EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Blast Impact Analysis
Severn Aggregates Cumberland Quarry
West Half Lots 12, 13, and 14 Concession 11,
Geographic Township of Orillia,
North Division Township of Severn,
County of Simcoe, Ontario.

Submitted to:

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EXECUTIVE SUMMARY

Explotech Engineering Ltd. was retained in August 2012 to provide a blast impact analysis for the proposed Cumberland Quarry for the Severn Aggregates Ltd. operation on West Half Lots 12, 13, and 14 Concession 11, Geographic Township of Orillia, North Division Township of Severn, County of Simcoe.

Vibration levels assessed in this report are based on the Ministry of the Environment, Conservation, and Parks Model Municipal Noise Control By-law (NPC119) with regard to Guidelines for Blasting in Mines and Quarries. We have assessed the area surrounding the proposed Aggregate Resources Act licence with regard to potential damage from blasting operations and compliance with the aforementioned by-law document.

We have inspected the site and reviewed the available site plans. Explotech Engineering Ltd. is of the opinion that the planned aggregate extraction on the proposed property can be carried out safely and within Ministry of the Environment, Conservation, and Parks guidelines as set out in NPC 119 of the By-Law.

Recommendations are included in this report to ensure that blasting operations in all phases of this project are carried out in a safe and productive manner and to suitably manage and mitigate the possibility of damage to any buildings, structures or residences surrounding the property.

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INTRODUCTION

Severn Aggregates Ltd. is applying for a Class A License for the property legally described as West Half Lots 12, 13, and 14, Concession 11, Geographic Township of Orillia, North Division Township of Severn, County of Simcoe. The proposed name for this operation is the Cumberland Quarry. This Blast Impact Analysis assesses the ability of the proposed licence to operate within the prescribed blast guideline limits as required by the Ontario Ministry of the Environment, Conservation and Parks (MECP).

This Blast Impact Analysis has been prepared based on the Ministry of the Environment, Conservation and Parks (MECP) Model Municipal Noise Control By-law with regard to Guidelines for Blasting in Mines and Quarries (NPC 119). We have additionally assessed the area surrounding the proposed licence with regard to potential damage from blasting operations.

Given that quarrying and blasting 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 at a variety of quarries across Ontario which present similar 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 monitoring program be initiated on-site upon the commencement of blasting operations and maintained for the duration of all blasting activities to permit timely adjustment to blast parameters as required. We note that blast monitoring is a prescribed condition to any licence issued for the proposed quarry under the Aggregate Resources Act.

While not specifically required as part of the scope of the Blast Impact Analysis under the Aggregate Resources Act, this report also touches on the topics of an adjacent TransCanada pipeline, flyrock, residential water wells, and fish habitat for general informational purposes only. Specific flyrock control is addressed at the operational level given significant influences related to blast design, geology, and field accuracy, while exhaustive details related to residential water wells and fish habitat are addressed in the hydrogeological report and natural environment report, respectively.

Recommendations are included in this report to advocate for a safe and productive blasting operation and to suitable manage and mitigate the possibility of damage to any buildings, structures or residences surrounding the property.

EXISTING CONDITIONS

The licence area for the proposed Cumberland Quarry encompasses a total area of approximately 138.0HA with a net extraction area of 118.5HA. The proposed Cumberland Quarry operation is described as West Half Lots 12, 13, and 14, Concession 11, Geographic Township of Orillia, North Division Township of Severn, County of Simcoe. There are existing quarry operations along the Eastern and Western boundaries of the proposed Cumberland Quarry. Lands to the North are rural in nature and owned by the County of Simcoe. Lands South of the Site contain a portion of the Grass Lake Wetland which is a Provincially Significant Wetland, rural vacant land, and a TransCanada pipeline right-of-way. The closest sensitive receptor over the life of the proposed operation lies approximately 155m to the East of the proposed operation at 2670 South Sparrow Lake Road.

The closest sensitive receptors surrounding the proposed Cumberland Quarry extraction boundaries are listed in Table 1 below as well as in the Sensitive Receptor Overview contained in Appendix A:

Sensitive Receptor Address	Approximate Distance to Receptor (m)	Direction from Extraction Limits
2462 South Sparrow Lake Road	555	NE
2670 South Sparrow Lake Road	155	E
2819 South Sparrow Lake Road	990	E
2514 Cambrian Road	1360	SW
2871 Cambrian Road	835	SE

Table 1: Closest Sensitive Receptors to Proposed Cumberland Quarry

PROPOSED AGGREGATE EXTRACTION

The extraction will proceed in four phases defined as Phase 1, Phase 2, Phase 3, and Phase 4. Phases 1, 3, and 4 are split into sub-phases (Refer to Appendix A - Operational Plan).

The deepest final design quarry floor elevation has been established at 216masl. Given maximum existing topographic elevations of approximately 243masl, this will lead to the execution of 1 to 2 benches. Extraction in multiple benches and multiple phases may be undertaken concurrently.

Extraction operations will be initiated in the Southwest corner of Phase 1A. The sinking cut will be located approximately 860m from the closest sensitive receptor, namely 2781 Cambrian Road. Phase 1A will be extracted in a general Northern direction to permit extraction in subsequent Phases to a final floor elevation of approximately 224masl. The free face created will allow for extraction of Phase 1B, retreating in a project North direction to a final floor elevation of approximately 216masl.

Extraction of Phase 2 may occur concurrently with Phase 1B, retreating in a generally project North direction. Aggregate in Phase 2 will be extracted to a final floor elevation of 216masl.

Extraction of the Southern portion of Phase 3A will commence following the completion of aggregate extraction of the Western portion of Phase 2. Extraction of Phase 3A will retreat in a project North direction and aggregate will be extracted to a final floor elevation of approximately 216masl.

Completion of aggregate extraction from Phase 3A creates a free face allowing for Phase 3B to be extracted in a project North direction to a final floor elevation of approximately 216.5masl.

Phase 4A will commence utilizing the free face created from the Northern portion of Phase 2. Phase 4A will be excavated to an approximate final floor elevation of 216masl.

Phase 4B will commence utilizing the free face created from Phase 4A, and will retreat in a project North direction with a final floor elevation of approximately 216masl.

Phase 4C will commence utilizing the free face created from Phase 4B, and will retreat in a project North direction with a final floor elevation of approximately 216masl.

Phase 4D will commence utilizing the free face created from Phase 4C, and will retreat in a project North direction with a final floor elevation of approximately 216masl.

Limestone Quarries in Ontario normally employ 76 to 152mm diameter blast holes which, for a maximum 16m bench, would employ approximately 75kg to 300kg of explosive load per hole. The choice of hole diameter and bench height will govern the maximum number of holes to be fired per period. As extraction progresses, it will be possible to vary operational aspects of the drilling and blasting program in response to monitoring program results and observed outcomes in order to maintain compliance.

It is a recommendation of this report that all blasts shall be monitored for both ground vibration and overpressure at the closest privately owned sensitive receptors adjacent the site, or closer, with a minimum of two (2) digital seismographs – one installed in front of the blast and one installed behind the blast. Monitoring shall be performed by an independent third-party engineering firm with specialization in blasting and monitoring.

BLAST VIBRATION AND OVERPRESSURE LIMITS

The Ontario MECP guidelines for blasting in quarries are among the most stringent in North America.

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 range permitted by the MECP. The limits suggested by the MECP are as follows:

Vibration___________12.5mm/sec Peak Particle Velocity (PPV)

Overpressure_______128 dB Peak Sound Pressure Level (PSPL)

The above guidelines apply when blasts are being monitored. It is a recommendation of this report that all blasts at the operation be monitored to quantify and record ground vibration and overpressure levels employing a minimum of two (2) digital seismographs, one installed at the closest receptor behind the blast, or closer, and one installed at the closest receptor in front of the blast, or closer.

BLAST MECHANICS AND DERIVATIVES

The detonation of explosives within a borehole results in the development of very high gas and shock pressures. This energy is transmitted to the surrounding rock mass, 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 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.

Particle velocity is the descriptor of choice when dealing with vibrations because of its superior correlation with the appearance of cosmetic cracking. As such, for the purposes of this report, ground vibration units have been listed in mm/s.

In addition to the ground vibrations, overpressure, or air vibrations are generated through the direct action of the explosive venting through cracks in the rock or through the indirect action of the rock movement. In either case, the result is a pressure wave which travels through the air, measured in decibels (or dB(L)) for the purposes of this report.

VIBRATION AND OVERPRESSURE THEORY

Transmission and decay of vibrations and overpressure can be estimated by 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 prediction equations are reliable, divergence of data occurs as a result of a wide variety of variables, most notably site-specific geological conditions and blast geometry and design for ground vibrations and local prevailing climatic conditions for overpressure.

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, usually by the application of 95% confidence lines to attenuation data.

The attenuation relations are not designed to conclusively predict vibration 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.

While the data still provides insight into probable vibration intensities, attenuation relations for overpressure tends to be less reliable and precise than results for ground vibrations. This is due primarily to wider variations in variables outside of the influence of the blast design which impact propagation of the vibrations. Atmospheric factors such as temperature gradients and prevailing winds (refer to Appendix B) as well as local topography can all serve to significantly alter overpressure attenuation characteristics.

Our experience and analysis demonstrate that blast overpressure is greatest when blasting toward receptors, and blast vibrations are greatest when retreating towards the receptor.

VIBRATION LEVELS AT THE NEAREST SENSITIVE RECEPTOR

The most commonly used formula for predicting PPV is known as the Bureau of Mines (BOM) prediction formula or Propagation Law. We have used this formula to predict the PPV's at the closest house for the initial operations.

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

Where, PPV = the predicted peak particle velocity (mm/s)

K, e = site factors

d = distance from receptor (m)

w = maximum explosive charge per delay (kg)

The value of K and e are variable and is 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 interested.

The portion of the BOM prediction formula 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, square root scaling was adopted for ground vibration analysis for the purposes of this report.

