VIA EMAIL & USPS
September 27, 2024

Daniel Husted, PE, Chief, Permit & Technical Services
DEP Moshannon District Mining Office
186 Enterprise Drive
Phillipsburg, PA 16866

Re: Module 16: Blast Impact Analysis
Minard Mine – SMP 08230301
Bishop Brothers Construction Company, Inc.
Athens Township, Bradford County, Pennsylvania

Mr. Husted:

Enclosed please find the Blast Impact Analysis report prepared for the Minard Mine. Three (3) copies of the documents listed in Table 1 are included with this submission.

Table 1: Summary of Documents

Updated Document:	Replaces:
Module 16: pgs 16-7 to 16-37 Blast Impact Analysis, Bishop Brothers – Minard Mine Athens Township, Bradfrod County, Pennsylvania Prepared by Vibra-Tech Engineers, Inc. dated September 4, 2024	None

Should you have any questions, please contact me at 814-272-0301.

Tract Engineering, PLLC

/s Timothy S Gourley

Timothy S. Gourley, P.E.

encl.

cc: G. Aaron, PG, PA DEP (w/ encl.) via email
J. Mital, PG, PA DEP (w/ encl.) via email
N. Craven, PE, PA DEP (w/ encl.) via email
D. Bishop, BB (w/ encl.) via email
M. Lee, BB (w/ encl.) via email
R. Stormer, PG, EADS (w/ encl.) via email
C. Jones, Esq., Griffin, Dawsey, DePaola, & Jones (w/ encl.) via email
K. Garber, Esq., Babst Calland (w/ encl.) via email
D. Rudenko, PG, Vibra-Tech (w/ encl.) via email
Athens Township (w/ encl.) public copy for review

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Blast Impact Analysis
Bishop Brothers – Minard Mine
Athens Township, Bradford County, Pennsylvania

Prepared for:

Christopher D. Jones, Esquire
GRIFFIN, DAWSEY, DEPAOLO & JONES
101 Main Street
Towanda, PA 18848

Prepared by:

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September 4, 2024

Table of Contents

Purpose

The purpose of this analysis is to evaluate the potential impact and to assist Bishop Brothers Construction, Inc. in developing strategies for conducting the excavation and removal of materials with minimal disturbance to areas of concern in the vicinity of the proposed Minard Mine. The Minard site is located in Athens Township which is west of the town of Sayre in Bradford County, Pennsylvania. It is approximately 0.69 mile west of the Pine Street interchange of SR-220 and 0.86 mile south of the intersection of Meadowlark Drive and Minard Lane. Evaluations will be made as they relate to the closest receptors and five other court-approved appellant/objectors.

Discussion on Blasting and Vibrations

Human perception and response to ground vibrations from blasting have been a continual issue for the mining industry, the public living near mining operations, and regulatory agencies responsible for setting environmental standards since the 1930s. In order to understand the nature of this issue the following pages are dedicated to educating the reader about mineral recovery via blasting, the effects of blasting operations on the earth, the causes of blast vibrations, why people feel vibrations, and how vibrations are measured.

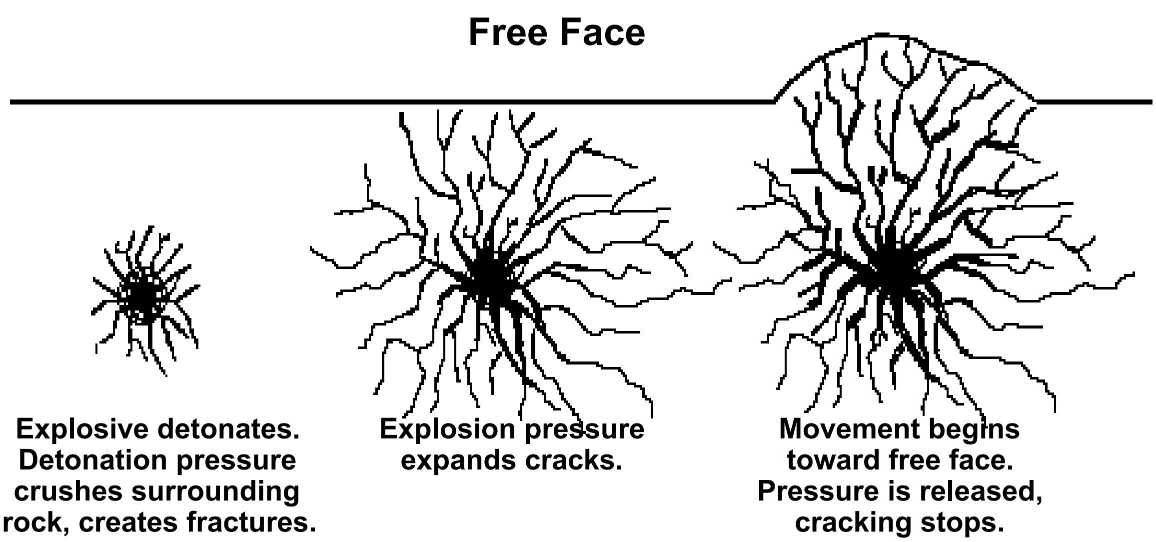

Figure 1. Rock Breakage by Explosives

A common misconception among the general public is that mining operations blast so that they can crush stone. Crushed stone is actually produced in machines called crushers. In order to obtain rock for the crushers, a small amount of bedrock must be broken off and fractured into pieces, which will fit into the crusher. The most cost-effective way to achieve this is through blasting. A typical response from homeowners located near blasting operations is that since they feel the vibrations at some distance, the fracturing of rock must also occur at this distance. This assumption is far from the truth.

