January 3, 2019

Freymond Lumber Ltd.
2287 Bay Lake Road
Bancroft, ON
K0L 1C0

Attention: Mr. Lou Freymond

Subject: Freymond Quarry Blast Impact Analysis
Response to William Hill Peer Review

Dear Mr. Freymond,

In response to the peer review performed by William Hill on behalf of the Quarry Awareness Research Group (QUARG) for the Freymond Quarry application Blast Impact Analysis (BIA) prepared by Explotech Engineering Ltd. (Explotech), we present the following clarifications.

Mr. Hill's report states that the BIA prepared by Explotech utilizes 6.5kg of explosives per meter of loaded column for the proposed initial blasting parameters. This is an incorrect statement, as the initial blasting parameters utilize a 0.0889m (3 ½") borehole diameter, a 7m (23') deep hole (1.5m (5') collar with 5.5m (18') column of loaded explosives) and an explosive density of 1.2g/cm^3. The volume of the loaded column is 0.034m^3, and when multiplied by the density (1200kg/m^3) provides 40.8kg of explosives. When divided by the 5.5m loaded column, Explotech has proposed 7.4kg of explosives per meter of loaded column versus the 6.5kg/m as suggested in Mr. Hill's technical review.

To address Mr. Hill's concern with regards to flyrock, the September 25, 2018 Blast Impact Analysis has been amended to include a section titled 'Flyrock'. The amended report can be found attached to this letter. The initial blasting parameters have been optimized to minimize the distance potential flyrock may be thrown. The hole depth has been increased from 7m to 8m, and the collar has been increased from 1.5m to 2.5m.

The explosives per meter of loaded column remain the same as the initial proposed blasting parameters (7.4kg/m). It is noteworthy that regulations and conditions of site plan approval at the quarry will impose a categoric restriction that all flyrock be contained within the quarry licence limits.

Mr. Hill states in his technical review that Explotech's choice of constants used when calculating estimated vibrations using the USBOM formula may not provide a sufficiently conservative representation of the vibration propagation through rock in the area of the proposed Freymond Quarry. To address this concern, Explotech has amended the 'Predicted Vibration Levels at the Nearest Sensitive Receptor' section of the September 25, 2018 Blast Impact Analysis to utilize a variety of industry standards and proprietary formulae. These ten (10) imperial and metric equations accommodate a range of geological conditions and provide a complete analysis into the potential vibrations imparted on the nearest sensitive receptors utilizing the proposed initial blasting parameters.

Attached please find a copy of the amended September 25, 2018 Blast Impact Analysis for the Freymond Quarry, dated January 3, 2019. We trust the foregoing addresses the comments raised by Mr. Hill on behalf of QUARG with regards to the Freymond Quarry. We remain available to expand on the comments made as required.

Best regards,

Andrew Campbell, P. Eng.

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Blast Impact Analysis
Freymond Quarry
Part of Lots 51 & 51, Concession W.H.R.
Township of Faraday
County of Hastings

Submitted to:

Freymond Lumber Ltd.
2287 Bay Lake Road
Bancroft, ON
K0L 1C0

LICENSED PROFESSIONAL ENGINEER
A. M. CAMPBELL
100209604
PROVINCE OF ONTARIO

Prepared by

Explotech Engineering Ltd.
58 Antares Drive, Unit 5
Ottawa, Ontario
K2E 7W6

January 3, 2019

EXPLOTECH

EXECUTIVE SUMMARY

Explotech Engineering Ltd. was retained in February 2014 to provide a Blast Impact Analysis for the proposed Freymond Quarry located on Part Lots 51 & 52, Concession W.H.R., Township of Faraday, County of Hastings.

Vibration levels assessed in this report are based on the Ontario Ministry of the Environment, Conservation and Parks (MECP) 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 license with regard to potential damage from blasting operations and compliance with the aforementioned by-law document.

We have inspected the property and reviewed the available site plans. Explotech is of the opinion that the planned aggregate extraction on the proposed property can be carried out safely and within MECP 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 to ensure that no possibility of damage exists to any buildings, water wells, structures or facilities surrounding the property.

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INTRODUCTION

Freymond Lumber Ltd. (Freymond) are applying for a Class A, Category 2 Licence for the property legally described as Part Lots 51 & 52, Concession W.H.R., Township of Faraday, County of Hastings. 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).

The land surrounding the proposed Freymond Quarry is a mixture of rural, industrial, environmental protection, rural residential, cemetery and commercial land uses. The site is currently zoned Rural and Industrial.The proposed Freymond Quarry operation is bounded by scrub brush and Bay Lake Road to the South, Gaebel Road and scrub brush to the West, properties fronting onto Jeffery Lake Road to the North and properties fronting onto Bay Lake Road and Highway 62 to the East. The property is accessed via a private haulage road off of Bay Lake Road.

This Blast Impact Analysis has been prepared based on the Ontario 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 license with regard to potential damage from blasting operations.

Given that 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 comprehensive 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.

Recommendations are included in this report to ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility of damage exists to any buildings, water wells, structures or residences surrounding the property.

As part of the preparation of this report, the following additional information was taken into consideration:

- Comments received at the June 25th Public Open House;
- Comments received by the County on July 1, 2015 from Steve Gaebel;
- Letter received by the County on July 14, 2015 from Tara McMurtry, Adrianne Schutt and Daisy McCabe-Lokos;
- Email received by the County on September 16, 2015 from Sheila and Mike Schneider.
- Email received by MHBC on October 14, 2015 from the County regarding blasting.
- Valcoustics peer review dated June 26, 2017.
- Peer review report written by William Hill prepared on behalf of Peter Wagner and QUARG (Quarry Awareness Research Group) dated November 14, 2018.

EXISTING CONDITIONS

The licenced area for the proposed Freymond Quarry encompasses a total area of approximately 33.3ha and an extraction area of approximately 27.8ha. The site is broken into four (4) distinct extraction phases (Refer to Appendix A Operational Plan). The Phase 1 extraction area lies in the Northeast portion of the proposed licence area and involves bringing the existing landscape down to an average ground level of 333 - 336masl. The Phase 2 area of the licence area involves excavation of the Northwest portion of the proposed licence to proposed elevation 337-338masl. The Phase 3 area of the licence area involves excavation of the Southwest portion of the proposed licence to proposed final elevation 337-340masl. The Phase 4 area of the licence involves excavation of the Southeast portion of the proposed licence to proposed elevation 334-336masl.

The topography of the proposed licence area is generally lowest in the East portion of the site at an elevation in the order of 335masl rising towards the West with the highest elevations (392masl) lying at the interface between Phase 2 and Phase 3. A ridge rises in the middle portion of the site to an elevation of approximately 389m.

The lands surrounding the proposed licence area are largely characterized by undeveloped natural vegetation and forested areas with the closest sensitive receptors lying to the South of the limits of extraction along Bay Lake Road, to the North along Jeffrey Lake Road, to the East along Highway 62 and Bay Lake Road, and to the West along Gaebel Road.

The land immediately to the North is predominantly natural vegetation and forest and an existing Class B gravel pit currently owned by the proponent but excluded from the licence application. Sensitive receptors further North along Jeffrey Lake Road lie in excess of 400m North of the limits of extraction. A cemetery lies Northeast of the extraction footprint.

The land immediately to the East is also owned by the proponent, but excluded from the licence application, and currently includes the Freymond Lumber Ltd. operation. Bay Lake Road and Highway 62 lie approximately 200m and 300m respectively East of the site and house several sensitive receptors.

The land immediately to the South is owned by the proponent, but excluded from the licence application, and consists predominantly of natural vegetation and forest. The closest sensitive receptors to the South front onto Bay Lake Road in excess of 300m removed from the limits of extraction.

The land to the West is privately owned and is predominantly natural vegetation and forest. One sensitive receptor fronting onto Gaebel Road is located 100m Northwest of the limit of extraction.