For a distance of 860m (the standoff distance to the closest sensitive receptor for the initial blasting, specifically 2781 Cambrian Road) and a maximum explosive load of 167kg (114mm diameter hole, 16m deep, 2.4m surface collar, and one hole per delay), we can calculate the maximum PPV at the nearest structure using the following formulae:

Imperial Equations:

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

Metric Equations:

General Blasting (Dupont)	$v = 1140(\frac{D}{\sqrt{W}})^{-1.6}$
Construction Blasting (Dowding 1998)	$v = 1326(\frac{D}{\sqrt{W}})^{-1.38}$
Agg. Quarry Blasting (Explotech 2005)	$v = 5175(\frac{D}{\sqrt{W}})^{-1.76}$
Agg. Quarry blasting (Explotech 2003)	$v = 7025(\frac{D}{\sqrt{W}})^{-1.85}$

The equations described above accommodate for a range of geological conditions. The proposed parameters were applied to the formulae to estimate a range of the potential vibrations to be imparted on the closest sensitive receptor behind the blast. As discussed in previous sections, the MECP guideline for blast-induced vibration is 12.5 mm/s (0.5 in/s). Appendix C demonstrates that the maximum calculated value for the vibration intensities imparted on the closest sensitive receptor based on all equations is 5.2mm/s for the initial blasting, below the MECP guideline limit. All blasts will be monitored for overpressure and ground vibrations with blast designs adjusted in response to readings on site in order to ensure consistent compliance with established limits.

Utilizing the formula providing the worst-case scenario for all geological conditions (Oriard 99% Bound), the table below states the maximum explosive loading based on MECP guideline limits. The following table will form a guideline for blasting operations until a site-specific equation is developed.

Separation distance between sensitive receptor and closest borehole (meters)	**Maximum recommended explosive load per delay (Kilograms)**
1000	670
900	543
800	429
700	328
600	241
500	167
400	107
300	60
200	26
100	6.7

Table 2: Maximum Loads per Delay to Maintain 12.5mm/s at Various Separation Distances

As the separation distance between the blast and closest receptor decreases, it will be necessary to adjust blast parameters to ensure continued compliance with the guideline limit. Fortunately, a variety of blast design alternatives are available to accomplish this including but not limited to reductions in blast hole diameter, change in explosives types, adjustment in bench heights and decking of holes. Given the planned phasing of the operation, vibration data will be continually collected and analyzed as the adjacent receptors are approached in order to confirm the requirement for any design modifications.

OVERPRESSURE LEVELS AT THE NEAREST SENSITIVE RECEPTOR

It is unusual for overpressure to reach damaging levels, and when it does, the evidence is immediate and obvious in the form of broken windows in the area. 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.

Air overpressure levels are analyzed using cube root scaling based on the following equation:

$$P = k\left(\frac{d}{\sqrt[3]{w}}\right)^{e}$$

Where, P = the peak overpressure level (psi – imperial, Pa, dB - metric)
K, e = site factors
d = distance from receptor (ft – imperial, m - metric)
w = maximum explosive charge per delay (lbs. – imperial, kg - metric)

The value of K and e are variable and are 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 overpressure characteristics at the specific operations of interested.

As discussed in previous sections, the MECP guideline for blast-induced overpressure is 128dB(L). For a distance of 860m (i.e. the standoff distance to the closest existing structure for the initial blasting, specifically 2781 Cambrian Road) and a maximum explosive weight of 167kg (114mm diameter hole, 16m deep, 2.4m collar, and one hole per delay), we can calculate the overpressure at the nearest receptor in front of the blast using the following equations:

Imperial Equations:

USBM RI8485 (Behind Blast)	$P = 0.056(\frac{D}{\sqrt[3]{W}})^{-0.515}$
USBM RI8485 (Front of Blast)	$P = 1.317(\frac{D}{\sqrt[3]{W}})^{-0.966}$
USBM RI8485 (Full Confined)	$P = 0.061(\frac{D}{\sqrt[3]{W}})^{-0.96}$
Construction Average (Oriard 2005)	$P = 1(\frac{D}{\sqrt[3]{W}})^{-1.1}$

Metric Equations:

Ontario Quarry - dB (Explotech)	$P = 159(\frac{D}{\sqrt[3]{W}})^{-0.0456}$
Limestone - dB (Explotech)	$P = 206(\frac{D}{\sqrt[3]{W}})^{-0.1}$
Ontario Quarry - Pa (Explotech)	$P = 1222(\frac{D}{\sqrt[3]{W}})^{-0.669}$

Appendix C demonstrates that the maximum calculated value for the overpressure intensities imparted on the closest sensitive receptor based on all equations is 126.4 dB(L) for the initial blasting, below the MECP guideline limit.

Utilizing the formula providing the worst-case scenario for all geological conditions (Ontario Quarry– Pa (Explotech)), Table 3 below can be used as an initial guide showing maximum loads per delay based on various separation distances for receptors in front of the blast face. The following maximum loads per delay are derived from the air overpressure equation above and are based on a peak overpressure level of 128dB(L):

Separation distance between sensitive receptor and closest blasthole (meters)	Maximum recommended explosive load per delay (kilograms)
1000	610
900	445
800	312
700	209
600	131
500	76
400	39
300	16
200	4.8
100	0.6

Table 3: Maximum Loads per Delay to Maintain 128dB(L) at Various Separation Distances for Receptors in Front of the Face

We note that the above values are typically conservative and are intended as a guideline only as the air overpressure attenuation equation is based on a calculated 95% regression line. Actual loads employed shall be based on the results of the monitoring program in place.

It is a recommendation of this report that all blasts be monitored for overpressure and ground vibrations with blast designs adjusted in response to readings on site in order to ensure consistent compliance with established limits.

We reiterate that air overpressure attenuation is far more variable due to its intimate relationship with environmental influences and as such, the equation employed is less reliable than that developed for ground vibration. Overpressure monitoring performed on site shall be used to guide blast design as it pertains to the control of blast overpressures.

ADDITIONAL CONSIDERATIONS OUTSIDE OF THE BLAST IMPACT ANALYSIS SCOPE

The following headings are addressed for general information purposes and are not strictly required as part of the scope of the Blast Impact Analysis as required under the ARA to ensure compliance with MECP NPC 119 guidelines. Considerations for the TransCanada Pipeline Right-of-Way can be expanded upon under separate cover with direct input from the facility owner as required. Flyrock control is addressed at the operational level given significant influences related to blast design, geology and field accuracy which render concrete recommendations related to control inappropriate at the licencing phase. The hydrogeological study prepared as part of the licence application will address residential water wells in detail. Considerations for aquatic species in the adjacent watercourses are further addressed in the Natural Environment report.

TRANSCANADA PIPELINE

An existing TransCanada pipeline right-of-way lies adjacent to the South portion of the property (Refer to Appendix A). All required blasting shall remain a minimum of 550m Northwest of the edge of the pipeline right-of-way.

As per TransCanada Pipeline specifications, a vibration limit of 50mm/s Peak Particle Velocity (PPV) as measured within 2m (6ft) of the closest pipeline facility. While research conducted in recent years has demonstrated this limit to be extremely conservative, and pipelines have been subjected to vibrations in excess of an order of magnitude above this limit with no resultant damage, there has been little appeal to revising this traditional threshold. It is a recommendation of this report that vibration levels at the pipeline be maintained below the 50mm/s PPV limit.

The initial blasting on site will take place approximately 675m removed from the pipeline and largely retreats away from the pipeline for the life of the quarry. Based on equations and parameters presented earlier in this report, (Oriard 99% Bound (2002)), vibrations as measured at the pipeline would be expected to reside at or below the following levels for the initial blasting:

$$ppv = 605\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$$

Where:

$$D = 675m = 2214.57ft \text{ and } W = 167kg = 368.172lb$$

$$ppv = 605\left(\frac{2214.57}{\sqrt{368.172}}\right)^{-1.6} = 0.3035in/s \ = 7.71mm/s$$

This calculated value is well below the current TransCanada vibration limit of 50mm/s PPV. Given a continual retreat away from the pipeline over the life of the quarry, there will be no negative impact on the pipeline from the blasting activities on site provided loads per delay do not significantly increase. In the event that increased loads are proposed, calculations shall be undertaken to confirm vibration intensities imparted on the pipeline are below TransCanada limits.

FLYROCK

Flyrock is the term used to define rocks which are propelled from the blast area by the force of the explosion. This action is a predictable and necessary component of a blast and requires that every blast have an exclusion zone established within which no persons or property which may be harmed are permitted.

Government regulations strictly prohibit the ejection of flyrock off of a quarry property. The regulations regarding flyrock are enforced by the Ministries of Natural Resources and Forestry, Environment, Conservation and Parks and Labour. In the event of an incident where flyrock does leave a site, the punitive measures include suspension / revocation of licences and fines to both the blaster and quarry owner / operator. Fortunately, flyrock incidents are extremely rare due to the possible serious consequences of such an event. It is in the best interest of all, stakeholders and non-stakeholders, to ensure that dangerous flyrock does not occur. Through proper blast planning and design, it is possible to control and mitigate the possibility for flyrock.

THEORETICAL HORIZONTAL FLYROCK CALCULATIONS

Flyrock occurs when explosives in a hole are poorly confined by the stemming or rock mass and the high-pressure gas breaks out of confinement and launches rock fragments into the air. The three primary sources of fly rock are as follows:

- **Face burst:** Lack of confinement by the rock mass in front of the blast hole results in fly rock in front of the face.

- **Cratering:** Insufficient stemming height or weakened collar rock results in a crater being formed around the hole collar with rock projected in any direction.

- **Stemming Ejection:** Poor stemming practice can result in a high angle throw of the stemming material and loose rocks in the blasthole wall and collar.

The horizontal distance flyrock can be thrown (L_H) from a blast hole is determined using the expression:

$$L_H = \frac{V_o^2 \sin 2\theta_0}{g} \qquad [1]$$

where: V_o = launch velocity (m/s)
θ_0 = launch angle (degrees)
g = gravitational constant (9.8 m/s^2)

The theoretical maximum horizontal distance fly rock will travel occurs when θ_0 = 45 degrees, thereby yielding the equation:

$$L_H = \frac{V_o^2}{g} \qquad [2]$$

The normal range of launch velocity for blasting is between 10m/s - 30m/s. To calculate the launch velocity of a blast the following formula is used:

$$V_o = k\left(\frac{\sqrt{m}}{B}\right)^{1.3} \qquad [3]$$

where: k = a constant
m = charge mass per meter (kg/m)
B = burden (m)

By combining equations 2 and 3 and taking into account the different sources of fly rock, the following equations can be used to calculate the maximum fly rock thrown from a blast:

Face burst:
$$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{B}\right)^{2.6}$$

Cratering:
$$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH}\right)^{2.6}$$

Stemming Ejection:
$$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH}\right)^{2.6} \sin 2\theta$$

where:

θ = drill hole angle
L_{hmax} = maximum flyrock throw (m)
m = charge mass per meter (kg/m)
B = burden (m)
SH = stemming height (m)
g = gravitational constant
k = a constant

For calculation purposes, we have applied the blasting parameters used in the theoretical calculation of ground vibrations and air overpressure, utilizing 114mm (4 1/2”) diameter holes on a 4.0m x 4.0m (13’x 13’) pattern, with total depths of up to 16m (52.5’) and a collar length of 1.8m (6’) to 3.0m (10’).

