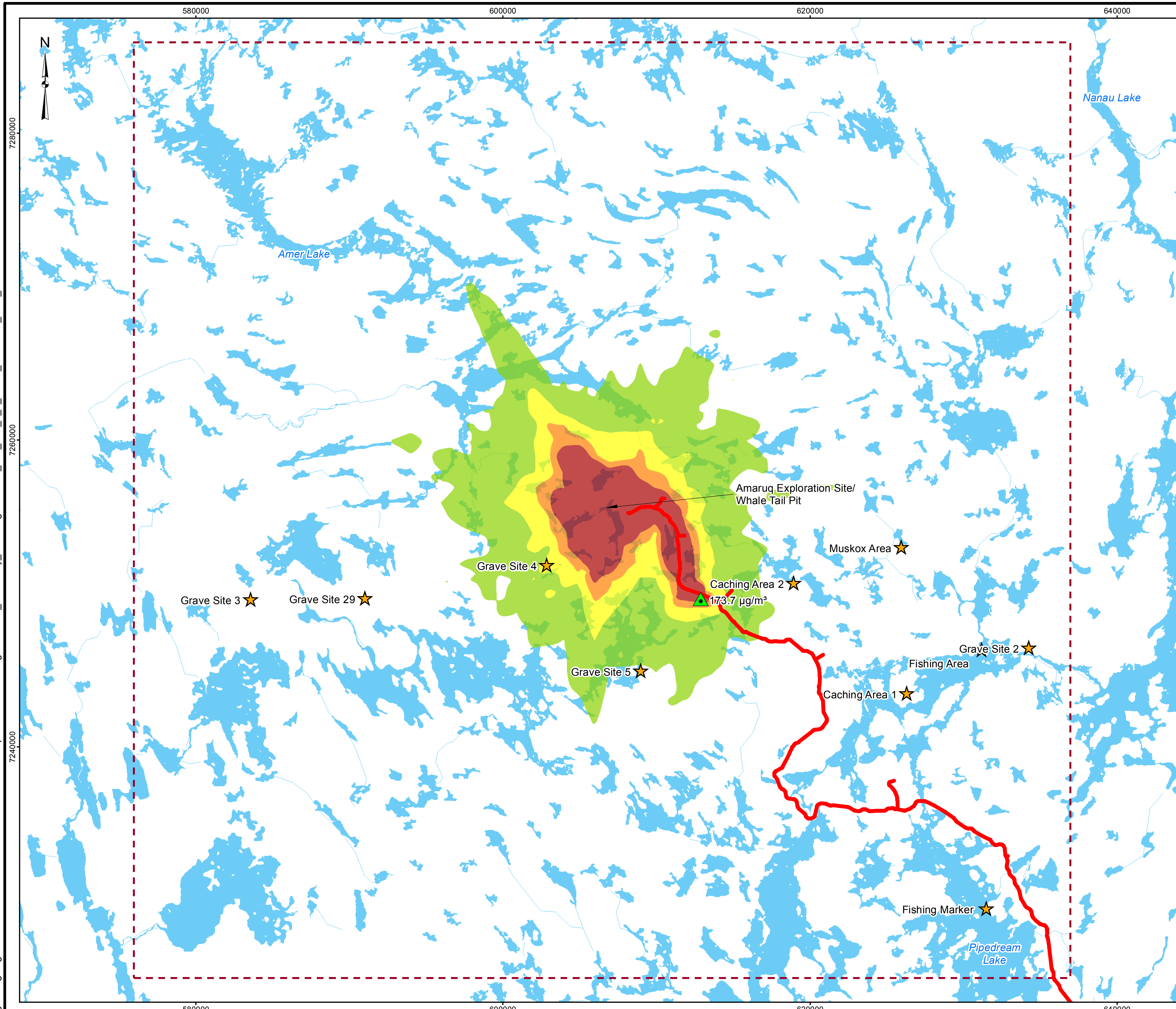
| Compound (units) | Averaging Period | Background Concentrations | Maximum plus Background Concentrations | Air Quality Standard |
|---|---|---|---|---|
| CO (ppmv) | 1-hr | 0.3 | 0.9 | **13** |
| | 8-hr | 0.3 | 0.5 | **5** |
| $NO_2$ (ppbv) | 1-hr | 5.0 | 0.1 | **159** |
| | 24-hr | 4.5 | 30.3 | **106** |
| | Annual | 1.9 | 4.4 | **24** |
| $SO_2$ (ppbv) | 1-hr | 1.0 | 6.7 | **172** |
| | 24-hr | 1.0 | 2.2 | **48** |
| | Annual | 0.1 | 0.2 | **8** |
| $PM_{2.5}$ (µg/m³) | 24-hr | 6.6 | 20.1 (13.5[b]) | **28[b]** |
| | Annual | 3.6[a] | 4.3 | **8.8** |
| $PM_{10}$ (µg /m³) | 24-hr | 3.6[a] | 52.4 | **50** |
| TSP (µg /m³) | 24-hr | 3.6[a] | 174 | **120** |
| | Annual | 3.6[a] | 16.9 | **60** |

[a] Geometric average (median or 50th percentile) of 5-years of 24-hr average concentrations after removing zeros and hourly concentrations above the 97.6th percentile.

[b] 3-year, 98th percentile.

CO = carbon monoxide; $NO_2$ = nitrogen dioxide; $SO_2$ = sulfur dioxide; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometres in aerodynamic diameter; $PM_{10}$ = particulate matter smaller than 10.0 micrometres in aerodynamic diameter; TSP = total suspended particulate matter; ppbv = parts per billion, volumetric; ppmv = parts per million, volumetric; µg/m³ = micrograms per cubic metre; hr = hour.

\\golder.gds\gal\Saskatoon\GGIS\2015\1524321 AEM Amaruq Whale Tail EIS\Figures\1400_AirQuality_Modeling\1541520_EIS_FIG_4_4_Model_Predicted_24hr_TSP.mxd




**LEGEND**

- MAXIMUM POINT OF IMPINGEMENT
- DISCRETE RECEPTOR
- MODEL BOUNDARY
- PROPOSED WHALE TAIL PIT HAUL ROAD
- WATERCOURSE
- WATERBODY

**CONCENTRATION (µg/m³)**

- 0 - 30
- 30 - 60
- 60 - 90
- 90 - 120
- > 120

**REFERENCE**

1. PROJECT BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

5 0 5

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOW BANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

**MODEL PREDICTED 24-HOUR TSP CONCENTRATIONS**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT | | 1524321 | FILE No. |
| DESIGN | ZY | 2016-03-02 | SCALE AS SHOWN REV. A |
| GIS | SBM | 2016-05-11 | |
| CHECK | CMc | 2016-05-11 | **FIGURE 4.3-4** |
| REVIEW | CM | 2016-05-11 | |

#### *4.3.3.3 Effect of Extension of Meadowbank Mill and Camp Operations on Air Quality*

The Meadowbank Mill and camp will continue to operate during the mining of the Whale Tail Pit. Emission sources from Meadowbank and camp operations include the following:

- power plant;
- primary crusher and mills;
- stockpile wind erosion;
- tailing wind erosion;
- an incinerator, and
- waste rock disposal fugitive emissions from three distinct sources including:
  - equipment traffic in storage area;
  - waste aggregate unloading (handling); and
  - wind erosion of pile surfaces and surrounding area.

Potential effects of the continued operations of the Meadowbank Mill and camp on air quality are assessed by evaluating the 2014 monitoring results from the Meadowbank Mine. The rational for using this approach includes the following:

- In the Cumberland (2005d) air quality impact assessment, the power plant, mobile emission sources, and the fugitive dust sources were modelled. The air quality impact assessment for the Meadowbank Mine predicted effects to air quality would be negligible to the LSA, and were predicted to have no impact to the RSA.
- Since November, 2011, Agnico Eagle has conducted dustfall and air quality monitoring at Meadowbank Mine. The objective of this program is to monitor ambient air quality around the mine site perimeter to verify compliance with relevant environmental standards and, if necessary, mitigate any potential environmental effects. Results of the dustfall and air quality monitoring program are briefly summarized in the sections below.
- During 2014, the Meadowbank Mill processed an average of 11,313 tonnes of ore per day (t/d). The proposed ore production of the Whale Tale pit in the peak year is 328,500 tonnes, which is equivalent to approximately 9,000 t/d. Therefore, the proposed throughput at the Meadowbank Mill while processing ore from the Whale Tail Pit is approximately 15 to 20% lower than the current throughput.
- The Whale Tail Pit is located approximately 53 km from the Meadowbank Mill. Combustion emissions from the Project are low, and the potential effects of fugitive dust are local (i.e., <10 km) rather than regional (i.e., > 10 km) in extent. Therefore no measurable cumulative effects are predicted to occur as a result of the development of the Whale Tail Pit and continued operations of the Meadowbank Mill and camp.

In the following sections the 2014 air quality and dustfall monitoring program at Meadowbank Mine are reviewed and results compared to the relevant ambient air quality standards.

### Air Quality Monitoring Locations

There are four air quality monitoring locations at Meadowbank, which were selected in consultation with Environment Canada. Table 4.3-5 summarizes the parameters measured at the stations and the station locations. Station DF-1 is located next to explosive storage area, and approximately 500 m north of the all-weather access road. Station DF-2 is located at the northern corner of south Camp Island. Station DF-3 is approximately 1.8 km east of the East Dike. Station DF-4 is approximately 1.5 km southwest of Vault Pit.

**Table 4.3-5: UTM Coordinates and Dates of Measurement for the Meadowbank Air Quality and Dustfall Monitoring Locations**

| Monitoring Location | Measured Parameters | Easting, m | Northing, m |
|---|---|---|---|
| DF-1 | TSP, $PM_{10}$, $PM_{2.5}$, $NO_2$, Dustfall | 636850 | 7217663 |
| DF-2 | TSP, $PM_{10}$, $PM_{2.5}$, $NO_2$, Dustfall | 637895 | 7213049 |
| DF-3 | Dustfall | 639599 | 7213198 |
| DF-4 | Dustfall | 639233 | 7217074 |

$NO_2$ = nitrogen dioxide; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometres in aerodynamic diameter; $PM_{10}$ = particulate matter smaller than 10.0 micrometres in aerodynamic diameter; TSP = total suspended particulate matter.