PROPOSED AGGREGATE EXTRACTION

The proposed initial quarry operations will involve extraction in the Phase 1 area with extraction initiated at the Northeast base of the existing escarpment and retreating towards the Southwest corner of the Phase 1 area. Phase 1 extraction will take place to approximate elevation 333masl – 336masl with the existing topography eliminating the need for a sinking cut. Initial blasting will be located approximately 750m from the closest sensitive receptor behind the blast, namely 342 Gaebel Road, and 250m from the closest current occupied sensitive receptor in front of the blast, 2344 Bay Lake Road. Please note that 2353 Bay Lake Road is owned by the proponent and will not qualify as a sensitive receptor upon commencement of blasting operations. Based on existing Phase 1 elevations in the order of 339 – 387masl, this phase of extraction will take place in 1 – 2 benches.

Extraction in Phase 2 will leverage the existing Phase 1 West boundary face. Blasting shall commence at the Phase 1 / Phase 2 interface thereby eliminating the need for a sinking cut. Extraction will retreat in a general West and South direction to a final design floor elevation of 337masl – 338masl. Based on Phase 2 maximum elevations in the order of 392masl, this phase of extraction will take place in 1 - 2 benches.

Extraction in Phase 3 will leverage the existing Phase 2 South boundary face. Blasting shall commence at the Phase 2 / Phase 3 interface thereby eliminating the need for a sinking cut. Extraction will retreat in a general South and East direction to a final design floor elevation of 337masl – 340masl. Based on Phase 3 maximum elevations in the order of 391masl, this phase of extraction will take place in 1 - 2 benches.

Extraction in Phase 4 will leverage the existing Phase 3 East boundary face and the existing Phase 1 South boundary face. Blasting shall commence at the Phase 3 / Phase 4 interface thereby eliminating the need for a sinking cut. Extraction will retreat in a general East direction to a final design floor elevation of 334masl – 336masl. Based on Phase 4 maximum elevations in the order of 387masl, this phase of extraction will take place in 1 – 2 benches.

As previously noted, benching shall be employed as required so as to limit the size of blasts conducted. Quarrying operations on varied phases and benches may be ongoing concurrently throughout the life of the quarry.

As quarry operations migrate across the property, the closest sensitive receptors to the required blasting operations will vary with the governing structures and approximate closest separation distances being as follows:

- Northwest corner: 342 Gaebel Road - 100m
- Southwest corner: 431 Gaebel Road - 450m
- South central corner: 2204 Bay Lake Road - 250m
- East central corner: 27915 Highway 62 - 265m
- Northeast corner: 2344 Bay Lake Road - 250m

As noted above, the closest sensitive receptor to the initial blast is located approximately 750m and 250m (back and front respectively) removed from the blast. Initial blasting will involve a reduced bench height given the retreat from the base of the escarpment up the slope towards the West and South.

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.

BLAST VIBRATION AND OVERPRESSURE DATA

Blast vibration and overpressure data used in this report was collected from an amalgamation of quarries and mines throughout Ontario. All ground vibration data was plotted using square root scaling from blast vibrations (Refer to Appendix C for a sample plot of data).

Overpressure data was plotted employing cube root scaling (Refer to Appendix C for a plot of data). It should again be noted that given the high dependence on local environmental conditions, overpressure prediction is far less reliable as a means of blast control.

Our experience and analysis demonstrates that blast overpressure is greatest when blasting toward residences, and blast vibrations are greatest when retreating towards the residences.

INITIAL BLASTING PARAMETERS

Blast Pattern:	1800mm x 1800mm to 3300mm x 3300mm
Number of holes:	Varies
Hole depth:	5 – 15m
Hole Diameter:	76 to 152mm
Stemming:	Clearstone
Toe Load:	Cast Booster / Cartridge
Column Load:	ANFO / ANFO WR / Emulsion
Maximum Charge per hole:	Varies with cut depth
Total Explosives per blast:	Varies with blast size
Material being blasted:	Precambrian bedrock
Tonnage per blast:	Varies
Number of blasts per year	Anticipated 3 – 5 blasts per year but actual blast requirements will vary with production required

The above parameters provide initial guidance to direct blasting operations. Upon the commencement of blasting on site, these parameters will require revision based on site-specific data obtained and attenuation equations developed required as a recommendation of this report.

While initial operations and in fact the majority of required blasting will be performed at extended distances from the closest sensitive receptors, blasting along the extraction limit perimeters will come within approximately 100m of some residences bordering the property. Data collected on-site during blasting operations will be continually analyzed and designs adjusted accordingly to ensure compliance with applicable guideline limits for ground vibration and overpressure.

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 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 though the air, measured in decibels (or dB) 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 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.

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 demonstrates that blast overpressure is greatest when blasting toward receptors, and blast vibrations are greatest when retreating in the direction of the receptor.

PREDICTED VIBRATION LEVELS AT THE NEAREST SENSITIVE RECEPTOR

The most commonly used formula for predicting PPV is known as 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 calculated 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 is highly 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 750m (the standoff distance to the closest existing sensitive receptor behind the blast for the initial blasting) and a maximum explosives load per delay of 41kg (88.9mm diameter hole, 8m deep, 2.5 meter surface collar and 1 hole per delay), we can calculate the maximum PPV at the closest building 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 2.1mm/s for the initial blasting, well 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.

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 6dBL for every doubling of distance.

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

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

Where, PSPL = the peak sound pressure level particle velocity (dBL)
K, e = site factors
d = distance from receptor (m)
w = maximum explosive charge per delay (kg)

Data collected at various Ontario quarries were used to develop the following 95% regression equation (refer to Appendix C). The values for "e" and “K” have been established at -0.0456 and 159 respectively based on the collected empirical data.

$$PSPL = 159\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.0456}$$

As discussed in previous sections, the MECP guideline for blast-induced overpressure is 128dBL. For a distance of 250 m (i.e. the standoff distance to the closest existing sensitive receptor in front of the blast for the initial blasting) and a maximum explosive load per delay of 41kg (88.9mm diameter hole, 8m deep, 2.5 meter collar, one hole per delay), we can calculate the PSPL at the nearest receptor in front of the blast to be at or below 130.8dBL.

Based on this calculation and the assumed blast parameters, blasting from the initial operations may marginally exceed the MECP NPC 119 guideline limit of 128dBL. The above equation suggests that the explosive load per delay will need to be maintained at or below 5kg in order to remain compliant with guideline limits for overpressure. This can be accomplished by reducing the bench height, decking holes for blasting along the eastern extraction limit, or blasting when environmental conditions are favourable. Once blasting has progressed sufficiently West (ie thereby increasing the separation distance between the blast and the receptor at 2344 Bay Lake Road) or face orientation has been rotated to a southerly retreat, it will be possible to increase the load per delay while still maintaining compliance with guideline overpressure 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, Environment 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:

$$L_{H\max} = \frac{V_o^{\,2}}{g} \qquad [2]$$

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: $$L_{H\max} = \frac{k^2}{g} * \left(\frac{\sqrt{m}}{SH}\right)^{2.6} Sin2\theta$$

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 initial blasting parameters which utilize 89mm (3 ½") diameter holes on a 2.6m x 2.6m (8.5' x 8.5') pattern, with a lift height of up to 8m (26') and a collar length of 2.5m (8').

The range for the constant k is 13.5 for soft rocks and 27 for hard rocks. Given the proposed licence area is predominantly granite, 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).

The maximum horizontal throw for the flyrock using a varied collar is shown in Table 1 below.

Table 1 – Maximum Flyrock Horizontal		
***Collar* Lengths** (m)	**Maximum Throw Face Burst** (m)	**Maximum Throw Cratering and Stemming Ejection** (m)
1.5	85	354
2.0	85	167
2.5	85	94
3.0	85	58
3.5	85	39

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.

The current proposed initial blasting parameters have the potential to send flyrock 94m in front of the blast assuming all holes achieve the designed collar lengths of 2.5m. This will keep the flyrock contained within the quarry limits and closer than the nearest sensitive receptor, 2344 Bay Lake Road, located roughly 250m in front of the initial blasting operations. Blast mats or sand can be placed on top of the shot to further reduce the distance for potential flyrock.