The range for the constant k is 13.5 for soft rocks and 27 for hard rocks. Given the proposed licence area is predominantly limestone, we have applied a k value of 27. The explosive density is assigned to be 1.2 g/cc for emulsion products and the drill hole angles are assumed to be 90 degrees (i.e., vertical).

Based on a free face blast, maximum anticipated horizontal flyrock projection distances are calculated as follows in Table 4:

Collar Length (m)	**Maximum Throw Face Burst** (m)	**Maximum Throw Cratering and Stemming Ejection** (m)
1.8	54	422
2.1	54	282
2.4	54	200
2.7	54	147
3	54	112

Table 4: Maximum Flyrock Horizontal Distances

Different collar lengths are displayed in the table above to account for over or under loaded holes. As demonstrated with these various collar lengths, any deviation, no matter how slight, can greatly affect these maximum values.

Through proper blast design and diligence in inspecting the geology before every blast, flyrock can readily be maintained within the quarry limits. It may be necessary to increase collars and adjust designs accordingly when blasting along the perimeter to accommodate the reduced distance to receptors and to ensure flyrock remains within the property limit.

RESIDENTIAL WATER WELLS

Possible impacts to the water quality and production capacity of groundwater supply wells are common concerns for residents near blasting operations. Complaints related to changes in water quality often include the appearance of turbidity, water discolouration and changes in water characteristics (including nitrate, e-coli, and coliform contamination). Complaints regarding water production most often involve loss of quantity production, air in water and damage to well screens and casings. A review of research and common causes of these problems indicates that most of these concerns are not related to blasting and can be shown to be the direct impact of environmental factors and poor well construction and maintenance.

There is an intuitive belief that blasting operations have dramatic and disastrous impacts on residential water wells for large distances around such operations. However, there is no scientific basis for such claims. Outside of the immediate radius of approximately 20-25 blasthole diameters from a loaded hole, there is no permanent ground displacement. As such, barring blasting activity within several meters of an existing well, the probability of damage to residential wells is essentially non-existent.

Despite the scientific support for the above conclusion, numerous studies have been performed to verify the validity of this statement. These studies have investigated the effects of blasting on varied well configurations and in varied geological mediums to ensure results could be readily extrapolated to all blasting operations. The conclusion of these studies has confirmed that with the exception of possible temporary increases in turbidity, blasting operations did not result in any permanent impact on wells outside of the immediate blast zone of the blast until vibrations levels reached exceedingly high intensities, far beyond the limits permitted for quarries. Applying universally accepted threshold levels for ground vibrations eliminates the possibility for any long-term adverse effects on wells in the vicinity of blasting operations.

In a study by Froedge (1983), blast vibration levels of up to 32.3mm/s were recorded at the bottom of a shallow well located at a distance of 60 meters (200 feet) from an open pit blast. There was no report of visible damage to the well nor was there any change in the water pumping flow rate. This study concluded that the commonly accepted limit of 50mm/s PPV level is adequate to protect wells from any damage. We reiterate, the current guideline limit for vibrations from quarry and mining operations is 12.5mm/s.

BLAST IMPACT ON ADACENT WATERCOURSES/FISH HABITATS

The detonation of explosives in or near water can produce compressive shock waves which initiate damage to the internal organs of fish in close proximity, ultimately resulting in the death of the organism. Additionally, ground vibrations imparted on active spawning beds have the ability to adversely impact the incubating eggs and spawning activity. In an effort to alleviate adverse impacts on fish populations as a result of blasting, the Department of Fisheries and Oceans (DFO) developed the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (1998). This publication establishes limits for water overpressure and ground vibrations which are intended to mitigate impacts on aquatic organisms while providing sufficient flexibility for blasting to proceed. Specifically, water overpressures are to be limited to 100kPa and, in the presence of active spawning beds, ground vibrations at the bed are to be limited to 13mm/s.

Table 5 below is presented as initial guidance showing maximum permissible loads per delay based on various separation distances from spawning beds. The following maximum loads per delay are derived from the equation for ground vibrations listed earlier in this report and are based on a maximum vibration intensity of 13.0mm/s as experienced at the active spawning habitat:

Separation distance between possible spawning bed and closest borehole (meters)	Maximum recommended explosive load per delay (Kilograms)
500	176
450	142
400	112
350	86
300	63
250	44
200	28
150	15
100	7

Table 5: Maximum Loads per Delay to Maintain 13.0mm/s at Various Separation Distances

The generation of suspended solids within the watercourse as a result of the blasting activities will be negligible and grossly subordinate to suspended solids generated as a result of spring runoff and rain activity.

RECOMMENDATIONS

It is recommended that the following conditions be applied for all blasting operations at the proposed Cumberland Quarry:

1. An attenuation study shall be undertaken by an independent blasting consultant during the first 12 months of operation in order to obtain sufficient quarry data for the development of site-specific attenuation relations. This study shall be used to confirm the applicability of the initial guideline parameters and assist in developing future blast designs.

2. Blasts shall be designed and loaded adhering to Table 2: Maximum Explosive Load at Set Offset Distances – 12.5 mm/sec as well as Table 3: Maximum Explosive Load at Set Offset Distances to Receptors in Front of the Blast – 128 dB(L) until the attenuation study is completed. Upon completion of the attenuation study, a site-specific attenuation relation shall be developed and shall be utilized to develop a new load chart to be utilized going forward.

3. All blasts shall be monitored for both ground vibration and overpressure at the closest privately owned sensitive receptors adjacent the site, or closer, with a minimum of two (2) digital seismographs – one installed in front of the blast and one installed behind the blast. Monitoring shall be performed by an independent third-party engineering firm with specialization in blasting and monitoring.

4. The guideline limits for vibration and overpressure shall adhere to standards as outlined in the MECP Model Municipal Noise Control By-law publication NPC 119 (1978) or any such document, regulation or guideline which supersedes this standard.

5. In the event of an exceedance of NPC 119 limits or any such document, regulation or guideline which supersedes this standard, blast designs and protocols shall be reviewed prior to any subsequent blasts and revised accordingly in order to return the operations to compliant levels.

6. Orientation of the aggregate extraction operation shall be designed and maintained so that the direction of the overpressure propagation and flyrock from the face shall be away from structures as much as possible.

7. Blast designs shall be continually reviewed with respect to fragmentation, ground vibration and overpressure. Blast designs shall be modified as required to ensure compliance with applicable guidelines and regulations.

Decking, reduced hole diameters and sequential blasting techniques shall be used to ensure minimal explosives per delay period initiated.

8. Blasting procedures such as drilling and loading shall be reviewed on a yearly basis and modified as required to ensure compliance with industry standards.

9. Detailed blast records shall be maintained in accordance with current industry best practices

10. The guideline for flyrock shall adhere to the standard as outlined in the Aggregate Resources Act O. Reg 244/97, specifically “A licensee or permittee shall take all reasonable measures to prevent flyrock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site” or any such document, regulation or guideline which supersedes this standard.

The blast parameters described within this report are supported by the modeling in the attached appendices. As the quarry progresses and as site-specific data is collected from the on-going operation, the blast parameters can be refined, as necessary, to ensure continual compliance with MECP Guidelines.

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.

Blasting operations required for operations at the proposed Cumberland Quarry site can be carried out safely and well within governing guidelines set by the Ministry of the Environment, Conservation and Parks.

Modern blasting techniques will permit blasting to take place with explosives charges below allowable charge weights ensuring that blast vibrations and overpressure will remain minimal at the nearest receptors and compliant with applicable guideline limits.

Appendix A

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OPERATIONAL NOTES:

PROPOSED REHABILITATION

1. EXTRACTION AND REHABILITATION OF THE QUARRY WILL RETURN THE SITE TO PRODUCTIVE AGRICULTURE WITH ECOLOGICAL ENHANCEMENTS COMPATIBLE WITH THE SURROUNDING LANDS SUCH AS OPEN FIELD MEADOWS WETLAND AND FOREST CORRIDORS.

MAXIMUM AREA TO BE EXTRACTED

2. THE MAXIMUM AREA TO BE EXTRACTED WILL BE 118.5 HA. THE AREA TO BE LICENSED WILL BE 138 HA.

MAXIMUM TONNAGE LIMIT

3. THE AMOUNT OF AGGREGATE TO BE REMOVED FROM THE SITE WILL NOT EXCEED 500,000 TONNES IN ANY CALENDAR YEAR.

HOURS OF OPERATION

4. LOADING AND SHIPPING - 6:00 AM TO 6:00 PM MONDAY TO FRIDAY. 6:00 AM TO 12:00 PM ON SATURDAYS. AFTER HOURS LOADING AND SHIPPING MAY OCCUR AT THE REQUEST OF THE PROVINCE OF ONTARIO.

5. PROCESSING - CRUSHING, SCREENING AND WASHING - 7:00 AM TO 6:00 PM MONDAY TO FRIDAY. 7:00 AM TO 12:00 PM ON SATURDAYS.

6. BLASTING - 8:00 AM TO 6:00 PM MONDAY TO FRIDAY.

7. CONSTRUCTION ACTIVITIES INCLUDING STRIPPING AND REHABILITATION - 7:00 AM TO 7:00 PM MONDAY TO FRIDAY.

8. NO OPERATIONS ARE PERMITTED ON PUBLIC HOLIDAYS AS DEFINED BY THE EMPLOYMENT STANDARDS ACT.

EXTRACTION SEQUENCE

9. EXTRACTION OF THE SITE WILL BE DONE IN NINE PHASES AND WILL OCCUR SEQUENTIALLY TO MINIMIZE THE DISTURBED AREA. SEE STAGES OF OPERATIONS (SHEETS 6, 7 AND 8) FOR A DESCRIPTION OF THE ACTIVITIES PROPOSED FOR EACH PHASE AND FINAL REHABILITATION.

PROCESSING/SHIPPING/RECYCLING AREA

10. PHASE 1A (THE PROCESSING/SHIPPING/RECYCLING AREA) WILL BE DESIGNATED AS THE MAIN AREA FOR CRUSHING, SCREENING AND WASHING OF AGGREGATE. PRIMARY CRUSHING OPERATIONS MAY ALSO OCCUR IN AREAS UNDERGOING EXTRACTION PENDING APPROVAL OF APPROPRIATE NOISE MITIGATION MEASURES (SEE NOISE RECOMMENDATIONS ON SHEET 3 OF 8).

