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Eagle Harbor Sand & Gravel, Inc.

Eagle Harbor Mine

(MLF #80171)

Town of Barre, Orleans County, New York

Blasting Impact Assessment

November 21, 2018

Prepared for: New York State Department of Environmental Conservation

Submitted by: Mr. Thomas Biamonte
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1.0 INTRODUCTION

Blasting is the most effective and environmentally friendly method of loosening solid rock. Holes are drilled to prescribed depths in a regular pattern, loaded with explosives and covered with crushed stone (stemming). The explosive column is effectively confined by the surrounding rock mass and the stemming and is not comparable to an explosion seen in a Hollywood movie.

The purpose of mine blasting is to fragment the solid rock so it can be excavated and crushed. Blasting is an expensive process that makes up a significant portion of the overall cost of mining.

The public commonly believes that an explosion that can fragment rock at a quarry face will open up large cracks in the ground at great distances. In fact, the rock 15 to 20 feet beyond a blasthole is not damaged during detonation. Rock breakage from a blast is generally limited to a distance approximately 40 times the diameter of the blasthole used in the blast. A blast detonated by means of 6-inch blastholes would, conceivably, fracture or break rock to a distance of approximately 20 feet (6 inches x 40) from the center of each blasthole.

The vibrations that people might feel at their home during a blast are wasted energy that escaped from the rock mass being blasted. This wasted energy costs the mining company money and consequently, it is in the best financial interests of the miner to reduce off-site blasting vibrations.

Blasting is a well understood science that is done safely by licensed blasters thousands of times each year in just New York State. Blasting at the Eagle Harbor Mine will be done in accordance with the USBM guidelines and will not cause any damage at any surrounding homes.

2.0 BLASTING PROCEDURE

Once the overburden has been stripped, the producer and the driller determine the area that will be blasted. The blaster then lays out a location, depth and diameter of holes to be drilled to achieve the desired goal. Each shot is analyzed separately by the blaster depending on influential factors including but not limited to the type of rock, presence of fractures in the rock, the geologic characteristics of the rock, the height of the face, the size of the primary crusher, the type of equipment used to excavate the stone from the shot rock pile, the location of structures relative to the blast, the allowable vibration limits, the presence of seams in the rock and the shape of the face.

All relevant information is assessed by the licensed blaster and incorporated into the blast design to meet the goals of:

- Preventing flyrock;
- Complying with the USBM guidelines;
- Properly fragmenting the rock;
- Properly displacing the rock so that it can readily excavated and
- Minimizing fracturing of the rock face immediately adjacent to the blast.

Typically, the grid pattern will have a burden (distance between rows or a row and the face) and spacing (distance between holes in the same row) ranging from about six feet by six feet for short faces to about 16 feet by 18 feet for tall faces.

The holes will then be drilled in the grid pattern to the depths specified by the blaster. The driller will keep a log of the holes and provide it to the blaster. The blaster will check to insure the holes were drilled as directed and then schedule a date for the blast.

The frequency of blasts will be dependent on market demand for the product. Blasting will be scheduled based on short term weather forecasts to meet the applicant's market demand. The decision to blast on the scheduled day will be made early in the morning. If strong, low-level thermal inversions or thunderstorms are forecast throughout the day, the blast will be postponed to avoid such adverse weather conditions.

Once the decision to blast has been made, the holes will be cleaned out and loaded with explosives by a team of trained professionals under the direction of the licensed blaster. Each hole will be loaded with explosives and connected by millisecond delays, or equivalent. The blasting team will secure the blast area, sound a warning in a distinctive manner and then detonate the blast. Shot rock will fall down to the bottom of the mine face. Once the blast

area has been checked, the blaster will provide the “all clear signal” and loadout from the shot rock pile will begin.

All blasts will be monitored using a properly calibrated seismograph in order to determine compliance with the USBM guidelines. The licensed blaster also uses the monitoring reports to design future blasts. These records will be maintained by the applicant and provided to the Department upon request.

