Information Request 11.1

Acoustic Environment

Effects of Noise on Wildlife

References:

EIS Guidelines	- Section 2.7.2.2, p. 52 (PDF 57)
EIS Main Report	- Section 6.2.7, p. 6.80 (PDF 586)
	- Section 6.2.11, p. 6.131 (PDF 637)

Contributing IRs:
RSMIN-9

Rationale:

The EIS Guidelines require a discussion of the impacts of noise on potential wildlife receptors. However, the impacts of noise were not identified or evaluated and no measures were identified to mitigate the potential effects of noise on wildlife. The discussion should provide a description of the percent distribution of both the high level and low-level noise frequencies which will be produced, as certain wildlife receptors (i.e. beaver within their huts, mink and denning foxes) are sensitive to noise disturbance during birth and weaning of their young. The EIS should provide a discussion on how noise generated at the mine site could impact wildlife receptors.

Information Request:
Using the peak sound pressure measurements (LCpk), provide an assessment of the potential impact (startle effects) of noise on wildlife receptors and identify appropriate mitigation measures. Provide a breakdown of the low frequencies and high frequencies noise events which will be generated by the Project.

SCI RESPONSE

In Figure 1 (noise grid map), attached, and Table 1, below, C-weighted peak sound levels at receptor locations N1, N3, N4, N5 and N6 during the worst case operating scenario are provided. In order to characterize worst case noise emissions, a model was created based on a scenario that combines peak mining activity during Year 3 with the construction of the PSMF during Year 1. This worst case scenario is overly conservative as the south cell of the PSMF will be complete in Year 1 and during Year 1 the mining activity will be less than in Year 3. The results of this model show the combined worst case noise impacts from construction and operations.

The noise grid map shows the overall C-weighted peak sound levels throughout the Project site at a height of 1.5 m at the noise receptor locations. The receptor locations were chosen based on four background noise measurement locations (N1, N3, N4, and N5) and an additional receptor N6, chosen to cover the gap between N3 and N5.

Table 1: Daytime C-weighted Peak Sound Levels (See Figure 1 for receptor locations)

Location	C-Weighted Sound Pressure Levels (dBC)								
	Octave Band Frequencies (Hz)								Overall
	63	125	250	500	1000	2000	4000	8000	
N1	55.3	50.9	45.9	42.2	36.9	28.3	18.4	-0.8	57.2
N3	40.2	34.7	28.4	23.3	16.2	3.7	-17.4	--	41.5
N4	57.7	56.2	52.2	43.0	39.3	36.4	31.4	24.9	60.8
N5	53.8	49.8	45.7	42.5	36.3	18.4	--	--	56.0
N6	50.3	46.7	42.1	38.8	31.3	8.4	--	--	52.5

Table 1 shows the contribution of sound levels occurring at frequencies in each of eight octave bands to the overall sound level at each receptor location. The overall C-weighted peak sound levels ranged from 41.5 to 60.8 dBC at receptors N1, N3, N4, N5 and N6. The most influential octave band frequency on the overall C-weighted sound level was 63 Hz. For some receptor locations, there are unreported sound levels in the 4000 and 8000 Hz frequency bands because sound levels at these frequencies are naturally attenuated by the time they reach certain receptor locations. The receptor locations closer to noise sources have reported sound levels at these higher frequencies.

The following sections describe the noise sensitivities of wildlife at the Project.

Noise Effects on Wildlife

Animals rely on meaningful sounds for communication, navigation, avoiding danger and finding food against a background of noise (US DoT 2007). Noise effects on wildlife can include (Barber et al. 2010; Dooling and Popper 2007; Ortega 2012; US FWS 2013):

- Hearing loss due to acute acoustic overexposure;
- Behavioural and/or physiological effects e.g., increased heart rate, respiration, and general stress reactions;
- Flight/fright or avoidance responses;
- Masking of vocal communication signals, which could lead to lower reproductive success for example; and
- Masking of other biologically relevant sounds e.g., interfering with hearing predators or prey.

These effects vary significantly depending on the type of sounds and taxa involved. Reactions to noise depend on the type of noise produced, including frequency, loudness, consistency, and duration as well as of course on the species (Orgtega 2012). Many wildlife species are adapted to or at least tolerant of noise in the environment such as thunder, wind, and running water, but these effects are often of short duration or limited spatial area (US FWS 2013; Willem 2001).

The ability of wildlife to communicate is limited by the active space of a signal i.e., the distance over which a signal can be perceived by a receiver over a background of noise in a particular habitat (Marten and Marler 1977; Lohr et al. 2003). In general sound attenuates as the square of the distance from the source and is greater at higher frequencies. The sensitivities of various groups of wildlife can be summarized as (US DoT 2007):

- Mammals < 10 Hz to 150 kHz ; sensitivity to -20 dB
- Birds (more uniform than mammals) 100 Hz to 8-10 kHz; sensitivity at 0-10 dB;

- Reptiles (poorer than birds) 50 Hz to 2 kHz; sensitivity at 40-50 dB
- Amphibians 100 Hz to 2 kHz; sensitivity from 10-60 dB

Some species are remarkably tolerant and even seek out noisy areas. Avoidance is a more common response to human noise disturbance, although anthropogenic noise is almost always associated with other confounding variables (Ortega 2012). Depending on the species, some individuals often habituate to high anthropogenic noise levels, although there can be reproductive or other costs (Habib et al. 2007).

In the case of the Project, avoidance of the SSA by wildlife will be beneficial in as much as it reduces the possibility of accidental mortality caused by industrial activity (e.g., roadkill). Nonetheless, noise impacts in the surrounding landscape outside the direct Project footprint has been raised as a potential concern.

Mammals

Much of noise research related to mammals has been related to military or helicopter overflights on large mammals (e.g. (Calef et al. 1976; Bleitch et al. 1996) whereas noise from industrial facilities has received less attention, and noise effects are difficult to disentangle from other disturbance factors (Bunsell and Fletcher 1978; Burke and Lapka 2007).

Large mammals may be repelled by noise, although in most cases the effect appears to be slight to moderate (US DoT 2007). Woodland caribou are sensitive to noise (Calef et al. 1976). After chronic noise exposure, caribou were found to significantly alter their daily activity cycles and movements (Maier et al. 1998). The simulated sound of a gas compressor elicited an increased incidence of alert postures in caribou passing within about 300 m in a study by MccCourt et al. (1974), and although no strong reactions were observed there was some apparent zone avoidance. Mitigation for potential impacts from noise on woodland caribou habitat use or connectivity from the Project will include improving habitat in the adjacent range as discussed in response to Information Request 23.1. Potential reductions in use of the landscape immediately surrounding the RSA by black bear, white-tailed deer, moose, and grey wolves from noise disturbance would be considered beneficial to woodland caribou due to potential negative impacts on predator-prey dynamics.

The only other mammalian Species at Risk that may potentially use the SSA and LSA are little brown myotis and northern myotis. Foraging efficiency of these species in the SSA could potentially be impacted by elevated noise. Schaub et al.(2008) found that traffic noise, and other sources of intense, broadband noise deterred greater mouse-eared bats (*Myotis myotis*) from foraging in areas where these noises were present presumably because these sounds masked relevant sounds or echoes the bats use to locate food. As foraging habitat does not appear to be limited for bat species in the LSA, no significant impacts are predicted.

Concern has also been expressed potential noise impacts on regarding beaver within their lodges, mink, and denning foxes. Red foxes in particular, are relatively tolerant of anthropogenic disturbance including noise (Adkins and Stott 1998; Voigt 1987). They readily habituate, commonly dwell in urban areas (Rosatte and Allan 2009), and often forage along busy highways in northern Ontario (Foster, pers. obs). Beaver do not appear to be particularly sensitive to traffic noise (Teske 2012). Any beavers in the SSA will be displaced by the Project. Impacts on beavers elsewhere in the LSA are expected to be minor since the hills surrounding the project site act as a noise buffer (Figure 1). Small mammals do not appear to be adversely affected by road noise occurring in significant numbers in rights-of-way of busy transportation corridors (US DoT 2007). Although there may be some impairment of habitat use adjacent to the SSA for some individuals of small to medium-sized mammals, no population-level effects for these species are expected.

Birds

Bird vocalizations are typically within the 2-5 kHz frequency range (Dooling and Popper 2007) and birds hear best between 1-5 kHz (Dooling 2002). For the average bird in a signal frequency of 1-4 kHz, noise must be 24-30 dB above the ambient noise level in order for a bird to detect it (USFWS 201).

Declines in densities of woodland bird species have been shown to occur at noise thresholds of approximately 45 dB, respectively; with the most sensitive species showed declines at 35 dB (USFWS 2013). Total passerine density was 1.5 times greater near noiseless energy facilities than near noisy ones, and White-throated Sparrows, Yellow-rumped Warblers, and Red-eyed Vireos less common in noisy areas (Bayne et al. 2008). In another study (Habib et al. 2007), Ovenbird pairing success at compressor was significantly reduced compared to noiseless well pads (77% vs. 92%). These species are common in the LSA, so could potentially be affected by noise near the SSA. At most locations beyond approximately 500 m from the SSA noise levels were lower than these thresholds at the higher frequencies at which birds are typically vocalizing (≥2 kHz) (Figure 1, Table 1). Given noise levels within the SSA would likely exceed that tolerated for at least sensitive species, but clearing of the forest will displace forest-dependent species in the SSA.

Studies have shown that traffic noise can have significant negative impacts on bird behavior, communication and even health(e.g., Lohr et al. 2003, Lengagne 2008, Barber et al. 2010). The overall effect of traffic noise on nesting birds, measured through lack of habitat occupancy, may extend more than 300 m on both sides of roadways (Forman and Deblinger 2000). However, not all species are negatively impacted by roads and associated noise. For example, Ferris (1979) found that breeding Bay-Breasted Warbler, Blue Jay, Blackburnian Warbler and Winter Wren were negatively affected within 300-400 m of an interstate highway in Maine, whereas Chest-sided Warbler, White-throated Sparrow, Wood Thrush, Common Yellowthroat, American Robin, and Tennessee Warbler showed a positive effect.

In general, traffic noise falls below the frequency of bird communication and hearing. The levels of traffic on Project roads are much lower than the nearby Highway 17 or the interstate highways in the cited studies. As a result, no significant impacts on birds is anticipated due to noise from traffic on Project roads.

Reptiles and Amphibians

Anurans (frogs and toads) are dependent upon vocalizations for attracting mates during the breeding season in the spring and early summer. Although Project noise could potentially interfere with anuran vocalizations, amphibians have been shown to have behavioural mechanisms for coping with noisy environments, natural or otherwise. For example, some species have been shown to avoid vocalizing during loud calling by other frog species (Matsui et al. 1993) or cicadas (Páez et al. 1993), whereas others time their calls to use brief periods of silence (Schwartz 1991) or adapt their calling to circumvent cacophonies of conspecifics (Narins 1992).

Foraging frogs and toads outside the SSA are less likely to be negatively affected by noise, although Project noise could potentially affect foraging efficiency and predator avoidance within or near the SSA. Given that a) any effect is likely to be localized to the SSA and immediately adjacent area, b) no amphibian or reptile Species at Risk occur in the LSA, and c) the confirmed species are abundant and widespread in the RSA, these effects are not concluded to be significant.

Other amphibians (e.g. newts and salamanders) occurring in the LSA are either fossorial or aquatic and are therefore largely buffered from ambient noise outside the SSA and immediately adjacent buffer. No significant negative effects are anticipated for these species or the few reptile species potentially found in the LSA (e.g., Eastern garter snakes, painted turtles).

Other Taxa

Fish are capable of reception of sound in the water, with sound perception generally below 2-3 kHz (Hawkins 1986) and the greatest sensitivity at 200-800 Hz (Hastings 1995) There will be no fish-bearing waters in or immediately adjacent to the SSA and therefore no negative impacts are anticipated.

Noise impacts on invertebrates are poorly understood (US DoT 2007) but no regionally or provincially rare insects have been documented for the LSA so no significant impacts are expected.

Mitigation

As potential impacts are expected to be localized and relatively minor, general noise mitigation measures adopted for human health and safety (see IR 11.6, SID #17) are considered sufficient and no specific noise mitigation measures for wildlife are proposed during construction and operation phases of the project. While there will be some impairment of habit use adjacent to the SSA for individuals of different wildlife species, no population level effects are expected.

In general, many species seem to abandon the area when the noise is occurring and return once the noise has dissipated (Bayne et al. 2008). Individuals or their descendants that were displaced into the surrounding forested landscape of the LSA during the construction and operational phases of the Project are likely to generally return to the SSA overtime assuming rehabilitation results in otherwise suitable habitat.

References

Adkins, C.A. and P. Stott. 1998. Home ranges, movements and habitat associations of red foxes, *Vulpes vulpes* in suburban Toronto, Ontario, Canada. Journal of Zoology (London) 244:335-346.

Barber, J.R., K.R. Crooks, and K. Fristrup. 2010. The costs of chronic noise exposure for terrestrial organisms. Trends Ecology and Evolution 25(3): 180–189.

Bayne, E.M., L. Habib and S. Boutin. 2008. Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. Conservation Biology 22(5) 1186-1193

Bleich,V.C., R.T. Bowyera, A.M. Paulib, M.C. Nicholsona and R.W. Anthesb. 1994. Mountain sheep (*Ovis Canadensis*) and helicopter surveys: ramifications for the conservation of large mammals. Biological Conservation. (70):1-7.

Brown, L.. 2001. Overview of research on the effects of noise on wildlife. in Proceedings of the Effects of Noise on Wildlife Conference, Happy Valley-Goose Bay, Bunsel R.G., and Fletcher J., 1978. Effects of noise on wildlife. Academic Press, New York:

Burke, D. And S. Lapka. 2007. Effects of industrial noise on wildlife: Issues and challenges in Alberta. 13 pp.

Calef, G.W., E.A. Debock, And G.M. Lortie. 1976. The reaction of barren-ground caribou to aircraft. Arctic 29:201-212.

California Department of Transportation, Technical Noise Supplemental, A Technical Supplement to the Traffic Noise Analysis Protocol, October 1998.

Dooling, R. J., Lohr, B. andd Dent, M. L. 2000. Hearing in birds and reptiles. pp. 308–359 *in* R. J. Dooling, R. R. Fay and A. N. Popper [eds.]. Comparative Hearing: Birds and Reptiles. Springer–Verlag, New York.

Dooling, R. 2002. *Avian Hearing and the Avoidance of Wind Turbines*. National Renewable Energy Laboratory, NREL/TP-500-30844. 83 p.

Dooling R. J., and A. N. Popper. 2007. The effects of highway noise on birds**.** Report to the California. Department of Transportation, contract 43AO139. California Department of Transportation, Division of Environmental Analysis, Sacramento, California, USA.