### Monitoring Methods

In 2014, size-resolved particulate measurements (TSP, $PM_{10}$, $PM_{2.5}$) at two locations (DF-1 and DF-2) were collected for 24-h periods every six days using Partisol Plus Model 2025 Sequential Air Samplers (TSP) and Partisol Plus Model 2025-D Dichotomous Sequential Air Samplers ($PM_{2.5}$ and $PM_{10}$). Partisol samplers draw in a stream of ambient air at a controlled flow rate, and particulates are collected on a pre-weighed filter supplied by an accredited laboratory (Maxxam Analytics). The exposed filter is then shipped back to the laboratory and re-weighed to measure the total accumulated particulate; TSP, $PM_{10}$, and $PM_{2.5}$ concentrations are then calculated based on filter mass, flow rate, and duration of the sample.

Dustfall was collected in open vessels containing a purified liquid matrix over periods of approximately one month at each of the four air quality monitoring stations. Particles are deposited into the liquid matrix, which was then analyzed for total and fixed (non-combustible) dustfall. Calculated dustfall rates were normalized to 30 days ($mg/cm^2$/30days) for comparison to relevant air quality standards.

Passive $NO_2$ sampling devices are deployed at the air quality monitoring stations over approximately one month periods. After exposure the passive samples are put into sealed containers and shipped to Maxxam Analytics who analyze the media to calculate ambient concentrations of $NO_2$ by volume (parts per billion [ppb]).

### Monitoring Results

The suspended particulate matter sampling units were nearly fully operational in 2014. TSP concentrations are generally highest in April, and include one exceedance of the 24-h standard of 120 $\mu g/m^3$ at 219 $\mu g/m^3$. The annual geometric mean concentrations of TSP at DF-1 and DF-2 were 6.5 and 12.8 $\mu g/m^3$, respectively. These concentrations are well below the annual TSP standard of 60 $\mu g/m^3$.

The highest $PM_{10}$ concentrations were observed at DF-2 between April and November. There is no 24-hr air quality standard for $PM_{10}$ in Nunavut. Annual average 24-hr $PM_{10}$ concentrations were 10 and 11 $\mu g/m^3$ at DF-1 and DF-2, respectively.

One 2014 sample exceeded the Government of Nunavut standard of 30 µg/m$^3$ for 24-h average $PM_{2.5}$, and the Canadian Ambient Air Quality Standard of 28 µg/m$^3$; the $PM_{2.5}$ concentration was 56 µg/m$^3$. Annual average concentrations of $PM_{2.5}$ were 1 and 5 µg/m$^3$ at DF-1 and DF-2, respectively. These values are consistent with estimated annual average background concentration of $PM_{2.5}$ (3.6 µg/m$^3$) and are below the Canadian Ambient Air Quality Standard annual average $PM_{2.5}$ concentration of 10 µg/m$^3$.

There are no dustfall standards or guidelines for Nunavut. Of the 44 dustfall samples collected in 2014, there are five measurements that exceed the BC lower dustfall criteria of 0.51 mg/cm$^2$/30days. To provide additional context, Alberta Environment and Parks specifies recreational/residential and industrial/commercial area dustfall guidelines of 0.53 mg/cm$^2$/30days and 1.58 mg/cm$^2$/30days for total dustfall. The Alberta recreational/residential area guideline was exceeded in 5 out of 44 samples but the industrial/commercial area guideline was not exceeded in 2014. Historically dustfall guidelines were created to prevent the accumulation of nuisance dust. The applicability of these guidelines to the Project are not well established, as there are no recreational or residential activities occurring near the Whale Tail Pit or the haul road to the Meadowbank Mill.

Concentrations of $NO_2$ vary between non-detect (<0.1 ppb) and 3.3 ppb. Annual arithmetic mean concentrations were calculated for each station from the monthly-average values. The annual mean concentrations of $NO_2$ were 0.5 ppb and 1.9 ppb for DF-1 and DF-2, respectively (January 2, 2014 – January 18, 2015). These values are consistent with the estimated annual average background $NO_2$ concentration of 1.9 ppbv (Table 4.3-1) and well below the Government of Nunavut Ambient Air Quality Standard annual average (32 ppbv).

#### *Summary*

The 2014 air quality and dustfall monitoring indicate one 24-hr exceedance each for Government of Nunavut's ambient air quality standards for TSP and $PM_{2.5}$ in 2014. There were no exceedances of $NO_2$ concentrations in 2014. There are no dustfall guidelines for Nunavut. However, 5 out of 44 dust fall samples at Meadowbank exceeded the Alberta recreational/residential area dustfall guideline; no dustfall samples at Meadowbank exceed the industrial/commercial dustfall guideline.

Based on: monitoring results; an estimated 15 to 20% reduction in Meadowbank Mill throughput using ore from the Whale Tail Pit; and, the short operations phase of the Project; the spatial and temporal effects of an extension to the operations of the Meadowbank Mill and camp on regional air quality are considered low. Any potential effects are considered reversible in that emissions will no longer affect air quality once the Whale Tail Pit and Meadowbank Mill are decommissioned.

### *4.3.3.4 Effect of Extension of All Weather Access Road on Air Quality*

The All-Weather Access Road (AWAR) between the community of Baker Lake and the Meadowbank Mine is expected to remain active for a period of up to three years after the Whale Tail Pit operations commence. The potential combined effects of emissions resulting from the ongoing use of the AWAR and the Whale Tail Pit operations including the haul road have been considered qualitatively in this assessment because of the limited possibility for interaction between the multiple potential emissions sources, the significant distance between the AWAR and the Whale Tail operations and the expected limited use of the AWAR.

The quantitative assessment completed for the Whale Tail haul road can also be used as an appropriate analog for the AWAR. The findings of the modelling assessment (Section 4.3.3.1) indicate that predictions of $PM_{2.5}$ adjacent to the haul road were below Nunavut ambient air quality guidelines within 50 to 75 m from the haul road and further, that in the near field, maximum TSP concentrations adjacent to the road are predicted to exceed the

24-hour average ambient air quality standard at distances of up to 1,500 m from the haul road. Maximum annual TSP concentrations are predicted to exceed the ambient air quality standard (60 $\mu g/m^3$) only within the first 100 to 300 m from the haul road.

The effects of fugitive dust emissions on air quality adjacent to the haul road are limited in spatial extent and occur primarily on dry windy days in the summer. These effects are reversible in that fugitive dust will no longer affect air quality once the AWAR is decommissioned.

The most recent (2015) results of the Meadowbank dustfall monitoring program were reported in March of 2016. They indicate that even in close proximity to the project operations, all samples but one out of the 48 collected compared favourably with the Alberta guidance on dustfall for recreational and residential areas. The single excursion above the Alberta guideline was recorded immediately adjacent to the explosives emulsion plant where there is regular activity. None of the samples collected resulted in deposition rates above the Alberta guidance for industrial areas and all samples were collected within approximately 500 m of the Meadowbank facility operations. A supplemental dustfall monitoring program is planned for the AWAR and for the Whale Tail Pit haul road to confirm the assessment conclusions.

#### *4.3.3.5 Potential for Acid Deposition*

Atmospheric deposition of acid gases and particulate matter produced from the use of explosives and from fuel combustion can affect soil quality, water quality, and therefore flora and fauna upon which the Inuit depend for the social, cultural, and economic well-being.

Acid deposition modelling requires the use of specialized air quality models (e.g., CALPUFF). In Alberta, acid deposition modelling may be required if:

1) the proponents combined emissions of $SO_2$, $NO_x$ and ammonia ($NH_3$) is greater than 0.175 t/d of hydrogen ion ($H^+$) equivalents in t/d, where:

    Total $H^+$ equivalent = $2*(SO_2)/(64)+1*(NO_x)/(46)+1*(NH_3)/(17)$; or

2) there is evidence that regional soil and surface water is more sensitive to acidification than estimated in the <Alberta> framework; or

3) there is existing deposition and/or acidification impact monitoring that indicates a potential concern is acid deposition increases.

Table 4.3-5 summarizes Project emissions of $SO_2$, $NO_x$ (as $NO_2$) and $NH_3$, current emissions estimates for the Meadowbank Mill and camp, as well as emissions from other reported sources in Nunavut (Environment Canada 2016). Project emissions and emissions from the Meadowbank Mill and camp are conservative because annual totals are based on maximum daily output and because it is assumed that the Projects emit enough ammonia to completely neutralize all emissions of sulfur and nitrogen oxides. Including ammonia represents a very conservative assumption as the Project is not a source of these emissions (other than very small amounts that may be emitted from wastewater systems).

Results indicate that conservatively estimated Project emissions of hydrogen ion equivalents (0.140 t/d) do not meet acid deposition modelling requirement #1 (i.e., 0.175 t/d). Project emissions plus current emissions of hydrogen ion equivalents from the Meadowbank Mill and camp (0.24 t/d) exceed modelling requirement #1 (Table

4.3-6). However, acid deposition modelling was not undertaken because: there are few sources in Nunavut and they are distributed over a large area; emissions reported for Nunavut are likely underestimated; and, there is no evidence that current emissions from the Meadowbank Mine/Mill and camp result in acid deposition related impacts. Further justification is provided in the discussion that follows.