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 deportation distance to receptors and to ensure flyrock remains within the property limits. The operational plan for the quarry has been designed to retreat towards the closest receptors thereby projecting flyrock and overpressures away from the receptors.

RESIDENTIAL WATER WELLS

Possible impacts to the water quality and production capacity of groundwater supply wells is a common concern 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. Unfortunately, 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. 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.

Rose et al. (1991) studied the effect of blasting in close proximity to water wells near an open pit mine in Nevada, USA. Blasts of up to 70 kilograms of explosives per delay period were detonated at a distance of 75 meters (245 feet) from a deep water well. There was no reported visible damage to the well. Fluctuations in water level and flow rate were evident immediately after the blast. However, the well water level and flow rate quickly stabilized.

The U.S. Bureau of Mines conducted a study (Robertson et al., 1990) to determine the changes in well capacity and water quality. This involved pumping from wells before and after nearby blasting. One experiment with a well in sandstone showed no change in well capacity after blasts induced PPV's at the surface of 84mm/s and there was no change in water level after PPV's of 141mm/s, well above the current guideline limit of 12.5mm/s.

Matheson et al. (1997) brought together available information on the most common complaints, the possible causes of the complaints and the relation between blasting and the complaint causes. This study yet again reaffirmed the fact that the attribution of well problems to blast sources are unfounded.

The MECP vibration limit of 12.5mm/s effectively excludes any possibility of damage to residential water wells. Based on available research and our extensive experience in Ontario quarry blasting, blasting at the Freymond Quarry will induce no permanent adverse impacts on the residential water wells at properties surrounding the site.

BLAST IMPACT ON ADJACENT WATERCOURSES

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.

The Natural Environment study prepared for the application indicated that there are fish present in the adjacent watercourses on the property or in the study area which includes a minimum separation distance of 75m along the Southeastern boundary of the existing and proposed extension lands. Based on this separation distance, water overpressures generated by the blasting will reside below the DFO 100kPa guideline limit and will have no impact on the adult fish populations present.

The fish species identified in the adjacent watercourse/open water portions of the wetlands could be utilizing any of the vegetation that proliferates through the system as spawning beds. The spawning time for the identified fish species in the adjacent watercourses has been established from September 1 – June 15. The spawning beds present within a 75m radius surrounding the Southeastern portion of the quarry would be subject to the DFO vibration limit of 13mm/s while active. During spawning season, vibration monitoring will be required at the shoreline adjacent the spawning area, or closer to the blast, in order to ensure compliance with DFO limits for ground vibration.

Table 1 below is presented as an initial guide 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 spawning bed:

Separation distance between possible spawning bed and closest borehole (meters)	Maximum recommended explosive load per delay (Kilograms)
500	278
450	225
400	178
350	137
300	100
250	70
200	45
150	25
100	12
75	7
50	3
30	1

Table 1: 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 Freymond 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 will be used to confirm the applicability of the initial guideline parameters and assist in developing future blast designs.

2. 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.

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

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

5. 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 current applicable guidelines and regulations. Decking, reduced hole diameters and sequential blasting techniques will be used to ensure minimal explosives per delay period initiated.

6. Clear crushed stone will be used for stemming

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

8. Blasts shall be designed to restrict flyrock to the quarry limits. Blasting mats or sand cover will be employed as necessary to further restrict flyrock projection.

9. Detailed blast records shall be maintained. The MECP (1985) recommends that the body of blast reports should include the following information:

    - Location, date and time of the blast.
    - Dimensional sketch including photographs, if necessary, of the location of the blasting operations, and the nearest point of reception.
    - Physical and topographical description of the ground between the source and the receptor location.
    - Type of material being blasted.
    - Sub-soil conditions, if known.
    - Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in °C, relative humidity, degree of cloud cover and ground moisture content.
    - Number of drill holes.
    - Pattern and pitch of drill holes.
    - Size of holes.
    - Depth of drilling.
    - Depth of collar (or stemming).
    - Depth of toe-load.
    - Weight of charge per delay.
    - Number and time of delays.
    - The result and calculated value of Peak Pressure Level in dB and Peak Particle Velocity in mm/s.
    - Applicable limits and any exceedances.

CONCLUSION

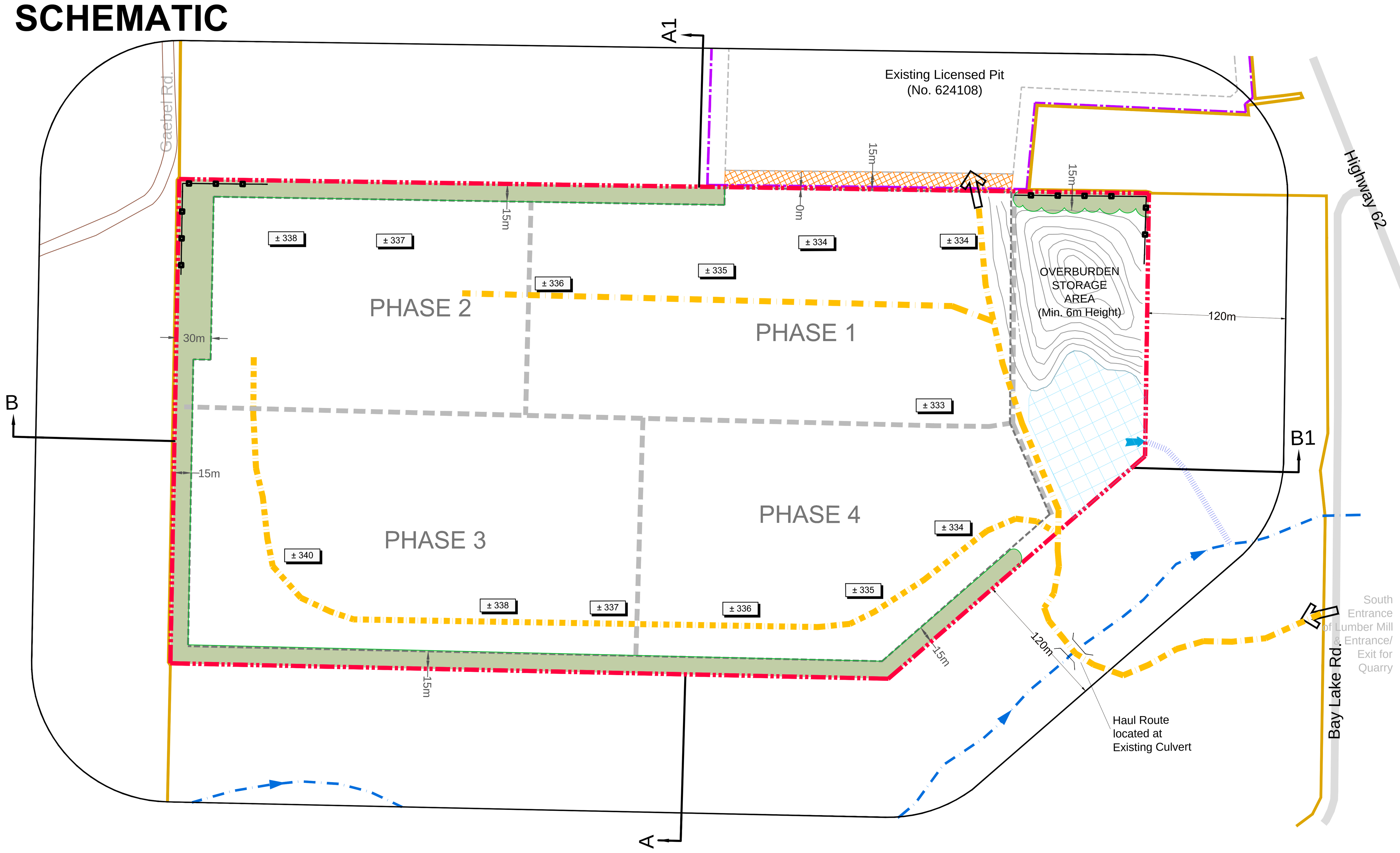
The blast parameters described within this report will provide a good basis for the initial blasting operations at this location. As site specific blast vibration and overpressure data becomes available, it will be possible to refine these parameters on an on-going basis.