11. THIS AREA WILL ALSO BE THE MAIN AREA FOR THE STORAGE OF FUEL, SCRAP, AND AGGREGATE RECYCLING. THE SHOP AND SCALE HOUSE WILL ALSO BE LOCATED IN THIS AREA.

DEPTH OF EXTRACTION AND EXTRACTION LIFTS

12. PHASE 1A WILL BE EXTRACTED DOWN TO 224 MASL MAKING THE DEPTH OF EXTRACTION RANGE FROM 3 METERS TO 18 METERS.

13. THE ELEVATION OF THE QUARRY FLOOR IN PHASES 2 THROUGH 4D WILL RANGE FROM 216.0 M TO 217 MAMSL, 216.4 MAMSL ON AVERAGE. THE HIGHEST GROUND ELEVATION ON THE SITE IS 242.5 MASL, WHICH OCCURS IN THE NORTHWEST CORNER OF THE SITE. THE MAXIMUM DEPTH OF EXTRACTION WILL BE 25.5 METERS, WHICH WILL BE EXTRACTED IN TWO LIFTS OF APPROXIMATELY 13 METERS EACH (SEE DETAIL A ON SHEET 4 OF 8). TWO LIFTS WILL BE USED ALONG THE WEST BOUNDARY AND THE NORTH BOUNDARY. ONCE THE UPPER LIFT HAS BEEN REMOVED ALONG THESE TWO BOUNDARIES, THE LOWER LIFT WILL BE EXTRACTED DOWN TO FULL DEPTH (SEE DETAIL B). FOR THE REMAINDER OF THE SITE, ONE LIFT WILL BE USED AND THE DEPTH OF EXTRACTION WILL VARY FROM 7 METERS TO 16 METERS. THE MAXIMUM HEIGHT OF EACH LIFT WILL NOT EXCEED MINISTRY OF LABOUR REQUIREMENTS.

14. THE AVERAGE ELEVATION OF THE SHALLOW GROUNDWATER IN THE NORTHWEST PORTION OF THE SITE IS 238.58 MASL (AT MW6S-07) AND 214.97 MASL IN THE SOUTHEAST PORTION (AT MW14-12) (SEE TABLE 1 ON SHEET 1 OF 8). AT ITS LOWEST POINT, THE QUARRY FLOOR WILL BE 216.0 MASL SO THAT IT WILL REMAIN ABOVE THE ELEVATION OF THE WATER IN THE PSW AND ENSURE FLOW CONTINUES TO THIS WETLAND POST EXTRACTION.

15. THE ELEVATION OF THE QUARRY FLOOR MAY VARY AS IT FOLLOWS THE ELEVATION OF THE SHADOW LAKE FORMATION. WHERE THE QUALITY OF MATERIAL DOES NOT MEET THE OPERATOR'S MARKET REQUIREMENTS, THE DEPTH OF EXTRACTION MAY BE REDUCED.

16. AS THE LIMIT OF EXTRACTION IS REACHED, THE OPERATOR WILL UTILIZE ONE OF THE LIFT EXTRACTION OPTIONS AS OUTLINED IN DETAIL A ON SHEET 4 OF 8. ALL EXCAVATION FACES WILL BE STABILIZED TO PREVENT EROSION INTO THE SETBACK AREA.

17. CROSS-SECTIONS SHOWING THE EXISTING GROUND ELEVATION, THE SHALLOW GROUNDWATER ELEVATION AND THE FINAL FLOOR ELEVATION ARE SHOWN ON SHEET 3 OF 8.

AGGREGATE STOCKPILING

18. STOCKPILES OF AGGREGATE WILL BE LOCATED IN THE PROCESSING/SHIPPING/RECYCLING AREA OR IN THE OPERATING PHASE. THE MAXIMUM HEIGHT OF AGGREGATE STOCKPILES WILL BE 20 METERS. AGGREGATE STOCKPILES IN THE OPERATING PHASE WILL REMAIN NO CLOSER THAN 30 METERS FROM THE LICENSED BOUNDARY. A VARIANCE IS REQUIRED SO THAT STOCKPILES STORED IN THE PROCESSING/SHIPPING/RECYCLING AREA CAN BE LOCATED CLOSER THAN 30 METERS FROM THE LICENSED BOUNDARY (TABLE 4).

FENCING

19. 1.2 METER HIGH POST AND WIRE FENCING OF THE LICENSED BOUNDARY WILL BE COMPLETED WITHIN 1 YEAR OF THE DATE OF THE LICENSE AND WILL BE MAINTAINED FOR THE LIFE OF THE QUARRY. EXCEPTIONS TO THE FENCING REQUIREMENTS ARE NOTED ON TABLE 4. 1.2 M MARKER POSTS WILL BE INSTALLED ALONG UNFENCED LICENSED BOUNDARIES SO THAT POSTS CAN BE SEEN FROM ONE POST TO THE NEXT WITH A MAXIMUM SEPARATION OF 30 M. MARKER POSTS WILL BE INSTALLED WITHIN 1 YEAR OF LICENCING.

SETBACKS AND BUFFERS

20. APPROPRIATE SETBACKS SHALL BE MAINTAINED AS SHOWN ON THE SITE PLANS; A 15 METER SETBACK ALONG THE EAST BOUNDARY (ON LOT 14); A 30 METER SETBACK ALONG THE SOUTHEAST BOUNDARY ADJACENT TO THE PSW; AND A 15 METER SETBACK ALONG THE SOUTH BOUNDARY.

21. A VARIANCE (0 METER SETBACK) IS REQUIRED ALONG THE NORTH BOUNDARY, EAST BOUNDARY (ON LOT 13), AND ALONG THE WEST BOUNDARY AS DETAILED IN TABLE 4.

22. IN LIEU OF A 15 METER SETBACK ALONG THE NORTH BOUNDARY, A 90 METER BUFFER WILL BE MAINTAINED TO ALLOW FOR THE CONSTRUCTION OF A TREE NURSERY AND A FISH HABITAT LINKAGE CONNECTING THE NORTH OUTLET TO THE NEW DRAINAGE CHANNEL (SEE DETAIL D, SHEET 4 OF 8).

SITE PREPARATION, TOPSOIL AND OVERBURDEN STRIPPING

23. CLEARING OF VEGETATION IS TO OCCUR OUTSIDE THE PEAK BREEDING BIRD SEASON (APRIL 15TH - AUGUST 15TH). IF CLEARING MUST BE CONDUCTED DURING THIS TIME, A QUALIFIED BIRD BIOLOGIST MUST CONDUCT A NEST SEARCH FOR ANY EVIDENCE OF ACTIVE NESTS WITHIN THE AREA TO BE CLEARED.

24. TREE STUMPS AND BRUSH COLLECTED WHILE CLEARING TREES DURING SITE PREPARATION WILL BE STORED IN THE EXTRACTION AREA OF THE SITE UNTIL THEY ARE BURNED OR CHIPPED FOR REHABILITATION PURPOSES.

25. NO TOPSOIL WILL BE REMOVED FROM THE SITE. TOPSOIL AND OVERBURDEN FROM PHASE 1A WILL BE STRIPPED AND USED FOR CONSTRUCTING NOISE ATTENUATION BARRIERS (I.E. BERMS) AROUND THE PROCESS/SHIPPING/RECYCLING AREA OR STOCKPILED FOR USE DURING THE REHABILITATION OF PHASE 1B. TOPSOIL AND OVERBURDEN FROM SUBSEQUENT PHASES WILL BE USED FOR PROGRESSIVE REHABILITATION OR TEMPORARILY STOCKPILED WITHIN THE DISTURBED AREA BUT NOT WITHIN 30 METERS OF THE LICENSE BOUNDARY. A VARIANCE IS REQUIRED TO ALLOW TOPSOIL AND OVERBURDEN TO BE STORED CLOSER THAN 30 METER TO THE LICENSED BOUNDARY IN THE PROCESS/SHIPPING/RECYCLING AREA (SEE TABLE 4).

NOISE ATTENUATION BARRIERS

26. NOISE ATTENUATION BARRIERS WILL BE CONSTRUCTED AROUND THE PROCESS/SHIPPING/RECYCLING AREA USING TOPSOIL AND OVERBURDEN FROM PHASE 1A AS PER NOISE CONTROL RECOMMENDATIONS BY VALCOUSTICS CANADA LTD (SEE NOISE RECOMMENDATIONS ON SHEET 3 OF 8). WHEN THIS TOPSOIL/OVERBURDEN IS REQUIRED FOR REHABILITATION IN PHASE 1B, IT WILL BE REPLACED WITH AN APPROPRIATE ALTERNATIVE NOISE BARRIER (SEE DETAIL C ON SHEET 4 OF 8). THE OTHER REQUIRED NOISE ATTENUATION BARRIERS WILL BE CONSTRUCTED IN STAGES AS PER DETAIL E ON SHEET 4 OF 8.

SLOPES AND GRADING

27. NOISE ATTENUATION BARRIERS THAT ARE MADE USING TOPSOIL/OVERBURDEN AND/OR UNMARKETABLE LIMESTONE AND/OR IMPORTED CLEAN INERT FILL WILL BE GRADED TO A MINIMUM 2:1 SLOPE.

28. PERIMETERS WILL BE REHABILITATED AS THE LIMITS OF EXTRACTION ARE REACHED. ANY SLOPES CONSTRUCTED WILL BE ESTABLISHED AS OUTLINED IN DETAIL B ON SHEET 4 OF 8 BY BACKFILLING WITH OVERBURDEN, IMPORTED CLEAN INERT FILL, AND/OR UNMARKETABLE LIMESTONE. PERIMETER SLOPES WILL BE GRADED PRIOR TO THE PLACEMENT OF TOPSOIL. 300 METERS OF PHASE 3B ONLY WILL BE REHABILITED AS A VERTICAL FACE (SEE DETAIL B ON SHEET 4 OF 8).

29. ALL AVAILABLE OVERBURDEN, TOPSOIL AND ORGANIC MATTER WILL BE APPLIED TO THE SLOPES AND QUARRY FLOOR. WHERE THERE IS A DEFICIT OF OVERBURDEN FOR REHABILITATION PURPOSES, CLEAN INERT FILL WILL BE IMPORTED AS PER NOTE 40. TOPSOIL, OVERBURDEN AND ORGANIC MATERIAL, AND IMPORTED CLEAN INERT FILL WILL BE SPREAD AT VARIABLE DEPTHS IN AREAS TO BE FORESTED TO CREATE THE NECESSARY SOIL DEPTH FOR TREE GROWTH AND WHERE WETLANDS ARE PROPOSED.