When a blast hole is detonated, the explosion produces a high temperature, high-pressure gas. This gas pressure, known as the detonation pressure, crushes the rock adjacent to the borehole. The detonation pressure rapidly dissipates, consuming approximately ten to fifteen percent of the energy available in the explosive. The remaining energy produces a second, lower pressure gas, known as the explosion pressure. Most of the work done by the explosive is done by the explosion pressure. The explosion pressure expands the cracks made by the detonation pressure, and pushes the fractured rock toward the free face. Once the blasted material is separated from the bedrock, the gas pressure escapes, and no further fracturing of the bedrock can occur. The momentum of the fractured rock continues its movement toward the open pit. This entire process occurs within a few hundredths of a second after the detonation, and takes place within about twenty feet of a typical blast hole. The volume of rock that is permanently displaced (fractured) is a cone with its apex at the bottom of the borehole and its base on the surface of the ground. The radius of the base is equal to the depth of the borehole. Beyond this cone-shaped volume, no permanent deformation (inelastic movement) of the rock occurs, and elastic waves are generated.

The ground vibrations that homeowners may feel are not caused by the fracturing of rock. Blast induced ground vibrations are primarily the result of the detonation pressure acting on the rock around the borehole and the explosion gas pressure pushing the fractured rock away from the bedrock toward the open pit. The application of this large force against the bedrock followed by its subsequent release causes the bedrock to vibrate, much like pushing and releasing a swing will cause it to vibrate. When a part of the bedrock is vibrated within the mine, the vibration is transmitted into the ground surrounding it. This transmission of vibration is called propagation.

The propagation of the ground vibration continues away from the blast location in all directions, similar to ripples in a pond, which move away from the initial disturbance. The ripples in the pond, like ground vibration, are examples of elastic vibration. Elastic vibration means that the material never moves very far from its original position while it is vibrating, and once the vibration event is over, the material will be in its original position and condition. Unlike the ripples in the pond, the motion of the ground is so small it cannot be detected visually. Therefore, sensitive scientific equipment is required for its measurement. Outside of the mine, the ground rarely moves farther than the thickness of a sheet of paper before returning to its original position, and it may do so faster than the eye can sense. Seismographs can measure how the ground moves from its original position; much like a fisherman's bobber can detect how the water surface moves from rest when a ripple passes by.

As the ground vibrations propagate further away from the source, the energy is dissipated. When the energy dissipates, ground vibration amplitude decreases, until eventually the ground vibration falls below perceptible levels. The rate at which ground vibration amplitude decreases as it propagates away from the blast location is called seismic attenuation. The rate of attenuation is specific to the location of the mining operation and varies based upon the site conditions. Seismic attenuation has been studied extensively and found to occur geometrically. A geometric reduction in ground vibration means that ground vibration amplitude decreases very quickly near the source, but very slowly far from the source. As a result, almost all of the ground vibration energy is dissipated within the mine, but the small amount of energy remaining may produce perceptible vibrations at some distance.

Since blasting can sometimes produce perceptible ground vibrations beyond the mine property, attempts to control vibrations have been accomplished via laws, regulations, and industry standards. Maximum permissible levels have been established based on academic and government studies of the effects of vibration on nearby property and people. Seismographs are used to measure the vibrations, and ensure that the permissible levels are not exceeded. The seismograph may measure how far the ground moves from rest (displacement), how fast it moves (velocity), or how fast the velocity changes (acceleration). These three parameters are related by the frequency of the vibrations.

Frequency is a measure of how many times the ground will vibrate through its original position in one second. The seismograph also measures frequency, which is commonly reported in cycles per second or hertz (Hz). Standards limit the maximum amount of vibration that can occur at any point, or particle, on the ground surface. The limit is therefore commonly referred to as a peak particle displacement, peak particle velocity, or peak particle acceleration. Nearly all residential vibration standards limit the peak particle velocity.

Operators must have a method of estimating ground vibrations from a blast during its planning to confidently adhere to vibration limits. Since the amplitude of ground vibration is determined by how much energy is present to create vibration and how far the vibrations have propagated, researchers devised a single number to relate these parameters. This number, called the Square Root Scaled Distance, or simply Scaled Distance, relates ground vibration amplitude to explosive charge weight and distance from the blast. The scaled distance requires the explosive charge weight to decrease as the distance from the blast decreases in order to adhere to ground vibration peak particle velocity limits. The scaled distance provides a convenient method of comparing the ground vibration potential of different blast designs. Some regulations do not require the use of seismographs if the scaled distance from the blast is large enough.