Ferris, C.R. 1979. Effects of interstate 95 on breeding birds in northern Maine. Journal of Wildlife Management. 43:421-427.

Forman, Richard T.T. and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecological Systems 29: 207-231.

Forman, R. T. T., and R. D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (U.S.A.) suburban highway. Conservation Biology 14:36–46.

Francis, C.D., C.P. Ortega and A. Cruz. 2009. Noise Pollution Changes Avian Communities and Species Interactions. Current Biology, in press, doi: 10.1016/j.cub.2009.06.052.

Habib, L, E.M. Bayne and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds *Seiurus aurocapilla.* Journal of Applied Ecology 44: 176-184.

Hawkins, A.D. 1986. Underwater sounds and fish behaviour. pp. 114-151. In: The behaviour of teleost fishes. T.J. Pitcher (ed.) The Johns Hopkins Press, Baltimore, MD. 553 pp.

Hastings, M.C. 1995. Physical effects of noise on fishes. Inter-noise 95, the 1995 International congress on noise control Engineering Vol 2: 979-984.

Larken, R.P. 1996. Effects of military noise on wildlife: a literature review. 87 pp. Available at http://nhsbig.inhs.uiuc.edu/bioacoustics/noise_and_wildlife.pdf

Lengagne, T. 2008. Traffic noise affects communication behaviour in a breeding anuran, *Hyla arborea.* Biological conservation 141: 2023-2031.

Lohr, B., T.F. Wright and R.J. Dooling. 2003. Detection and discrimination of natural calls in masking noise by birds: estimating the active space of a signal. Animal Behavior 65:763-777.

Maier, J.A.K., S.M. Murphy, R.G. White, And M.D. Smith. 1998. Responses of caribou to overflights by low-altitude jet aircraft. J. Wildl. Manage. 62:752-766.

Marten, K. & Marler, P. 1977. Sound transmission and its significance for animal vocalization. I. Temperate habitats. Behavioral Ecology and Sociobiology, 2, 271–290.

Matsui, M., Wu, G. F., and Yong, H. S. 1993. Acoustic characteristics of 3 species of the genus *Amolops* (*amphibia anura, ranidae*). *Zoological Science*, 10:691-695.

Narins, P. M. 1992. Evolution of anuran chorus behavior: Neural and behavioral constraints. American Naturalist, 139:S90-S104.

Ortega, C.P. 2012. Chapter 2: Effects of noise pollution on birds: A brief review of our knowledge. Ornithological Monographs (74): 6-22.

Páez, V. P., Bock, B. C., and Rand, A. S. 1993. Inhibition of evoked calling of *Dendrobates pumilio* due to acoustic interference from cicada calling. Biotropica, 25:242-245.

Rabin, L.A., R.G. Coss, D.H. Owings. 2006. The effects of wind turbines on antipredator behavior in California ground squirrels (*Spermophilus beecheyi*). Biological Conservation 131: 410-420..

Rosatte, R. And M. Allan. 2009. The ecology of Red Foxes, *Vulpes vulpes*, in metropolitan Toronto, Ontario: disease management implications. Canadian Field-Naturalist 123(3): 215–220.

Schaub, A, J. Ostwald and B.M. Siemers. 2008. Foraging bats avoid noise. The Journal of Experimental Biology 211: 3174-3180.

Schwartz, J. J. 1991. Why stop calling? A study of unison but singing in a Neotropical treefrog. Animal Behaviour, 42:565-577.

Teske, M. 2012. Habitat connectivity for beaver (*Castor canadensis*) in the Columbia Plateau Ecogregion). Apppendix A.10 *in* Washington Wildlife Habitat Connectivity Working Group. Washington Connected Landscapes Project: Analysis of the Columbia Plateau Ecoregion. 26 pp. Washington's Department of Fish and Wildlife, and Department of Transportation, Olympia, WA. Available at http://waconnected.org/columbia-plateau-ecoregion/

United States Department of Transportation (US DoT). 2004. Synthesis of noise effects on wildlife populations. Publication No. FHWA-HEP-06-016. 75 pp.

United States Fish and Wildlife Service (US FWS). 2013. The Effects of Noise on Wildlife. Available at http://www.fws.gov/windenergy/docs/Noise.pdf

Van den Berg, G.P. 2004. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration 277: 955-970.

Voigt, D. 1987. Red fox. Pages 379-393 *in* M. Novak, J. Baker, M. Obbard, and B. Malloch [eds.] Wild Furbearer Management and Conservation in North America. Ontario Trappers Association publishers, North Bay, Ontario.

Willem, V. M. 2001. Influence of weather circumstances on behaviour and hunting success of wintering long-eared owls *Asio otus*. Limosa 74: 81-86.

Information Request 11.2

Air Blast Assessment

References:

EIS Guidelines	- Section 2.7.2.2, p. 52 (PDF 57)
SID#17	- Section 5.0, p. 30 (PDF 40)

Contributing IRs:
Town of Marathon-3

Rationale:

SID #17 states that predicted air blast results for downwind wind speed of 4km/hour or less are lower than the Noise Pollution Control (NPC) 119 cautionary air blast limit of 120 dB. Predicted air blast results for wind speeds of 20 km/hour or greater exceed the NPC cautionary limit. Section 5.0 states that blasting will not be done when offsite buildings are considered to be under a "strong" downwind propagation. However, it is not clear what specific wind speed will be considered "strong", thereby triggering a temporary suspension of blasting.

Information Request:
Clarify the specific wind speed that is considered "strong", and would trigger a temporary suspension of blasting.

SCI RESPONSE

The blast vibrations and overpressure (airblast) assessment was updated taking into account the conceptual blasting approach and the updated conceptual mine design. See the attached report Explotech Engineering Ltd. (Explotech) report entitled *Analysis of Blast Vibrations and Overpressure from the Proposed Stillwater Marathon PGMC Development*.

In summary, the Explotech report concludes that offsite buildings are not at risk of damage from overpressure associated with blasting. Monitoring of selected offsite locations is recommended by Explotech as set out in the attached report.

EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

April 27, 2013

Stillwater Canada Inc.
Box 357, 1100 Memorial Avenue
Thunder Bay, Ontario
P7B 4A3

Attention: Ms. Tabatha LeBlanc

Subject: Analysis of Blast Vibrations and Air Overpressure from the Proposed Blasting Operations for the Marathon PGM-Cu Project

Dear Ms. Leblanc,

In response to your request, Explotech Engineering Ltd. (Explotech) has performed an analysis of blast derivatives (ground vibrations and air overpressure) for the planned Marathon PGM-Cu project located North of Marathon, Ontario. This brief report summarizes our analysis and conclusions.

Background

The Marathon PGM-Cu project consists of a proposed copper/platinum group metals mine located North of Marathon, Ontario. As part of the operation, open-pit production blasting will be undertaken to remove waste rock and gain access to ore deposits. Additionally, during the construction phases of the mine, blasting will be required for the construction of various haul roads as well as the Process Solids Management Facility (PSMF) and borrow pits (contained within the footprint of the PSMF). This report addresses potential impacts from ground vibrations and air overpressure on the nearest sensitive receptors as defined by Ministry of the Environment (MOE) Model Municipal Noise Control By-law section NPC 119).

Lands immediately adjacent to the proposed Stillwater PGM-Cu site are sparsely developed. Undeveloped forested areas characterize the majority of the surrounding area. The closest sensitive receptors, as currently defined by the MOE, to both the open-pit production and construction phase blasting over the life of the operation are listed in Table 1 below. Please note, we have included the Airport in our analysis, however, this facility is not catagorized as a sensitive receptor under current MOE definitions.

	Sensitive Receptors	Closest Distance to Receptor	Direction from Blasting
Ore Pit Blasting	May's Gifts Residence	3290m	Southwest
	Peninsula Inn	3290m	Southwest
	Wayfare Inn	3520m	Southwest
	Marathon Airport **	2930m	Southwest
	Travelodge Hotel	3800m	Southwest
	North Hare Lake Cottage	4535m	West
	South Hare Lake Cottage	5165m	West
Construction Phase Blasting (Haul Roads, PSMF, Borrow Pits)	May's Gifts Residence	615m	South
	Peninsula Inn	545m	South
	Wayfare Inn	660m	South
	Marathon Airport **	1020m	Southeast
	Travelodge Hotel	2090m	Southeast
	North Hare Lake Cottage	1200m	Northwest
	South Hare Lake Cottage	1630m	West

** Note: An Airport is not defined as a Sensitive Receptor under the current MOE guidelines and is hence not subject to the NPC 119 limits.

TABLE 1 – Closest Sensitive Receptors

Given that mining operations have not been undertaken in the past on this property, site-specific blast monitoring data is not available. We have therefore applied data generated from a variety of research studies which present a variety of material characteristics. It has been our experience that this data represents a conservative starting point for blasting operations. It is a recommendation of this report that a vibration and over pressure monitoring program be initiated on-site upon the commencement of blasting operations to permit timely adjustment to blast parameters as required.

Blast Vibration and Overpressure Suitable Limit Criteria

The detonation of explosives results in the development of very high gas and shock pressures. This energy is transmitted to the surrounding rock, crushing the rock immediately surrounding the borehole (approximately 1 borehole radius) and permanently distorts the rock to several borehole diameters (5-25, depending on the rock type, prevalence of joint sets, etc).

The intensity of this stress wave decays quickly so that there is no further permanent deformation of the surrounding rock mass. The remaining energy from the detonation travels through the unbroken material in the form of a pressure wave or shock front which, although it causes no plastic deformation of the rock mass, is transmitted in the form of vibrations.

Recent years have seen an almost universal adoption of blast vibration control standards developed by the United States Bureau of Mines (USBM). The USBM conducted extensive scientific research on the effects of blasting vibrations on structures, using some of the most respected scientists and engineers in the field. Their report (Report of Investigation 8507) was issued in the early 1980's and established baselines for measuring, analyzing and mitigating blast induced vibrations and their risks and effects. Research has been conducted by countless organizations in the years since the release of RI8507 and have confirmed the authenticity and conservatism of the original report findings. Accordingly, these standards have been utilized as the basis for the development of blast and vibration control regulations by the overwhelming majority of Government and private organizations across North America.

Particle velocity is the descriptor of choice when dealing with vibrations because of its superior correlation with the appearance of cosmetic cracking. While particle velocities provide one measurement statistic, structural responses to varied frequency necessitates the inclusion of frequency analysis in all vibration measurement. As such, the USBM criteria developed utilizes a graded scale incorporating reduced permissible particle velocities at reduced dominant frequencies (Refer to Figure 1 below). This is not to say that damage automatically occurs once these levels are breached and, in fact, threshold damage would not occur in the weakest component (i.e. plaster walls) of the average residence until ground vibrations reached significantly higher intensities than those listed above. We further note that damage of any kind as a result of blast induced vibrations has not been observed below the so-called USBM 'Z-Curve' threshold limits. As such, provided the USBM limits are adhered to, damage as a result of blast induced vibrations is rendered effectively impossible.

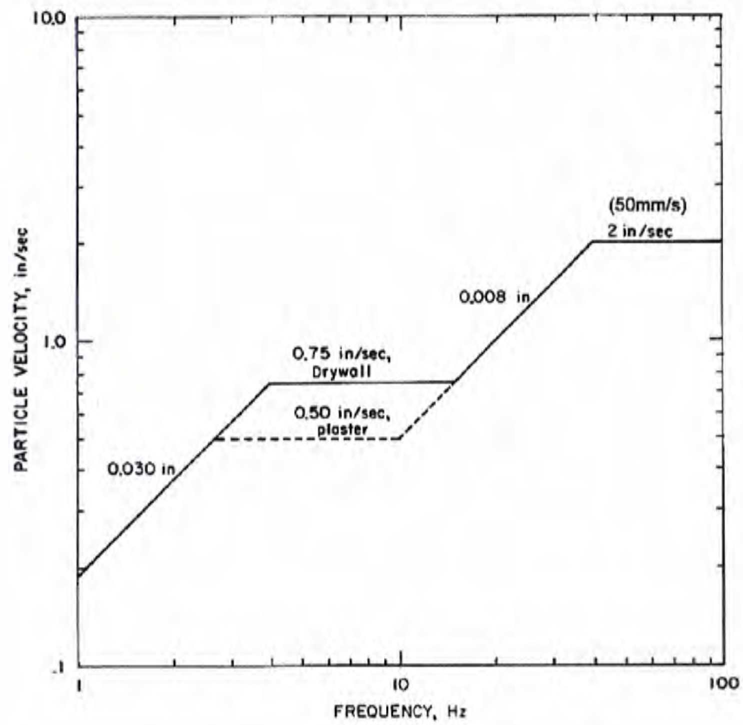


Figure 1 – USBM Z-Curve

It is an intrinsic nature of blast induced vibrations that these vibrations decrease with increasing distance. Under typical conditions, the vibration intensity decreases by two thirds of its previous value for every doubling of distance. That is to say that a peak particle velocity measurement of 100mm/s at a distance of 100 m from the blast location will have decreased to 33.3mm/s at a separation distance of 200m and 11.1 mm/s at a separation distance of 400m. While the nature of the transmitting medium (rock, earth, water) and presence of joint sets, fractures, faults and shear zones will all impact the rate of decay of the ground vibrations, the fact that intensities diminish with distance within consistent media is unavoidable. As such, the aforementioned vibration criteria as displayed graphically in the attachment can be readily extrapolated to elements falling further from the blast site than the monitoring location.

In terms of air overpressures, overpressures in the 140dB range are considered by most experts in the field to be the threshold level at which damage to windows could possibly begin to occur and at which long term exposure to persons can become of concern. This level is approximately equivalent to a wind gust of 65km/hr.

Quarry and Mining operations in the Province of Ontario are governed by the Ministry of Natural Resources and the Ministry of Environment. The Ontario MOE guidelines for blasting in mines and quarries are among the most stringent in North America. Exhaustive studies by the U.S. Bureau of Mines have shown that normal temperature and humidity changes can cause more damage to residences than blast vibrations and overpressure in the ranges suggested as appropriate limits by the MOE. The limits suggested by the MOE for monitored blasts are as follows.

Vibration__________12.5mm/sec Peak Particle Velocity (PPV)

Overpressure_______128 dB(L) Peak Sound Pressure Level (PSPL)

MOE Cautionary levels are set to 10.0mm/s and 120 dB(L) when blasts are not monitored on a routine basis. It is a recommendation of Explotech that blasts for both the initial construction phase operations and the continual open pit operation be monitored to quantify and record ground vibration and overpressure levels employing a minimum of one (1) digital seismographs. As such, all discussion in this report relates to the 12.5mm/s and 128dBL MOE guideline limits for ground vibration and overpressure respectively. It is noteworthy that to the extent that the construction phase activities are defined as “construction” work, the MOE limits noted above would not apply. Notwithstanding, for the purpose of this report, no distinction has been made.