**Table 4.3-6: Acidic Gas Emissions Summary**

| Parameter | $SO_2$ | $NO_2$ | $NH_3$ |
|---|---|---|---|
| Whale Tail Pit and Haul Road Emission (t/d) | 0.03 | 3.2 | 1.2[a] |
| Meadow Bank Mill Emissions (t/d) | 0.05 | 5.4 | 2.0[a] |
| Total Project Emissions (t/d) | 0.08 | 8.6 | 3.2[a] |
| Total Nunavut Emissions (t/d) | 0.41[b] | 9.9[c] | -[d] |
| Project $H^+$ equivalents (t/d) | 0.14 | | |
| Project plus Meadowbank Mill $H^+$ equivalents (t/d) | 0.38 | | |
| Acid Deposition Modelling Threshold | 0.175 | | |

[a] assuming complete conversion of $SO_2$ to sulfate ($SO_4^{2-}$) and $NO_x$ to nitrate ($NO_3^-$), and their complete neutralization by ammonium ($NH_4^+$).

[b] 2010 to 2014 NPRI average (Environment Canada 2016).

[c] 2010 NPRI data only.

[d] no $NH_3$ air emissions reported to NPRI (2010 to 2014).

$SO_2$ = sulfur dioxide; $NO_2$ = nitrogen dioxide; $NH_3$ = ammonia; t/d = tonnes per day; % = percent; NPRI = National Pollutant Release Inventory.

National Pollutant Release Inventory (NPRI) $SO_2$ emissions for Nunavut are likely under-reported as there are no reported $SO_2$ emissions for 2013 or 2014 and only a single facility reported in 2011 and 2012. $SO_2$ emissions in Table 4.3-6 are based on 2010 data, for which 6 facilities reported emissions. $NO_2$ emissions for Nunavut are based on the 5-year 2010 to 2014 average (approximately 30 facilities). However, NPRI emissions exclude mobile and transportation emissions of $NO_2$, which may be a significant source of emissions for Nunavut. There are no 2010 to 2014 NPRI reported $NH_3$ emissions for Nunavut.

The Canada-wide requirement for the use of ultra-low sulfur diesel in on- and off-road equipment results in a low rates of $SO_2$ emissions from the Project plus the Meadowbank Mill (0.08 t/d). Maximum predicted $SO_2$ deposition near the Whale Tail Pit is 0.012 grams per square metre per year (g/m$^2$/yr). This is equivalent to 0.036 equivalent hydrogen per square meters per year (eq $H^+$/m$^2$/yr) and occurs within the Project boundary.

$NO_2$ emissions rates from the Project are predicted to be 3.2 t/d, which is below the current Meadowbank emissions rate (5.4 t/d). The maximum predicted $NO_2$ deposition rate is within the Whale Tail property boundary (0.39 g/m$^2$/yr) and is equivalent to 1.2 kilograms of nitrogen per hectare per year (kg-N/ha/yr). The region near the Whale Tail Pit with $NO_2$ deposition rates greater than 0.04 g/m$^2$/yr extends to ~8 km south-east of property boundary. There are no rates of nitrogen deposition greater than 0.04 g/m$^2$/yr outside the property boundary in other directions. A deposition rate of 0.04 g/m$^2$/yr is equivalent to an increase in nitrogen deposition rates in the region of 0.12 kg-N/ha/yr.

Background levels of Arctic nitrogen deposition are approximately less than 1 kg-N/ha/yr. Changes to Arctic heath composition appear at ~10 kg-N/ha/yr, and the critical load of nitrogen is predicted to be on the low end of 5 to 15 kg-N/ha/yr (Gordon et al. 2001). The nitrogen deposition results presented in this assessment indicate that even within the property boundary, no changes to tundra vegetation due to N deposition is expected. Results from the monitoring program in place at the Meadowbank Mine appear to confirm this, as there have been no effects to water quality detected due to acid deposition. As a result, the $NO_x$ term in the Total $H^+$ equivalent emissions determination can likely be ignored (i.e., these rates of nitrogen [a nutrient] deposition are not predicted to have adverse effects on the Arctic terrestrial or aquatic ecosystems).

$NH_3$ emissions have not been directly estimated for this assessment. There is some potential for $NH_3$ emissions from the use of ammonium nitrate and fuel oil explosives, and from ammonia generated by camp waste water systems. For this assessment, $NH_3$ emissions are estimated by assuming that each equivalent of sulfate (2) and each equivalent of nitrate (1) is neutralized by one equivalent of ammonium (i.e., 2 + 1 = 3 equivalents). For this location, with a presumed absence of major $NH_3$ emissions (dominant sources = sewage, livestock, and agriculture), the complete neutralization of acidic sulfate and nitrate emissions by ammonium is a very conservative assumption.

### 4.3.4 Residual Impact Classification

Primary pathways have been identified for air quality. However, no residual impact classification are made because air quality does not have an assessment endpoint, only measurement endpoints (i.e., comparison to relevant ambient air quality guidelines or standards). Any potential effects associated with the primary pathways are captured in the assessment of potential effects to, and residual impact classifications for, other VCs (e.g., soil quality, water quality, and human health).

### 4.3.5 Cumulative Effects Assessment

No cumulative effects for air quality are anticipated for this Project because of the following:

- emissions of gases and $PM_{2.5}$ from the Project are relatively low;
- concentrations of gases and $PM_{2.5}$ are all well below their relevant air quality guidelines or standards outside the Project boundary;
- air quality and dustfall monitoring at the existing Meadowbank Mine indicate only occasional exceedances of the 24-hr air quality standard for total suspended particulate and dust fall, but with annual averages near regional background values; and
- other than the existing Meadowbank Mine, there are no existing or proposed additional sources of TSP emissions within the 60 km x 60 km study domain, a region that can reasonably be expected to bind the area over which TSP concentrations above background values can be measured/monitored.

### 4.3.6 Uncertainty

The following sources of uncertainty could affect the predictions of air emissions and/or the predicted concentrations and deposition rates of CACs within the study domain:

- Differences in actual versus predicted emissions from the uses of explosives or the consumption of fossil fuels at the Project.
- Differences in actual versus predicted natural mitigation of windblown fugitive dust from un-paved road surfaces, drilling and blasting activities, materials handling, or wind erosion of the ore pad or the waste rock storage facility.

- Differences in actual versus predicted road-bed silt content and/or the effectiveness of proposed dust mitigation measures at the Project.
- Extension of the life of the Whale Tail Pit, and/or development of new mines or mining areas in the region could affect the amount of fugitive dust generated at the site and along the haul road.
- Actual emissions are predicted to be below those presented in this assessment because they are conservatively estimated assuming equipment (e.g., power generators) are operated at 100% of their capacity at all times.

## 4.3.7 Monitoring and Follow-up

### *4.3.7.1 Dust Mitigation*

Both IQ and scientific monitoring suggest that road watering and the application of chemical suppressants can reduce fugitive dust emissions. Road watering is a simple cost effective dust mitigation option provided that adequate water resources are available. Proposed dust mitigation efforts include the following:

1) daily road watering at the Whale Tail Pit and Meadowbank Mill during the frost free summer season;
2) continued use of current mitigation measures on the all-weather-access road;
3) enforcement of haul truck speed limits along the haul road; and
4) strategic road watering along the haul road at hot-spots, near sensitive habitat, and/or during dry windy conditions in summer.

The use chemical dust suppressants was considered (see Volume 4, Appendix 4-C) but is not recommended for the Project. Chemical suppressants include organic hydrocarbon-based products and mineral salts (e.g., EK-35 or calcium chloride). While the human health and ecological effects of these dust suppressants are predicted to be low, they are not native to the Kivalliq region and their long-term effects on Arctic ecosystems has not been evaluated. Chemical suppressants can run off mine and road surfaces during spring melt and during precipitation events with the potential to affect soil or water quality.

### *4.3.7.2 Particulate Matter and Dustfall Monitoring*

Agnico Eagle currently monitors $NO_2$, particulate matter ($PM_{2.5}$, $PM_{10,}$ and TSP) and dustfall at the Meadowbank Mine and along the Meadowbank AWAR to Baker Lake (Agnico Eagle 2015).

The results of this assessment indicate particulate matter and dustfall monitoring at the Whale Tail Pit and along the haul road to the Meadowbank Mine is warranted. The monitoring program will be based on the existing air quality and dustfall monitoring conducted at the Meadowbank Mine, and dustfall monitoring along the Meadowbank AWAR to Baker Lake (Agnico Eagle 2013a; 2015).

# 4.4 Noise and Vibration

## 4.4.1 Incorporation of Inuit Qaujimajatuqangit

As part of the Project NIA, the following documents were reviewed for IQ-specific information and guidance:

- Inuit Qaujimajatuqangit Baseline Report (Volume 7, Appendix 7-A);
- Guidelines for the Integration of IQ into the Environmental Assessment (Golder 2016);
- Public Information Meeting 2014 Summary Report (NIRB 2014);
- Public Information Meeting 2015 Summary Report (NIRB 2015);
- Meadowbank Gold Project – Baseline Traditional Knowledge Report (Cumberland 2005c);
- Proposed All-weather Exploration Road from the Meadowbank Mine to the Amaruq Site – Baseline Traditional Knowledge Report Version 2 (Agnico Eagle 2014a); and
- Community Consultations/Public Information Meeting Summary Reports for 2014 and 2015 (NIRB 2014, 2015).

### *4.4.1.1 Existing Environment and Baseline Information*

It is well-known that wildlife may *"temporarily avoid an area until they become familiar with or acclimatized to industrial noise"* (AER 2007). As such, changes in noise levels are particularly relevant to IQ because potential changes in wildlife distribution, especially to caribou, will have effects on traditional land use and harvesting patterns. In addition, concerns were expressed by Baker Lake community members that are either directly or indirectly related to Project noise effects on wildlife (Volume 7, Appendix 7-A).

### *4.4.1.2 Valued Component Selection*

Noise and vibration was selected as a VC for the Project, partly in response to IQ-specific concerns (Volume 7, Appendix 7-A; Cumberland 2005c). Concerns about the direct and indirect effects of noise on wildlife have been raised by Baker Lake Elder community members during consultation for the Meadowbank Mine, and again during the TK workshop in 2014 and follow-up consultation meetings in 2015 and 2016 (Volume 7, Appendix 7-A).