Blasting operations required for operations at the proposed Freymond Quarry site can be carried out safely and 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.

Appendix A

Operation Plan - DRAFT
SCHEMATIC



HOURS OF OPERATION

1. SITE PREPARATION, REHABILITATION, EXTRACTION, DRILLING AND PROCESSING IS PERMITTED FROM 7:00AM TO 5:30PM (MONDAY TO FRIDAY).
2. SHIPPING IS PERMITTED FROM 6:00AM TO 7:00PM (MONDAY TO FRIDAY) AND ON SATURDAYS FROM 7:00AM TO 12:00PM.
3. BLASTING IS PERMITTED FROM 8:00AM TO 5:30PM (MONDAY TO FRIDAY) PROVIDED IT IS DAYLIGHT.
4. THERE WILL BE NO OPERATIONS ON SUNDAYS AND STATUTORY HOLIDAYS AS DEFINED IN ACCORDANCE WITH THE EMPLOYMENT STANDARDS ACT.

MAXIMUM ANNUAL TONNAGE LIMIT

5. THE MAXIMUM AMOUNT OF MATERIAL THAT MAY BE SHIPPED FROM THIS LICENCE IN ANY CALENDAR YEAR SHALL BE 300,000 TONNES.

SEQUENCE OF EXTRACTION / EXTRACTION SETBACKS

6. THE AREA TO BE EXTRACTED IS 27.5HA (68.0AC).
7. EXTRACTION SETBACKS ARE SHOWN AND LABELLED ON THE OPERATION SCHEMATIC (SEE SITE PLAN OVERRIDES 1.2.25 (SEC. 5.10) THIS PAGE).
8. EXTRACTION OF THE SITE IS PROPOSED IN FOUR PHASES AND WILL OCCUR SEQUENTIALLY TO MINIMIZE THE DISTURBED AREAS. SEE CONCEPTUAL PHASING SCHEMATICS.
9. EXTRACTION WILL COMMENCE IN THE NORTH-EASTERN PORTION OF THE SITE (PHASE 1) AND WILL PROCEED WEST TO THE NORTH-WESTERN PORTION OF THE SITE (PHASE 2).
10. EXTRACTION WILL THEN PROCEED SOUTH TO THE SOUTH-WESTERN PORTION OF THE SITE (PHASE 3) PRIOR TO PROCEEDING EAST TO THE SOUTH-EASTERN PORTION OF THE SITE (PHASE 4).
11. EXISTING VEGETATION WITHIN THE SETBACKS WILL BE MAINTAINED EXCEPT WHERE REQUIRED FOR OVERBURDEN STORAGE IN THE NORTHEAST CORNER OF THE SITE, CONSTRUCTION OF THE STORMWATER MANAGEMENT POND, AND THE INTERNAL HAUL ROAD. SEE OPERATIONS SCHEMATIC FOR THE LOCATION OF THESE ACTIVITIES.

BENCH HEIGHTS / MAXIMUM DEPTH OF EXTRACTION

12. EXTRACTION WILL TAKE PLACE IN ONE OR TWO BENCHES. THE MAXIMUM BENCH HEIGHT WILL NOT EXCEED MINISTRY OF LABOUR REQUIREMENTS.
13. WHERE A SECOND BENCH IS REQUIRED APPROXIMATELY A 5 M LEDGE WILL REMAIN. SEE QUARRY FACE DETAIL PAGE 3 OF 3.
14. THE MAXIMUM DEPTH OF EXTRACTION IS +/-333 M.A.S.L. AS INDICATED BY PROPOSED SPOT ELEVATIONS AS SHOWN ON THE OPERATION SCHEMATIC.

INTERNAL HAUL ROUTES AND ENTRANCE / EXIT

15. THE MAIN INTERNAL HAUL ROUTES ARE APPROXIMATELY SHOWN ON THE OPERATION SCHEMATIC AND MAY BE DEVELOPED DURING SITE PREPARATION. THE NORTHERN INTERNAL HAUL ROUTE IS TO TRANSFER AGGREGATE FROM THE PROCESSING AREA TO THE ENTRANCE / EXIT AND WILL BE LOCATED ON THE QUARRY FLOOR. THE SOUTHERN INTERNAL HAUL ROUTE IS FOR THE PURPOSE OF SITE PREPARATION AND WILL OCCUR AT GRADE.
16. THERE WILL BE ADDITIONAL INTERNAL HAUL ROUTES ON THE QUARRY FLOOR WITHIN EACH PHASE TO ACCESS THE ACTIVE EXTRACTION AREAS AND THE PROCESSING PLANT.
17. ENTRANCE/EXITS ARE SHOWN ON THE OPERATION SCHEMATIC. AGGREGATE WILL BE TRANSFERRED FROM THE LICENSED AREA TO THE FREYMOND LUMBER YARD FOR SHIPPING.
18. AGGREGATE RESOURCES FROM THE CLASS B LICENSE LOCATED TO THE NORTH MAY ALSO BE TRANSFERRED THROUGH THE LICENSED AREA TO THE FREYMOND LUMBER YARD FOR SHIPPING.

BUILDING / STRUCTURES

19. OTHER THAN THE PROCESSING PLANT NO BUILDINGS ARE TO BE ERECTED ON-SITE.

PROCESSING PLANT / OTHER ON-SITE EQUIPMENT

20. A PROCESSING PLANT IS PERMITTED WITHIN PHASES 1 AND 2 (INCLUDES PRIMARY, SECONDARY AND TERTIARY CRUSHING AND SCREENING UNITS WITH AN ASSOCIATED DIESEL GENERATOR). WITHIN PHASE 1, PROCESSING IS PERMITTED WITHIN THE EXTRACTION LIMIT. WITHIN PHASE 2, PROCESSING IS PERMITTED WITHIN THE EXTRACTION LIMIT EXCEPT WITHIN 90 M OF THE WESTERN LICENSE BOUNDARY. THERE WILL BE NO PROCESSING IN PHASES 3 AND 4.
21. THE PROCESSING PLANT SHALL IMPLEMENT THE MITIGATION MEASURES OUTLINED IN SECTION 7.0.3 OF THE NOISE STUDY (SOURCE: HUGH WILLIAMSON ASSOCIATES INC., ___2016) TO ENSURE MOECC NOISE LIMITS ARE MET FOR SURROUNDING RESIDENTS.
22. THE OVERBURDEN STORAGE AREA IN THE NORTHEAST CORNER OF THE SITE SHALL BE BUILT DURING SITE PREPARATION OF PHASE 1 TO A MINIMUM HEIGHT OF 6 METRES AND BE MAINTAINED FOR THE DURATION OF OPERATIONS TO SERVE AS A NOISE BARRIER FOR THE SENSITIVE RECEPTORS TO THE EAST. WHEN EXTRACTING PHASE 4, THE BENCH HEIGHT TO THE EAST IS TO BE MAINTAINED AT A MINIMUM HEIGHT OF 6 METRES TO SERVE AS A NOISE BARRIER TO THE SENSITIVE RECEPTORS TO THE EAST. IF REQUIRED, OVERBURDEN OR A NOISE BARRIER MAY BE UTILIZED TO ACHIEVE REQUIRED HEIGHTS. EXAMPLES OF SUITABLE NOISE BARRIERS ARE OUTLINED IN SECTION 7.0.6 D) OF THE NOISE STUDY (SOURCE: HUGH WILLIAMSON ASSOCIATES INC., ____2016).
23. OTHER EQUIPMENT ON-SITE MAY INCLUDE ROCK DRILLS, LOADERS, QUARRY TRUCKS, HAULAGE TRUCKS, AND EQUIPMENT FOR SITE PREPARATION AND REHABILITATION INCLUDING BUT NOT LIMITED TO EXCAVATORS, HYDRAULIC SHOVELS AND DOZERS.
24. EQUIPMENT USED FOR SITE PREPARATION AND REHABILITATION SHALL COMPLY WITH MOECC PUBLICATION NPC-115.
25. THE ROCK DRILLS SHALL IMPLEMENT THE MITIGATION MEASURES OUTLINED IN SECTION 7.0.1 AND 7.0.2 OF THE NOISE STUDY (SOURCE: HUGH WILLIAMSON ASSOCIATES INC., _____ 2016) TO ENSURE MOECC LIMITS ARE MET FOR SURROUNDING RESIDENTS.
26. TECHNICAL ADVANCEMENTS IN EXTRACTION METHODS, PROCESSING EQUIPMENT, DRILLS, QUARRY TRUCKS, LOADERS AND OTHER EQUIPMENT MAY ALLOW FOR ALTERNATIVE MITIGATION APPROACHES TO BE IMPLEMENTED SUBJECT TO THE LICENSEE CONFIRMING THAT MOECC NOISE LIMITS ARE MET FOR SURROUNDING RESIDENTS.
27. IF AN OPERATIONAL CHANGE IS CONSIDERED THAT HAS A POTENTIAL TO INCREASE NOISE LEVELS, THEN THIS CHANGE SHALL BE ASSESSED BY A QUALIFIED ACOUSTICAL CONSULTANT AND NOISE MITIGATION MEASURES SHALL BE REVIEWED, AND ALTERED IF NECESSARY, TO ENSURE THAT MOECC SOUND LEVEL LIMITS ARE MET FOR SURROUNDING RESIDENTS.