Blasting will be done between 10 a.m. and 5 p.m. Monday through Friday. Blasting will not occur on New Year’s Day, Memorial Day, July 4th, Labor Day, Thanksgiving and Christmas Day.

3.0 BLAST VIBRATIONS

The energy and gas produced by the controlled detonation of the explosives expands outward fragmenting the rock in the immediate vicinity of the drill holes. Quarry blasts are designed so that most of the energy and gases are used up in breaking the rock in the blast area. The vibrations that leave the blast area through the ground are called ground vibration; those leaving through the air are called air overpressure.

3.1 GROUND VIBRATION

Ground vibration usually dissipates more rapidly than air overpressure. The particle velocity[1] of the ground vibration is measured by the geophone component of a seismograph and is usually reported in three components—longitudinal, transverse and vertical. The longitudinal component measures the particle velocity in a horizontal direction on a line from the blast to the seismograph, the transverse component velocity in a direction perpendicular to the longitudinal and the vertical component in an up and down direction perpendicular to the longitudinal. The seismograph also measures the frequency[2] of the ground vibration.

3.2 AIR OVERPRESSURE

Air overpressure is measured by the microphone component of a seismograph and is usually measured in psi and reported as decibels (dB). Many people mistakenly compare the dB reading for air overpressure and a steady state community sound level. The human ear is sensitive to particular frequencies of sound, typically in the range from 15 to 16,000 hertz for a young person with normal hearing. Sound meters that measure community sounds filter out those frequencies that the human ear does not hear. The microphone used to measure air overpressure measures all frequencies, including those outside of the normal hearing range.

Most of the air overpressure occurs at frequencies below the normal human hearing range of 15 hertz. Consequently, air overpressure is not a significant source of noise.

The formula for converting air overpressure in psi to decibels is:

$$dB = 20 \log_{10} (P/P_0)$$

$$\text{Where } P_0 = 2.9 \times 10^{-9} \text{ psi}$$

Air overpressure is caused by three main sources:

[1] The speed at which a point vibrates
[2] The number of times per second a point vibrates

- *Air Pressure Pulse*—Direct displacement of the air by the moving mass of blasted rock
- *Rock Pressure Pulse*—Vibrating ground at some distance from the blast
- *Gas Release Pulse*—Venting at the blast hole due to improper confinement

3.3 BLASTING RESEARCH

The United States Bureau of Mines (USBM), formerly part of the United States Department of the Interior, undertook extensive research to determine the vibration levels that begin to cause damage. Based on the results of thousands of blasts in a wide range of geologic settings and laboratory tests simulating decades of blasting, the USBM developed guidelines intended to prevent cosmetic damage to the weakest building materials. These guidelines for ground vibration[3] and air overpressure[4] were presented in two landmark publications.