Concerns that were raised by Baker Lake Elders and land users that are directly related to noise include:

- The destruction or disturbance of nesting and moulting waterfowl and geese habitat due to the effects of noise and repeated disturbance, and especially to nesting, moulting and staging habitats of the highly sensitive snow goose.
- The impact of noise on wildlife, notably caribou.

Concerns that were raised by Baker Lake community members that are indirectly related to noise include:

- Potential changes in caribou distribution.
- Potential effects of construction activities on caribou.
- Disturbance to dens of wolves, foxes, and wolverines near the Project footprint.

- Potential disturbance to wolves due to construction activities causing them to leave the area.

#### 4.4.1.3 Impact Assessment

In the documents listed in Section 4.4.1, members of the community, including Elders, hunters, and trappers, expressed a general concern with the effects of industrial noise on wildlife. Particular concerns were expressed about the effects of industrial noise on caribou and birds. In addition, one community member interviewed as part of the TK baseline study for the Meadowbank Mine indicated that he could *"hear a noise all night long"* at a site of spiritual significance (Cumberland 2005c), which suggests a general community concern about the audibility of industrial noise at spiritual sites.

In the absence of IQ-specific guidance on assessment methodologies or acceptable limits, the Project NIA considered noise and vibration regulations based on western science (AER 2007; DFO 1998; OMOE 1978). However, outputs from the Project NIA (i.e., predicted noise and vibration levels) were provided to the IQ and wildlife disciplines for assessment of the effects of noise on wildlife, including caribou (Table 4.3 of Cumberland 2005a).

#### 4.4.1.4 Mitigation and Monitoring

The mitigation and monitoring plan for the Project is largely consistent with the management plan originally developed for the Meadowbank Mine in 2005 (Cumberland 2005d) and subsequently updated in 2009 and 2013 (Agnico Eagle 2009, 2013b). Based on public concerns related to the effect of noise on wildlife, the plan outlines Agnico Eagle's strategies for reducing noise disturbance with particular regard to wildlife.

### 4.4.2 Existing Environment and Baseline Information

As discussed in Volume 4, Appendix 4-E, the Permissible Sound Level (PSL) values used to assess broadband noise from conventional Project sources (i.e., all Project noise sources except blasting) are cumulative limits that apply to Project noise in combination with existing ambient noise levels. To gather information about existing ambient noise levels in support of the Project NIA, a baseline field survey was completed in August 2015 (Volume 4, Appendix 4-D). The purpose of this baseline field survey was to measure existing ambient noise levels at four locations in the LSA and RSA.

The results of the baseline field survey are described in detail in Volume 4, Appendix 4-D. The key findings of the baseline survey (i.e., existing daytime and nighttime ambient noise levels measured at locations in the LSA/RSA) are re-produced in Table 4.4-1.

Existing ambient noise levels at R6 were dominated by noise from the Meadowbank Vault Pit: a facility whose noise effects have already been well-characterized as part of an earlier regulatory process (Cumberland 2005a; Cumberland 2005b) and will cease operations during the operations of Whale Tail Pit. The objective of the Project NIA was to assess potential noise and vibration effects from the Project and not to reassess potential effects from Meadowbank. As such, the existing ambient noise levels measured at R6 were excluded when estimating representative existing ambient noise levels for use in the Project NIA.

**Table 4.4-1: Baseline Field Survey - Results Summary**

| Baseline Noise Monitoring Location | Universal Transverse Mercator Coordinates [NAD83, Zone 14] | | Description | Measured Existing Ambient Nosie Level [dBA] | | Measured Existing Ambient Nosie Level [dBC] | |
|---|---|---|---|---|---|---|---|
| | Easting [m] | Northing [m] | | Daytime | Nighttime | Daytime | Nighttime |
| R6 | 640708 | 7221964 | Unoccupied location north of existing Meadowbank Vault Pit; noise environment dominated by activities in Vault Pit | 39 | 41 | 59 | 58 |
| R7 | 620194 | 7239038 | Unoccupied location adjacent to the proposed Project haul road; noise environment dominated by natural sources (e.g., wind, waves, birds) | 29 | 29 | 42 | 43 |
| R8 | 610725 | 7256677 | Unoccupied location northeast of proposed Whale Tail Pit; noise environment dominated by wind and activities associated with existing Whale Tail Exploration Camp | 30 | 31 | 46 | 47 |
| R9 | 602488 | 7255946 | Unoccupied location northwest of proposed Whale Tail Pit; noise environment dominated by wind and activities associated with existing Whale Tail Exploration Camp | 31 | 31 | 47 | 47 |

NAD = North American Datum; dBA = A-weighted decibel; dBC = C-weighted decibel; m = metre.

Ambient noise levels measured at R7, R8, and R9 are representative of existing conditions in the LSA/RSA. As such, the noise levels measured at these monitoring locations were averaged and used to represent existing ambient noise levels for the Project NIA. Table 4.4-2 presents the average of R7, R8, and R9 measured noise levels, which were used to represent existing ambient noise levels in the Project NIA.

**Table 4.4-2: Representative Existing Ambient Noise Levels**

| Area of Applicability | Existing Ambient Noise Levels [dBA] | | Existing Ambient Noise Levels [dBC] | |
|---|---|---|---|---|
| | Daytime | Nighttime | Daytime | Nighttime |
| LSA and RSA | 30 | 30 | 45 | 46 |

dBA = A-weighted decibel; dBC = C-weighted decibel; LSA = local study area; RSA = regional study area.

### 4.4.3 Potential Project-related Effects Assessment

Pathway analysis is provided in Volume 3, Section 3.4. Primary pathways that require further effects analysis to determine the environmental significance from the Project are provided below. Pathways determined to have no linkage or those that are considered secondary are not predicted to result in environmentally significant effects are provided in Volume 3, Appendix 3-C, Table 3-C-1.

The following primary pathways were identified for the Project NIA:

- Haul Road Construction:

- noise emissions from construction equipment can increase ambient noise levels;
- if required, blasting can result in ground vibration and increase ambient noise levels;

- Pit Operations:
  - noise emissions from mining equipment can increase ambient noise levels;
  - blasting can result in ground vibration and increase ambient noise levels;
- Haul Road Operations:
  - noise emissions from vehicles on the haul road can increase ambient noise levels.

### *4.4.3.1 Haul Road Construction*

#### 4.4.3.1.1 Conventional Noise Sources

In the absence of Nunavut-specific regulatory guidance, noise from conventional sources associated with haul road construction (i.e., noise sources – like excavators, loaders, and trucks – which emit noise continuously) were assessed in accordance with methods and limits described in Alberta Energy Regulator (AER) Directive 038 (AER 2007). Haul road upgrades and construction noise levels were predicted using the ISO 9613-2 technical standard (ISO 1996) and were compared to PSL and Low Frequency Noise (LFN) limits set out in AER Directive 038. The AER Directive 038 PSL values are not strictly applicable to construction activities. However, when assessing haul road construction it was still instructive to compare predicted noise level to PSL values, since they represent acceptable noise levels in other contexts (i.e., Project operations). An earlier version of AER Directive 038 was used to assess potential noise effects from the Meadowbank Mine (Cumberland 2005a; Cumberland 2005b) as part of the original regulatory process for this facility. Additional discussion on the use of AER Directive 038 in the Project NIA is provided in Volume 4, Appendix 4-E, Section 4.E-3.

Figure 4.4-1 presents predicted Project noise levels for haul road construction under summertime and wintertime conditions. As discussed in Volume 4, Appendix 4-E, the Project NIA considered road construction for a representative 140 m section of road and predicted noise levels across an LSA and RSA surrounding these activities. Similar noise levels can be expected at comparable distances from other sections of the Project haul road.


## LEGEND

ENERGY EQUIVALENT SOUND LEVEL ($L_{eq}$) (dBA)

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- > 55


## REFERENCE

1 0 1
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE
# HAUL ROAD CONSTRUCTION NOISE LEVEL PREDICTIONS: SUMMER AND WINTER

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT | | 1541520 | FILE No. |
| DESIGN | VY | 01 Mar. 2016 | SCALE AS SHOWN REV. 0 |
| GIS | CDB | 20 Apr. 2016 | FIGURE 4.4-1 |
| CHECK | JR | 06 May 2016 | |
| REVIEW | LY | 06 May 2016 | |

As shown in Figure 4.4-1, haul road construction Project noise levels are predicted to be less than 30 A-weighted decibel (dBA) at 5 km and 7 km from the haul road for both summertime and wintertime. In other words, for all periods, haul road construction Project noise levels are predicted to be less than the existing ambient noise level (see Table 4.4-2) at the boundary of the LSA and at the boundary of the RSA.

As discussed in Volume 4, Appendix 4-E, the PSL values used to assess broadband Project noise are cumulative limits. As such, to assess potential Project noise effects using PSL values, it was necessary to calculate cumulative noise levels associated with haul road construction by summing predicted Project noise levels with existing ambient noise levels.

In the interest of assessing potential Project noise effects conservatively, the PSL assessment was focused on that point on the LSA boundary with maximum predicted Project noise level (Rmax). The PSL assessment for Rmax is presented in Table 4.4-3.

The results presented in Table 4.4-3 show that for both summertime and wintertime haul road construction, cumulative noise levels on the LSA boundary are predicted to be less than the relevant PSL value.

**Table 4.4-3: Haul Road Construction - Permissible Sound Level Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBA] | Haul Road Construction Project Noise Level [dBA] | Haul Road Construction Cumulative Noise Level[a] [dBA] | Permissible Sound Level [dBA] |
|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 30 | 21 | 31 | 50 |
| | Summertime / Nighttime | 30 | 21 | 31 | 40 |
| | Wintertime / Daytime | 30 | 21 | 31 | 55 |
| | Wintertime / Nighttime | 30 | 21 | 31 | 45 |

[a] Calculated as the logarithmic sum of the existing ambient noise level and the haul road construction Project noise level.
dBA = A-weighted decibel; LSA = local study area; RSA = regional study area; Rmax = maximum predicted Project noise level.