Calculated Blasting Ground Vibration and Overpressure Levels

Transmission and decay of vibrations can be calculated through the development of attenuation relations. These relations utilize empirical data relating measured velocities at specific separation distances from the vibration source to predict particle velocities at variable distances from the source. While the resultant equations are reliable, divergence (scatter) of data occurs as a result of a wide variety of variables, most notably site-specific geological conditions, explosive properties, wave types and blast geometry and design. In order to circumvent this scatter and improve confidence in forecast vibration levels, probabilistic and statistical modeling is employed to increase conservatism built into prediction models and ensure blasts are designed based on maximum probable velocity as opposed to average anticipated velocity.

This is accomplished by the application of 95% regression analysis to attenuation data. While the attenuation relations are not designed to conclusively predict vibrations levels at a specific location as a result of a specific blast design, application of this probabilistic model creates confidence that for any given scaled distance, 95% of the resultant velocities will fall below the calculated 95% regression line.

The most commonly used formula for calculating Peak Particle Velocity (PPV) is known as the USBM 95% Confidence Equation, with general expression as follows:

$$PPV = K\left(\frac{d}{\sqrt{w}}\right)^{e}$$

Where,	PPV	= the maximum peak particle velocity (mm/s)
	K, e	= site factors
	d	= separation distance between blast and receptor (m)
	w	= maximum explosive charge per delay (kg)

The value of "K" and "e" are variable and influenced by many factors (i.e. rock type, geology, thickness of overburden, etc.). As such, these site factors are developed empirically through the measurement of vibration characteristics at the specific operations of interest.

The portion of Equation 1 contained within the parentheses is referred to as the *Scaled Distance* and represents another important PPV relation. It correlates the separation distance between a blast and receptor to the energy (usually expressed as explosive weight) released at any given instant in time. The two most popular approaches are square root scaling and cube root scaling:

$$(SDSR = \frac{R}{\sqrt{W}}) \qquad (SDCR = \frac{R}{\sqrt[3]{W}})$$

Where, SDSR = Scaled distance square root method
SDCR = Scaled distance cube root method
R = Separation distance between receptor site and blast (m)
W = Maximum explosive load per delay period (kg)

Historically, square root scaling is employed in situations whereby the explosive load is distributed in a long column (i.e. blasthole) while cube root scaling is employed for point charges. In accordance with industry standard and for the purposes of this report, square root scaling was adopted for ground vibration analysis and cube root scaling was adopted for air overpressure analyis.

Our experience and analysis demonstrates that blast overpressure is greatest when blasting toward receptors, and blast vibrations are greatest when retreating towards the receptor. For the purposes of this report, all ground vibration calculations assume a retreat towards the closest receptors. Such an approach ensures for inclusion of the 'worst case scenario' for all required blasting.

It is unusual for overpressure to reach damaging levels, and instances when it does, the evidence is immediate and obvious in the form of broken windows. However, overpressure remains of interest due to its ability to travel further distances as well as cause audible sounds and excitation in windows and walls.

Air overpressure decays in a known manner in a uniform atmosphere; however, a uniform atmosphere is not a normal condition. As such, air overpressure attenuation is far more variable due to its intimate relationship with environmental influences. Air vibrations decay slower than ground vibrations with an average decay rate of 6dB(L) for every doubling of distance. Given the high dependence on local environmental conditions, overpressure prediction is far less reliable as a means of blast control. As stated previously, overpressure data was plotted employing cube root scaling.

For the ground vibration and air overpressure analysis we have reviewed the Ore and Waste Rock blast parameters prepared by NordPro (Orava) dated April 11, 2013 (Refer to Appendix A) and been provided direction on planned conceptual construction blasting parameters. A summary of the design is as follows:

- Ore blasting is designed to employ a 165mm (6 ½") hole on a 4m x 5.5m (13' x 18') pattern applied to a 12m bench. The blasts will utilize 4.1m (13.5') collars on a design of one hole per delay, resulting in a maximum explosive load per delay of **229.2kg**.
- Waste Rock blasting is designed to employ 203mm (8") holes on a 5m x 6.5m (16.5' x 21') pattern applied to a 12m bench. The blasts will utilize 5.1m (16.5') collars on a design of one hole per delay, resulting in a maximum explosive load per delay of **315.7kg**.
- For Construction Phase blasting of the various Access Roads, Process Solids Management Facility (PSMF) and Borrow Pits (housed within the PSMF area), preliminary blast estimates call for a maximum load per delay of **12 – 14kg**. To provide additional conservatism and flexibility to the construction phase blasting, all calculations contained within this report have employed a maximum load per delay of **30kg**.

Ground Vibration Analysis

Imperial Ground Vibration Equations:

1. Oriard 50% bound (2002) $$v = 160(\frac{D}{\sqrt{W}})^{-1.6}$$

2. Oriard 90% Bound (2002) $$v = 242(\frac{D}{\sqrt{W}})^{-1.6}$$

3. Oriard 99% Bound (2002) $$v = 605(\frac{D}{\sqrt{W}})^{-1.6}$$

4. Typical Production Blast (Bulletin 656 – 1971) $$v = 182(\frac{D}{\sqrt{W}})^{-1.82}$$

5. Typical limestone Quarry (Pader report – 1995) $$v = 52.2(\frac{D}{\sqrt{W}})^{-1.38}$$

6. Typical Coal Mine (RI8507 1980) $$v = 133(\frac{D}{\sqrt{W}})^{-1.5}$$

Metric Ground Vibration Equations:

7. DuPont General (1968) $$v = 1140(\frac{D}{\sqrt{W}})^{-1.6}$$

8. Construction Blasting (Dowding 1998) $$v = 1326(\frac{D}{\sqrt{W}})^{-1.38}$$

9. Aggregate Quarry Blasting (Explotech 2005) $$v = 5175(\frac{D}{\sqrt{W}})^{-1.78}$$

10. Aggregate Quarry Blasting (Explotech 2003) $$v = 7025(\frac{D}{\sqrt{W}})^{-1.85}$$

The maximum load per delay and closest distances to each sensitive receptor were applied to the formulae listed above to provide a calculation of the ground vibrations which would be specifically imparted on each sensitive receptor as well as the Marathon Airport.

As demonstrated in the Appendix B summary table, in all instances, calculated values for ground vibration intensities experienced at the closest sensitive receptors remained well below the MOE NPC 119 guidelines of 12.5mm/s and thereby categorically below threshold intensities for the initiation of damage to even the weakest cosmetic components of a building. The following table lists the highest calculated vibration levels estimated at each receptor.

	Sensitive Receptors	Calculated PPV (mm/s)
Ore Pit Blasting	May's Gifts	1.0
	Peninsula Inn	1.0
	Wayfare Inn	0.9
	Marathon Airport **	1.2 **
	Travelodge Hotel	0.8
	North Hare Lake Cottage	0.6
	South Hare Lake Cottage	0.5
Construction Phase Blasting (Haul Roads and PSMF)	May's Gifts	2.3
	Peninsula Inn	2.7
	Wayfare Inn	2.0
	Marathon Airport **	1.0 **
	Travelodge Hotel	0.4
	North Hare Lake Cottage	0.8
	South Hare Lake Cottage	0.5

** Note: An Airport is not defined as a Sensitive Receptor under the current MOE guidelines and is hence not subject to the NPC 119 limits.

TABLE 2 – Ground Vibrations imparted on closest Sensitive Receptors

EXPLOTECH

Air Overpressure Analysis

Imperial Air Overpressures Equations:

D = Separation distance between receptor site and blast (ft.)
W = Maximum explosive load per delay period (lbs.)
p = Air Overpressure (psi)

1. *Metal Mine (USBM RI8485)* $$p = 0.401(\frac{D}{\sqrt[3]{W}})^{-0.71}$$

2. *Quarry Face (USBM RI8485)* $$p = 1.32(\frac{D}{\sqrt[3]{W}})^{-0.97}$$

3. *Construction (Average) (Oriard 2005)* $$p = 1.00(\frac{D}{\sqrt[3]{W}})^{-1.1}$$

4. *Construction (Highly Confined) (Oriard 2005)* $$p = 0.1(\frac{D}{\sqrt[3]{W}})^{-1.1}$$

5. *Buried (Total Confinement) (USBM RI8485)* $$p = 0.061(\frac{D}{\sqrt[3]{W}})^{-0.96}$$

Imperial Air Overpressures Equations (USBM RI8485)

D = Separation distance between receptor site and blast (ft.)
W = Maximum explosive load per delay period (lbs.)
p = Air Overpressure (psi)

6. *Behind Quarry Blast (USBM RI8485)* $$p = 0.056(\frac{D}{\sqrt[3]{W}})^{-0.515}$$

7. *In Front of Quarry Blast (USBM RI8485)* $$p = 1.317(\frac{D}{\sqrt[3]{W}})^{-0.966}$$

Metric Air Overpressures Equations (Pa)

D = distance from receptor (m)
W = maximum explosive charge per delay (kg)
p = Peak overpressure level (Pa)

8. *Explotech Equation 1* $$p = 1222(\frac{D}{\sqrt[3]{W}})^{-0.669}$$

Metric Air Overpressures Equations (dBL)

D = distance from receptor (m)
W = maximum explosive charge per delay (kg)
p = Peak overpressure level (dB(L))

9. Explotech Equation 2 $$p = 159(\frac{D}{\sqrt[3]{W}})^{-0.0456}$$

10. Explotech Equation 3 $$p = 206(\frac{D}{\sqrt[3]{W}})^{-0.1}$$

The maximum load per delay and closest distances to each sensitive receptor were applied to the formulae listed above to provide a calculation of the air overpressure levels which would be specifically imparted on each sensitive receptor as well as the Marathon Airport.

When blasting is retreating towards the receptors, blast overpressures for receptors closer to the blasts will be reduced due to the projection direction of the overpressure. As the separation distance between blast and receptor increases beyond 3.2km, this difference is eliminated and no adjustment for direction of retreat is applicable. With the exception of Equation 6 (USBM RI8485 Behind), all equations employed in this report assume worst case conditions of receptors in front of the blast.

As demonstrated in the Appendix C summary table, in all instances, calculated values for the overpressure intensities experienced at the closest sensitive receptors remained below the MOE NPC 119 guidelines of 128 dB(L) and thereby below threshold intensities for the initiation of damage to even the weakest windows in a building. The following table lists the highest calculated overpressure levels at each sensitive receptor.

	Sensitive Receptors	Calculated Overpressure dB(L)
Ore Pit Blasting	May's Gifts	120.0
	Peninsula Inn	120.0
	Wayfare Inn	119.6
	Marathon Airport **	120.6 **
	Travelodge Hotel	119.2
	North Hare Lake Cottage	118.2
	South Hare Lake Cottage	117.5
Construction Phase Blasting (Haul Roads and PSMF)	May's Gifts	125.0
	Peninsula Inn	125.7
	Wayfare Inn	124.6
	Marathon Airport **	122.1 **
	Travelodge Hotel	118.2
	North Hare Lake Cottage	121.2
	South Hare Lake Cottage	119.5

** Note: An Airport is not defined as a Sensitive Receptor under the current MOE guidelines and is hence not subject to the NPC 119 limits.

TABLE 3 – Air Overpressure imparted on closest Sensitive Receptors

We reiterate that air overpressure attenuation is far more variable due to its intimate relationship with environmental influences and as such, the equations employed are less reliable than those developed for ground vibration. For the main pit blasting, collars have been significantly increased when compared to typical production blasts such that blast overpressures will be further reduced below typical calculated results. Overpressure monitoring performed on site will guide blast design as it pertains to the control of blast overpressures.

Based on historical weather data from the Marathon area, prevailing winds during the year are predominantly out of the Southwest and to a lesser degree out of the Northeast. When winds are blowing out of the South and Southwest, this condition will assist in directing overpressures towards the adjacent unoccupied lands thereby increasing attenuation rates in the direction of the closest receptors. In a similar fashion, when winds are blowing out of the North and Northeast, overpressures will be directed towards the South decreasing attenuation rates in the direction of the closest receptors.

As blasting progresses, overpressure generated at the receptors will be noted to vary considerably in response to blast location, face orientation and environmental conditions. Provided prevailing wind speeds remain below 20km/hr, we do not foresee a significant impact on attenuation rates. The effects of wind speed and direction can be gauged as blasting progresses through analysis of the overpressure data collected on site and correlation to blast details, locations and environmental conditions.

CONCLUSION

The blast parameters described within this report will provide a good basis for the initial blasting operations at this location. As site specific blast vibration and overpressure data becomes available, it will be possible to refine these parameters on an on-going basis. The vibration and overpressure monitoring program will be assessed on an ongoing basis as mine development proceeds.

Blasting operations required for operations for the proposed Stillwater Canada Inc. Marathon PGM-Cu project site can be carried out safely and within the guidelines established by the Ministry of the Environment.

We trust the above provides the requested insight and information. Should you require any clarification or additional information, we remain available as necessary.

Kindest regards,

<signature removed>

Rob Cyr, P. Eng.

<signature removed>

Mitchell Malcomson, B. Eng.

EXPLOTECH

REFERENCES

Dowding, C.H., (1985), "Blast Vibration, Monitoring and Control", Prentice-Hall Canada Inc., 297 pp.

International Society of Explosive Engineers Inc., (2011), "ISEE Blasters' Handbook 18th Edition"

Nicholls, H.R., Johnson, C.F., and Duvall W.I., (1971), "Blasting Vibrations and Their Effects on Structures", USBM Bulletin 656

Northwood, T.D., Crawford, R., NRC, Edwards, A.T., Research Division, Hydro-Electric Power Commission of Ontario, (1963), *"Blasting Vibrations and Building Damage"*, NRC Division of Building Research, Research Paper No. 186.

Ontario Ministry of the Environment, (1982), "Publication NPC-119, Blasting", Noise Pollution Control Section.

Oriard, L.L., (1989), *"The Scale of Effects in Evaluating Vibration Damage Potential"* Fifteenth Conference on Explosives and Blasting Technique, New Orleans, 1989.

Oriard, L.L. (1999) *"The Effects of Vibrations and Environmental Forces, A Guide for the Investigation of Structures"*, International Society of Explosive Engineers.

Oriard, L.L. (2002) *"Explosives Engineering, Construction Vibrations and Geotechnology"*, International Society of Explosive Engineers.

Siskind D.E., Stagg M.S., Kopp J.W., Dowding C.H., (1980), *"Structural Response and Damage Produced by Ground Vibration From Surface Mine Blasting"*, USBM RI 8507.