3.3.1 Ground Vibration Guidelines

3.3.1.1 Residential Structures

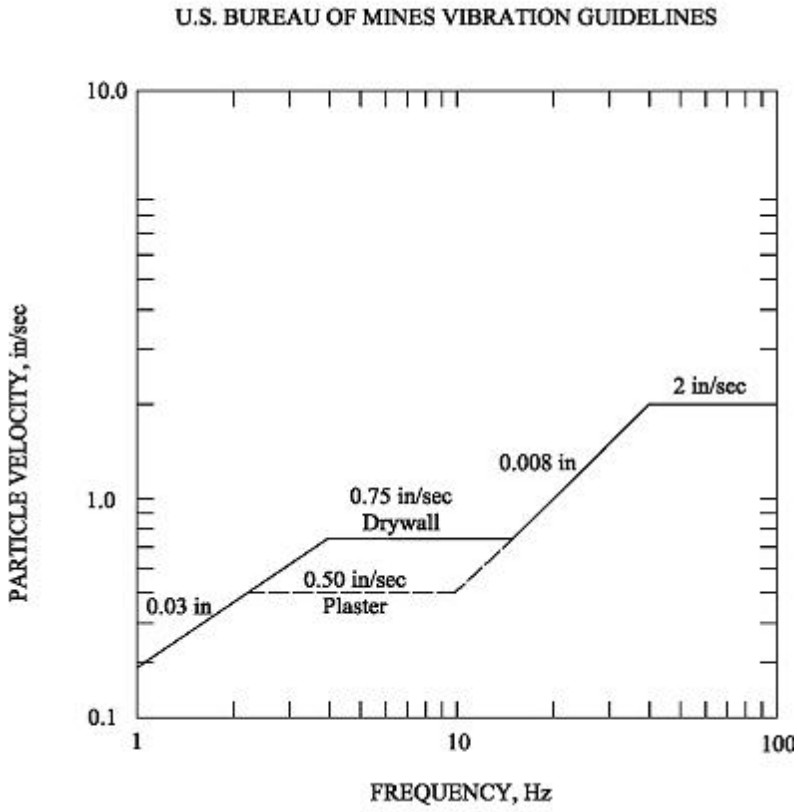
The USBM guidelines for ground vibration were developed to prevent cosmetic damage to the building material most susceptible to ground vibration. The USBM research indicated that plaster and gypsum wallboard are the first materials to show evidence of damage. The USBM defined cosmetic damage as the opening of new hairline cracks or the widening of existing cracks.

Research has shown that ground vibration levels many times higher than the limits developed by the USBM do not damage other building materials such as concrete. Concrete masonry can typically withstand ground vibration up to 3 inches per second (ips), concrete can withstand ground vibration up to 5 ips and an engineered steel structure can withstand even higher levels (5 to 10 ips).

The USBM guidelines for preventing cosmetic damage at residential structures due to ground vibration are summarized on the chart below.

[3] Siskind, D.E., Stagg, M.S. Kopp, J.W. and Dowding, C.H. (1980b), "Structure Response and Damage Produced by Ground Vibrations from Surface Blasting", USBM Report of Investigations 8507.

[4] Siskind, D.E., Stachura, V.J., Stagg, M.S. and Kopp, J.W. (1980a), "Structure Response and Damage Produced by Airblast from Surface Blasting", USBM Report of Investigations 8485.



When vibrations pass through a house, the house reacts by moving. The response of the house depends on the magnitude of the vibration (expressed as peak particle velocity in inches per second for ground vibration and peak air overpressure in pounds per square inch for air overpressure) and the frequency of the vibrations. Research has shown that typical residences are most responsive to low frequency (less than 20 Hz) vibrations. Separate limits were set plaster and drywall in order to be equally protective.

The so-called "Z-curve" shown above has been the Industry standard since the 1980's and has been found to be effective in preventing blasting damage from ground vibration. Compliance with these limits is routinely required in NYSDEC Mined Land Reclamation permits. All blasts at the Eagle Harbor Mine will be designed and implemented to so that these levels are not exceeded at any off-site structure.

3.3.1.2 Pipelines and Wells

The USBM also did research and published guidelines designed to prevent damage to gas and water transmission pipelines due to ground vibration. These guidelines were developed though field testing with a number of controlled quarry blasts near pressurized transmission pipelines

of various sizes and types[5]. The USBM determined that while pressurized transmission lines can sustain peak particle velocities over 600 mm/s (23.6 inches/sec) they recommended that 125 mm/sec (4.92 inches/sec) is a safe-level criterion for large surface mine blasts for Grade B or better steel pipelines. The same criterion is recommended for SDR 26 or better PVS pipe, vertical wells and telephone poles.

3.3.2 Air Overpressure Guidelines

The USBM research indicates that the glass in windows is the building material most susceptible to air overpressure. A properly installed window can withstand an air overpressure of 151 dB. The USBM guidelines were very conservatively set at the levels listed below:

Measuring System	Maximum Air Overpressure
0.1 Hz High Pass	134 dB
2.0 Hz High Pass	133 dB[6]
5 or 6 Hz High Pass	129 dB
C Slow (Not Exceeding 2 seconds)	105 dB

The limits shown above have been the Industry standard since the 1980's and have been found to be effective in preventing blasting damage from air overpressure. Compliance with these limits is routinely required in NYSDEC Mined Land Reclamation permits. All blasts at the Eagle Harbor Mine will be designed and implemented so that these limits are not exceeded at any offsite structure.