BLASTING

28. THE LICENSEE SHALL MONITOR ALL BLASTS FOR GROUND VIBRATIONS AND OVERPRESSURE AT THE CLOSEST PRIVATELY OWNED RESIDENTS TO ENSURE COMPLIANCE WITH CURRENT PROVINCIAL VIBRATION AND OVERPRESSURE STANDARDS. A MINIMUM OF ONE MONITOR SHALL BE INSTALLED IN FRONT OF THE BLAST AND ONE INSTALLED BEHIND THE BLAST.
29. AN ATTENUATION STUDY SHALL BE UNDERTAKEN BY AN INDEPENDENT BLASTING CONSULTANT DURING THE FIRST 12 MONTHS OF OPERATION TO ASSIST IN DEVELOPING FUTURE BLAST DESIGNS.
30. THE EXTRACTION FACE SHALL BE ORIENTATED SO THE DIRECTION OF THE OVERPRESSURE PROPAGATION IS AWAY FROM STRUCTURES AS MUCH AS POSSIBLE.
31. BLAST DESIGNS SHALL BE CONTINUALLY REVIEWED AND MODIFIED AS REQUIRED TO ENSURE COMPLIANCE WITH CURRENT PROVINCIAL STANDARDS.

AGGREGATE STOCKPILES / RECYCLED AGGREGATE

32. AGGREGATE STOCKPILES AND RECYCLABLE ASPHALT MAY OCCUR WITHIN THE EXTRACTION AREA LOCATED ON THE QUARRY FLOOR (SEE SITE PLAN OVERRIDES 1.2.25 (SEC. 5.13) THIS PAGE).
33. RECYCLABLE ASPHALT MATERIALS WILL NOT BE STOCKPILED WITHIN 30 M OF ANY WATER BODY OR MAN-MADE POND OR WITHIN 2 M OF THE GROUNDWATER WATER TABLE ON THE QUARRY FLOOR.
34. ONCE THE AGGREGATE ON SITE HAS BEEN DEPLETED THERE WILL BE NO FURTHER IMPORTATION OF RECYCLABLE MATERIALS PERMITTED AND RECYCLING OPERATIONS WILL CEASE PRIOR TO FINAL REHABILITATION.

STORAGE OF TOPSOIL AND SUBSOIL

35. WITHIN THE LIMIT OF EXTRACTION, THE SITE WILL BE STRIPPED OF TOPSOIL AND SUBSOIL.
36. THE INITIAL TOPSOIL AND SUBSOIL STRIPPED IN PHASE 1, THE STORMWATER MANAGEMENT POND AND CONSTRUCTION OF THE INTERNAL HAUL ROAD MAY BE TRANSPORTED PERMANENTLY TO THE NORTHEAST CORNER OF THE SITE AS SHOWN ON THE OPERATIONS SCHEMATIC AND PLANTED WITH RED PINE AND MAINTAINED TO CONTROL EROSION. THIS OVERBURDEN AREA SHALL BE A MINIMUM HEIGHT OF 6 M AND NOT BE LOCATED WITHIN 15 M OF THE ADJACENT CEMETERY. (SEE SITE PLAN OVERRIDES 1.2.25 (SEC. 5.13) THIS PAGE).
37. THE REMAINING TOPSOIL AND SUBSOIL MAY BE STORED ANYWHERE WITHIN THE LIMIT OF EXTRACTION AND WILL BE USED IN REHABILITATION.
38. NO IMPORTATION OF FILL IS PERMITTED ON-SITE.

TIMBER RESOURCES

39. TIMBER RESOURCES WILL BE SALVAGED FOR USE IN THE FREYMOND LUMBER OPERATION. STUMPS AND BRUSH CLEARED DURING SITE PREPARATION MAY BE BURNED (SUBJECT TO NECESSARY LOCAL APPROVAL), MULCHED OR USED IN THE PROGRESSIVE REHABILITATION OF THIS SITE.

FENCING

40. THE SITE WILL BE FENCED WITH A 1.2 METRE PAIGE WIRE FENCE IN THE NORTH-EASTERN CORNER ADJACENT TO THE CEMETERY AND IN THE NORTH-WESTERN CORNER ADJACENT TO GAEBEL ROAD.
41. THE REMAINDER OF THE LICENSED BOUNDARY WILL BE DELINEATED BY MARKER POSTS.
42. FENCING AND MARKER POSTS WILL BE INSTALLED PRIOR TO THE COMMENCEMENT OF OPERATIONS (SEE SITE PLAN OVERRIDES 1.2.25 (SEC. 5.1 AND 5.2) THIS PAGE).

SCRAP AREA

43. TEMPORARY SCRAP STORAGE MAY BE LOCATED IN THE PROCESSING AREA AND SHALL BE REMOVED ON AN ON-GOING BASIS.

FUEL STORAGE

44. THERE WILL BE NO FUEL STORAGE LOCATED ON-SITE. EQUIPMENT WILL BE FUELLED BY FUEL TRUCKS OR AT THE ADJACENT FREYMOND LUMBER YARD.

ON-SITE WATER RESOURCES

45. THE EXISTING WATER TABLE ELEVATION ON THIS PROPERTY RANGES FROM +/-352 M.A.S.L. TO +/-376 M.A.S.L.
46. THE LICENSEE SHALL DESIGN A STORMWATER MANAGEMENT POND AND OBTAIN AN MOECC ENVIRONMENTAL COMPLIANCE APPROVAL FOR PERIODIC DISCHARGE OF WATER. MONITORING OF THE STORMWATER MANAGEMENT FACILITY SHALL BE COMPLETED IN ACCORDANCE WITH MOECC APPROVALS.
47. WITHIN THE ACTIVE EXTRACTION AREAS AND REHABILITATED PORTIONS OF THE QUARRY SURFACE AND GROUNDWATER WILL BE DIVERTED TO THE STORMWATER MANAGEMENT POND. THERE WILL BE NO ACTIVE PUMPING OF WATER OFF-SITE.
48. THE LICENSEE SHALL COMPLETE THE ON-SITE GROUNDWATER MONITORING PROGRAM AS OUTLINED IN SECTION 7.5 OF THE WATER RESOURCES REPORT (SOURCE: MTE CONSULTANTS INC., ________, 2016). THE RESULTS OF THE MONITORING PROGRAM SHALL BE PRESENTED IN AN ANNUAL WATER MONITORING REPORT SUBMITTED TO MNRF AND MOECC BY MARCH 31ST OF EACH CALENDAR YEAR.