Siskind D.E., Stachura, V.J., Stagg, M.S. and Kopp, J.W., (1980), "Structure Response and Damage Produced by Air Blast From Surface Mining", USBM RI 8485

Stagg,M.S., Siskind,D.E., Stevens,M.G., Dowding, C.H., (1984), *"Effects of Repeated Blasting on a Wood-Frame House"*, USBM RI 8485

Appendix A

NordPro	
Client: Stillwater Canada	Prepared by: Dave Orava
Project: Marathon Cu-PGM	Date: April 11, 2013
Area: Open pit production blasting	Checked by:
Item: Production blasthole drilling	Date:
Note: For discussion on April 11, 2013.	
Re: blasthole diameter selection taking potential flyrock zone into consideration.	

Item	Unit	Ore			Waste Rock		
Bench Height	m	12.0			12.0		
Bench Height	ft	39.36			39.36		
Possible blasthole diameter	in	6.27			6.27		
Use blasthole diameter	in	6.5			8		
Use blasthole diameter	m	0.165	*metres*	D	0.203	*metres*	D
Sub-Drill	m	1.25	*7.6*	*xD*	1.4	*6.9*	*xD*
			0.31	*xB*		*0.28*	*xB*
Blasthole diameter	m	0.165	*6.50*	*inch dia.*	0.203	*8.00*	*inch dia.*
Burden	m	4.00	*24.2*	*xD*	5.00	*24.6*	*xD*
Spacing	m	5.50	*1.38*	*xB*	6.50	*1.30*	*xB*
Pattern Geometry							
Stemming	m	4.1	1.03	xB	5.1	1.0	xB
			24.8	*xD*		25.0	*xD*
Explosive Type							
Length of explosive column	m	9.15	55.4	*xD*	8.32	**40.9**	*xD*
Explosive column length:burden ratio	ratio	2.3	*OK*		1.7	*OK*	
Volume of explosive	m3	0.196			0.270		
Explosive density	g/cc	1.170			1.170		
Explosive / blast hole	kg	229.2			315.7		
Tonnage factor (t/bcm)	t/m3	3.12			3.08		
Tonnes broken / blasthole	t	824			1,201		
Powder factor	kg/t	0.28	kg/t PF		0.26	kg/t PF	
Powder factor	kg/m3	0.868	kg/m3		0.809	kg/m3	
Tonnes broken /m drilled		62.16	t/m drilled		89.64	t/m drilled	
Explosive per blast hole	kg	229.2	kg		315.7	kg	
Explosive type		Mixed			Mixed		

Appendix B

Imperial Equations

Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
Oriard 50% Bound (2002)	Oriard 90% Bound (2002)	Oriard 99% Bound (2002)	Typical Production Blast (Bulletin 656 – 1971)	Typical limestone Quarry (Pader report – 1995)	Typical Coal Mine (RI8507 1980)
$v = 160\,(\frac{D}{\sqrt{W}})^{-1.6}$	$v = 242(\frac{D}{\sqrt{W}})^{-1.6}$	$v = 605\,(\frac{D}{\sqrt{W}})^{-1.6}$	$v = 182\,(\frac{D}{\sqrt{W}})^{-1.82}$	$v = 52.2(\frac{D}{\sqrt{W}})^{-1.38}$	$v = 133(\frac{D}{\sqrt{W}})^{-1.5}$

Metric Equations

Equation 1	Equation 2	Equation 3	Equation 4
DuPont General (1968)	Construction Blasting (Dowding 1998)	Agg. Quarry Blasting (Explotech 2005)	Agg. Quarry blasting (Explotech 2003)
$v = 1140\,(\frac{D}{\sqrt{W}})^{-1.6}$	$v = 1326(\frac{D}{\sqrt{W}})^{-1.38}$	$v = 5175(\frac{D}{\sqrt{W}})^{-1.76}$	$v = 7025(\frac{D}{\sqrt{W}})^{-1.85}$

Maximum Ore Pit PPV Reading =	**1.2mm/s**
Maximum Construction Phase PPV Reading =	**2.7mm/s**

Blasting Type	Location	D (m)	W (Kg)	PPV1 (mm/s)	PPV2 (mm/s)	PPV3 (mm/s)	PPV4 (mm/s)	PPV5 (mm/s)	PPV6 (mm/s)	PPV1 (mm/s)	PPV2 (mm/s)	PPV3 (mm/s)	PPV4 (mm/s)
Ore Pit Blasting	May's Gift Residence	3290	316	0.3	0.4	1.0	0.1	0.3	0.4	0.3	1.0	0.5	0.4
	Peninsula Inn	3290	316	0.3	0.4	1.0	0.1	0.3	0.4	0.3	1.0	0.5	0.4
	Wayfare Inn	3520	316	0.2	0.4	0.9	0.1	0.3	0.4	0.2	0.9	0.5	0.4
	Airport	2930	316	0.3	0.5	1.2	0.1	0.4	0.5	0.3	1.2	0.6	0.6
	Travelodge Hotel	3800	316	0.2	0.3	0.8	0.1	0.3	0.3	0.2	0.8	0.4	0.3
	North Hare Lake Cottage	4535	316	0.2	0.2	0.6	0.0	0.2	0.3	0.2	0.6	0.3	0.2
	South Hare Lake Cottage	5165	316	0.1	0.2	0.5	0.0	0.2	0.2	0.1	0.5	0.2	0.2
Construction Phase Blasting (Haul Roads and PSMF)	May's Gift Residence	615	30	0.6	0.9	2.3	0.2	0.7	0.9	0.6	2.0	1.3	1.1
	Peninsula Inn	545	30	0.7	1.1	2.7	0.3	0.8	1.0	0.7	2.3	1.6	1.4
	Wayfare Inn	660	30	0.5	0.8	2.0	0.2	0.6	0.8	0.5	1.8	1.1	1.0
	Airport	1020	30	0.3	0.4	1.0	0.1	0.3	0.4	0.3	1.0	0.5	0.4
	Travelodge Hotel	2090	30	0.1	0.1	0.3	0.0	0.1	0.1	0.1	0.4	0.1	0.1
	North Hare Lake Cottage	1200	30	0.2	0.3	0.8	0.1	0.3	0.3	0.2	0.8	0.4	0.3
	South Hare Lake Cottage	1630	30	0.1	0.2	0.5	0.0	0.2	0.2	0.1	0.5	0.2	0.2

Appendix C

Air Overpressure Equations (psi to dB(L))					Air Overpressure Equations (psi to dB(L))	
Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7
Metal Mine (USBM RI8485)	Quarry Face (USBM RI8485)	Construction (Average) (Oriard 2005)	Construction (Highly Confined) (Oriard 2005)	Buried (Total Confinement) (USBM RI8485)	USBM RI8485 for BEHIND Quarry Blast	USBM RI8485 for FRONT of Quarry Blast
$p=0.401(\frac{D}{\sqrt[3]{W}})^{-0.71}$	$p=1.32(\frac{D}{\sqrt[3]{W}})^{-0.97}$	$p=1.00(\frac{D}{\sqrt[3]{W}})^{-1.1}$	$p=0.1(\frac{D}{\sqrt[3]{W}})^{-1.1}$	$p=0.061(\frac{D}{\sqrt[3]{W}})^{-0.96}$	$p=0.056(\frac{D}{\sqrt[3]{W}})^{-0.515}$	$p=1.317(\frac{D}{\sqrt[3]{W}})^{-0.966}$

Air Overpressure Equations (pa to dB(L))	Air Overpressure Equations (dB(L))	
Equation 8	Equation 9	Equation 10
Explotech Equation 1	Explotech Equation 2	Explotech Equation 3
$p=1222(\frac{D}{\sqrt[3]{W}})^{-0.669}$	$p=159(\frac{D}{\sqrt[3]{W}})^{-0.0456}$	$p=206(\frac{D}{\sqrt[3]{W}})^{-0.1}$

Maximum Ore Pit Overpressure Reading =	120.6 dB(L)
Maximum Construction Phase Overpressure Reading =	125.7 dB(L)

Blasting Type	Location	D (m)	W (Kg)	P1 (dB(L))	P2 (dB(L))	P3 (dB(L))	P4 (dB(L))	P5 (dB(L))	P6 (dB(L))	P7 (dB(L))	P8 (dB(L))	P9 (dB(L))	P10 (dB(L))
Ore Pit Blasting	May's Gift Residence	3290	316	119.0	113.3	102.9	82.9	87.2	113.9	113.5	119.8	120.0	111.0
	Peninsula Inn	3290	316	119.0	113.3	102.9	82.9	87.2	113.9	113.5	119.8	120.0	111.0
	Wayfare Inn	3520	316	118.6	112.7	102.2	82.2	86.7	113.6	113.0	119.4	119.6	110.3
	Airport	2930	316	119.7	114.3	104.0	84.0	88.2	114.5	114.5	120.5	120.6	112.3
	Travelodge Hotel	3800	316	118.1	112.1	101.5	81.5	86.0	113.3	112.3	119.0	119.2	109.4
	North Hare Lake Cottage	4535	316	117.0	110.6	99.8	79.8	84.5	112.5	110.8	117.9	118.2	107.5
	South Hare Lake Cottage	5165	316	116.2	109.5	98.6	78.6	83.5	111.9	109.7	117.2	117.5	106.1
Construction Phase Blasting (Haul Roads and PSMF)	May's Gift Residence	615	30	124.5	120.8	111.4	91.4	94.7	117.9	121.0	125.0	124.9	121.4
	Peninsula Inn	545	30	125.2	121.8	112.5	92.5	95.7	118.5	122.0	125.7	125.6	122.9
	Wayfare Inn	660	30	124.1	120.2	110.7	90.7	94.1	117.6	120.4	124.6	124.5	120.5
	Airport	1020	30	121.4	116.6	106.6	86.6	90.4	115.7	116.8	122.1	122.1	115.4
	Travelodge Hotel	2090	30	117.0	110.5	99.7	79.7	84.5	112.5	110.8	117.9	118.2	107.4
	North Hare Lake Cottage	1200	30	120.4	115.2	105.0	85.0	89.1	114.9	115.4	121.1	121.2	113.5
	South Hare Lake Cottage	1630	30	118.5	112.6	102.1	82.1	86.5	113.6	112.8	119.3	119.5	110.1

Appendix D

Stillwater Canada Inc. Marathon PGM-Cu Project

PREVAILING METEOROLOGICAL CONDITIONS

Medians provided by Environment Canada

Date	Mean Monthly Temperatures (◦C)	Average Wind Velocity (km/h)
January	-14.1	14.5
February	-11.5	15.3
March	-6.2	15.4
April	1.5	15.8
May	7.2	15.6
June	10.8	13.3
July	14.7	12.5
August	14.6	14.5
September	10.9	14.6
October	5.8	14.9
November	-1.1	14.8
December	-9.3	14.7

** Data is not available specifically for the proposed mining location. Nearest weather station is Marathon A

** Data is based on averaged climate normals gathered 2007-2013

Appendix E

EXPLOTECH

Robert J. Cyr, P. Eng.

Associate, Explotech Engineering Ltd.

EDUCATION

Bachelor of Applied Science,
Civil Engineering, Queen's University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
Association of Professional Engineers and Geoscientists of BC (APEG)
International Society of Explosives Engineers (ISEE)
Aggregate Producers Association of Ontario (APAO)
Canadian Institute of Mining and Metallurgy (CIMM)

SUMMARY OF EXPERIENCE

Over twenty years experience in many facets of the construction and mining industry has provided the expertise and experience required to efficiently and accurately address a comprehensive range of engineering and construction conditions. Sound technical training is reinforced by formidable practical experience providing the tools necessary for accurate, comprehensive analysis and application of feasible solutions. Recent focus on vibration analysis, blast monitoring, blast design, damage complaint investigation for explosives consumers and specialized consulting to various consulting engineering firms.

PROFESSIONAL RECORD

2001 – Present	-Project Engineer, Explotech Engineering Ltd.
1996 – 2001	-Leo Alarie & Sons Limited - Project Engineer/Manager
1993 – 1996	-Rideau Oxford Developments Inc. – Project Manager
1982 – 1993:	-Alphe Cyr Ltd. – Project Coordinator/Manager/Engineer

EXPLOTECH

René A. (Moose) Morin, P. Eng.

Co-owner, Principal of Explotech Engineering Ltd.

EDUCATION

B. Sc. Mining Engineering, University of Alberta 1959
Summer Management Program University of Western Ontario
Extension English - Queen's University
Extension French - University of Montreal

PROFESSIONAL AFFILIATIONS

P. E. O. O.I.Q.
Canadian Institute of Mining and Metallurgy (CIMM)
International Society of Explosives Engineers (ISEE)

SUMMARY OF EXPERIENCE

Since 1958, Mr. Morin has specialized in drilling and blasting phases of mining, quarrying and construction throughout Canada as well as offshore. This experience includes all aspects of drilling, blast design, blast control, operations and management. Mr. Morin has been accepted as an expert witness in the field of explosives and blasting in provincial and federal courts as well as at Municipal Board hearings in Ontario.

INSTANTEL INC., the world leader in digital blasting seismographs was created by Mr. Morin and Mr. Doyle some twenty years ago.

PROFESSIONAL RECORD

1979- Present	- Owner/Principal, Explotech Engineering Ltd.
1977 - 1979	- Manager Operations, Armac Drilling and Blasting
1961 - 1977	- Various responsibilities, starting as Branch Manager in Western Quebec, through Construction Sales Manager, Bulk Products Manager and National Sales Manager DuPont of Canada Explosives Division.

EXPLOTECH

Mitch Malcomson, B.Eng.

Explotech Engineering Ltd.

EDUCATION

Bachelor of Engineering,
Civil Engineering with Concentration in Business Management,
Carleton University

PROFESSIONAL AFFILIATIONS

International Society of Explosives Engineers (ISEE)
Canadian Society for Civil Engineering (CSCE)

SUMMARY OF EXPERIENCE

A senior field technican and project manager working for Explotech Engineering Ltd., Mitch holds a Bachelor of Engineering degree from Carleton University in Civil Engineering with a Concentration in Business Management. Mitch has strong analytical, technical, business and leadership skills. Recent projects have focused on vibration analysis and the drilling and blasting portions of mining, quarrying and construction projects across Canada.