3.3.3 Effects of Repeated Blasting

In order to scientifically examine the effects of repeated blasting the United States Bureau of Mines (USBM) constructed a test house in the path of an advancing surface mine. Over the duration of the test, the test house was subjected to 587 production blasts with ground vibration levels ranging from 0.10 to 6.94 inches per second. Following this study, the test house was mechanically shaken. The first cosmetic cracks from shaking only appeared in the

[5] Siskind, D.E., Sragg, M.S., Wiegand, J.E. and Schulz, D.L. (1994), "Surface Mine Blasting Near Pressurized Transmission Pipelines", USBM Report of Investigations 9523.
[6] This is the most common type of seismograph used for blast monitoring

test house after the equivalent of 392 years of blasting once per week, or 20,384 blasts, with a ppv of 0.5[7].

While the test house was being built hairline cracks formed due to settling and workmanship and they also formed during periods when no blasts were detonated due to changes in temperature and humidity. The test concluded that, when blasting, the number of new cracks per week did not increase with time when the blast vibrations were up to 1 inch per second and therefore those blasts did not cause fatigue-related damage.

3.3.4 Comparison of Blasting Limits to Every Day Events

The USBM measured common events that occur on a daily basis to determine how they compare to the vibration levels allowable under the USBM guidelines for ground vibration and air overpressure.

The USBM found that such common events as a gust of wind, children running through a house, door slamming and typical fluctuations in temperature and atmospheric pressure create strains on buildings that are comparable to or greater than those resulting from blasting done in accordance with the USBM guidelines. This further confirms that the USBM guidelines are conservative and protective. Most reasonable people are not concerned that their house is going to fall down due to such routine activities or routine changes in weather and they should likewise not be concerned that blasting in accordance with the USBM guidelines will damage their homes in any way.

3.3.5 Applicability of the USBM Guidelines to the Eagle Harbor Quarry

The USBM guidelines were developed based on testing of thousands of blasts in a wide range of geologically and geographically diverse conditions. In addition, these limits have been used for the last 30+ years as the Industry standard. Blasting occurs about 15,000 times per day in the United States and the USBM guidelines are the most commonly applied limits used to prevent blasting damage. The vast number of blasts designed to comply with the USBM guidelines further verifies their validity.

3.4 Factors Affecting Vibration Levels

Blasts are designed so that the energy from the detonated explosives efficiently fragments the rock next to the drill holes. The excess energy that leaves the blast area through the ground

[7] Stagg, M.S., Siskind, D.E., Stevens, M.G., and Dowding, C.H. (1984), "Effects of Repeated Blasting on a Wood-Frame House", USBM RI 8896.

(ground vibration) or the air (air overpressure) is wasted. It is in the best interest of the blaster and the applicant to minimize the amount of this wasted energy.

The magnitude of the vibrations depends mainly on the amount of explosive detonated at any one time. Modern blasting is done using delays that detonate a few milliseconds apart. Extensive research by the U.S. Bureau of Mines has shown that in a properly designed and implemented blast, vibrations from adjacent holes that detonate more than eight milliseconds apart are not additive.

This allows blasters to most efficiently fragment the rock while producing the least amount of excess vibration.

The amount of explosives shot at once depends on a wide variety of factors, including:

- The diameter of the blast hole
- The height of the explosives column in the blast hole
- The density of the explosives in the blast hole
- The number of "millisecond delays" in a blast hole
- The number of holes shot per 8 millisecond delay

Effective millisecond delays first became commercially available in the late 1960's. They allow the blaster to detonate adjacent holes at times that are milliseconds (thousandths of a second) apart. Extensive research has shown that the vibrations from nearby holes that are detonated a minimum of eight milliseconds apart do not have a cumulative effect. This means that in a properly designed blast using millisecond delays, the impact of the blast is largely based on the maximum amount of explosive per eight millisecond delay.