As discussed in Volume 4, Appendix 4-E, the Project NIA assessed the potential for LFN effects by comparing predicted noise levels expressed in C-weighted decibel (dBC) and dBA. Table 4.4-4 presents the results of the haul road construction LFN assessment for Rmax – the point on the LSA boundary with maximum predicted Project noise level. Again, it should be noted that AER Directive 038 does not require the LFN test to be applied to construction noise; however it is still instructive to do so.

**Table 4.4-4: Haul Road Construction – Low Frequency Noise Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBC] | Haul Road Construction Project Noise Level [dBC] | Haul Road Construction Cumulative Nosie Level [dBC] | Haul Road Construction Cumulative Noise Level [dBA] | Difference: dBC minus dBA |
|---|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 45 | 36 | 46 | 31 | 15 |
| | Summertime / Nighttime | 46 | 36 | 46 | 31 | 15 |
| | Wintertime / Daytime | 45 | 38 | 46 | 31 | 15 |
| | Wintertime / Nighttime | 46 | 38 | 47 | 31 | 16 |

Rmax = maximum predicted Project noise level; dBA = A-weighted decibel; dBC = C-weighted decibel; LSA = local study area.

The results presented in Table 4.4-4 show that the difference between dBC and dBA Project noise levels is predicted to be less than 20 at Rmax. Based on the first LFN condition set out in AER Directive 038, this result suggests that there will be no LFN effect along the LSA boundary.

#### 4.4.3.1.2 Blasting Noise and Vibration Sources

Haul road construction is not currently expected to require any blasting; however, in the interest of conservatism, haul road construction blasting was assessed in case it should become necessary once work on the Project begins. In the absence of Nunavut-specific regulatory guidance, noise and vibration from blasting activities associated with haul road construction were assessed in accordance with methods and limits described in the Ontario Ministry of Environment (OMOE) *Noise Pollution Control Publication 119* (OMOE 1978) – hereafter referred to as NPC-119 – and in the Department of Fisheries and Oceans (DFO) *Guidance for the Use of Explosives In or Near Canadian Fisheries Waters* (DFO 1998). In particular, ground vibration levels and airborne noise levels associated with haul road construction blasting were predicted using empirical formulae (ISEE 1998; DFO 1998) and were compared to limits set out in NPC-119 and the DFO guidance document.

Table 4.4-5 presents the predicted blasting vibration levels associated with haul road construction in the form of Peak Particle Velocity (PPV) at various distances from the blasting activity. Table 4.4-5 also presents predicted blasting noise levels associated with haul road construction in the form of Peak Pressure Level (PPL) at various distances from the blasting activity. Both PPV and PPL values were calculated using empirical formulae discussed in detail in Volume 4, Appendix 4-E (ISEE 1998). As discussed in Volume 4, Appendix 4-E, the haul road construction blasting assessment was based on the assumption that up to 45 kg of explosives will be detonated simultaneously.

**Table 4.4-5: Haul Road Construction – Blasting Noise and Vibration Predictions**

| Distance from Blast [m] | Peak Particle Velocity – Ground Vibration [mm/s] | Peak Pressure Level – Airborne Noise [dBZ] |
|---|---|---|
| 100 | 23 | 130 |
| 165 | 10 – NPC-119 limit[a,b] | 125 |
| 200 | 8 | 123 |
| 300 | 4 | 120 – NPC-119 limit[a,c] |
| 1000 | 1 | 108 |
| 5000 – LSA boundary | 0 | 93 |

[a] OMOE (1978)

[b] The NPC-119 PPV limit is the maximum ground vibration level considered acceptable by the regulation. The results in this table show that PPV values are predicted to decay to below the NPC-119 limit for distances greater than 165 m from haul road construction blasting activities.

[c] The NPC-119 PPL limit is the maximum airborne noise level considered acceptable by the regulation. The results in this table show that PPL values are predicted to decay to below the NPC-119 limit for distances greater than 300 m from haul road construction blasting activities.

LSA = local study area; m = metre; mm/s = millimetres per second; dBZ = unweighted or linear decibels; PPL = Peak Pressure Level; PPV = Peak Particle Velocity.

The PPV results presented in Table 4.4-5 suggest that ground vibration associated with blasting as part of haul road construction will decay to the 10 mm/s limit established in NPC-119 (OMOE 1978) within 165 m of the blasting source and that PPV ground vibration will decay to below quantifiable levels at the LSA boundary. In other words, at the LSA boundary ground vibration levels from Project blasting are predicted to be well below the NPC-119 limit.

The PPL results presented in Table 4.4-5 suggest that airborne noise associated with blasting as part of haul road construction will decay to the 120 unweighted or linear decibels (dBZ) limit established in NCP-119 (OMOE 1978) within 300 m of the blasting source and that PPL airborne noise will decay to 93 dBZ at the LSA boundary. In other words, at the LSA boundary airborne noise levels from Project blasting are predicted to be well below the NPC-119 limit.

Table 4.4-6 presents predicted setback distances from haul road construction blasting activities required to achieve compliance with DFO PPV and PPL limits for the protection of spawning fish and fish habitat, respectively. Both of these setback distances were calculated using empirical formulae discussed in detail in Volume 4, Appendix 4-E (DFO 1998). As discussed above, the haul road construction blasting assessment was based on the assumption that up to 45 kg of explosives will be detonated simultaneously.

**Table 4.4-6: Haul Road Construction –Fisheries and Oceans Canada Blasting Setback Predictions**

| Setback Criterion | Setback Distance [m] |
|---|---|
| Fish Spawning – Ground Vibration (PPV) | 101 |
| Fish Habitat – Airborne Noise (PPL) | 22 |

m = metre; PPL = Peak Pressure Level; PPV = Peak Particle Velocity.

The results presented in Table 4.4-6 suggest that, to achieve compliance with DFO blasting limits, haul road construction blasting should not occur within 101 m of areas used for fish spawning and should not occur within 22 m of fish habitat.

### 4.4.3.2 Whale Tail Pit Operations

#### 4.4.3.2.1 Conventional Noise Sources

In the absence of Nunavut-specific regulatory guidance, noise from conventional sources associated with Pit Operations were assessed in accordance with methods and limits described in AER Directive 038 (AER 2007). In particular, pit operations noise levels were predicted using the ISO 9613-2 technical standard (ISO 1996) and were compared to PSL and LFN limits set out in AER Directive 038.

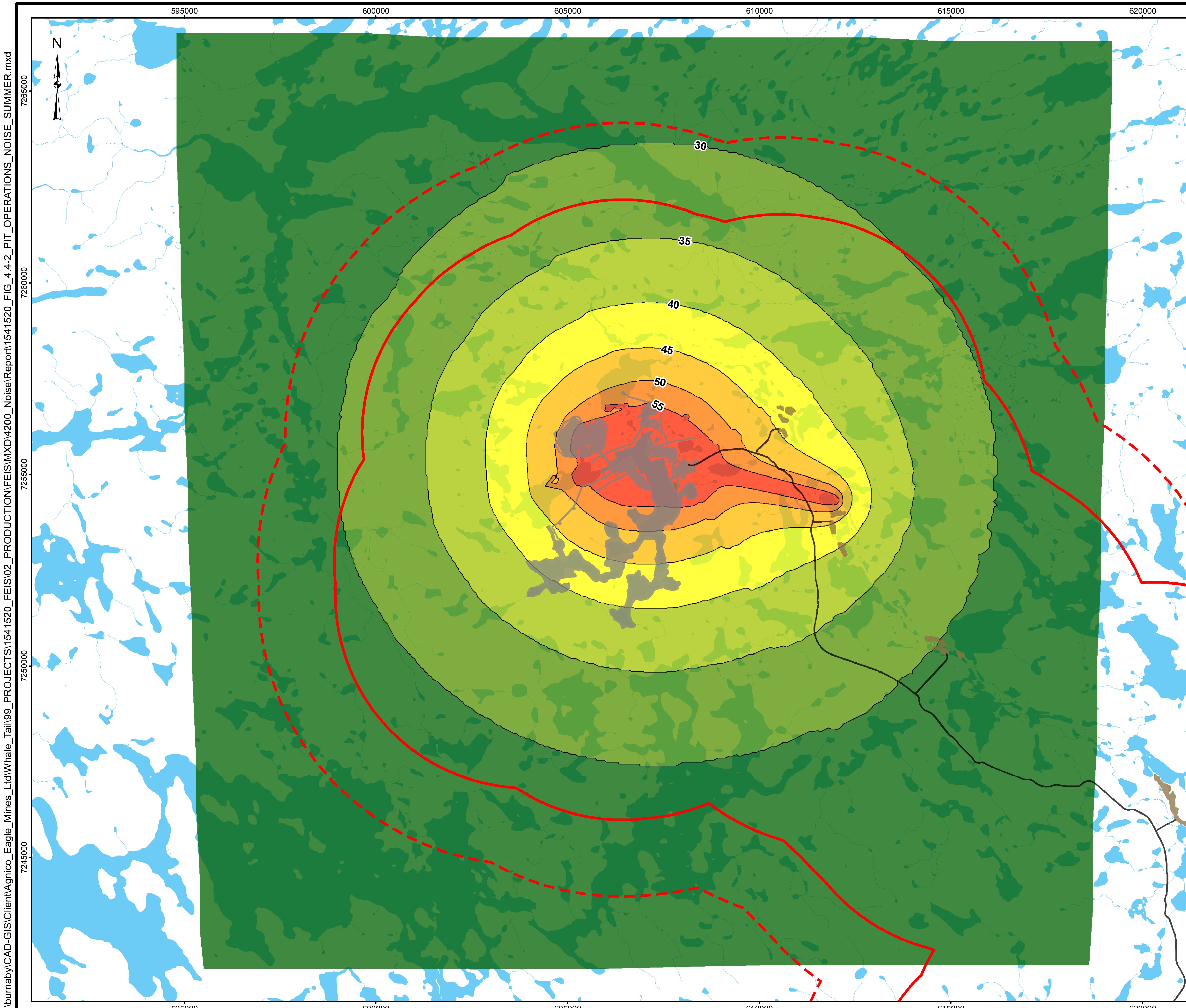
Figure 4.4-2 presents predicted Project noise levels for pit operations under summertime conditions. Figure 4.4-3 presents predicted Project noise levels for pit operations under wintertime conditions.