OFF-SITE PRIVATE WATER WELLS

49. THE LICENSEE SHALL COMPLETE THE PRIVATE WELL MONITORING PROGRAM AS OUTLINED IN SECTION 7.5 OF THE WATER RESOURCES REPORT (SOURCE: MTE CONSULTANTS INC., ________, 2016). THE RESULTS OF THE MONITORING PROGRAM SHALL BE PRESENTED IN ANNUAL WATER MONITORING REPORT SUBMITTED TO MNRF AND MOECC BY MARCH 31ST OF EACH CALENDAR YEAR.
50. ALTHOUGH NO WELL IMPACTS ARE PREDICTED, IN THE EVENT OF A WELL COMPLAINT FROM SURROUNDING RESIDENTS THE LICENSEE SHALL IMPLEMENT THE WELL INTERFERENCE COMPLAINT RESPONSE PROCEDURE AS OUTLINED IN SECTION 7.1 OF THE WATER RESOURCES REPORT (SOURCE: MTE CONSULTANTS INC., ________, 2016) TO ENSURE THAT ANY WELL IMPACTED BY THE QUARRY IS REPLACED OR RESTORED AT THE EXPENSE OF THE LICENSEE.

SPILLS CONTINGENCY PLAN

51. A SPILLS CONTINGENCY PROGRAM WILL BE DEVELOPED PRIOR TO SITE PREPARATION AND AVAILABLE ON-SITE.

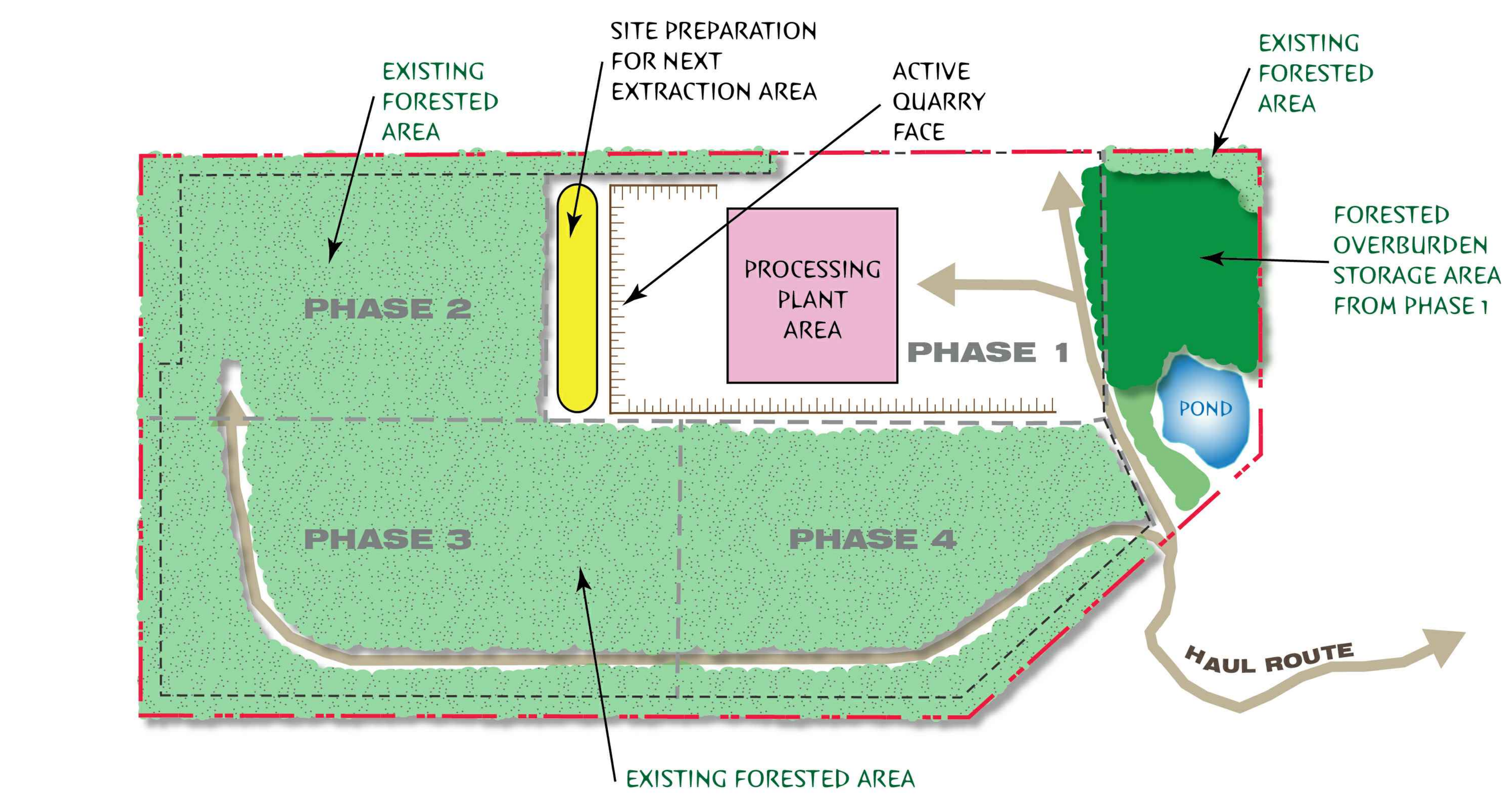
TREE REMOVAL

52. VEGETATION CLEARING SHALL BE CONDUCTED IN STAGES AND THE AREA CLEARED SHOULD BE MINIMIZED TO ONLY CLEAR THE AREA REQUIRED FOR FUTURE EXTRACTION NEEDS.
53. NO REMOVAL OF VEGETATION OR CLEARING OF LAND SHALL OCCUR FROM APRIL 1 TO JULY 31.