30. THE QUARRY FLOOR WILL FOLLOW THE SHADOW LAKE FORMATION AND BE GRADED AS REQUIRED BY THE REHABILITATION PLAN FOR EACH PHASE. PHASES 1 AND A PORTION OF PHASE 2 WILL BE GRADED SUCH THAT DRAINAGE IS TOWARDS THE SOUTH, WHILE THE BALANCE OF PHASE 2 PLUS PHASES 3 AND 4 ARE TO BE GRADED TOWARDS THE NEW DRAINAGE CHANNEL BUILT IN EACH PHASE. WHERE SAID GRADING IS NOT POSSIBLE DUE TO UNDULATIONS IN THE SHADOW LAKE FORMATION, THEN GRADING WILL BE DONE IN CONSULTATION WITH THE MNRF AND A QUALIFIED ENVIRONMENTAL BIOLOGIST AND/OR ENGINEER SO THAT HABITATS ARE RECREATED IN A WAY THAT IS SUITABLE TO EACH PHASE.

SEEDING AND PLANTING

31. EXISTING TREES AND SHRUBS WITHIN THE SETBACK ALONG THE EAST LICENSED BOUNDARY IN LOT 14 WILL BE MAINTAINED AS SCREENS.

32. ANY NOISE ATTENUATION BARRIERS THAT ARE MADE USING TOPSOIL AND OVERBURDEN, AS WELL AS ANY STOCKPILES OF TOPSOIL AND OVERBURDEN WILL BE SEEDED WITH A NATIVE GRASS SEED MIX. VEGETATION SHALL BE MAINTAINED TO CONTROL EROSION.

33. ANY PERIMETER SLOPES MADE USING TOPSOIL AND OVERBURDEN WILL BE SEEDED WITH A NATIVE GRASS SEED MIX TO CONTROL EROSION.

34. NATIVE TREE AND SHRUB SPECIES INDIGENOUS TO THE ORILLIA/WASHAGO AREA WILL BE PLANTED IN AREAS SLATED FOR REHABILITATION TO FOREST. PLANT MATERIALS WILL BE OBTAINED FROM LOCAL NURSERIES, THE ON-SITE NURSERY, OR TRANSPLANTED FROM AREAS THAT ARE TO BE PREPARED FOR EXTRACTION.

35. FORESTED AREAS WILL BE COMPRISED OF SUGAR MAPLE, EASTERN WHITE PINE, EASTERN HEMLOCK, EASTERN WHITE CEDAR, WHITE BIRCH, RED OAK AND RED MAPLE. IT IS RECOMMENDED THAT 70% OF THE SPECIES WITHIN EACH FOREST POCKET BE CONIFEROUS AND 30% DECIDUOUS TO RE-ESTABLISH WHAT EXISTED PRIOR TO CLEARING.

36. AREAS OF THE SITE TO BE REHABILITATED TO AGRICULTURE WILL BE SEEDED WITH A SUITABLE CROP TYPE.

37. AREAS OF THE SITE TO BE REHABILITATED TO OPEN FIELD MEADOW WILL BE SEEDED WITH A NATIVE GRASS SEED MIX.

38. THERE ARE FOUR CATEGORY 2 BUTTERNUT TREES FOUND ON THE SITE. A NOTICE OF ACTIVITY UNDER THE ENDANGERED SPECIES ACT WILL BE REQUIRED FROM THE MNRF TO ENSURE PROPER REPLACEMENT/COMPENSATION FOR THE REMOVAL OF THESE TREES.

39. THERE ARE EIGHT REGIONALLY RARE VEGETATION SPECIES IN THE PROPOSED LICENSED AREA. A PROFESSIONAL BIOLOGIST WILL DEVELOP A VEGETATION SALVAGE PLAN TO TRANSPLANT AND RELOCATE ANY RARE VEGETATION SPECIES. THE VEGETATION SALVAGE PLAN WILL BE APPROVED BY MNRF BEFORE EXTRACTION PROCEEDS.

IMPORTATION OF MATERIAL FOR REHABILITATION

40. TOPSOIL AND CLEAN INERT FILL MAY BE BROUGHT ON SITE FOR REHABILITATION AS PER AR POLICY 6.00.03. TOPSOIL AND CLEAN INERT FILL WILL BE STOCKPILED SEPARATELY FROM NATIVE MATERIAL, IF NOT USED IMMEDIATELY FOR REHABILITATION. THE LICENSEE MUST ENSURE THAT THE MATERIAL IS TESTED AT SOURCE BEFORE IT IS DEPOSITED ON SITE TO ENSURE THAT THE MATERIAL MEETS THE MOECC'S CRITERIA UNDER TABLE 1 OF THE MOECC'S SOILS, GROUNDWATER AND SEDIMENT STANDARDS FOR USE UNDER PART XV.1 OF THE ENVIRONMENTAL PROTECTION ACT. SAMPLING RESULTS WILL BE PROVIDED TO THE MNRF UPON REQUEST.

EQUIPMENT

41. EQUIPMENT USED ON SITE WILL VARY DEPENDANT ON OPERATIONS. EQUIPMENT SHALL OPERATE IN ACCORDANCE WITH THE NOISE IMPACT ANALYSIS RECOMMENDATIONS FOUND ON SHEET 3 OF 8. IF REQUIRED, AN MOECC ENVIRONMENTAL COMPLIANCE APPROVAL WILL BE OBTAINED FOR PROCESSING EQUIPMENT TO BE USED ON-SITE.

42. EQUIPMENT USED FOR STRIPPING AND REHABILITATION WILL INCLUDE SCRAPERS, EXCAVATORS, LOADERS, BULLDOZERS AND TRUCKS. PROCESSING OPERATIONS WILL USE PORTABLE CRUSHING AND SCREENING PLANTS, WASH PLANTS, CONVEYORS, STACKERS, FEED BINS, TOOL TRAILERS, ROCK SAWS, AND WOOD GRINDERS. ADDITIONAL EQUIPMENT MAY BE PERMITTED ON-SITE WITH WRITTEN APPROVAL FROM MNRF.

43. ELECTRIC POWER WILL BE PROVIDED USING PORTABLE POWER PLANTS OR AN EXISTING HYDROELECTRIC LINE.

44. FARM EQUIPMENT MAY BE USED IN UNDISTURBED A'REAS WHILE EXTRACTION PROCEEDS AND FOR PROGRESSIVE AND FINAL REHABILITATION PURPOSES.

45. PORTABLE EQUIPMENT WILL MOVE THROUGHOUT THE SITE IN PROXIMITY TO THE EXTRACTION FACE OR IN THE PROCESSING/SHIPPING/RECYCLING AREA. IF REQUIRED, AN ENVIRONMENTAL COMPLIANCE APPROVAL WILL BE OBTAINED FOR PROCESSING EQUIPMENT TO BE USE ON SITE.

FUEL STORAGE AND EQUIPMENT MAINTENANCE

46. FUEL STORAGE WILL BE IN ABOVE GROUND TANKS CERTIFIED IN ACCORDANCE WITH APPROVED STANDARDS. REFUELING BY A FUEL TRUCK IS ALSO PERMITTED. FUEL STORAGE WILL BE LOCATED IN THE PROCESSING/SHIPPING/RECYCLING AREA. THE OPERATOR SHALL MAINTAIN A RECORD OF FUEL DELIVERIES NOTING THE QUANTITY AND DATE OF EACH TRANSFER.

47. MINOR SERVICING OF MOBILE EQUIPMENT WILL OCCUR ON SITE. MAJOR SERVICING OF MOBILE EQUIPMENT MAY OCCUR IN THE SHOP WHEN CONSTRUCTED. STATIONARY EQUIPMENT WILL BE SERVICED ON SITE.

48. ALL PETROLEUM WASTE PRODUCTS WILL BE COLLECTED AND DISPOSED OF BY AN MOECC APPROVED AGENT.

49. A SPILLS CONTINGENCY PLAN WILL BE IN PLACE PRIOR TO SITE PREPARATION.

BUILDINGS AND STRUCTURES

50. A SCALE AND SCALE HOUSE, SHOP AND FUEL STORAGE FACILITIES MAY BE INSTALLED IN THE LOCATIONS IDENTIFIED ON THE SITE SUBJECT TO APPLICABLE PERMITS AND APPROVALS.

HAUL ROUTE

51. THE HAUL ROUTE FOR ALL SHIPPING, EXCEPT LOCAL DELIVERIES, WILL BE SOUTH FROM THE SITE ENTRANCES/EXITS ON THE DESIGNATED HAUL ROUTE KNOW AS NICHOL'S LINE, WHICH PROVIDES ACCESS TO HIGHWAY 11 SOUTH.

52. THE RECONSTUCTION AND DESIGN OF THE UNOPENED PORTION OF NICHOL'S LINE LEADING TO THE SITE ENTRANCE WILL REQUIRE APPROVAL BY THE TOWNSHIP OF SEVERN VIA AN AGREEMENT, AND THEN CONSTRUCTED TO SERVICE THE SITE. THIS HAUL ROAD SHALL BE CONSTRUCTED TO MUNICIPAL STANDARDS FOR YEAR ROUND USE BY THE REGISTERED LANDOWNER AND LICENSEE AT NO COST TO THE MUNICIPALITY.

ENTRANCE AND EXIT AND GATES:

53. TRUCK TRAFFIC WILL ENTER AND LEAVE THE SITE ONTO NICHOL'S LINE THROUGH THE PROCESSING/SHIPPING/RECYCLING AREA. THE ENTRANCE AND EXIST WILL BE GATED AND LOCKED WHEN THE QUARRY IS NOT IN USE.

INTERNAL HAUL ROADS

54. AGGREGATE WILL BE TRANSPORTED BY TRUCKS FROM THE ACTIVE QUARRY FACE OR PROCESSED STOCKPILES USING AN INTERNAL HAUL ROAD TO BE ESTABLISHED ON THE QUARRY FLOOR. THE INTERNAL HAUL ROAD IS TEMPORARY AND THE ACTUAL LOCATION WILL VARY AS THE OPERATION PROGRESSES.

55. EQUIPMENT CROSSINGS WILL BE CONSTRUCTED ACROSS THE NEW DRAINAGE CHANNEL TO ALLOW ACCESS TO CERTAIN PHASES. DETAIL DESIGNS FOR EQUIPMENT CROSSINGS WILL BE APPROVED BY A PROFESSIONAL ENGINEER AND PROVIDED TO MNRF PRIOR TO EXTRACTION IN PHASES 3A, 3B, 4A THROUGH 4D.