As shown in Figure 4.4-2 and Figure 4.4-3, pit operations Project noise levels are predicted to be less than 30 dBA at the RSA boundary for both summertime and wintertime. In other words, for all periods, pit operations Project noise levels are predicted to be less than the existing ambient noise level (see Table 4.4-2) at the boundary of the RSA.

Similarly, for all periods, pit operations Project noise levels are predicted to be less than the 30 dBA existing ambient noise level for most of the LSA boundary. There are areas of the LSA boundary north and west of the Whale Tail Pit where pit operations Project noise levels are predicted to exceed 30 dBA but, for all periods and all points on the LSA boundary, pit operations Project noise levels are predicted to be less than 35 dBA.

As discussed in Volume 4, Appendix 4-E, the PSL values used to assess broadband Project noise are cumulative limits. As such, to assess potential Project noise effects using PSL values, it was necessary to calculate cumulative noise levels associated with pit operations by summing predicted Project noise levels with existing ambient noise levels.

In the interest of assessing potential Project noise effects conservatively, the PSL assessment was focused on that point on the LSA boundary with maximum predicted Project noise level. This point was found to be north-northeast of the Whale Tail Pit – almost directly north of the point at which the haul road joins the pit infrastructure. The PSL assessment for this location, hereafter referred to as Rmax, is presented in Table 4.4-7.




## LEGEND

- NOISE AND VIBRATION LOCAL STUDY AREA
- NOISE AND VIBRATION REGIONAL STUDY AREA

WHALE TAIL

- BORROW SOURCE
- INFRASTRUCTURE
- PROPOSED HAUL ROAD

ENERGY EQUIVALENT SOUND LEVEL ($L_{eq}$) (dBA)

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- > 55
- WATERCOURSE
- WATERBODY


## REFERENCE

1. WHALE TAIL INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON DECEMBER 21, 2015.
2. MEADOWBANK INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON NOVEMBER 12, 2015.
3. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
4. INSET MAP DATA OBTAINED FROM ESRI

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

2 0 2

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

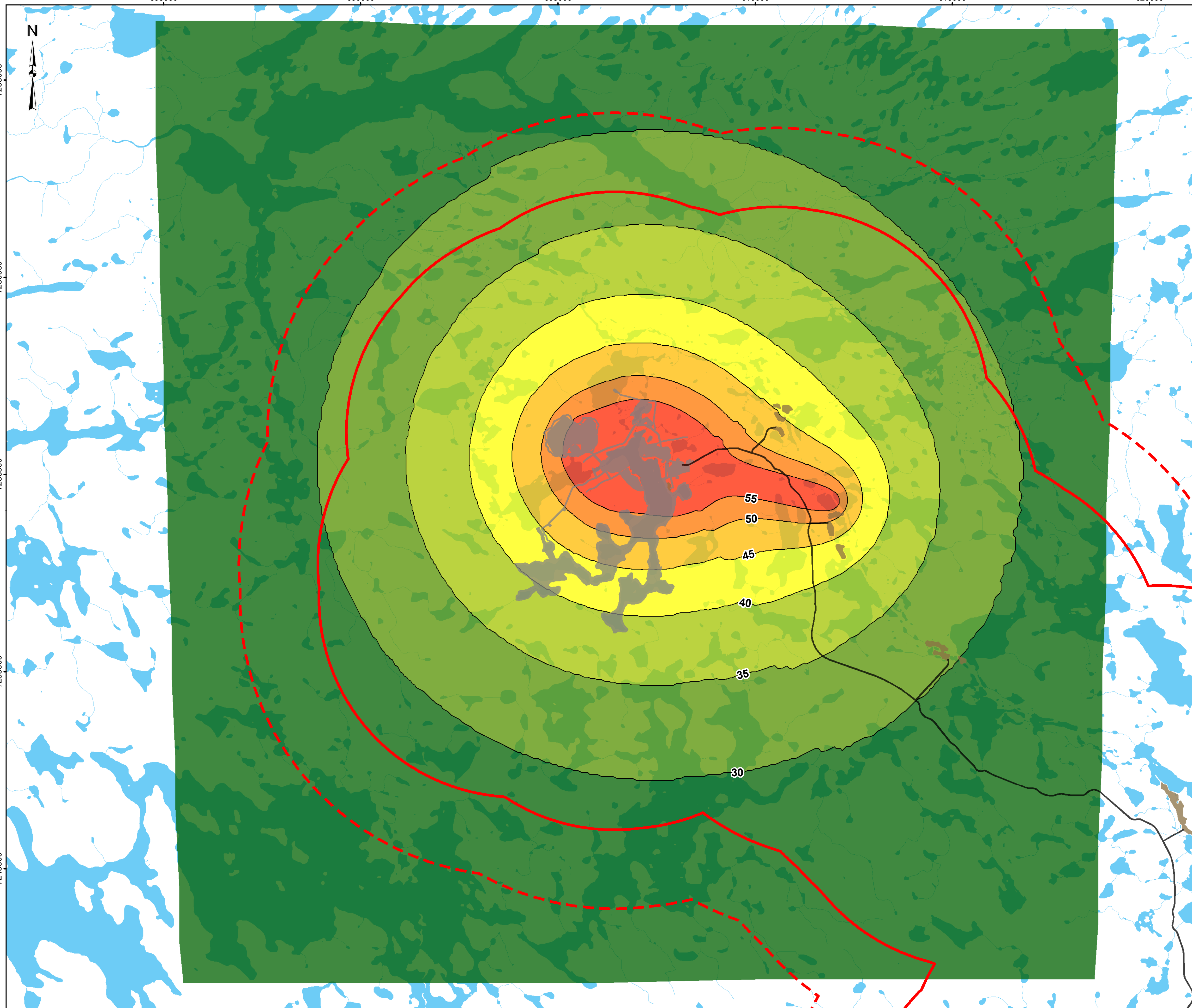
TITLE

# WHALE TAIL PIT OPERATIONS NOISE LEVEL PREDICTIONS: SUMMER

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT | | 1541520 | FILE No. | |
| DESIGN | VY | 01 Mar. 2016 | SCALE AS SHOWN | REV. 0 |
| GIS | CDB | 20 Apr. 2016 | FIGURE 4.4-2 | |
| CHECK | JR | 06 May 2016 | | |
| REVIEW | LY | 06 May 2016 | | |

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1541520_FEIS\02_PRODUCTION\FEIS\MXD\4200_Noise\Report\1541520_FIG_4.4-3_PIT_OPERATIONS_NOISE_WINTER.mxd




## LEGEND

- NOISE AND VIBRATION LOCAL STUDY AREA
- NOISE AND VIBRATION REGIONAL STUDY AREA

WHALE TAIL

- BORROW SOURCE
- INFRASTRUCTURE
- PROPOSED HAUL ROAD

ENERGY EQUIVALENT SOUND LEVEL ($L_{eq}$) (dBA)

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- > 55
- WATERCOURSE
- WATERBODY


## REFERENCE

1. WHALE TAIL INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON DECEMBER 21, 2015.
2. MEADOWBANK INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON NOVEMBER 12, 2015.
3. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
4. INSET MAP DATA OBTAINED FROM ESRI

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

2 0 2

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

# WHALE TAIL PIT OPERATIONS NOISE LEVEL PREDICTIONS: WINTER

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT | | 1541520 | FILE No. | |
| DESIGN | VY | 01 Mar. 2016 | SCALE AS SHOWN | REV. 0 |
| GIS | CDB | 20 Apr. 2016 | FIGURE 4.4-3 | |
| CHECK | JR | 06 May 2016 | | |
| REVIEW | LY | 06 May 2016 | | |

**Table 4.4-7: Whale Tail Pit Operations - Permissible Sound Level Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBA] | Pit Operations Project Noise Level [dBA] | Pit Operations Cumulative Noise Level[a] [dBA] | Permissible Sound Level [dBA] |
|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 30 | 33 | 35 | 50 |
| | Summertime / Nighttime | 30 | 33 | 35 | 40 |
| | Wintertime / Daytime | 30 | 34 | 35 | 55 |
| | Wintertime / Nighttime | 30 | 34 | 35 | 45 |

[a] Calculated as the logarithmic sum of the existing ambient noise level and the Pit Operations Project noise level.
Rmax = maximum predicted Project noise level; LSA = local study area; dBA = A-weighted decibel.

The results presented in Table 4.4-7 show that for both summertime and wintertime pit operations, cumulative noise levels on the LSA boundary are predicted to be less than the applicable PSL value. In other words, pit operations are predicted to comply with the AER Directive 038 PSL limit everywhere along the LSA boundary.

As discussed in Volume 4, Appendix 4-E, the Project NIA assessed the potential for LFN effects by comparing predicted noise levels expressed in dBC and dBA. Table 4.4-8 presents the results of the pit operations LFN assessment for Rmax – the point on the LSA boundary with maximum predicted Project noise level.

**Table 4.4-8: Whale Tail Pit Operations – Low Frequency Noise Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBC] | Whale Tail Pit Operations Project Noise Level [dBC] | Whale Tail Pit Operations Cumulative Nosie Level [dBC] | Whale Tail Pit Operations Cumulative Noise Level [dBA] | Difference: dBC minus dBA |
|---|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 45 | 53 | 54 | 35 | 19 |
| | Summertime / Nighttime | 46 | 53 | 54 | 35 | 19 |
| | Wintertime / Daytime | 45 | 53 | 54 | 35 | 19 |
| | Wintertime / Nighttime | 46 | 53 | 54 | 35 | 19 |

Rmax = maximum predicted Project noise level; LSA = local study area; dBC = C-weighted decibel; dBA = A-weighted decibel.