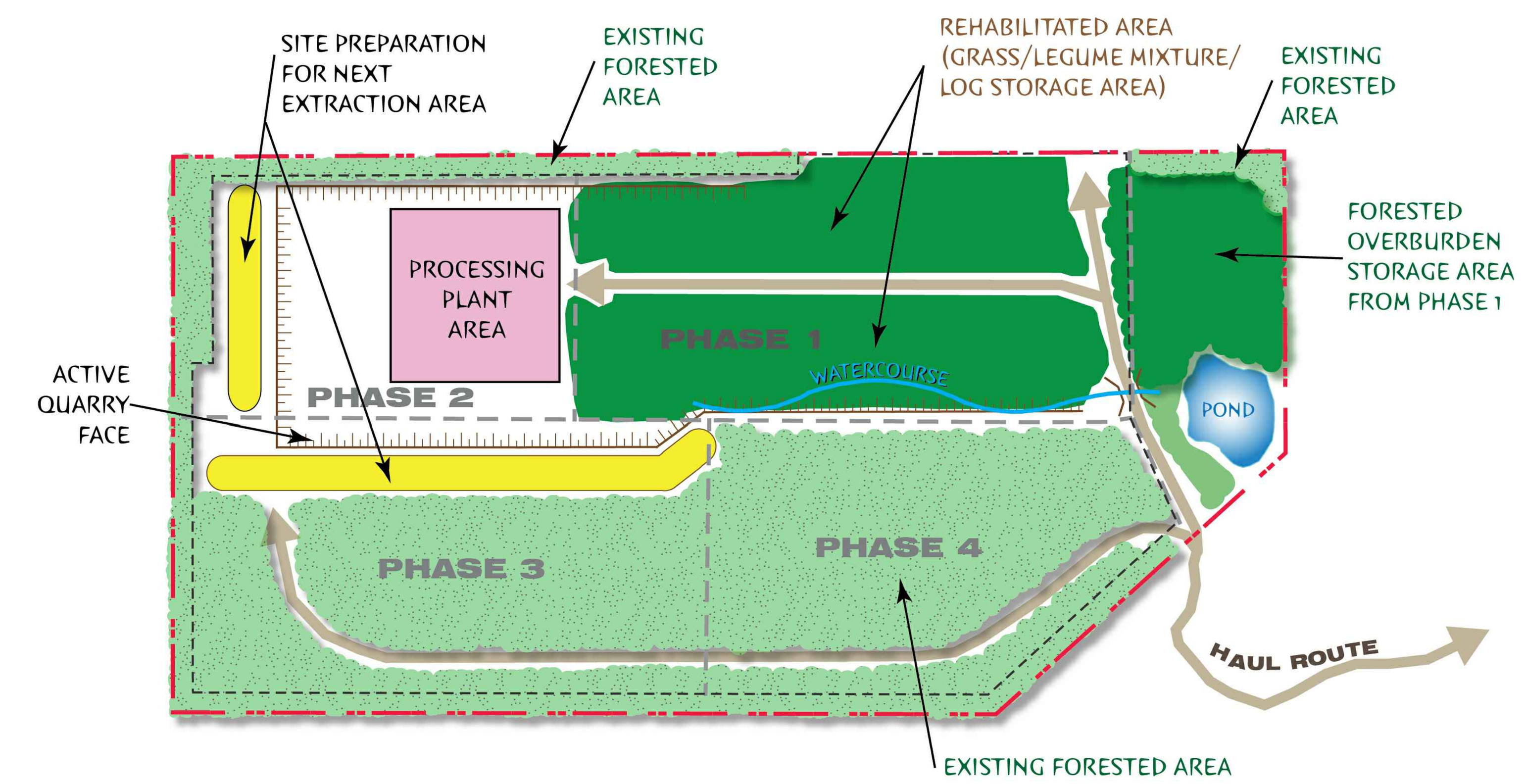
ARCHAEOLOGY

54. IN THE EVENT THAT DEEPLY BURIED ARCHAEOLOGICAL MATERIAL IS FOUND WHILE WORKING ON SITE, ALTERATION OF THAT AREA SHALL BE TEMPORARILY SUSPENDED AND THE MINISTRY OF TOURISM, CULTURE AND SPORT SHALL BE NOTIFIED IMMEDIATELY.
55. IN THE EVENT THAT HUMAN REMAINS ARE ENCOUNTERED WHILE WORKING ON SITE, ALTERATION OF THAT AREA SHALL BE TEMPORARILY SUSPENDED AND THE POLICE AND THE REGISTRAR OF CEMETERIES AT THE MINISTRY OF CONSUMER SERVICES MUST BE NOTIFIED IMMEDIATELY.

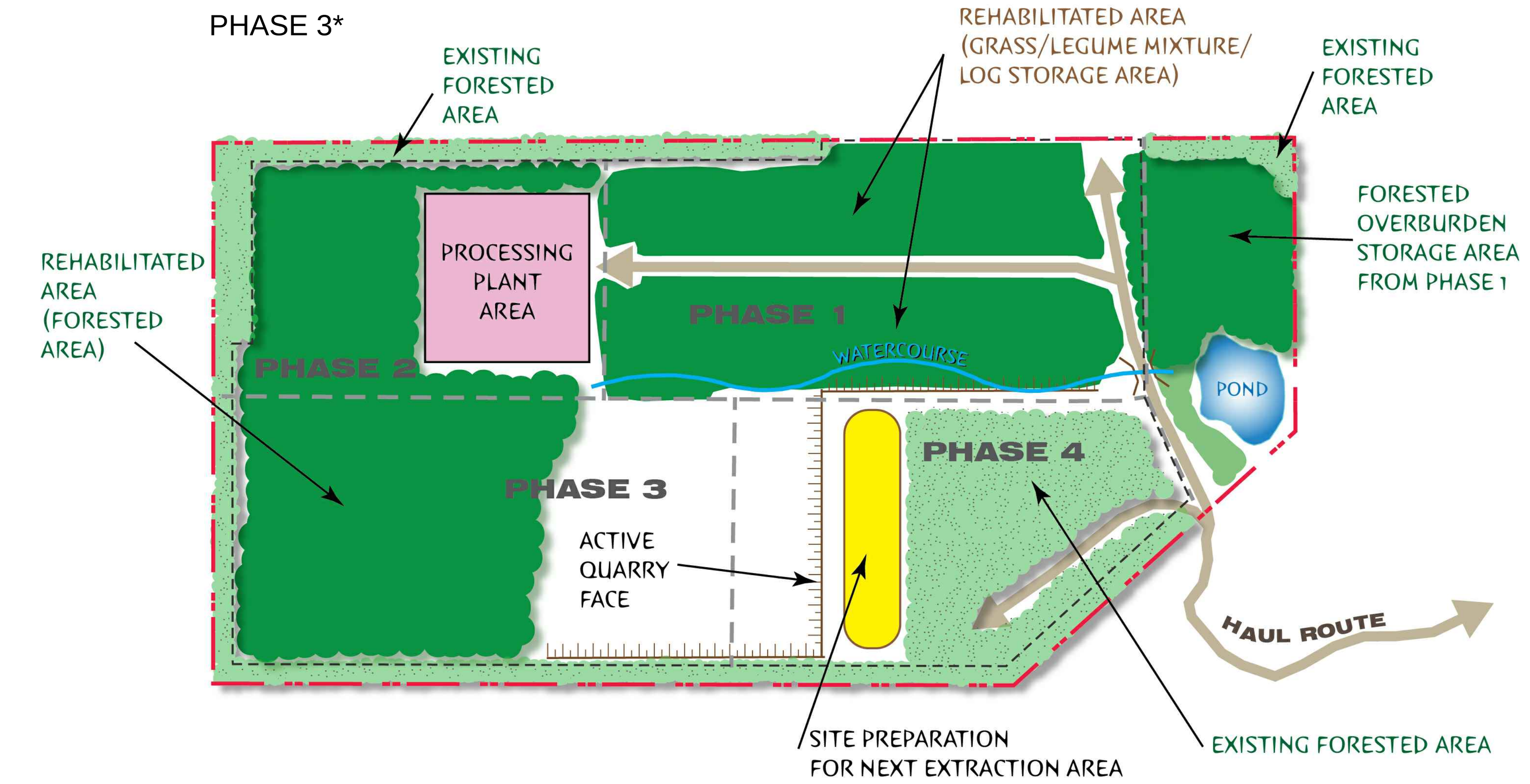
CONCEPTUAL PHASING PLAN
PHASE 1*



PHASE 2*



PHASE 3*



** THE CONCEPTUAL PHASING PLAN IS AN APPROXIMATE REPRESENTATION OF THE PROPOSED SEQUENCE OF OPERATIONS AND IS NOT TO SCALE.*

THE ESTIMATED RESERVE LOCATED WITHIN THE EXTRACTION LIMIT IS APPROXIMATELY 15,000,000 TONNES.
THE FOLLOWING TIMELINES REPRESENT THE DURATION OF EACH PHASE ASSUMING THE MAXIMUM LIMIT OF 300,000 TONNES IS EXTRACTED EACH YEAR:

- PHASE 1: 13 YEARS OF EXTRACTION
- PHASE 2: STARTS YEAR 14 OR LATER
- PHASE 3: STARTS YEAR 27 OR LATER
- PHASE 4: STARTS YEAR 44 OR LATER

VARIATIONS FROM OPERATIONAL STANDARDS

OPERATIONAL STANDARD	VARIATION
5.1	THE SITE WILL BE FENCED ONLY IN THE NORTH-EASTERN CORNER ADJACENT TO THE CEMETERY AND IN THE NORTH-WESTERN CORNER ADJACENT TO GAEBEL ROAD. SEE OPERATION SCHEMATIC FOR LOCATION. THE REMAINDER OF THE LICENCED BOUNDARY WILL BE DELINEATED BY MARKER POSTS.
5.2	A GATE WILL NOT BE REQUIRED AT THE ENTRANCE/EXIT BETWEEN LICENCE NO. 624108 AND THIS SITE.
5.10	EXCAVATION SETBACK ADJACENT TO LICENCE NO. 624108 WILL BE REDUCED TO 0M.
5.13	WITHIN PHASES 1 AND 2, AGGREGATE, TOPSOIL, OVERBURDEN AND RECYCLED AGGREGATE MAY BE LOCATED WITHIN THE LIMIT OF EXTRACTION. WITHIN PHASES 1 AND 2, PROCESSING IS PERMITTED WITHIN THE LIMIT OF EXTRACTION EXCEPT ALONG THE WESTERN LICENCE BOUNDARY WHERE A 90M SETBACK SHALL BE MAINTAINED. TO THE EAST OF PHASE 1, OVERBURDEN AND TOPSOIL MAY BE PLACED WITHIN THE LICENCE BOUNDARY, EXCEPT WITHIN 15 M OF THE CEMETERY. WITHIN PHASES 3 AND 4, AGGREGATE, TOPSOIL AND OVERBURDEN MAY BE PERMITTED WITHIN THE LIMIT OF EXTRACTION.
5.19.2	PORTIONS OF THE QUARRY FACE MAY REMAIN VERTICAL. SEE REHABILITATION PLAN AND QUARRY FACE DETAIL ON PAGE 3 OF 3.