PROFESSIONAL RECORD

2008 – Present	- Senior Field Technican / Project Manager, Explotech Engineering Ltd.
2005 – 2007	- Computer Sales Representative, Staples Business Depot

Information Request 11.3

Measuring Baseline Sound Levels

References:

EIS Guidelines	- Section 2.6.1.3, p. 32 (PDF 37)
	- Section 2.7.3.5, p. 68 (PDF 73)
EIS Main Report	- Table 6.2-5, p. 6.40 (PDF 546)
SID#13	- Executive Summary (p ii), (PDF 3)
	- Section 3.0, p. 15 (PDF 23)
	- Section 4.0, p. 17 (PDF 25)
	- Section 5, p. 21 (PDF 29)
SID#17	- Section 2.2.1, p. 10 (PDF 21)
	- Section 4.1, p. 24 (PDF 35)
	- Section 4.2.1-4.2.2, p. 25 (PDF 36)
	- Tables 1 to 5, (PDF 44-48)

CEAR Doc #235 "Ontario Ministry of Environment to True Grit Consulting Ltd., on behalf of Stillwater Canada Inc. - Email Questions and Responses on Issues Related to Noise Assessment" (PDF 5)

Contributing IRs:
HC-20
MOE-Noise-5

Rationale:

Remote rural locations such as some of the Points of Reception can sometimes be measured with overnight background sound levels well below 40 dBA (A-weighted decibels), with values of 25 dBA occurring. However, the EIS shows minimum measured sound levels at several locations of 40.0 dBA.

Existing baseline sound levels were measured using Integrating Quest NoisePro DL and Quest Q-300 Logging Dosimeters. In its comments to the Panel, the MOE reports that the meters that were used for these measurements are not recommended by their manufacturer for levels lower than 40.0 dB and that the meters used are not designed for this sort of measurement. The operating manual for one of the meters states that the noise floor (generated within the meter itself) is "approximately 35 dBA", and that the minimum sound level with which the meter should be used is 40 dBA.

According to detailed measurement logs (CEAR Doc #235), a number of measurements were made with a 40.0 dB "Threshold" setting engaged in the meter. Non-zero thresholds are intended for measurements of occupational (close-up worker exposure) noise, and not for environmental (distant community exposure) measurements; the effects of this error upon the indicated reading can vary among meters.

The possible systemic error in the measurement of existing background noise at remote receptors in the baseline Noise Report, arising from equipment limitations, can lead to inappropriate noise criteria being established and predicted impacts being minimized.

As a result of the potential issue with the instrumentation that was used, it is not clear what the internal background noise of the device is, or if the background noise reported in the raw data is attributable to the instrumentation or natural conditions on site. If the internal background noise of the instrumentation is too high, the measured baseline noise at the North Hare Lake and South Hare Lake cottages could be inflated, which could modify the predicted effect (which is based on an average population in a quiet rural area based on a percent highly annoyed criterion). Therefore, the measured baseline noise at these sites may be less than 40 dBA, which is the value used in the conclusion.

Information Request:
Justify the use of the dosimeters that were utilized to measure baseline sound levels in light of comments received.

Assuming the baseline data remains appropriate, subtract the internal background noise of the recording device to obtain the measured baseline noise, and where necessary, revise modelling results and associated conclusions.

SCI RESPONSE

The two Quest (Q300 and Noise Pro) meters used for the noise baseline measurements meet Ministry of Environment (MOE) and Health Canada reference documents listed in the EIS Guidelines. The EIS document references MOE noise publication NPC 232 as well as the Health Canada document, *Useful Information for Environmental Assessments*, which references the CAN/CSA ISO Standards.

NPC 232 references NPC 102 for noise meter instrumentation and NPC 103 for noise measuring procedures. NPC 103 states that sound other than impulsive sounds, quasi-steady impulsive sounds or buzzing sounds can be measured using a general sound level meter. The Quest meters used meet the definition of a general sound level meter defined in NPC 102, specifically, "*the sound level meter shall have a minimum usable range of sensitivity of from 40 dBA to 100 dBA*".

The CAN/CSA ISO standards specify that a Type 2 meter is acceptable for environmental monitoring. Both Quest meters meet the requirements of a Type 2 meter as defined in IEC Publications 651 and 804.

Since, due to microphone electrical noise, the noise floor of the instrument is 35 dBA and measurements must be at least 5 dB above the noise floor to be valid, the instruments used are considered to be accurate for sound levels of 40 dBA or greater. In SID#17 the only background measurement used as a criterion was at the north end of Hare Lake (measurement N3). The sound level measurement N3 during the assessment period of 48 hours did not dip below 41.9 dBA. There is no reason to believe that sound levels below 40 dBA occurred during the measurement period, or that it is necessary to adjust the results by subtracting any arbitrary value for background noise of the instrument. Based on the measurement taken at N3, the lowest night time one hour equivalent sound level (L_{eq}) of 41.9 dBA was used as the noise criterion as per MOE noise publication NPC 233. Stillwater could simply remove the 41.9 dBA criterion and rely on the MOE exclusionary night time noise criterion of 40 dBA for a wilderness (Class 3) area. This would meet MOE standards and industry practice in Ontario. Reducing the night time criterion does not significantly influence the results of the noise impact assessment.

Stillwater does not believe further background noise measurements are necessary; nor does it believe that additional measurements will fundamentally change the acoustic analysis or the conclusions drawn from it. The next opportunity to collect measurements is the spring of 2013 when the environmental temperature is within the manufacturer's recommended range for a different the sound level meter.

Information Request 11.4

Effects of Changes to the Characteristics of Sound

References:

EIS Guidelines	- Section 2.7.5.5, p. 68 (PDF 73)
SID#17	- Section 2.2.2, p. 11-12 (PDF 22-23)
	- Section 5, p. 29-30 (PDF 40-41)

Contributing IRs:
HC-21

Rationale:

Changes to the characteristics of the sounds from baseline (e.g. a change in frequency, changes in sound modulation, increased impulsiveness, or a shift in time of day in which noise is experienced) may be perceived and may cause noise to be more noticeable, even if the absolute equivalent continuous sound level (in dBA) is not substantially increased. For this reason it is advised that statements relating to perceptibility are avoided (see ANSI S12.9-2005/Part 4, clause A. 1.3).

Information Request:

In tabular format, identify the potential sources of noise associated with the Project that could result in the following:

- changes in the frequency;
- changes in sound modulation;
- increased impulsiveness; and
- shifts in time of day in which noise is experienced.

Assess the effects of the changes listed above on human health and well-being. Where necessary, identify mitigation measures.

Also, where information is provided in the EIS on averaged noise levels over time, provide data on the maximum, non-averaged (instantaneous) levels and the implications of these on human health and well-being.

SCI RESPONSE

EIS GUIDELINES

Section 2.7.3.5 of the Guidelines requires that the assessment include the expected duration of noise from the Project and an evaluation of the severity of predicted changes in noise levels and how they may affect human health.

Note also that Section 2.7.2.2, "Acoustic Environment" of the EIS Guidelines requires the noise assessment to use the Ontario Ministry of the Environment (MOE) noise guidelines and specifically NPC-232 (or its successor). The MOE noise guidelines have been used successfully since 1978 (some, but not all, including NPC-232 have been updated since 1978) and are regularly used for noise assessment of similar projects such as quarries.

The MOE environmental noise guidelines and criteria are based on perceptibility and annoyance that can influence the use and enjoyment of property and interfere with lifestyle or normal functioning (e.g., for residential properties this may mean interference with relaxing, speech intelligibility, sleep).

The environmental noise criteria used are several orders of magnitude less than the thresholds typically associated with direct health effects; for example, as may be found in occupational health and hygiene regulations at both the federal and provincial levels.

B. SID #17 (NOISE ASSESSMENT)

Section 2.2.2 addresses Highway 17 and Town of Marathon transportation corridors. It shows the hours of operation related to the project and provides baseline sound exposures; that is, sound exposures from existing traffic. Section 2.2.2 mentions the normal MOE objective of $\mathbf{L_{eq}}_{16}$ (day) of 55 dBA (for outdoor living areas) and that mitigation is necessary when this is exceeded and an increase of at least 5 dBA is predicted. It also mentions the Ontario Ministry of Transportation (MTO) criteria for new or expanded highways that require consideration of noise mitigation where 65 dBA would be exceeded and the increase over baseline is more than 5 dBA. It points out that perhaps the 65 dBA criterion may not be appropriate (may be excessive) for Marathon, but that a 5 dBA increase is an appropriate criterion to trigger mitigation, even at lower sound exposure, because a 5 dBA change is likely perceptible. This is an entirely appropriate assessment and is consistent with the concepts and principles of the MOE noise guidelines which address perceptibility.

The ranges of existing and predicted sound levels discussed are well below the thresholds for health effects.

C. ANSI S12.9-2005/PART 4

The scope of this American standard is *"....to assess environmental sounds and to predict the potential for annoyance response to a community....".* The scope also clearly states this standard *"....does not address other effects of noise such as sleep disturbance or health effects.".*

Section A.1.3 "Background Sound Situations" is part of an "informative" annex on "adjustments for background sound" and is a brief discussion that a sound may mask or interfere with another sound and may alter the annoyance of the other sound.

D. INFORMATION REQUEST

D.1.0 The request is to identify potential sources of noise associated with the Project that could result in:

- changes in the frequency;
- changes in sound modulation;
- increase in impulsiveness; and
- shifts in time of day in which noise is experienced.

Also requested was information on maximum, (non-averaged) instantaneous sound levels.

D.1.1 Changes in Frequency

Many of the sources will operate continuously in steady state. Some sources, such as engine-powered mobile equipment outdoors have variable sound output related to operation and throttle-setting. The frequency spectrum also changes somewhat as operations vary. An example is trucks on the road as they accelerate or decelerate. The changes in frequency spectrum typically are not particularly significant. Some equipment, such as a wood chipper, produces quite different sound output (level and frequency) when chipping compared to just idling.

The attached Table 11.4-1 summarizes the main project-related equipment with potential for spectrum variations.

D.1.2 Changes in Sound Modulation

Modulation is the effect of one frequency, which is relatively constant (the carrier), being multiplied by another signal of much lower frequency. This causes the amplitude of the carrier frequency to vary at the rate of the modulating frequency; resulting in a steady, regular, low frequency change in the carrier frequency that is readily perceptible. In acoustics, this phenomenon usually requires the modulating frequency to consist primarily of pure tones, otherwise the modulation effect would not be perceptible. An example of where this effect can be generated is with the operation of two identical pumps in parallel, where they produce pure tones (impeller blade passage frequency). Although identical units should operate at exactly the same speed (frequency), in practice there are small differences. This results in "beat frequencies" (the difference between rotating speeds and corresponding difference in blade passage frequencies). This would be apparent as modulation of the base frequency at the beat frequency. (This is also the same principle used by musicians to tune stringed instruments.) The potential for this is minimal in this case unless there are identical pumps running in parallel in the process. Where such equipment is indoors, the effect is typically not perceptible in the outdoor environment. Most other pieces of equipment, as well as engine-powered, mobile, outdoor machinery are incoherent, broadband sound sources, with no potential for sound modulation effects.

D.1.3 Increase in Impulsiveness

A sound source is typically either impulsive or non-impulsive. We are not aware of any machinery or process sources associated with the project that would experience a change in sound impulsiveness.

D.1.4 Shifts in Time of Day

The process is expected to be 24/7, except that certain operations such as transportation will only occur during the day. Thus, we are not aware of any sources that would be expected to shift their operation to another time.

D.2.0 Instantaneous Sound Levels

- The MOE noise guidelines do not deal with instantaneous sound levels. The MOE noise guideline sound limits/criteria also do not deal with averaged sound levels. The MOE noise criteria for stationary sources (the mining project and all its activities on-site, except transportation on public roadways, is considered a stationary source) is in terms of one-hour $\mathbf{L_{eq}}$ (dBA). $\mathbf{L_{eq}}$ is the energy equivalent, continuous sound level. This is the constant sound level (in dBA) that corresponds to the same total sound energy (dose) as the actually varying sound, over the specified time period (one hour in this case). $\mathbf{L_{eg}}$ may be viewed as an average sound energy. $\mathbf{L_{eg}}$ is logarithmically related to the sound energy and is thus heavily weighted towards the higher sound levels. It is thus quite different than a sound level average because of the logarithmic relationship.

- For much engine-powered (construction) machinery, the Leq is established from the maximum sound level produced (as per various standards such as by SAE), in accordance with the MOE principle of “predictable worst case”.

- Where a source operates continuously in steady state for the full hour, the instantaneous sound level and $\mathbf{L_{eg}}$ are equal. Where a source operates in steady state for a portion of the hour, the instantaneous sound level will be L_{eg} + 10 Log (operating time in minutes/60). Appendix C of SID #17 provides this information. Some sources such as engine-powered outdoor machines will have variations in sound level throughout their cycle. In most cases, the instantaneous maximum sound level would be less than 10 dBA higher than the hourly $\mathbf{L_{eg}}$**,** unless the sound was produced for only a fraction of the hour. (For example, a steady source with an hourly $\mathbf{L_{eq}}$ of 50 dBA operating for only 6 minutes out of an hour would have an instantaneous sound level of 60 dBA; operating for only 30 minutes would have an instantaneous sound level of 53 dBA, etc.

D.3.0 Health Effects

None of the factors (changes to the characteristics of sound) discussed above would be expected to result in any health effects. As noted above, the MOE noise criteria against which the Project is assessed are several orders of magnitude less than the thresholds typically associated with direct health effects.

TABLE 11.4-1

EFFECTS OF CHANGES TO THE CHARACTERISTICS OF SOUND

Factor	Equipment with Potential to Exhibit Factor	Health Effects	Comments
Changes in frequency (of sound emission spectrum)	Cyclical engine-powered equipment such as trucks, excavator, dozer, loader, etc. Variable feed processing equipment such as chipper or crushers	Nil	Normally experienced in most projects
Sound Modulation	Minimal or nil potential	Nil	Requires special circumstances
Increased Impulsiveness	Minimal or nil potential	Nil	
Shifts in time of day in which noise experienced	Nil	Nil	Processing is 24/7 Transportation is day only
Maximum, non-averaged instantaneous sound levels	See SID #17, Appendix C See text	Nil	

Information Request 11.5

Ground Absorption Coefficient

References:

EIS Guidelines	- Section 2.7.3.5, p. 68 (PDF 73)
SID#17	- Section 2.3.2, p. 16 (PDF 27)

Contributing IRs:
HC-22

Rationale:

No rationale was provided in the EIS to support the use of an overall site ground absorption coefficient of 0.6 in the modelling. A coefficient that is too high can reduce the predicted sound levels at receptors.

Information Request:
Justify the use of 0.6 as a ground absorption coefficient, and provide a sensitivity analysis on the effect of noise levels using a feasible range of coefficients.

SCI RESPONSE

Two ground absorption coefficients were used in the acoustic modelling: 0.0 and 0.6 (refer to Section 2.3.2 of SID #17).

A coefficient of 0.0, meaning 100% of sound is reflected, was used to represent surfaces such as the open pits, concentrator area, mine rock storage area, process solids management facility, process water pond and paved surfaces.

A coefficient of 0.6, meaning 60% of sound is absorbed, was used to represent all other surface areas within the project boundary, such as small ponds and lakes, areas covered by grass, trees and all other ground surfaces suitable for the growth of vegetation.