The results presented in Table 4.4-8 show that the difference between dBC and dBA Project noise levels is predicted to be less than 20 at Rmax for all periods. Based on the first LFN condition set out in AER Directive 038, this result suggests there will be no LFN effect along the LSA boundary.

While it is not appropriate to compare directly measured Meadowbank Mine noise levels and the model-predicted Whale Tail noise levels, due to the day to day variability in measured noise levels from changes in local meteorological conditions (i.e., wind speed and direction), a high-level general comparison can be done. In general, the noise levels that have been measured at Meadowbank in the last three years (i.e., 2012, 2013, and 2014 annual reports) are consistent with the model-predicted Whale Tail noise levels, taking into account the conservatism inherent in computer modelling (i.e., using downwind receptors 100% of the time). The Whale Tail model predictions are, generally-speaking, close to but slightly higher than the measured Meadowbank noise levels.

#### 4.4.3.2.2 Blasting Noise and Vibration Sources

Table 4.4-9 presents the predicted blasting vibration levels associated with pit operations in the form of PPV at various distances from the blasting activity. Table 4.4-9 also presents predicted blasting noise levels associated with pit operations in the form of PPL at various distances from the blasting activity. Both PPV and PPL values were calculated using empirical formulae discussed in detail in Volume 4, Appendix 4-E (ISEE 1998). As discussed in Volume 4, Appendix 4-E, the pit operations blasting assessment was based on the assumption that up to 2150 kg of explosives will be detonated simultaneously (i.e., simultaneous detonation of ten blast holes each containing 215 kg of explosives).

**Table 4.4-9: Whale Tail Pit Operations – Blasting Noise and Vibration Predictions**

| Distance from Blast [m] | Peak Particle Velocity – Ground Vibration [mm/s] | Peak Pressure Level – Airborne Noise [dBZ] |
|---|---|---|
| 100 | 504 | 142 |
| 200 | 166 | 136 |
| 500 | 38 | 127 |
| 1000 | 13 | 120 – NPC-119 limit[a,c] |
| 1150 | 10 – NPC-119 limit[a,b] | 119 |
| 1500 | 7 | 117 |
| 2000 | 4 | 114 |
| 4000 | 1 | 107 |
| 5000 – LSA boundary | 1 | 105 |

[a] OMOE (1978)

[b] The NPC-119 PPV limit is the maximum ground vibration level considered acceptable by the regulation. The results in this table show that PPV values are predicted to decay to below the NPC-119 limit for distances greater than 1150 m from pit operations blasting activities.

[c] The NPC-119 PPL limit is the maximum airborne noise level considered acceptable by the regulation. The results in this table show that PPL values are predicted to decay to below the NPC-119 limit for distances greater than 1000 m from pit operations blasting activities.

LSA = local study area; m = metre; mm/s = millimetres per second; dBZ = unweighted or linear decibels; PPL = Peak Pressure Level; PPV = Peak Particle Velocity.

The PPV results presented in Table 4.4-9 suggest that ground vibration associated with blasting as part of pit operations will decay to the 10 mm/s limit established in NPC-119 (OMOE 1978) within 1150 m of the blasting source and that PPV ground vibration will decay to 1 mm/s at the LSA boundary. In other words, at the LSA boundary ground vibration levels from Project blasting are predicted to be well below the NPC-119 limit.

Recent blast monitoring at the Vault Pit suggests that the empirical formula used to predict PPV ground vibration levels is highly conservative (Agnico Eagle 2014b) as it tends to overestimate PPV levels. At Vault Pit, PPV ground vibration levels are monitored at two locations: "Vault Pit Station #1", approximately 110 m southwest of the pit itself, and "Vault Pit Station #2", approximately 650 m northeast of the pit itself. Based on the results in Table 4.4-9, PPV ground vibration levels above 166 mm/s would be expected at "Vault Pit Station #1" but during the 2014 blast monitoring program, the maximum PPV level observed at this location was 23.8 mm/s (Agnico Eagle 2014b). Similarly, based on the results in Table 4.4-9, PPV ground vibration levels would be expected to be above 13 mm/s at "Vault Pit Station #2" but during the 2014 blast monitoring program, the maximum PPV level observed at this location was 4.13 mm/s (Agnico Eagle 2014b).

The PPL results presented in Table 4.4-9 suggest that airborne noise associated with blasting as part of pit operations will decay to the 120 dBZ limit established in NCP-119 (OMOE 1978) within 1000 m of the blasting source and that PPL airborne noise will decay to 105 dBZ at the LSA boundary. In other words, at the LSA boundary airborne noise levels from Project blasting are predicted to be well below the NPC-119 limit.

Table 4.4-10 presents predicted setback distances from pit operations blasting activities required to achieve compliance with DFO PPV and PPL limits for the protection of spawning fish and fish habitat, respectively. Both of these setback distances were calculated using empirical formulae discussed in detail in Volume 4, Appendix 4-E (DFO 1998). As discussed above, the pit operations blasting assessment was based on the assumption that up to 2150 kg of explosives will be detonated simultaneously.

**Table 4.4-10: Pit Operations – Fisheries and Oceans Canada Blasting Setback Predictions**

| Setback Criterion | Setback Distance [m] |
|---|---|
| Fish Spawning – Ground Vibration (PPV) | 700 |
| Fish Habitat – Airborne Noise (PPL) | 148 |

m = metre; PPL = Peak Pressure Level; PPV = Peak Particle Velocity.

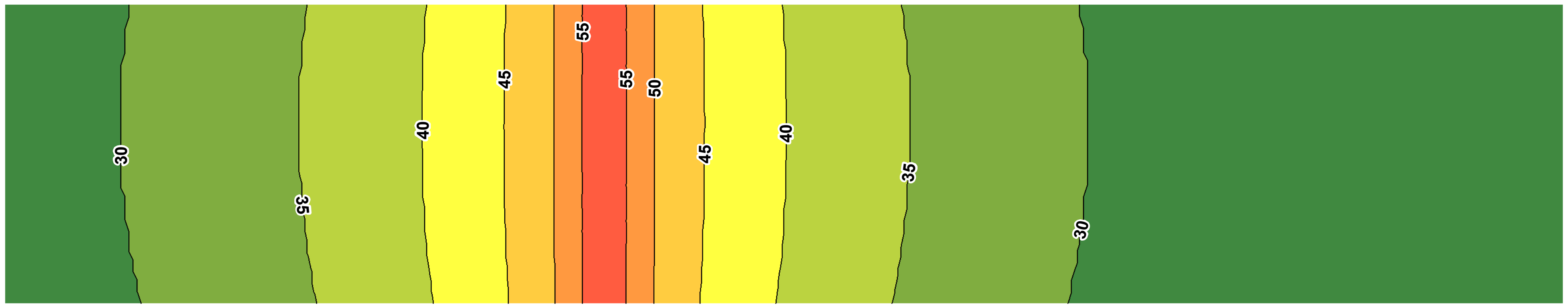
The setback predictions presented in Table 4.4-10 suggest that, to achieve compliance with DFO blasting limits, pit operations blasting should be carefully managed when it occurs within 700 m of areas used for fish spawning and/or within 148 m of fish habitat. However, recent blast monitoring conducted at the Meadowbank Vault Pit suggests that the setback predictions presented in Table 4.4-10 are highly conservative and that much smaller setbacks will be sufficient to achieve compliance with DFO blasting limits (Agnico Eagle 2014b). In particular, at "Vault Pit Station #1" (located approximately 110 from the pit) the DFO PPV limit was only exceeded on three occasions during 2014 and at "Vault Pit Station #2" (located approximately 650 m from the pit) the DFO PPV limit was never exceeded during 2014 (Agnico Eagle 2014b). Similarly, the DFO PPL limit was never exceeded at either "Vault Pit Station #1" or "Vault Pit Station #2" during 2014. The observed PPL levels were usually three orders of magnitude smaller than the DFO PPL limits (Agnico Eagle 2014b). During pit operations, blasting will be carefully managed and monitored in the context of DFO limits and appropriate setbacks will be established so that noise and vibration from pit operations blasting do not affect fish spawning or general habitat.

### *4.4.3.3 Haul Road Operations*

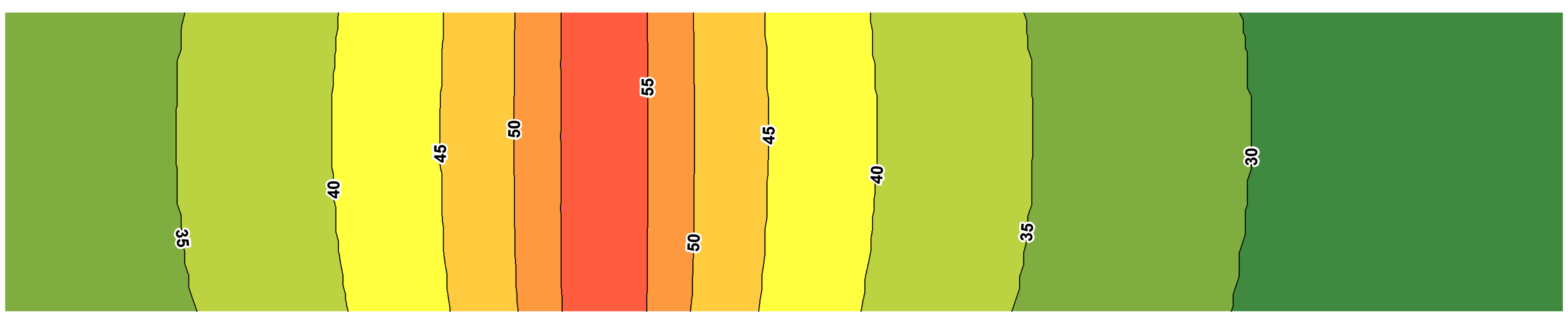
Haul road operations noise levels were predicted using the widely-accepted ISO 9613-2 technical standard (ISO 1996) and were compared to PSL and LFN limits set out in AER Directive 038. Figure 4.4-4 presents predicted Project noise levels for haul road operations under summertime conditions and wintertime conditions. As discussed in Volume 4, Appendix 4-E, the Project NIA considered a representative 5 km section of haul road and predicted noise levels across an LSA and RSA surrounding this representative section. Similar noise levels can be expected at comparable distances from other sections of the Project haul road.