AGGREGATE WASHING

56. A WASH PLANT WILL BE ESTABLISHED IN THE PROCESSING/SHIPPING/RECYCLING AREA. A PERMIT TO TAKE WATER WILL BE OBTAINED FROM MOECC FOR UTILIZING GROUND AND/OR SURFACE WATER.

57. WATER WILL BE PUMPED FROM THE CLEAN WATER POND TO BE LOCATED IN PHASE 1B. WASH WATER WILL BE DISCHARGED INTO SETTLING POND 1 WHERE FINE MATERIAL WILL SETTLE OUT SO THAT CLEAN WATER CAN BE REUSED IN THE WASHING PROCESS. THE WASH PLANT SYSTEM WILL FUNCTION AS A CLOSED LOOP SYSTEM WHICH RECYCLES ALMOST ALL WATER.

AGGREGATE RECYCLING

58. RECYCLING OF ASPHALT, CONCRETE, AND MASONRY MATERIALS WILL BE STOCKPILED IN THE PROCESSING/SHIPPING/RECYCLING AREA FOR THE PURPOSE OF RESALE AND/OR BLENDING WITH ON SITE PRODUCTS. RECYLCED AGGREGATE WILL BE REMOVED ON AN ON-GOING BASIS. RECYCLED ASPHALT WILL NOT BE STOCKPILED WITHIN 30 METERS OF ANY WATER BODY OR MAN-MADE POND; OR TWO METERS OF THE SURFACE OF THE WATER TABLE. A VARIANCE IS REQUIRED TO PERMIT STOCKPILES OF RECYCLED AGGREGATE CLOSER THAN 30 METERS TO THE LICENSED BOUNDARY (SEE TABLE 4).

59. ANY REBAR AND OTHER METAL WILL BE REMOVED FROM THE RECYCLED AGGREGATE AND PLACED IN A DESIGNATED SCRAP BIN ON SITE WHICH WILL BE REMOVED ON AN ON-GOING BASIS. ALL RECYCLED AGGREGATE WILL BE REMOVED FROM THE PROPERTY PRIOR TO FINAL REHABILITATION OF THE SITE.

60. ONCE THE AGGREGATE ON SITE HAS BEEN DEPLETED, NO FURTHER IMPORTS WILL BE PERMITTED. ONCE FINAL REHABILITATION HAS BEEN COMPLETED AND APPROVED IN ACCORDANCE WITH THE SITE PLAN, ALL RECYCLING OPERATIONS SHALL CEASE.

SCRAP

61. ANY SCRAP SUCH AS DISCARDED MACHINERY, EQUIPMENT, MOTOR VEHICLES, AND TIRES WILL BE COLLECTED AND TEMPORARILY STORED WITHIN THE CURRENT OPERATING PHASE IN ONE LOCATION, OR STORED IN THE PROCESSING/SHIPPING/RECYCLING AREA AND WILL BE REMOVED ON AN ONGOING BASIS. NO SCRAP WILL BE LOCATED WITHIN 30 METERS OF ANY BODY OF WATER. SCRAP STORED WITHIN THE CURRENT OPERATING PHASE WILL REMAIN 30 METERS FROM THE LICENSED BOUNDARY. A VARIANCE IS REQUIRED TO PERMIT SCRAP STORAGE CLOSER THAN 30 METERS OF THE LICENSED BOUNDARY IN THE PROCESSING/SHIPPING/RECYCLING AREA (SEE TABLE 4).

DRAINAGE CONTROLS

62. DURING EXTRACTION, WATER WILL DRAIN ACROSS THE SITE PASSIVELY VIA GRAVITY SO AS TO MIMIC EXISTING CONDITIONS AND ENSURE FLOW CONTINUES TO THE PSW DURING EXTRACTION.

63. CURRENTLY, THERE ARE TWO SURFACE WATER FEATURES THAT DRAIN THE SITE. WATERCOURSE 1 DRAINS THE NORTHERN AND CENTRAL PORTIONS, WHILE WATERCOURSE 2 DRAINS THE SOUTHERN PORTION, SEE EXISTING FEATURES (SHEET 1 OF 8). THE ELEVATION OF THE INLET OF WATERCOURSE 1 ALONG THE NORTH BOUNDARY IS 232 MASL AND THE ELEVATION OF THE OUTLET ALONG THE EAST BOUNDARY IS 217 MASL. SURFACE WATER IN WATERCOURSE 1 MIXES WITH GROUNDWATER, EMANATING FROM A SPRING AT SW5 (ELEVATION 215.5 MASL), APPROXIMATELY 40 M DOWNSTREAM OF THE OUTLET.

64. TO MIMIC EXISTING CONDITIONS, THE QUARRY FLOOR WILL BE GRADED TO CONVEY WATER TO A NEW DRAINAGE CHANNEL TO BE ALIGNED PARALLEL TO WATERCOURSE 1. THE STAGING OF THE NEW DRAINAGE CHANNEL IS SHOWN ON THE STAGES OF OPERATION PLAN (SHEETS 6, 7, AND 8). THE NEW DRAINAGE CHANNEL WILL ALSO RECEIVE AND CONVEY WATER FROM THE SEVERN PINES QUARRY.

65. THE NEW DRAINAGE CHANNEL WILL CONNECT TO THE NORTH INLET AT THE SAME ELEVATION AS WATERCOURSE 1 AND OUTLET AT SW5 SO THAT SURFACE WATER AND GROUNDWATER COLLECTED ON-SITE WILL BE DISCHARGED AT A SIMILAR LOCATION POST-EXTRACTION AND MIMIC EXISTING CONDITIONS.

66. THE NEW DRAINAGE CHANNEL WILL CONNECT TO THE NORTH INLET USING A HABITAT LINKAGE SEE DETAIL D ON SHEET 4 OF 8. FINAL DESIGN DETAILS FOR THE HABITAT LINKAGE WILL BE PROVIDED TO MNRF BEFORE EXTRACTION COMMENCES IN PHASE 3B.

67. WHEN MAKING THE SWITCH FROM WATERCOURSE 1 TO THE NEW DRAINAGE CHANNEL, FISH WILL NEED TO BE SALVAGED AND TRANSFERRED TO THE NEW DRAINAGE CHANNEL. SEE FISH SALVAGE PLAN ON SHEET 5 OF 8.

68. THE QUANTITY AND QUALITY OF THE WATER LEAVING THE SITE AND ENTERING THE PSW WILL BE CONTROLLED USING SETTLING PONDS WITH ENGINEERED OUTLETS. SEE THIS SHEET FOR THE LOCATION OF SETTLING POND 1 AND SETTLING POND 2.

69. SETTLING POND 1 WILL BE DESIGNED PRIOR TO EXTRACTION IN PHASE 1B AND LOCATED ALONG THE SOUTHERN EXTRACTION BOUNDARY. SETTLING POND 1 WILL OUTLET TO WATERCOURSE 2. AN MOECC ENVIRONMENTAL COMPLIANCE APPROVAL FOR PERIODIC DISCHARGE OF WATER WILL BE REQUIRED. CONCEPTUAL DETAILS FOR THIS POND ARE SHOWN ON DETAIL F (SHEET 4 OF 8).

70. SETTLING POND 2 WILL BE DESIGNED PRIOR TO EXTRACTION IN PHASE 2 AND LOCATED AT THE OUTLET OF THE NEW DRAINAGE CHANNEL. AN MOECC ENVIRONMENTAL COMPLIANCE APPROVAL FOR PERIODIC DISCHARGE OF WATER WILL BE REQUIRED. CONCEPTUAL DETAILS FOR THIS POND ARE SHOWN ON DETAIL G (SHEET 4 OF 8). THE CONSTRUCTION OF SETTLING POND 2 WILL REQUIRE EXCAVATION IN THE 30 METER RESIDENTIAL SETBACK FOR THE INSTALLATION OF A CULVERT. A VARIANCE IS REQUIRED TO PERMIT EXCAVATION IN THIS AREA (SEE TABLE 4).

71. TEMPORARY MINOR DRAINAGE DITCHES WILL BE CREATED AS NECESSARY TO CATCH PRECIPITATION AND GROUNDWATER AND DIRECTED TOWARDS SETTLING POND 1 OR THE NEW DRAINAGE CHANNEL.

72. TO ASSIST WITH DRAINAGE CONTROL, WETLANDS ARE PROPOSED FOR CONSTRUCTION ON THE QUARRY FLOOR IN PHASES 2, 3A, AND 4A ADJACENT TO THE NEW DRAINAGE CHANNEL (SEE SHEET 5 OF 8). FINAL DESIGN DETAILS FOR THE CONSTRUCTED WETLAND WILL BE PROVIDED TO MNRF BEFORE EXTRACTION PROCEEDS IN PHASE 3A.

EROSION AND SEDIMENTATION CONTROLS

73. A SEDIMENT AND EROSION CONTROL PLAN WILL BE DESIGNED AND IMPLEMENTED PRIOR TO SITE PREPARATION OF EACH STAGE SHOWN ON SHEETS 6, 7, AND 8.