ISO 9613-2 *Attenuation of Sound During Propagation Outdoors, 1996* recommends an absorption coefficient of 1 for porous ground; that is, 100% of sound that comes in contact with the surface is absorbed. Porous ground is defined as areas covered by grass, trees and all other ground surfaces suitable for the growth of vegetation. Areas outside of the reflective surfaces described above, fit the description of porous ground with the exception of the small ponds, lakes and bare rock surfaces in the project boundary, which together comprise less than 5% of the ground surface within the mine claim boundary. Since the acoustic model used an absorption coefficient of 0.6, the results are considered conservative and a sensitivity analysis is not considered necessary.

Information Request 11.6

Effects of Blasting Noise on Humans

References:

EIS Guidelines	- Section 2.7.2.2, p. 52 (PDF 57)
SID#17	- Section 5, p. 29 (PDF 40)

Contributing IRs:
MOE-Noise-1
MOE-Noise-2

Rationale:

The EIS Guidelines require the identification and evaluation of impacts from noise on potential human receptors. However, the blasting noise and vibration criteria quoted in SID #17 are intended to address the issue of building damage, not human health effects, perception or annoyance. For example, SID #17 states "Vibration impact is not expected to cause structural damage to off-site buildings since the highest predicted vibration for an off-site building of 0.31 mm/s, at the Marathon airport during open pit blasting, is less than the NPC 119 limit of 10.0 mm/s."

The EA does not address the human consequences of introducing a regular schedule of blasting in or near a populated area which has historically not been subject to such activities. With regard to the threshold for human perception of vibration, vibration limits of 0.14 mm/s are suggested by both ISO Standard 2631, Annex A and CN Rail (from "CN Principal Main Line Requirements").

Information Request:
Discuss how instantaneous blast noise (startle effect) and vibration levels compare against appropriate guidelines in Canada for effects on humans. If appropriate standards/guidelines do not exist in Canada, compare against other relevant guidelines from other jurisdictions.

SCI RESPONSE

Blast overpressure (airblast) and ground vibration calculations are discussed in the Explotech Engineering Ltd. (Explotech) report *Analysis of Blast Vibrations and Overpressure from the proposed Stillwater Marathon PGMC Development*.

Given that within consistent media, ground vibrations and overpressure decrease with increasing distance, the analysis focussed on the closest sensitive receptors to the required blasting operations, specifically:

- May's Gifts Residence
- Peninsula Inn
- Wayfarer Inn
- Travelodge Hotel
- North Hare Lake Cottage
- South Hare Lake Cottage

For the pit complex, the closest separation distance between required blast and sensitive receptor is approximately 3300m (May's Gifts Residence). Similarly, for the borrow pit, Process Solids Management Facility (PSMF) and access road blasting, the closest separation distances are 545m (Peninsula Inn), 615m (May's Gift Residence) and 660m (Wayfare Inn) respectively.

The MOE NPC 119 Guidelines for ground vibration and overpressure are 12.5mm/s and 128dBL respectively for monitored operations. As demonstrated in the Explotech analysis, all ground vibrations and overpressures at the closest sensitive receptors are calculated to be below the NPC guideline limits.

With respect to blast overpressures, the NPC 119 128dBL guideline limit is equivalent to a 35km/hr wind. As such, the ultimate effects of a 128dBL blast overpressure on receptor structures and persons will be effectively the same as a 35km/hr wind. Wind gusts at this level and above are routinely experienced in the Marathon area. In fact, the potential harm from a cyclical wind pressure is in fact greater than that associated with a transient blast overpressure pulse. While on a calm, windless day, the transient blast overpressure may startle some individuals, this is strictly a nuisance effect.

Most blast consultants and environmental scientists have concluded that adverse health effects from infrequent (< 5 occurrences per day) transient overpressures do not occur below levels of 140dBL (Hirsch 1968; US Department of Defense 1973; US EPA 1974). There are no scientifically established human health implications correlated to transient blast overpressures at NPC 119 guideline levels. Thousands of quarries and mines operate within North America with no documented cases of adverse health effects from periodic blasting on surrounding persons to our knowledge.

For ground vibrations, the threshold of human perception is in the order of 0.15 – 0.2mm/s in more sensitive individuals. This base threshold is intimately dependent on the individual and the ambient vibration levels at the point of reception. It is very common for structures and persons housed therein to routinely be subjected to vibrations well above the NPC 119 guideline limit. Sources of these vibrations include road traffic, air traffic, vibration from adjacent construction and manufacturing facilities, and occupancy influences to name but a few.

Additionally, the human body is routinely subjected to vibrations an order of magnitude higher than the 12.5mm/s guideline limit through routine activities such as traveling in vehicles.

The NPC 119 guideline limits have been established at sufficiently conservative levels so as to mitigate nuisance effects as opposed to strictly alleviating damage potential. For construction projects in Ontario, the provincial standard limit for blast induced vibrations is 50mm/s (>40Hz). That is to say that if blasting were required on Highway 17, which runs through the claim and lease boundary, the vibration limit imposed on the construction project would be 50mm/s or a value four (4) times higher than those under NPC 119 guideline limit.

As detailed in the Explotech report, calculated maximum vibration levels over the life of the development are below 3mm/s or 75% below the guideline of 12.5mm/s. At the NPC 119 guideline limit, there are no scientifically established human health implications correlated to transient blast vibrations.

Information Request 11.7

Use of non-Canadian Blasting Standards

References:

EIS Guidelines - Section 2.7.2.2, p. 52 (PDF 57)
SID#17 - Executive Summary, p. iii (PDF 5)

- Section 2.2.4, p. 12 (PDF 23)
- Section 4.5, p. 26-27 (PDF 37-38)
- Section 4.5.2.1, p. 28 (PDF 39)
- Section 5, p. 29 (PDF 40)

Contributing IRs:
MOE-Noise-3

Rationale:

Blasting criteria from outside Canada are referenced with significantly higher limits than criteria from the Ministry of the Environment. This could lead to overoptimistic claims of predicted compliance. For instance, one of the criteria quoted for limits on blasting noise and vibration is from the United States Bureau of Mines, which uses numbers that are more than 5 dB higher than the highest figures given in the Ontario criterion from MOE NPC 119.

Information Request:

Update the assessment of potential effects on the acoustic environment from blasting using the Ontario criterion MOE NPC 119.

SCI RESPONSE

The acoustic assessment included the evaluation of potential blasting impacts on the acoustical environment by comparing predicted airblast and vibration to MOE NPC 119 criteria and therefore no update is necessary (Refer to Section 2.2.4 of SID#17).

Blasting effects were also compared for informational purposes to criteria developed by the United States Department of the Interior and Bureau of Mines (USBM). The reference to non-Canadian blasting standards is considered to add value to the blasting impact assessment by broadening its perspective. The USBM airblast and vibration criteria were developed by extensive research and testing results from 184 blasts at 56 residential structures. The USBM vibration criterion was developed based on testing from 219 blasts at 76 residential structures. Further, the USBM criteria, published in 1980, are more recent than those published in NPC 119, which was published in 1978.

Information Request 11.8

Noise from Transport of Iron Concentrate

References:

EIS Guidelines - Section 2.7.2.2, p. 52 (PDF 57)
EIS Main Report - Section 1.4.3.4.3, p. 1.71 (PDF 140)

Contributing IRs:
MOE-Noise-4

Rationale:

The EIS discusses the potential for the large-scale production of iron at the site. Further, section 1.4.3.4.3 of the EIS indicates that iron production on the site could cause an increase in truck traffic from 8 to 50 trucks per day. This increase could result in an increase in truck-related road noise of 8 dB or more in a given hour; however, this potential effect has not been assessed in the EIS.

Information Request:
Provide an assessment of the potential environmental effects of increased noise in the local study area, along haul routes and at the rail load-out facility due to truck-related road traffic, assuming the production of an iron concentrate. Identify additional mitigation, if necessary, and update the significance conclusions.

SCI RESPONSE

The traffic noise impact assessment already includes the truck traffic associated with the production of iron concentrate (i.e., 50 haul trucks per day). In addition, SCI has in fact decided not to proceed with the production of iron concentrate and, as a result, the actual traffic will be substantially lower than the traffic volume modelled An updated assessment is therefore not necessary. With the removal of the iron concentrate, the existing traffic noise impact assessment is quite conservative.

Information Request 11.9

Sub-audible Low Frequency Sound

References:

EIS Guidelines - Section 2.6.1.3, p. 32 (PDF 37)
SID#13 - Section 4.2, p. 18 (PDF 26)
- Figure 7 (PDF 40)

Contributing IRs:
MOE-Noise-7

Rationale:

Figure 7 (section 4.2 of SID #13) provides a bar graph of spectral distribution (erroneously referred to as "frequency response") of background sound at measurement location N3, which shows what appears to be a very substantial rise in sound level in the (sub-audible)
16 Hz octave. The figure and the text discuss the sub-audible low frequencies in terms of annoyance.

Information Request:
Explain the cause of excessive low frequency as expressed in Figure 7 and its implications to the assessment.

SCI RESPONSE

The most probable sources of the measured low frequency sounds at test location N3 are wind and/or lake surf/wave sounds. The measurement site was in a large open area adjacent to Hare Lake. As discussed in SID #13 (*Baseline Technical Report – Noise – Marathon PGM-Cu Project),* the periods of elevated sound levels in the 16 Hz octave correspond to periods of higher wind speeds. As a result, the incidences of low frequency sounds appear to be caused either by these higher wind speeds or by surf/wave action at Hare Lake.

MOE noise criteria are based on A-weighted sound levels. A-weighted sound levels best represent the frequency response perceptible to the human ear and are more heavily weighted on mid to high frequency sound levels, and minimize the contribution of low frequency sound. Therefore, sound levels in the 16 Hz octave band do not significantly contribute to the overall A-weighted sound levels reported in SID #13.

There are no implications to the noise assessment.

Information Request 11.10

Description of Haul Route Noise Impacts

References:

EIS Guidelines	- Section 2.7.2.2, p. 52 (PDF 57) EIS
Main Report	- Section 6.2.2.2, p. 6.39 (PDF 545)

Contributing IRs:
MOE-Noise-8

Rationale:

Section 6.2.2.2 of the EIS states "An incremental change of less than 5 dB is commonly accepted as an incremental change that is imperceptible to the human ear." However, the Ministry of the Environment has stated that an increase of 1 dB would be imperceptible, and that an increase of 3 to 5 dB would be noticeable.

Information Request:
Justify the statement that an "incremental change of less than 5 dB is commonly accepted as an incremental change that is imperceptible to the human ear." Discuss if the use of the MOE ratings for sound level increase would change the conclusions in the EIS regarding the effects on humans, and result in the need for additional mitigation.

SCI RESPONSE

This statement was not made in the technical report submission (SID #17) and was likely the result of misinterpretation during preparation of the final EIS document.

Haul route noise impacts were assessed in SID#17 based on 16 hour equivalent continuous sound levels (L_{eq16}). For traffic noise, the *Ministry of Transportation (MTO) Environmental Guide for Noise* (MTO Guide), Table 2.1 suggests that predicted traffic sound increases of 5 dB or higher require mitigation. The MTO Guide criterion was used in SID #17 to assess the need for mitigation resulting from the Project along the Highway 17 corridor and along the proposed transportation routes in the Town of Marathon.

The predicted traffic impacts at sensitive receptors in the Highway 17 corridor and in the Town of Marathon (based on the original assumption that iron ore concentrate might be produced) are reviewed herein according to the sound level qualitative ratings provided by the MOE in its response to the Environmental Impact Statement. The MOE table summarizing qualitative effect of sound level increases is reproduced below:

Sound Level Increase (dB)	Qualitative Rating
1-3	Insignificant
3-5	Noticeable
5-10	Significant
10 and over	Very Significant

The following paragraphs discuss traffic noise impacts with reference to the MOE sound level ratings.

Highway 17 Corridor

The Project traffic L_{eq16} was predicted in the Highway 17 corridor during construction and operations.

Construction Traffic

The largest predicted increase in construction traffic noise of 3.8 dBA at the south Hare Lake Cottage, from 8.5 dBA to 12.3 dBA, is indistinguishable from background noise, since the lowest measured night time baseline Leq16 was 41.9 dBA. The highest predicted increase that is above background noise is 0.2 dB at the first floor of the Peninsula Inn. According to MOE qualitative rating, an increase of 0.1 dB is insignificant.

Operations Traffic

The largest predicted increase in operations traffic noise of 0.4 dBA at the north Hare Lake Cottage, from 4.0 dBA to 4.4 dBA, is indistinguishable from background noise, since the lowest measured night time baseline Leq16 was 41.9 dBA. The highest predicted increase that is above background noise is 0.1 dB at the first floor of the Peninsula Inn. According to MOE qualitative rating, an increase of 0.1 dB is insignificant.

Town of Marathon Operations Traffic

The L_{eq16} was predicted along the Project transportation routes in the Town of Marathon during operations. The amount of traffic from operations was significantly higher than construction and represented the worst case scenario. Therefore, construction traffic was not assessed. Two proposed travel routes were assessed: One route follows Peninsula Road and Marina Drive (Rail Loadout Route 1) and the second follows Peninsula Road, Stevens Avenue and Winton Street (Rail Loadout Route 2).

Rail Loadout Route 1

The largest predicted increase in traffic noise resulting from Rail Loadout Route 1 is 1.9 dBA at Kingdom Hall Church, from 50.3 dBA to 52.2 dBA. According to MOE qualitative rating, an increase of 1.9 dB is insignificant.

Rail Loadout Route 2

The largest predicted increase in traffic noise resulting from Rail Loadout Route 2 is 5.3 dBA at the Senior's Centre, from 46.5 dBA to 51.8 dBA. According to MOE qualitative rating, an increase of 5.3 dB is significant. The predicted L_{eq16} of 51.8 dBA is less than the MOE publication LU 131: *Noise Assessment Criteria in Land Use Planning* (LU 131) criterion of 55 dBA. However, the magnitude of this sound level increase may cause annoyance for some occupants.

While the predicted noise increase at the Senior's Centre would be considered significant using the MOE rating, it is noted that the predications were largely based on iron ore concentrate trucking and the associate truck traffic. Stillwater no longer intends to produce iron ore concentrate and accordingly these model predictions are quite conservative.

Information Request 11.11

Selection of Traffic Noise Model

References:

EIS Guidelines	- Section 2.6.1.3, p. 32 (PDF 37)
EIS Main Report	- Section 5.3.1, p. 5.44 (PDF 369)

Contributing IRs:
MOE-Noise-9

Rationale:

Baseline noise levels along Highway 17 and the proposed Town of Marathon transportation routes were determined through traffic noise modelling using current relevant traffic data. The Ministry of the Environment has stated that the specific traffic noise modelling program for generating background traffic sound at the Points of Reception is not an accepted modelling method.