In the last few years, the millisecond delays have been greatly improved by the introduction of electronic delays. These delays are more accurate and can be programmed by the blaster to the precise delays needed for any particular blast.

3.5 Prediction of Vibration Levels

There are formulas used on a regular basis by blasters to predict the ground vibration and air overpressure from a blast. These formulas are widely published in blasting textbooks and reports, including the International Society of Blasting Engineers' *Blasters Handbook*.

Using these formulas, it is possible to estimate the ground vibration levels and air overpressure levels that can be expected by homes around the Eagle Harbor Mine. Compliance with the USBM guidelines is readily possible.

A standard predictive formula for ground vibration is:

$$PPV=160\ SD^{-1.6}$$

Where SD = Distance From Blast (Feet) / (Pounds Explosive per 8 ms Delay)$^{0.5}$

For a 29-foot-high face at a distance of 505 feet (the shortest distance from the excavation area to the closest off-site structure) using a 4-inch diameter hole and 6.7 feet of stemming, the predicted peak particle velocity would be 0.44 inches per second.

The allowable ground vibration at normal ground vibration frequencies is 0.5-0.75+ inches per second, well above the predicted limits at even the closest off-site structures at any point over the life of the mine.

3.6 Potential Impacts to Wells

Blasting does not create enough energy to crack rock further than a few feet past the blasting area, does not divert water and does not crack well casings (research shows that steel casings will not crack unless subjected to ground vibrations in excess of 10 inches per second). Extensive research by the United States Bureau of Mines (particularly, *"Survey of Blasting Effects on Ground Water Supplies in Appalachia"*) proved that blasting does not impact groundwater quality or quantity.

4.0 BLASTING CHECKLIST INFORMATION

The following Blasting Checklist is provided for information only and is subject to change by the licensed blaster in order to comply with the USBM guidelines and the applicant's production needs.

It will change as new blasting technology is developed and proven or if experience shows that site specific conditions warrant it.

- *Frequency of Blasting*—Blasting will be done as often as needed to meet market demand. When faces are being developed, development shots will typically occur up to once per week. Production shots will occur roughly twice per month.

- *Blast Hole Diameter*—The blaster will vary the diameter of the blast hole depending on a wide variety of factors. Typically, blast holes will be 4 to 6.5 inches in production for a 30-foot-high face and as small as 3 inches for a 10-foot-high development shot.

- *Number of Holes Per Blast*—The blaster will vary the number of holes per shot as needed to meet production requirements. The number of holes per shot does not have a direct influence on the vibration levels due to the use of millisecond delays.

- *Burden and Spacing*—The blaster will vary the burden and spacing as needed to meet the goals of the blast.

- *Typical Pounds of Explosive Per Delay*—The blaster will vary the pounds of explosive per eight millisecond delay as needed to meet the production goals and comply with the USBM guidelines.

- *Predicted Peak Particle Velocity*—The blaster will design all blasts to comply with the USBM guidelines using predictive formulae as outlined in Section 3.5 above and his experience at the site. If the seismograph readings indicate the ground vibration or air overpressure levels are approaching the allowable limits, the blaster will adjust the blast as needed to avoid exceeding the limits. This could be accomplished a number of ways, including but not limited to reducing the hole diameter, reducing the density of explosive used, reducing the face height, increasing the amount of stemming and revising the blast timing.

- For a 30-foot-high face at a distance of 505 feet (the shortest distance from the excavation area to the closest off-site structure) using a 4-inch diameter hole and 6.7

feet of stemming, the predicted peak particle velocity would be 0.44 inches per second.