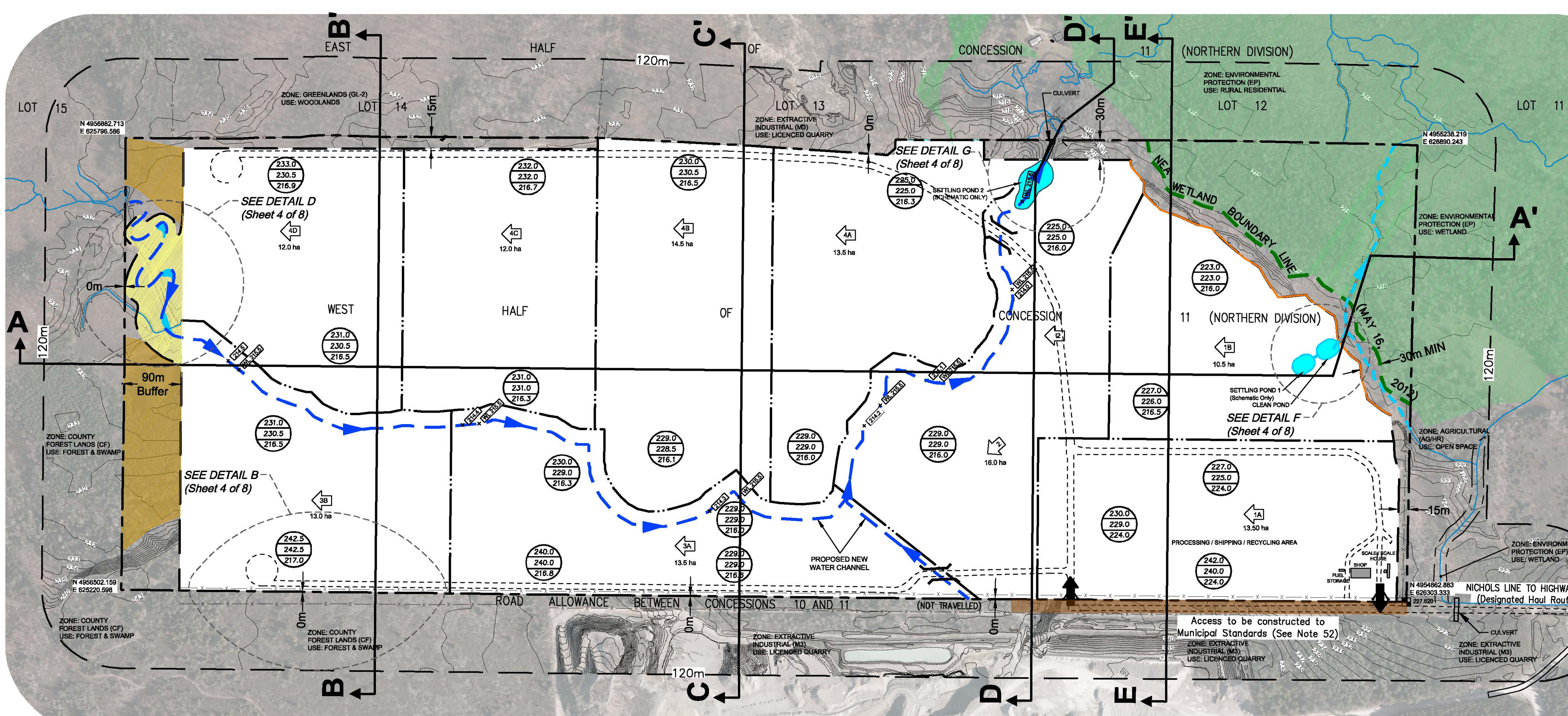
DUST CONTROLS

74. DUST WILL BE MITIGATED ON SITE. WATER OR OTHER PROVINCIALLY APPROVED DUST SUPPRESSANT WILL BE APPLIED TO INTERNAL HAUL ROADS AND PROCESSING AREAS AS OFTEN AS REQUIRED TO MITIGATE DUST. PROCESSING EQUIPMENT WILL BE EQUIPPED WITH DUST SUPPRESSING OR COLLECTING DEVICES WHERE THE EQUIPMENT CREATES DUST AND IS BEING OPERATED WITHIN 300 METRES OF A SENSITIVE RECEPTOR.

BLASTING CONTROLS

75. A BLASTING ATTENUATION STUDY WILL BE CARRIED OUT DURING THE FIRST 12 MONTHS OF OPERATION TO DESIGN FUTURE BLASTS.

76. ALL BLASTS WILL BE MONITORED AS PER THE BLASTING RECOMMENDATIONS (SEE SHEET 3 OF 8). ALL BLASTS WILL BE MONITORED FOR GROUND VIBRATION AND BLAST OVERPRESSURE TO ENSURE COMPLIANCE WITH CURRENT PROVINCIAL GUIDELINES. BLAST MONITORING REPORTS WILL BE AVAILABLE UPON REQUEST BY THE MNRF FOR AUDIT PURPOSES.



Site North

True North

80 0 80 160 240 metres

SCALE 1:4000

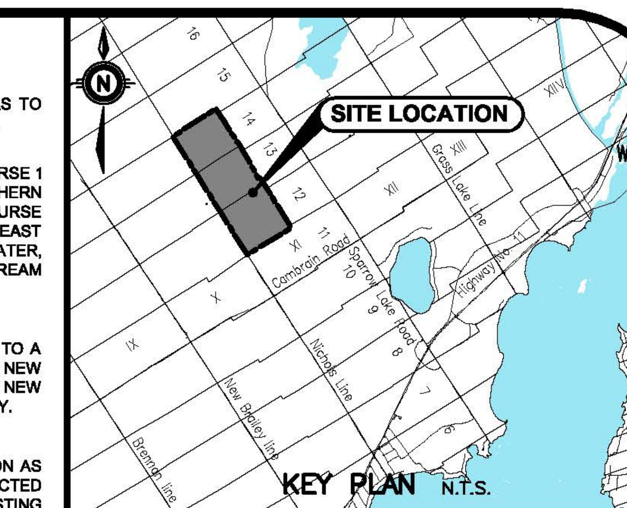
227.0 — EXISTING GROUND ELEVATION

226.0 — TOP OF BEDROCK ELEVATION

216.5 — LOWEST QUARRY FLOOR ELEVATION

TABLE 4: VARIATION OF OPERATIONAL STANDARDS

NO.	VARIANCE	STANDARD
1.0	STOCKPILES OF AGGREGATE AND/OR TOPSOIL AND/OR OVERBURDEN WILL BE LOCATED CLOSER THAN 30 METERS FROM THE LICENSED BOUNDARY IN THE PROCESSING/SHIPPING/ RECYCLING AREA.	AGGREGATE STOCKPILES (5.13)
2.0	THE LIMIT OF EXTRACTION ADJACENT TO THE PSW IN THE SOUTH EAST CORNER OF THE SITE WILL NOT BE FENCED, INSTEAD IT WILL BE DELINEATED WITH MARKER POSTS AND SILTATION CONTROLS. THE NORTH AND NORTH EAST LICENSED BOUNDARIES WILL NOT BE FENCED BUT WILL BE DEMARCATED WITH MARKER POSTS. THE ADJACENT LANDS ARE VACANT, HEAVILY WOODED, OR AN EXISTING QUARRY.	FENCING (5.1)
3.0	THE EXCAVATION SETBACK AREA ADJACENT TO THE BEAMISH/DUFFERIN SEYLER PIT/QUARRY MAY BE ELIMINATED IF A COMMON BOUNDARY AGREEMENT WITH THE APPLICABLE LICENSE HOLDER IS FILED WITH THE MNRF.	SETBACKS (5.10)
	THE SETBACK ALONG THE WEST SITE BOUNDARY ABUTS AN UNOPENED AND UNTRAVELED ROAD ALLOWANCE PATENTED TO THE TOWNSHIP OF SEVERN. THE EXCAVATION OF THE SETBACK AREA MAY BE ELIMINATED IF A BOUNDARY AGREEMENT BETWEEN THE TWO PARTIES IS FILED WITH THE MNRF TO REDUCE THE SETBACK TO 0 METERS.	
	IN LIEU OF THE 15 M SETBACK ALONG THE NORTH BOUNDARY, A 90 M BUFFER IS INCLUDED TO ALLOW FOR THE CONSTRUCTION OF A TREE NURSERY AND A FISH HABITAT LINKAGE CONNECTING THE NORTH INLET FROM COUNTY OWNED LANDS TO THE NEW WATER CHANNEL.	
4.0	SCRAP WILL BE STORED CLOSER THAN 30 METERS TO THE LICENSED BOUNDARY IN THE PROCESSING/SHIPPING/RECYCLING AREA.	SCRAP (5.9)
5.0	EXCAVATION IN THE 30 METER RESIDENTIAL SETBACK ALONG THE EAST BOUNDARY WILL BE REQUIRED TO PROPERLY CONSTRUCT SETTLING POND 2 SO THAT IT'S OUTLET IS AN ELEVATION BELOW 216 MASL.	EXCAVATION WITHIN SETBACK (5.11)
6.0	VERTICAL FACES WILL BE INCLUDED IN THE FINAL REHABILIATION OF THE WEST BOUNDARY OF PHASE 3B ONLY (SEE DETAIL B ON SHEET 4 OF 8).	SLOPING OF EXCAVATION FACES (5.19)



LEGEND

- LICENCED BOUNDARY / PROPERTY BOUNDARY
- LIMIT OF EXTRACTION
- PHASE BOUNDARY
- SILT FENCE
- BARN — BUILDINGS AND STRUCTURES
- POST & PAGE WIRE FENCE (UNLESS OTHERWISE NOTED)
- INTERNAL ROAD
- NEW WATER CHANNEL
- INTERMITTENT WATER COURSE
- OFFSITE WATER COURSE
- 250 — CONTOURS ELEVATION (masl)
- QUARRY ENTRANCE/EXIT
- 3 — DIRECTION/SEQUENCE OF EXTRACTION
- GATE
- EQUIPMENT CROSSING
- PROVINCIALLY SIGNIFICANT WETLAND
- NEA WETLAND BOUNDARY
- A A' — CROSS – SECTION ARROWS
- 227.620 — BENCHMARK WITH ELEVATION (masl)
- TREE NURSERY PLANTING AREA
- HABITATE LINKAGE

SITE PLAN AMENDMENTS

NO.	REVISION	BY	DATE

MTE

Engineers | Scientists | Surveyors

www.mte85.com

David W. Kennedy

LICENSED PROFESSIONAL ENGINEER V. E. ROWE 04/20/18 PROVINCE OF ONTARIO

DECLARATION OF PURPOSE

THIS SITE PLAN IS PREPARED UNDER THE AGGREGATE RESOURCES ACT FOR A CLASS 'A' LICENCE, CATEGORY 2.