In SID #13 and #17, SCI recommends that sound level limits at certain locations should be increased over the exclusionary values, using modelled traffic background noise values that are in excess of the exclusionary limits. However, it is possible that the predicted effects on the acoustic environment would be different if modelling accepted in Ontario were used. The Ministry of the Environment recommends that where recommendations are made to substitute modelled traffic background sound for MOE exclusionary limits, the background sound should be recalculated using the ORNAMENT and/or STAMSON methods, and these results used in place of the current traffic noise model values for new limits.

Information Request:
Justify the selection of the traffic noise model used to establish traffic noise and assess impacts. Discuss the potential differences in the results of the traffic noise model used with the results that would be obtained using the models recommended by MOE (ORNAMENT and STAMSON) and the implications of these differences.

SCI RESPONSE

SoundPLAN traffic noise modelling software was selected to establish background and project traffic noise because of advantages over older models. Comparison of the SoundPLAN traffic noise model (STNM) results to ORNAMENT results shows that STNM provides similar noise impact assessment conclusions. The use of STNM is considered to be justified on the basis of the comparison provided below.

The STNM used in the EIS was developed and issued by the United States Federal Highway Administration (FHWA) in April 2004. The ORNAMENT traffic model was based on a model developed by the FHWA in 1988. TGCL understands that STNM is advanced traffic modelling software and is advantageous over ORNAMENT for the reasons including the following:

- STNM has no vehicle restrictions for low traffic volumes. ORNAMENT requires a minimum traffic volume of 40 vehicles per hour. On streets with low volumes of traffic, ORNAMENT cannot predict traffic sound levels, but STNM can.

- STNM utilizes traffic controls such as stop signs and traffic lights at intersections. Therefore noise levels associated with acceleration and deceleration of vehicles are accounted for when vehicles approach/leave intersections. ORNAMENT does not account for traffic controls.
- STNM permits inputs of site wide detailed topography to accurately calculate shielding and reflection. ORNAMENT treats topography in a simplistic manner which lacks detailed barrier or multi barrier definition.
- STNM creates a graphic output of the modelled results which is easy for a lay person to understand. ORNAMENT cannot present a graphic result.

In order to address this information request, the traffic noise assessment was repeated using ORNAMENT based on the original assessment scenario which included iron ore concentrate being hauled to a rail load out facility in Marathon and the results are compared to the STNM results. As noted in the responses to IRs 11.8 and 11.19, Stillwater no longer intends to produce iron ore concentrate so these model predictions are quite conservative. ORNAMENT was used to model background and Project traffic at a noise sensitive receptor in the Highway 17 corridor and two noise sensitive receptors in the Town of Marathon. All tabulated traffic noise inputs and ORNAMENT modelling outputs are attached.

The noise sensitive receptor chosen for comparison in the Highway 17 corridor was May's Gifts.

STNM was used to predict the lowest background traffic one hour equivalent sound level (L_{eq1}) at May's Gifts, which was used as a noise criterion to assess noise emissions from activities within the project footprint. Since the lowest hourly traffic volume during the night time period of 7 pm to 7 am was only seven vehicles, ORNAMENT could not be used since it requires a minimum of 40 vehicles per hour. The lowest hourly traffic volume during the daytime period of 7am to 7pm was 49 vehicles and ORNAMENT could be used to predict daytime lowest background L_{eq1}. For the lowest hourly daytime traffic, STNM predicted a background L_{eq1} of 53.4 dBA. ORNAMENT predicted a background $L_{eq1}$of 56.4 dBA. Therefore, STNM predicted a more conservative criterion by which activities within the Project footprint would be assessed.

STNM was used to predict the daytime background traffic and Project traffic 16 hour equivalent sound level (L_{eq16}) at May's Gifts. Using background traffic data, STNM predicted a daytime L_{eq16} of 55.5 dBA. Using the combination of background traffic data and Project traffic data, STNMpredicted a daytime L_{eq16} of 55.6 dBA. Using the same traffic data, ORNAMENT predicted a background daytime L_{eq16} of 58.9 dBA and a Project daytime L_{eq16} of 59.0 dBA. ORNAMENT predicted background and Project traffic L_{eq16} approximately 3 dB higher than STNM. However when assessing the impact the project will have on the existing background sound levels, both models predicted a 0.1 dB increase in the L_{eq16}.

The noise sensitive receptors chosen for comparison in the Town of Marathon included the residence on the corner of Peninsula Road and Industrial Park Road and the second floor of the Senior's Centre. Two proposed travel routes were assessed: One route follows Peninsula Road and Marina Drive and the second follows Peninsula Road, Stevens Avenue and Winton Street. See attached Figure 6 from SID#13. The residence will be exposed to Project traffic in each of the proposed travel routes and the Senior's Centre will only be exposed by the second option.

STNM was used to predict the daytime background traffic and Project traffic Leq16 due to route one at the abovementioned residence. Using background traffic data, STNM predicted a daytime Leq16 of 56.1 dBA. Using the combination of background traffic data and Project traffic data, STNM predicted a daytime Leq16 of 57.3 dBA. Using the same traffic data, ORNAMENT predicted a background daytime Leq16 of 55.0 dBA and a Project daytime Leq16 of 57.0 dBA. ORNAMENT predicted background and Project traffic Leq16 that were within 1 dB of the results of STNM. However when assessing the impact the Project will have on the existing background sound levels, STNM predicted a 1.2 dB increase and ORNAMENT predicted a 2 dB increase. According to MOE qualitative ratings, increases sound levels ranging from 1-3 dB are insignificant and results are considered comparable.

STNM was used to predict the daytime background traffic and Project traffic Leq16 due to route two at the second floor of the Senior's Centre. Using background traffic data, STNM predicted a daytime Leq16 of 48.6 dBA. Using the combination of background traffic data and Project traffic data, STNM predicted a daytime Leq16 of 53.1 dBA. Using the same traffic data, ORNAMENT could not predict the background daytime Leq16 since the background traffic volume is less than 40 vehicles per hour. ORNAMENT predicted a Project daytime Leq16 of 55.6 dBA. ORNAMENT predicted Project traffic Leq16 that was 2.5 dB higher than the results of STNM.

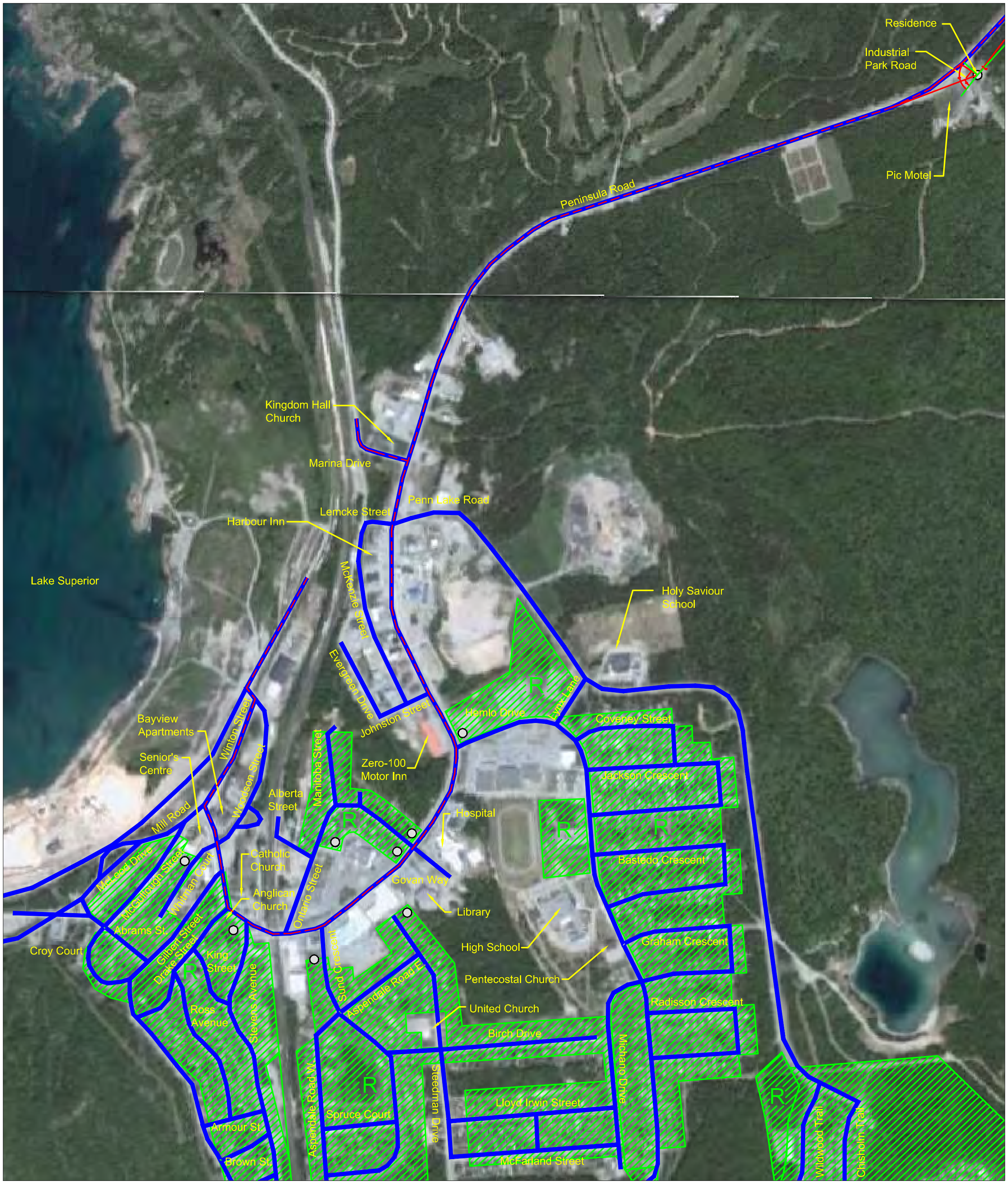
Below is a table summarizing predicted background and project impact noise at noise sensitive receptors.

Location (Noise Parameter)	Predicted Result	
	STNM	ORNAMENT
May's Gifts Traffic Background (L_{eq1})	53.4 dBA	56.4 dBA
May's Gifts Traffic Background (L_{eq16})	55.5 dBA	58.9 dBA
May's Gifts Project Traffic (L_{eq16})	55.6 dBA	59.0 dBA
Town of Marathon Residence Traffic Background	56.1 dBA	55.0 dBA
Town of Marathon Residence Project Traffic (L_{eq16})	57.3 dBA	57.0 dBA
Second Floor of Senior's Center Traffic Background	48.6 dBA	* n/a
Second Floor of Senior's Center Project Traffic	53.1 dBA	55.6 dBA
Notes: * Traffic was less than ORNAMENT's 40 vehicle per hour threshold.		

According to MOE qualitative ratings, the increased sound levels ranging from 1-3 dB are insignificant and results are considered comparable. Based on the increase from background sound levels, the results presented by STNM and ORNAMENT both suggest the second proposed rail loadout route will have a significant impact on the Senior's Centre.

As noted above, given that SCI has decided to forego the production of iron ore concentrate, the direct comparison provided above is considered quite conservative due to the inclusion of traffic associated with the transportation of iron ore concentrate into the Town of Marathon.

File No. 11-317-14A



N

Layout

m SCALE 1:20000

0 200 400

Legend

R Residential Zone

Proposed Rail Loadout Transportation Routes

Representative Residential Receptor

Stillwater Canada Inc.
Background Noise Report
Marathon, Ontario

Town of Marathon
Noise Sensitive Receptor Plan

TRUE GRIT CONSULTING LTD

Designed By: MS
Approved By: IC
Date: Oct 27, 2011

FIGURE 6

MAYSB1

STAMSON 5.0 NORMAL REPORT Date: 11-01-2013 10:31:11
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: Maysb1.te Time Period: 1 hours
Description: May's Gifts Background Daytime Lowest Hourly Leq

Road data, segment # 1:

```
Car traffic volume   :    33 veh/TimePeriod
Medium truck volume  :     3 veh/TimePeriod
Heavy truck volume   :    13 veh/TimePeriod
Posted speed limit   :    90 km/h
Road gradient        :     0 %
Road pavement        :     1 (Typical asphalt or concrete)
```

Data for Segment # 1:

```
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  45.00 m
Receiver height           :   1.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

♀
Results segment # 1:

Source height = 2.27 m

ROAD (0.00 + 56.43 + 0.00) = 56.43 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.64	65.66	0.00	-7.81	-1.42	0.00	0.00	0.00	56.43

Segment Leq : 56.43 dBA

Total Leq All Segments: 56.43 dBA

♀

TOTAL Leq FROM ALL SOURCES: 56.43
♀
♀

Highway 17 Traffic During the Worst Case Project Impact (Operations)

**NOTES: Mine traffic is limited between the hours of 7:00 am to 11:00 pm.

Peak Hours of Traffic

Site	Speed (km/h)	Relevant Roadway	Range	Stage	Vehicle Types	Hourly Traffic Volume / Lane of Traffic															
						7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM
North Side	90	Hwy 17	Peninsula Road to Coldwell	Background	Passenger Vehicles	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
				Impact	Passenger Vehicles	6												6			
				Total	**Passenger Vehicles**	**35.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**35.9**	**29.9**	**29.9**	**29.9**
				Background	Short Trucks	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
				Impact	Short Trucks																
				Total	**Short Trucks**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**
				Background	Long Trucks	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
				Impact	Long Trucks													3			
				Total	**Long Trucks**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**14**	**11**	**11**	**11**
				Background	Buses	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
				Impact	Buses																
				Total	**Buses**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
South Side	90	Hwy 17	Peninsula Road to Coldwell	Background	Passenger Vehicles	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
				Impact	Passenger Vehicles	6												6			
				Total	**Passenger Vehicles**	**35.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**29.9**	**35.9**	**29.9**	**29.9**	**29.9**
				Background	Short Trucks	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
				Impact	Short Trucks																
				Total	**Short Trucks**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**
				Background	Long Trucks	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
				Impact	Long Trucks	3															
				Total	**Long Trucks**	**14**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
				Background	Buses	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
				Impact	Buses																
				Total	**Buses**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
North Side	90	Hwy 17	Peninsula Road to Heron Bay	Background	Passenger Vehicles	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
				Impact	Passenger Vehicles	10												10			
				Total	**Passenger Vehicles**	**59.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**59.6**	**49.6**	**49.6**	**49.6**
				Background	Short Trucks	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
				Impact	Short Trucks																
				Total	**Short Trucks**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**
				Background	Long Trucks	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
				Impact	Long Trucks	3															
				Total	**Long Trucks**	**21.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**
				Background	Buses	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
				Impact	Buses																
				Total	**Buses**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**
South Side	90	Hwy 17	Peninsula Road to Heron Bay	Background	Passenger Vehicles	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
				Impact	Passenger Vehicles	10												10			
				Total	**Passenger Vehicles**	**59.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**49.6**	**59.6**	**49.6**	**49.6**	**49.6**
				Background	Short Trucks	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
				Impact	Short Trucks																
				Total	**Short Trucks**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**
				Background	Long Trucks	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
				Impact	Long Trucks													3			
				Total	**Long Trucks**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**18.2**	**21.2**	**18.2**	**18.2**	**18.2**
				Background	Buses	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
				Impact	Buses																
				Total	**Buses**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**

MAYSB16