- *Local Blasting Ordinances*—None

- *Location of Off-Site Receptors*—See Location Map and Mining Plan Map in the Mined Land-Use Plan. The nearest off-site receptor is 505 feet from the closest quarry excavation area; all other receptors are further away.

- *Best Management Practices to Prevent Fly Rock and Control Off-Site Vibrations*—See Section 5.0 below.

- *Seismographs*—All blasts will be monitored by properly calibrated seismographs set up at the off-site structures most likely to be impacted by any particular blast. The blaster in conjunction with the applicant will make this determination based on distance to off-site structures, past experience, requests from the public and the orientation of the blast.

- *Control of Blasting Emissions*— Blasting is an infrequent occurrence and overall a very minor source of dust. Frame by frame examination of videos of blasts confirms that the majority of dust generated by blasting is generated in the interior of rock mass from the pulverization of rock immediately adjacent to the explosives column. This is unavoidable in all production blasts where sufficient displacement of the rock occurs to allow for relatively easy extraction.

- Gases will be reduced by proper and complete ignition of the explosives and use of the appropriate type of explosives for the drill hole conditions (e.g. straight ANFO would not be suitable for use in a hole containing rain water).

- Blast Notification—Residents requesting to be notified prior to each blast will be called the morning of the blast. A siren will be sounded in a distinctive manner prior to each blast.

- *Pre-Blast Surveys*—See Section 6.1 below.

5.0 SUMMARY OF BEST MANAGEMENT PRACTICES

Eagle Harbor Sand & Gravel will follow the following standard procedures in the course of their blasting. The blaster will revise these best management practices as new technology is developed and proven or if experience shows that site specific conditions warrant it.

- All blasts will be designed and implemented following proper blast management practices in accordance with the requirements of the Mine Safety and Health Administration.
- A licensed expert blaster will do all blasting.
- The blaster will design and implement all blasts to comply with the USBM guidelines.
- The licensed expert blaster will lay out each blast, insuring appropriate burden is maintained to properly confine the explosive column. The face will be profiled to aid in determining the front row burden at the blaster's discretion.
- The blaster will specify the drill holes location, size and depth.
- The driller will keep a log describing any unusual conditions found in the holes.
- The blaster will review the drill logs and make any adjustments needed to account for the conditions of the holes.
- The blaster will insure the holes were drilled as specified. The holes will be bore tracked or equivalent at the discretion of the blaster.
- Holes containing large voids will be abandoned or the voids will be encased to avoid overloading of the holes.
- Blasting will be scheduled so as to avoid adverse weather conditions such as strong, low level thermal inversions and thunderstorms. The blaster will use a weather service to assist him in making such determinations.
- The blast holes will be loaded and implemented under the direct supervision of an expert licensed blaster.
- All blasts will be designed to assure proper confinement of the explosives column.
- The appropriate type of stemming will be used for the size of the hole.

- The blast area will be secured prior to each blast.
- Neighbors so desiring will be called the morning of each blast. This reduces the startle affect associated with some blasts.
- A siren will be sounded in a distinctive manner before each blast.
- Blasting will be done between 10 a.m. and 5 p.m. Monday through Friday. Blasting will not occur on New Year's Day, Memorial Day, July 4th, Labor Day, Thanksgiving and Christmas Day. Blasting during the middle of the day and at similar times of the day reduces the human response to blasting.
- All blasts will be monitored with a properly calibrated seismograph.
- The blaster will check the shot before sounding the all clear.
- The blaster will review the seismograph results to determine compliance with the USBM guidelines and adjust the blast design as needed.
- Records of all blasts will be kept and be made available to the Department upon request.
- The applicant will promptly and professional respond to and investigate all complaints.
- Offer pre-blast or condition inspections for neighbors to serve as a baseline in the event of a claim of blasting damage, as outlined below.

5.1 Pre-Blast Surveys

Eagle Harbor Sand & Gravel shall offer to conduct a pre-blast condition survey in accordance with the procedures detailed below for each off-site structure not owned by the Applicant or the Eagle Harbor Mine property owner located within 1000 feet of the planned limits of blasting. This survey shall determine and document the conditions of the structure at the time of the survey.