PROJECT

CUMBERLAND QUARRY

LICENSEE: SEVERN AGGREGATES LIMITED
151 WHITEHALL DRIVE,
MARKHAM, ONTARIO
L3R 9T1

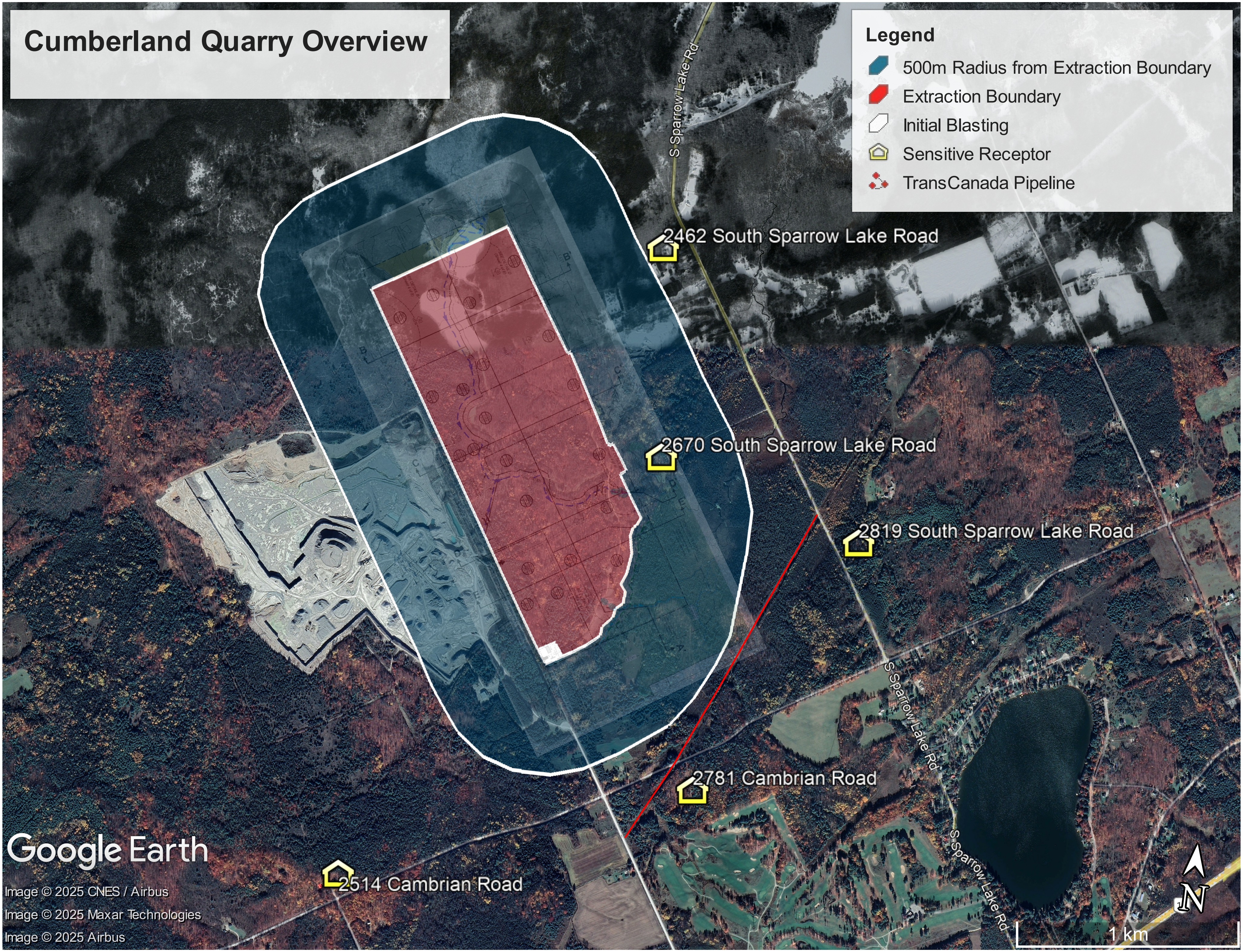
DRAWING

OPERATIONAL PLAN

WEST HALF LOTS 12, 13 AND 14, CONCESSION 11
GEOGRAPHIC TOWNSHIP OF ORILLIA, NORTH DIVISION
TOWNSHIP OF SEVERN, COUNTY OF SIMCOE

Project Manager J Flanagan	Project No. 33876-300
Design By	Checked By
Drawn By K.X.M.	Checked By
Surveyed By	Sheet No. 2
Date April 24, 2018	
Scale 1:4000	Sheet 2 of 8

April 24, 2018 — 8:26 a.m. — Plotted By: kmodsen


Cumberland Quarry Overview
Legend
500m Radius from Extraction Boundary
Extraction Boundary
Initial Blasting
Sensitive Receptor
TransCanada Pipeline
2462 South Sparrow Lake Road
2670 South Sparrow Lake Road
2819 South Sparrow Lake Road
2781 Cambrian Road
2514 Cambrian Road
S Sparrow Lake Rd
S Sparrow Lake Rd
S Sparrow Lake Rd
Google Earth
Image © 2025 CNES / Airbus
Image © 2025 Maxar Technologies
Image © 2025 Airbus
1 km
N

Appendix B

EXPLOTECH

Severn Aggregates Ltd. – Cumberland Quarry

PREVAILING METEOROLOGICAL CONDITIONS

Medians provided by Environment Canada
Canadian Climate Normals 1991-2020
Lagoon City

Date	Wind Direction	Wind Velocity Km/h	Temperature (Deg Celcius)
January	N	17.4	-8.2
February	NW	16.4	-7.5
March	N	15.9	-2.5
April	NW	16.4	4.7
May	NW	14.7	12.3
June	NW	13.8	17.8
July	NW	14.1	20.4
August	W	14	19.7
September	N	14.7	15.8
October	N	17.9	9.2
November	N	19.5	2.7
December	W	19.4	-3.6

Appendix C

Ground Vibrations

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)
$v = 160\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 242\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 605\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 182\left(\frac{D}{\sqrt{W}}\right)^{-1.82}$	$v = 52.2\left(\frac{D}{\sqrt{W}}\right)^{-1.38}$	$v = 133\left(\frac{D}{\sqrt{W}}\right)^{-1.5}$

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)
$v = 1140\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$	$v = 1326\left(\frac{D}{\sqrt{W}}\right)^{-1.38}$	$v = 5175\left(\frac{D}{\sqrt{W}}\right)^{-1.76}$	$v = 7025\left(\frac{D}{\sqrt{W}}\right)^{-1.85}$

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)
860	167.0	**1.4**	**2.1**	**5.2**	**0.5**	**1.4**	**1.9**	**1.4**	**4.0**	**3.2**	**3.0**

Air Overpressure

Imperial Equations

Equation 1	Equation 2	Equation 3	Equation 4
USBM RI8485 (Behind Blast)	USBM RI8485 (Front of Blast)	USBM RI8485 (Full Confined)	Construction Average
$P = 0.056\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.515}$	$P = 1.317\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.966}$	$P = 0.061\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.96}$	$P = 1\left(\frac{D}{\sqrt[3]{W}}\right)^{-1.1}$

Metric Equations

Equation 1	Equation 2	Equation 3
Ontario Quarry (Explotech 2013)	Limestone (Explotech 2011)	Ontario Quarry (Explotech 2012)
$P = 159\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.0456}$	$P = 206\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.1}$	$P = 1222\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.669}$

D (m)	W (Kg)	OP1 (dB)	OP2 (dB)	OP3 (dB)	OP4 (dB)	OP1 (dB)	OP2 (dB)	OP3 (dB)
860	167.0	**119.0**	**123.0**	**96.6**	**113.7**	**126.3**	**124.3**	**126.4**

Appendix D

Robert J. Cyr, P. Eng.

Principal, 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)
Association of Professional Engineers, Geologists and Geophysicists of Alberta
Association of Professional Engineers and Geoscientists of New Brunswick
Association of Professional Engineers of Nova Scotia
Association of Professional Engineers and Geoscientists Manitoba
Professional Engineers and Geoscientists Newfoundland and Labrador
Northwest Territories and Nunavut Association of Professional Engineers (NAPEG)
International Society of Explosives Engineers (ISEE)
Ontario Stone Sand & Gravel Association (OSSGA)
Surface Blaster Ontario Licence 450109

SUMMARY OF EXPERIENCE

Over thirty five 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	-Principal, 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

Andrew Campbell, P.Eng.

Explotech Engineering Ltd.

EDUCATION & QUALIFICATIONS

Bachelor of Engineering,
Mechanical Engineering, Carleton University

Advanced and Expert (Industry) CadnaA Modelling
DataKustik, Mississauga, Ontario

PROFESSIONAL AFFILIATIONS

Professional Engineers of Ontario (PEO)
Engineers and Geoscientists British Columbia (EGBC)
International Society of Explosive Engineers (ISEE)

SUMMARY OF EXPERIENCE

An engineer working for Explotech Engineering Ltd., Andrew holds a Bachelor of Engineering degree in Mechanical Engineering and has strong analytical, technical, and interpersonal skills. A proven leader in collaborative environments, Andrew is comfortable managing projects, specifying details, and communicating internally and externally. With a focus on blast designs, blast impact analyses, noise monitoring and modelling, damage complaint investigations, vibration analysis, and blast monitoring, Andrew has applied these skills across Canada.

PROFESSIONAL RECORD

2018 – Present	- Engineer, Explotech Engineering Ltd.
2013 – 2018	- Technician / EIT, Explotech Engineering Ltd.
2012 – 2012	- Ride Technician, Canada's Wonderland

Matthew Czapalay, B.Eng.

Explotech Engineering Ltd.

EDUCATION

Bachelor of Engineering,
Mechanical Engineering, Carleton University

SUMMARY OF EXPERIENCE

A technician working for Explotech Engineering Ltd., Matthew holds a Bachelor of Engineering degree from Carleton University in Mechanical Engineering. Matthew has strong analytical, technical, and interpersonal skills. Recent projects have focused on blast monitoring, vibration analysis, job estimation, blast impact analysis, and equipment maintenance and repair.

PROFESSIONAL RECORD

2022 – Present - Technician, Explotech Engineering Ltd.

2019 – 2022 - Technical Assistant, M-CINC.

Appendix E

EXPLOTECH

Blasting Terminology

ANFO: Ammonium Nitrate and Fuel Oil – explosive product

ANFO WR: Water resistant ANFO

Blast Pattern: Array of blast holes

Body hole: Those blast holes behind the first row of holes (Face Holes)

Burden: Distance between the blast hole and a free face

Column: That portion of the blast hole above the required grade

Column Load: The portion of the explosive loaded above grade

Collar: That portion of the blast hole above the explosive column, filled with inert material, preferably clean crushed stone

Face Hole: The blast holes nearest the free face

Overpressure: A compressional wave in air caused by the direct action of the unconfined explosive or the direct action of confining material subjected to explosive loading.

Peak Particle Velocity: The rate of change of amplitude, usually measured in mm/s or in/s. This is the velocity or excitation of the particles in the ground resulting from vibratory motion.

Scaled distance: An equation relating separation distance between a blast and receptor to the energy (usually expressed as explosive weight) released at any given instant in time.

Sensitive Receptor: Sensitive land use may include recreational uses which are deemed by the municipality or provincial agency to be sensitive; and/or any building or associated amenity area (i.e. may be indoor or outdoor space) which is not directly associated with the industrial use, where humans or the natural environment may be adversely affected by emissions generated by the operation of a nearby industrial facility. For example, the building or amenity area may be associated with residences, senior citizen homes, schools, day care facilities, hospitals, churches and other similar institutional uses, or campgrounds.

Spacing:	Distance between blast holes
Stemming:	Inert material, preferably clean crushed stone applied into the blast hole from the surface of the rock to the surface of the explosive in the blast hole.
Sub-grade:	That portion of the blast hole drilled band loaded below the required grade
Toe Load:	The portion of explosive loaded below grade

EXPLOTECH

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