```
STAMSON 5.0        NORMAL REPORT        Date: 11-01-2013 11:27:50
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: maysb16.te            Time Period: 16 hours
Description:May's Gifts Background 16 Hour Leq


Road data, segment # 1:
-----------------------
Car traffic volume  :   957 veh/TimePeriod
Medium truck volume :    83 veh/TimePeriod
Heavy truck volume  :   365 veh/TimePeriod
Posted speed limit  :    90 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1:
---------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  45.00 m
Receiver height            :   1.50 m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00

♀
Results segment # 1:
--------------------

Source height = 2.26 m

ROAD (0.00 + 58.88 + 0.00) = 58.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90     90   0.64  68.11   0.00  -7.81  -1.42   0.00   0.00   0.00  58.88
----------------------------------------------------------------------------

Segment Leq : 58.88 dBA

Total Leq All Segments: 58.88 dBA

♀


TOTAL Leq FROM ALL SOURCES:       58.88
♀
♀
```

MAYPRED1
STAMSON 5.0 NORMAL REPORT Date: 11-01-2013 11:38:44
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: maysp16.te Time Period: 16 hours
Description:May's Gifts Operations 16 Hour Leq

Road data, segment # 1:

Car traffic volume	:	981 veh/TimePeriod
Medium truck volume	:	83 veh/TimePeriod
Heavy truck volume	:	371 veh/TimePeriod
Posted speed limit	:	90 km/h
Road gradient	:	0 %
Road pavement	:	1 (Typical asphalt or concrete)

Data for Segment # 1:

Angle1 Angle2	:	-90.00 deg	90.00 deg
Wood depth	:	0	(No woods.)
No of house rows	:	0	
Surface	:	1	(Absorptive ground surface)
Receiver source distance	:	45.00 m	
Receiver height	:	1.50 m	
Topography	:	1	(Flat/gentle slope; no barrier)
Reference angle	:	0.00	

♀
Results segment # 1:

Source height = 2.25 m

ROAD (0.00 + 58.95 + 0.00) = 58.95 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.64	68.18	0.00	-7.81	-1.42	0.00	0.00	0.00	58.95

Segment Leq : 58.95 dBA

Total Leq All Segments: 58.95 dBA

♀

TOTAL Leq FROM ALL SOURCES: 58.95
♀
♀

Town Of Marathon Traffic During the Worst Case Project Impact (Operations - Rail Loadout 1)

**NOTES: Mine traffic is limited between the hours of 7:00 am to 11:00 pm.

Peak Hours of Traffic

Each direction of traffic has the same volume.

Site	Speed (km/h)	Relevant Roadway	Range	Stage	Vehicle Types	Hourly Traffic Volume / Lane of Traffic															
						7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM
Site 15	80	Peninsula Road	Hwy 17 to Industrial Park Road	Background	Passenger Vehicles	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5
				Impact	Passenger Vehicles	54												54			
				Total	**Passenger Vehicles**	**129.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**129.5**	**75.5**	**75.5**	**75.5**
				Background	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Impact	Short Trucks																
				Total	**Short Trucks**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**
				Background	Long Trucks	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
				Impact	Long Trucks	10	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	10	2.14	2.14	2.14
				Total	**Long Trucks**	**12.5**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**12.5**	**4.64**	**4.64**	**4.64**
				Background	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
				Impact	Buses																
				Total	**Buses**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
Site 15	60	Peninsula Road	Industrial Park Road to Marina Drive	Background	Passenger Vehicles	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5
				Impact	Passenger Vehicles	54												54			
				Total	**Passenger Vehicles**	**129.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**75.5**	**129.5**	**75.5**	**75.5**	**75.5**
				Background	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Impact	Short Trucks																
				Total	**Short Trucks**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**
				Background	Long Trucks	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
				Impact	Long Trucks	10	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	10	2.14	2.14	2.14
				Total	**Long Trucks**	**12.5**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**4.64**	**12.5**	**4.64**	**4.64**	**4.64**
				Background	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
				Impact	Buses																
				Total	**Buses**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
	40	Marina Drive	Marina Drive to Rail Loadout 1	Background	Passenger Vehicles																
				Impact	Passenger Vehicles																
				Total	**Passenger Vehicles**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
				Background	Short Trucks																
				Impact	Short Trucks																
				Total	**Short Trucks**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
				Background	Long Trucks																
				Impact	Long Trucks	10	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	10	2.14	2.14	2.14
				Total	**Long Trucks**	**10**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**2.14**	**10**	**2.14**	**2.14**	**2.14**
				Background	Buses																
				Impact	Buses																
				Total	**Buses**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

R1B16

STAMSON 5.0 NORMAL REPORT Date: 14-01-2013 16:36:04
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r1b16.te Time Period: 16 hours
Description: Background traffic 16 Hour Leq at Residence on corner of Peninsula Drive and Industrial Park Road.

Road data, segment # 1: Pen Rd (H-I)

Car traffic volume	:	2416 veh/TimePeriod
Medium truck volume	:	131 veh/TimePeriod
Heavy truck volume	:	106 veh/TimePeriod
Posted speed limit	:	80 km/h
Road gradient	:	0 %
Road pavement	:	1 (Typical asphalt or concrete)

Data for Segment # 1: Pen Rd (H-I)

Angle1 Angle2	:	-5.00 deg	85.00 deg
Wood depth	:	0	(No woods.)
No of house rows	:	0	
Surface	:	1	(Absorptive ground surface)
Receiver source distance	:	40.00 m	
Receiver height	:	1.50 m	
Topography	:	1	(Flat/gentle slope; no barrier)
Reference angle	:	0.00	

♀
Road data, segment # 2: Pen Rd (I-P)

Car traffic volume	:	2416 veh/TimePeriod
Medium truck volume	:	131 veh/TimePeriod
Heavy truck volume	:	106 veh/TimePeriod
Posted speed limit	:	60 km/h
Road gradient	:	6 %
Road pavement	:	1 (Typical asphalt or concrete)

Data for Segment # 2: Pen Rd (I-P)

Angle1 Angle2	:	-59.00 deg	-5.00 deg
Wood depth	:	0	(No woods.)
No of house rows	:	0	
Surface	:	1	(Absorptive ground surface)
Receiver source distance	:	41.00 m	
Receiver height	:	1.50 m	
Topography	:	1	(Flat/gentle slope; no barrier)
Reference angle	:	0.00	

♀
Results segment # 1: Pen Rd (H-I)

Source height = 1.41 m

ROAD (0.00 + 53.30 + 0.00) = 53.30 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-5	85	0.66	64.55	0.00	-7.07	-4.18	0.00	0.00	0.00	53.30

Segment Leq : 53.30 dBA

♀

Results segment # 2: Pen Rd (I-P)

Source height = 1.41 m

ROAD (0.00 + 50.00 + 0.00) = 50.00 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-59	-5	0.66	63.07	0.00	-7.25	-5.82	0.00	0.00	0.00	50.00

Segment Leq : 50.00 dBA

Total Leq All Segments: 54.97 dBA

♀

TOTAL Leq FROM ALL SOURCES: 54.97

♀

♀

R1P16
STAMSON 5.0 NORMAL REPORT Date: 14-01-2013 16:42:26
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r1p16.te Time Period: 16 hours
Description: Rail Loadout Route (Common to Option 1 & 2) Predicted 16 Hour Leq at Residence on the corner of Peninsula Drive and Industrial Park Road.

Road data, segment # 1: Pen Rd (H-I)

```
Car traffic volume   :  2632 veh/TimePeriod
Medium truck volume  :   180 veh/TimePeriod
Heavy truck volume   :   206 veh/TimePeriod
Posted speed limit   :    80 km/h
Road gradient        :     0 %
Road pavement        :     1 (Typical asphalt or concrete)
```

Data for Segment # 1: Pen Rd (H-I)

```
Angle1   Angle2             :  -5.00 deg   85.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0
Surface                     :      1       (Absorptive ground surface)
Receiver source distance    :  40.00 m
Receiver height             :   1.50 m
Topography                  :      1       (Flat/gentle slope; no barrier)
Reference angle             :   0.00
```

♀
Road data, segment # 2: Pen Rd (I-P)

```
Car traffic volume   :  2632 veh/TimePeriod
Medium truck volume  :   180 veh/TimePeriod
Heavy truck volume   :   206 veh/TimePeriod
Posted speed limit   :    60 km/h
Road gradient        :     6 %
Road pavement        :     1 (Typical asphalt or concrete)
```

Data for Segment # 2: Pen Rd (I-P)

```
Angle1   Angle2             : -59.00 deg   -5.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0
Surface                     :      1       (Absorptive ground surface)
Receiver source distance    :  41.00 m
Receiver height             :   1.50 m
Topography                  :      1       (Flat/gentle slope; no barrier)
Reference angle             :   0.00
```

♀
Results segment # 1: Pen Rd (H-I)

Source height = 1.62 m

ROAD (0.00 + 55.22 + 0.00) = 55.22 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-5	85	0.66	66.45	0.00	-7.06	-4.18	0.00	0.00	0.00	55.22

Segment Leq : 55.22 dBA

♀
Results segment # 2: Pen Rd (I-P)

Source height = 1.62 m

ROAD (0.00 + 52.28 + 0.00) = 52.28 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-59	-5	0.66	65.34	0.00	-7.23	-5.82	0.00	0.00	0.00	52.28

Segment Leq : 52.28 dBA

Total Leq All Segments: 57.00 dBA

♀

TOTAL Leq FROM ALL SOURCES: 57.00
♀
♀

Town Of Marathon Traffic During the Worst Case Project Impact (Operations - Rail Loadout 2)

**NOTES: Mine traffic is limited between the hours of 7:00 am to 11:00 pm.

Peak Hours of Traffic

Each direction of traffic has the same volume.

Site	Speed (km/h)	Relevant Roadway	Range	Stage	Vehicle Types	Hourly Traffic Volume / Lane of Traffic															
						7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM
Site 15	80	Peninsula Road	Hwy 17 to Industrial Park Road	Background	Passenger Vehicles	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5
				Impact	Passenger Vehicles	54.0												54.0			
				Total	Passenger Vehicles	129.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	129.5	75.5	75.5	75.5
				Background	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Impact	Short Trucks																
				Total	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Background	Long Trucks	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	12.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	12.5	4.6	4.6	4.6
				Background	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
				Impact	Buses																
				Total	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Site 15	60	Peninsula Road	Industrial Park Road to Penn Lake Road	Background	Passenger Vehicles	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5
				Impact	Passenger Vehicles	54.0												54.0			
				Total	Passenger Vehicles	129.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	129.5	75.5	75.5	75.5
				Background	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Impact	Short Trucks																
				Total	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Background	Long Trucks	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	12.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	12.5	4.6	4.6	4.6
				Background	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
				Impact	Buses																
				Total	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Site 15	50	Peninsula Road	Penn Lake Road to Hemlo Drive	Background	Passenger Vehicles	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5
				Impact	Passenger Vehicles	54.0												54.0			
				Total	Passenger Vehicles	129.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	129.5	75.5	75.5	75.5
				Background	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Impact	Short Trucks																
				Total	Short Trucks	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
				Background	Long Trucks	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	12.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	12.5	4.6	4.6	4.6
				Background	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
				Impact	Buses																
				Total	Buses	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Site 12	40	Peninsula Road	Hemlo Drive to Sund Crescent	Background	Passenger Vehicles	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3
				Impact	Passenger Vehicles	54.0												54.0			
				Total	Passenger Vehicles	304.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	250.3	304.3	250.3	250.3	250.3
				Background	Short Trucks	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
				Impact	Short Trucks																
				Total	Short Trucks	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
				Background	Long Trucks	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	18.3	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	18.3	10.4	10.4	10.4
				Background	Buses	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
				Impact	Buses																
				Total	Buses	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Site 17	40	Peninsula Road	Sund Crescent to Steven's Avenue	Background	Passenger Vehicles	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5
				Impact	Passenger Vehicles	54.0												54.0			
				Total	Passenger Vehicles	275.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	221.5	275.5	221.5	221.5	221.5
				Background	Short Trucks	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
				Impact	Short Trucks																
				Total	Short Trucks	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
				Background	Long Trucks	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	17.3	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	17.3	9.4	9.4	9.4
				Background	Buses	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
				Impact	Buses																
				Total	Buses	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Site 26	50	Steven's Avenue	Steven's Avenue to Rail Load Out 2	Background	Passenger Vehicles	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
				Impact	Passenger Vehicles																
				Total	Passenger Vehicles	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
				Background	Short Trucks	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
				Impact	Short Trucks																
				Total	Short Trucks	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
				Background	Long Trucks	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
				Impact	Long Trucks	10.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	10.0	2.1	2.1	2.1
				Total	Long Trucks	10.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	10.6	2.7	2.7	2.7
				Background	Buses	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
				Impact	Buses																
				Total	Buses	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

STAMSON 5.0 NORMAL REPORT Date: 15-01-2013 08:51:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r2p16s2.te Time Period: 16 hours
Description:Rail Loadout Route 2 Predicted 16 Hour Leq at the second floor of the Senior's Centre in the Town of Marathon.

Road data, segment # 1: Stevens Ave.

```
Car traffic volume    :   561 veh/TimePeriod
Medium truck volume   :    31 veh/TimePeriod
Heavy truck volume    :   125 veh/TimePeriod
Posted speed limit    :    50 km/h
Road gradient         :     0 %
Road pavement         :     1 (Typical asphalt or concrete)
```

Data for Segment # 1: Stevens Ave.

```
Angle1   Angle2            : -49.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  20.00 m
Receiver height            :   4.50 m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

♀
Results segment # 1: Stevens Ave.

Source height = 2.04 m

ROAD (0.00 + 55.55 + 0.00) = 55.55 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-49	90	0.55	59.52	0.00	-1.94	-2.03	0.00	0.00	0.00	55.55

Segment Leq : 55.55 dBA

Total Leq All Segments: 55.55 dBA

♀

TOTAL Leq FROM ALL SOURCES: 55.55
♀
♀