Eagle Harbor Sand & Gravel or their representative will notify each owner by registered mail, return receipt requested, of the offer to conduct a condition survey prior to beginning blasting. Eagle Harbor Sand & Gravel will include in the written notification contact information for their blasting representative as well as a self-addressed, stamped envelope for the owner to accept or decline the offer to perform a condition survey.

Any owner's failure to respond within 30 days of the postmark date (of the certified letter) shall be deemed a denial. If any owner decides not to participate in the Pre-Blast Survey, Eagle Harbor will not be required to include that dwelling in the survey.

Documentation will include voice-recorded descriptions, diagrams, notes and photographs and/or video as needed to detail existing defects in walls, ceilings, floors, foundations and windows both on the interior and exterior of the structure. Eagle Harbor Sand & Gravel will hire professionals experienced in condition or pre-blast surveys to perform all condition surveys. A copy of the documentation will be mailed to the owner, determined according to the municipal tax records, within 30 days of the completion of the survey.

All costs associated with conducting the Pre-Blast Surveys shall be paid by Eagle Harbor Sand & Gravel and they will maintain all correspondence to and from owners regarding condition surveys, all condition surveys performed and the supporting documentation.

Appendix

Ground Vibration and Airblast Estimation

Eagle Harbor Mine

September 2018

Highwall Quarry Blasting

Distance to Closest Residence:	505	feet
Hole dimater:	4	Inches
Face Height:	30	feet
Density of Explosive (g/cc):	1.25	
# of Holes Detonated Per Delay:	1	
Density of Explosive (lb/CF):	78.04	
Stemming (in feet):	6.67	
Explosives Cloumn Height:	23.33	
Hole Raius (in feet):	0.17	
Volume of Explosives (in CF):	2.04	
Explosive Weight (lbs):	158.90	
Charge Weight per Delay (lbs):	158.8962	
Scaled Distance:	40.06218	
Cubed Root Scaled Distance ($ft/lb^{1/3}$)	93.39434	
Pressure (lbs/square inch)	0.004417	
Predicted Airblast	**123.7**	**dB**
Predicted Ground Vibration:	**0.44**	**in/sec**

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Xxxxxx xx, 2019

Town of Barre Resident
Street Address
Albion, New York 14411

Dear Neighbor:

Eagle Harbor Sand & Gravel, Inc. is offering pre-blast surveys to all property owners with residences within 1000 feet of their quarry excavation limits. A pre-blast survey is a record on paper and video and it tells you what your home is like before any mine blasting begins. If there is damage claim from blasting there will be documented evidence that can be used as a baseline. This service is offered free of change and is entirely voluntary.

If you choose to have a pre-blast survey done, an independent pre-blast surveyor will look at each room in your home as well as each outside wall and foundation and document the current condition using one or more of the following: a camera, video camera, sketches, drawings, and/or narrative descriptions.

Eagle Harbor Sand & Gravel, Inc. is required by the DEC to keep blasting vibrations well below the point at which cosmetic damage occurs and will be taking appropriate precautions at their blasting operations to achieve that. While these precautions will reduce the ground vibrations from blasting, you may experience some vibrations which is normal. Seismographs will be placed between every blast and the closest structures to monitor the blast and make sure that it is in compliance. This pre-blast survey is an additional level of protection that is being offered over and above the legal requirements.

Pre-blast survey request and waiver forms are included with this letter. If you want to have a pre-blast survey, at no cost to you, please complete the "request" form. If you do not want a pre-blast survey, please fill out the "waiver" form. A stamped addressed envelope is included for your convenience. **If we do not receive one of the forms back from you before xxxxxx xx, 2019 we will assume that you do not want a pre-blast survey conducted.**

Sincerely,

Brian Milliman
Principal Geologist

cc Tom Biamonte, Eagle Harbor Sand & Gravel, Inc.