Legal Description

PART OF LOTS 51 & 52,
CONCESSION W.H.R.
TOWNSHIP OF FARADAY
COUNTY OF HASTINGS

Legend

- Proposed Licensed Boundary
- Proposed Limit of Extraction
- Existing Licence Boundary
- Existing Limit of Extraction
- Boundary of Lands Owned by Applicant
- 120m from Licensed Boundary
- 1.2m Fencing
- Phase Boundary
- A A Cross-Section
- Entrance/Exit
- Existing Watercourse
- Surface Water Discharge Point
- Connection from Stormwater Management Pond to Existing Watercourse (Drainage Feature or Pipe)
- Paved Road
- ± 333 Proposed Quarry Floor Elevation (m.a.m.s.l.)
- Approximate Location of Internal Haul Route
- Approximate Location of Stormwater Management Pond
- Existing Vegetation to remain
- Area Subject to Separate ARA Site Plan Amendment to Reduce Setback from 15m to 0m

Site Plan Amendments

No.	Date	Description	By

MHBC
PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE
113 COLLIER STREET BARRIE, ON, L4M 1H2 | P: 705 728 0045 F: 705 728 2010 | WWW.MHBCPLAN.COM

MNRF Approval Stamp

Stamp: DRAFT

north

Project

FREYMOND AGGREGATES

FREYMOND LUMBER LTD.
RR#1, 2287 Bay Lake Road
Bancroft, Ontario K0L 1C0

MNRF Licence Reference No.

Pre-approval review:

Plan Scale 1:3000
Metres
0 25 50 100 150

Drawn By: L.H.
File No.: 1515B
Checked By: B.Z.
Date: November 7, 2016

File Name

OPERATION PLAN

Drawing No.

2 OF 3


169 Jeffrey Lake Road
2344 Bay Lake Road
Hastings Heritage Trail
27915 Highway 62
342 Gaeble Road
62
Gaebel Rd
Jeffrey Lake Rd
2258 Bay Lake Road
431 Gaebel Road
2204 Bay Lake Road
Quarry Rd
2001 Bay Lake Road
Bay Lake Rd
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Image © 2016 DigitalGlobe
Google Earth

Appendix B

Freymond Quarry

PREVAILING METEOROLOGICAL CONDITIONS

Medians provided by Environment Canada

Date	Wind Direction	Wind Velocity Km/h	Temperature (Deg Celsius)
January	W	11.9	-10.0
February	W	12.5	-14.0
March	W	12.4	-7.9
April	W	12.6	0.9
May	W	12.2	11.6
June	W	11.2	14.5
July	W	10.1	18.2
August	W	10.0	16.4
September	W	10.1	12.6
October	W	11.7	4.6
November	W	12.6	-1.1
December	W	11.7	-8.8

** Data is not available specifically for the proposed quarry location.
Nearest weather station is Killaloe/Bonnechere Airport in Killaloe, Ontario
** Data is based on averaged climate normals gathered 1955 – 1980.

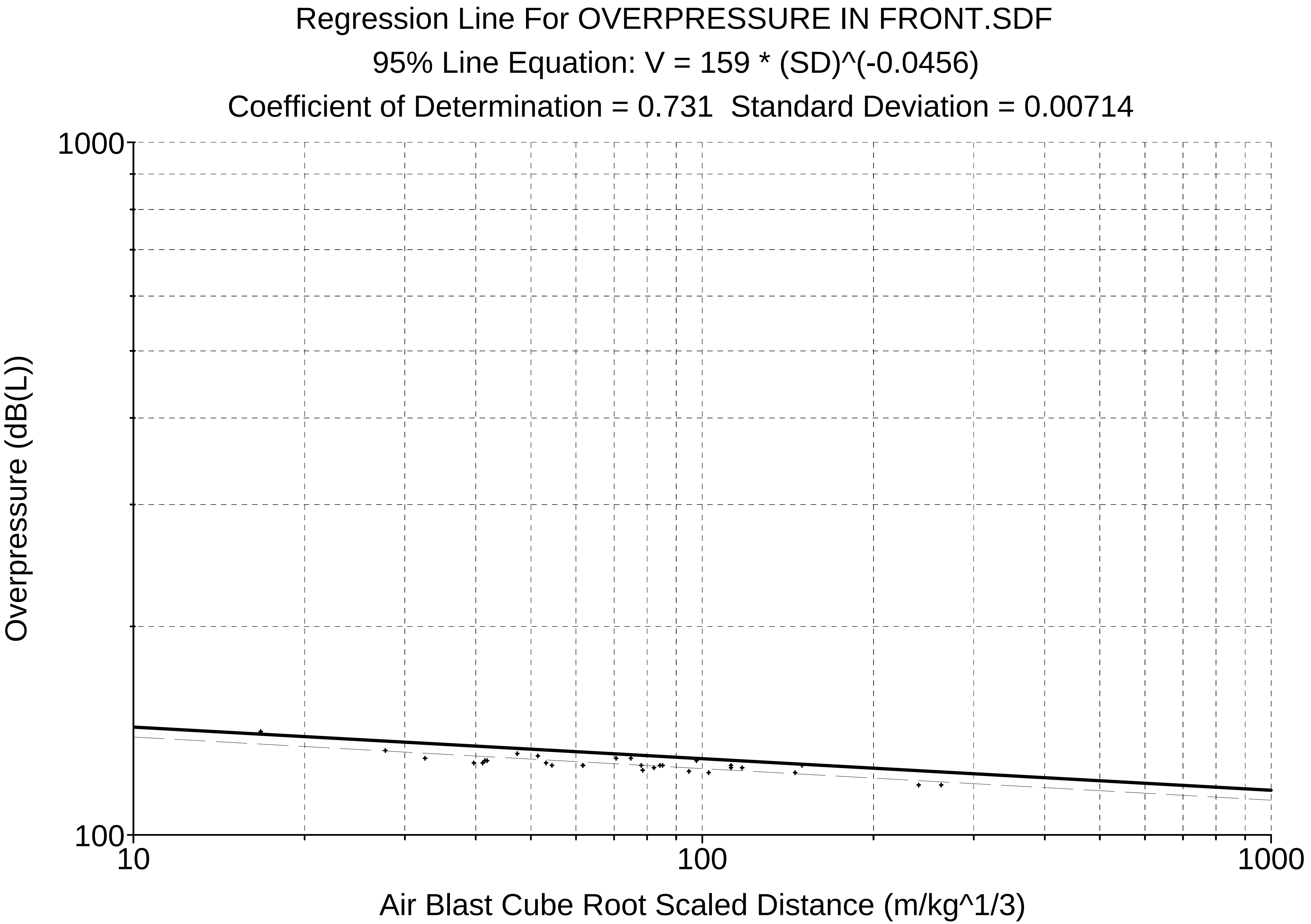
Appendix C

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)
750	41	**0.6**	**0.8**	**2.1**	**0.2**	**0.6**	**0.8**	**0.6**	**1.9**	**1.2**	**1.0**

Regression analysis in front of the shot



Appendix D

EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

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
International Society of Explosives Engineers (ISEE)
Aggregate Producers Association of Ontario (APAO)
Surface Blaster Ontario Licence 450109

SUMMARY OF EXPERIENCE

Over thirty 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

Bachelor of Engineering,
Mechanical Engineering, Carleton University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
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. Recent focus on blast designs, blast impact analyses, vibration analysis, damage complaint investigation, blast monitoring, and job estimations.

PROFESSIONAL RECORD

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

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.
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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