As shown in Figure 4.4-4, haul road operations Project noise levels are predicted to be less than 30 dBA at 7 km from the haul road for both summertime and wintertime. In other words, for all periods, haul road operations Project noise levels are predicted to be less than the existing ambient noise level (see Table 4.4-2) at the boundary of the RSA. Similarly, for all periods, haul road operations Project noise levels are predicted to be less than 35 dBA at 5 km from the haul road – i.e., at the boundary of the LSA.

## SUMMER




## WINTER




**LEGEND**

ENERGY EQUIVALENT SOUND LEVEL ($L_{eq}$) (dBA)

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- > 55


**REFERENCE**

1 0 1

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

**HAUL ROAD OPERATIONS
NOISE LEVEL PREDICTIONS:
SUMMER AND WINTER**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT | | 1541520 | FILE No. |
| DESIGN | VY | 01 Mar. 2016 | SCALE AS SHOWN REV. 0 |
| GIS | CDB | 20 Apr. 2016 | **FIGURE 4.4-4** |
| CHECK | JR | 06 May 2016 | |
| REVIEW | LY | 06 May 2016 | |

As discussed in Volume 4, Appendix 4-E, the PSL values used to assess broadband Project noise are cumulative limits. As such, to assess potential Project noise effects using PSL values, it was necessary to calculate cumulative noise levels associated with haul road operations by summing predicted Project noise levels with existing ambient noise levels.

In the interest of assessing potential Project noise effects conservatively, the PSL assessment was focused on that point on the LSA boundary with maximum predicted Project noise level (Rmax). The PSL assessment for Rmax is presented in Table 4.4-11.

**Table 4.4-11: Haul Road Operations - Permissible Sound Level Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBA] | Haul Road Operations Project Noise Level [dBA] | Haul Road Operations Cumulative Noise Level[a] [dBA] | Permissible Sound Level [dBA] |
|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 30 | 28 | 32 | 50 |
| | Summertime / Nighttime | 30 | 28 | 32 | 40 |
| | Wintertime / Daytime | 30 | 31 | 34 | 55 |
| | Wintertime / Nighttime | 30 | 31 | 34 | 45 |

[a] Calculated as the logarithmic sum of the existing ambient noise level and the haul road operations noise level.
Rmax = maximum predicted Project noise level; LSA = local study area; dBA = A-weighted decibel.

The results presented in Table 4.4-11 show that for both summertime and wintertime haul road operations, cumulative noise levels on the LSA boundary are predicted to be less than the applicable PSL value. In other words, haul road operations are predicted to comply with the AER Directive 038 PSL limit everywhere along the LSA boundary.

As discussed in Volume 4, Appendix 4-E, the Project NIA assessed the potential for LFN effects by comparing predicted noise levels expressed in dBC and dBA. Table 4.4-12 presents the results of the haul road operations LFN assessment for Rmax – the point on the LSA boundary with maximum predicted Project noise level.

**Table 4.4-12: Haul Road Operations – Low Frequency Noise Assessment**

| Assessment Location | Period | Existing Ambient Noise Level [dBC] | Haul Road Operations Project Noise Level [dBC] | Haul Road Operations Cumulative Nosie Level [dBC] | Haul Road Operations Cumulative Noise Level [dBA] | Difference: dBC minus dBA |
|---|---|---|---|---|---|---|
| Rmax – point on LSA boundary with maximum predicted Project noise level | Summertime / Daytime | 45 | 49 | 50 | 32 | 18 |
| | Summertime / Nighttime | 46 | 49 | 51 | 32 | 19 |
| | Wintertime / Daytime | 45 | 50 | 51 | 34 | 17 |
| | Wintertime / Nighttime | 46 | 50 | 51 | 34 | 17 |

Rmax = maximum predicted Project noise level; LSA = local study area; dBA = A-weighted decibel; dBC = C-weighted decibel.

The results presented in Table 4.4-12 show that the difference between dBC and dBA Project noise levels is predicted to be less than 20 at Rmax. Based on the first LFN condition set out in AER Directive 038, this result suggests that there will be no LFN effect along the LSA boundary.

### 4.4.4 Residual Impact Classification

The key predictions of the Project NIA are as follows:

- Noise levels associated with haul road construction will decay to below existing ambient noise levels at the boundary of the LSA.
- Noise levels associated with haul road construction will be less than AER Directive 038 PSL limits at the boundary of the LSA.
- Based on AER Directive 038 criteria, there is no LFN effect from haul road construction at the LSA boundary.
- Noise and vibration levels associated with blasting during haul road construction will decay to levels below NPC-119 limits at the boundary of the LSA.
- Noise levels associated with pit operations will decay to below existing ambient noise levels at the boundary of the RSA.
- Noise levels associated with pit operations will be compliant with AER Directive 038 PSL limits at the boundary of the LSA.
- Based on AER Directive 038 criteria, there is no LFN effect from pit operations at the LSA boundary.
- Noise and vibration levels associated with blasting during pit operations will decay to levels below NPC-119 limits at the boundary of the LSA.
- Noise and vibration associated with blasting during pit operations will not affect fish spawning or fish habitat.
- Noise levels associated with haul road operations will decay to below existing ambient noise levels at the boundary of the RSA.
- Noise levels associated with haul road operations will be compliant with AER Directive 038 PSL limits at the boundary of the LSA.
- Based on AER Directive 038 criteria, there is no LFN effect from haul road operations at the LSA boundary.

Although primary pathways have been identified for noise, no residual impact predictions are made because noise does not have measurable assessment endpoints. Any potential effects associated with the primary pathways are captured in the assessment of potential effects to, and residual impact classifications for, other VCs, specifically in wildlife, birds and fisheries.

### 4.4.5 Cumulative Effects Assessment

The assessment methodologies and limits set out in AER Directive 038 are based on cumulative noise levels (i.e., Project noise levels combined with existing ambient noise levels). As such, the potential Project-related noise effects assessment presented in Section 4.4.3 includes the cumulative effects assessment. In particular, the noise level predictions and analysis presented in Table 4.4-3, Table 4.4-4, Table 4.4-7, Table 4.4-8, Table 4.4-11, and Table 4.4-12 include the contribution of existing ambient noise levels.

Because blasting is an extremely short-duration activity, the likelihood of cumulative effects from blasting activities (i.e., the temporal overlap of multiple blasting events occurring simultaneously) is small. As such, a cumulative effects assessment for blasting activities is not appropriate and was not conducted.

### 4.4.6 Uncertainty

According to the ISO 9613-2 standard, the overall accuracy of the propagation algorithm used in the Project models of conventional noise sources is plus or minus (+/-) 3 decibels (dB) for distances between source and receptor up to 1 km. The accuracy for propagation distances greater than 1 km is not stated in the standard. Model accuracy also depends on the accuracy of the noise emissions inputs, which is often +/- 2 dB for measured sources and larger for emissions values calculated from acoustics handbooks or technical standards. Accounting for both these sources of uncertainty, the overall accuracy of the conventional noise level predictions presented in the Project noise and vibration assessment is expected to be +/- 3.6 dB.

Conservative assumptions regarding the Project were made to account for the level of uncertainty inherent in the noise level predictions. Most importantly, all receptor points were assumed to be downwind from all sources 100% of the time. Because downwind conditions enhance noise propagation, this assumption tends to overestimate the noise effects of the Project. Likewise, the terrain in the Project area was assumed to be flat so that noise sources and receptors are located in effectively the same plane. This assumption eliminates the possibility of terrain-based screening and tends to overestimate the noise effects of the Project. Furthermore, the noise sources associated with pit operations were all modelled at grade level to match their position at the beginning of mining operations. As mining progresses the depth of the open pit will increase and the sides of the pit will provide screening for the noise sources inside. As such, modelling mining sources at grade level is conservative and will tend to overestimate noise effects for later years of Project operations.

The empirical formulae used to assess Project blasting have only one input: charge mass and they do not account for specific ground conditions or atmospheric conditions in the LSA/RSA; therefore, there is substantial uncertainty associated with the specific predictions obtained using these formulae. Comparison with recent blast monitoring results from the Vault Pit suggest the empirical formulae used in the Project NIA are highly conservative (Agnico Eagle 2014b) and subsequently, tend to overestimate noise and vibration levels associated with blasting. However, the empirical formulae are useful for conservatively gauging the likely magnitude of noise and vibration effects associated with blasting activities (i.e., they provide useful information about approximate setbacks required to achieve compliance with regulatory limits). As such, use of empirical formulae to assess blasting is appropriate in the context of a FEIS - particularly, in the case of this Project since there are no dwellings or other sensitive receptors at which specific values must be predicted.

### 4.4.7 Monitoring and Follow-up

Follow-up noise monitoring for the Project will be conducted in general accordance with the regular noise monitoring currently being conducted as part of the Meadowbank Mine noise management plans (Cumberland 2005d; Agnico Eagle 2009, 2013b). In particular, yearly noise monitoring will be conducted at four locations in the vicinity of the Project. Specific monitoring locations will be selected and adjusted as Project activities evolve, but an appropriate starting point would be to monitor noise levels once each year at the same four receptor locations used for baseline monitoring (Volume 4, Appendix 4-D). Follow-up noise monitoring will be conducted in general accordance with methodologies described in AER Directive 038 and the monitoring results will be compared to the same target values considered in the Meadowbank Mine noise management plans and to model predictions presented in the Project NIA. If monitored noise levels exceed appropriate limits, Agnico Eagle will take appropriate actions to identify the specific cause of the exceedance and, if practical, to mitigate the relevant noise source.

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