In response to mine operator desires to minimize ground vibrations and still operate efficiently, explosive manufacturers developed millisecond delayed blasting caps. Research has shown that several charges detonated only a few thousandths of a second apart would not only produce less ground vibration, but are also more effective at fracturing and moving rock than a simultaneous detonation of all charges. All mine blasts today consist of many charges detonated several hundredths or thousandths of a second apart. The scale distance equation defines maximum charge weight per delay as the total weight of explosives detonated within a certain period of time, rather than the total weight of explosives in the blast.

Air-borne vibration may also be produced by blasting. These vibrations may occur within the audible range of the human ear (sound), or at frequencies below those humans can hear (infrasonic). Many sources for air vibration exist in a typical blast, but all can be traced back to either the venting of the detonation and explosion pressures or the fractured rock pushing air out of the mine. Seismographs are equipped with microphones and measure these changes in air pressure occurring as the air vibration passes to determine if permissible limits are exceeded.

The weight of the air in Earth's atmosphere produces pressure upon everything on Earth. This pressure, known as atmospheric pressure, is commonly reported in daily weather reports in millibars (mbar, metric) or inches of mercury (in.Hg, USCS). The air vibrations produced by blasting cause the normal air pressure to fluctuate. Changes in normal air pressure due to the airblast are referred to as overpressure, as in pressure over atmospheric pressure. Air overpressure resulting from blasting is measured by microphones attached to seismographs.

When air pressure changes rapidly however, different pressures can result on both the inside and outside of a structure. A change in pressure that occurs between locations is often called a pressure gradient. A pressure gradient from the inside of a structure to the outside produces forces, which are exerted over the structure's exterior surfaces. These forces, if large enough, can cause structural damage. Examples of causes of air pressure gradients which damage residential structures are the winds from hurricanes, tornadoes, and thunderstorms. Changes in air pressure due to blasting, like wind, occur very rapidly, resulting in different pressures on the inside and outside of a structure. These changes in pressure are not stationary; they travel away from their source. When either a blast induced air pressure wave or a gust of wind propagates, they can produce a pressure gradient not only from the inside of a structure to the outside, but also from one side to the other. The difference between an air pressure wave from blasting and one produced by wind lies in the magnitude and frequency of the event.

Changes in air pressure due to wind are many times greater than the changes in pressure produced by blasting. This is why a gust of wind may push a garbage can down the street, but the airblast from a mine cannot. The frequency of the changes in air pressure produced by wind is much lower than the frequency of the air pressure wave produced by blasting. Two important effects can be traced to this difference in frequency. First, wind remains inaudible, while air overpressure from blasting may rumble or boom. Second, higher frequency changes in air pressure due to blasting means forces on the structure's exterior change quickly. A window pane may be alternately pushed and pulled fast enough to make it rattle as a result of a blast. Wind force, on the other hand, does not change direction quickly. Wind can therefore push or pull on a window pane with a much greater force without producing audible sounds.

Most air overpressures from blasting are measured in thousandths or ten thousandths of pounds per square inch (psi). Rather than reporting air overpressures in psi, most regulations specify decibels (dB). Since a decibel is a measure of change, it must be with respect to some value. The reference pressure for air overpressure monitoring is 2.9×10^{-9} psi. A small change in decibels can represent a very large change in pressure. Doubling of the overpressure in psi yields a 6 dB increase; a tenfold increase in overpressure equates to a 20 dB increase.

Established Vibration Criteria

Ground Vibration Criteria from USBM RI-8507

In order to establish a rational ground vibration criteria it is first necessary to examine the effects of ground borne vibrations on structures (Residential and Commercial). Structures situated above ground are able to amplify or attenuate ground motion depending upon their own unique characteristics. This fact is taken into consideration in the criteria suggested by the U.S. Bureau of Mines (USBM). The U.S. Bureau of Mines has studied various aspects of ground vibration and air blast since 1930. In 1980, the culmination of over 50 years of research was compiled into RI-8507[1] entitled "Structure Response and Damage Produced by Ground Vibrations from Surface Mine Blasting". In this study direct measurements of structural response and damage from actual surface-mine production blasting was observed in 76 residences for 219 production blasts. This data along with damage data from six additional studies were combined with the historical data from an earlier report entitled Bulletin 656. Particular emphasis was placed on the frequency dependence of structure response and its relationship to damage.

[1] Siskind, D.E., Stagg, M.S., Kopp, J.W. & Dowding, C.H. (1980). Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting (Report of Investigation 8507). U.S. Bureau of Mines, Washington, D.C.

The culmination of this study was the Appendix B curve which was entitled “Alternative Blasting Level Criteria”. The Appendix B curve used both measured structure amplification and damage evaluations to develop criteria that involved both displacement and velocity.

The curve in Figure 2 below shows that above 40 Hz, a constant peak particle velocity of 2.0 in/sec is the maximum safe value. This level was established to protect the interior walls and ceilings of structures, regardless of construction material.

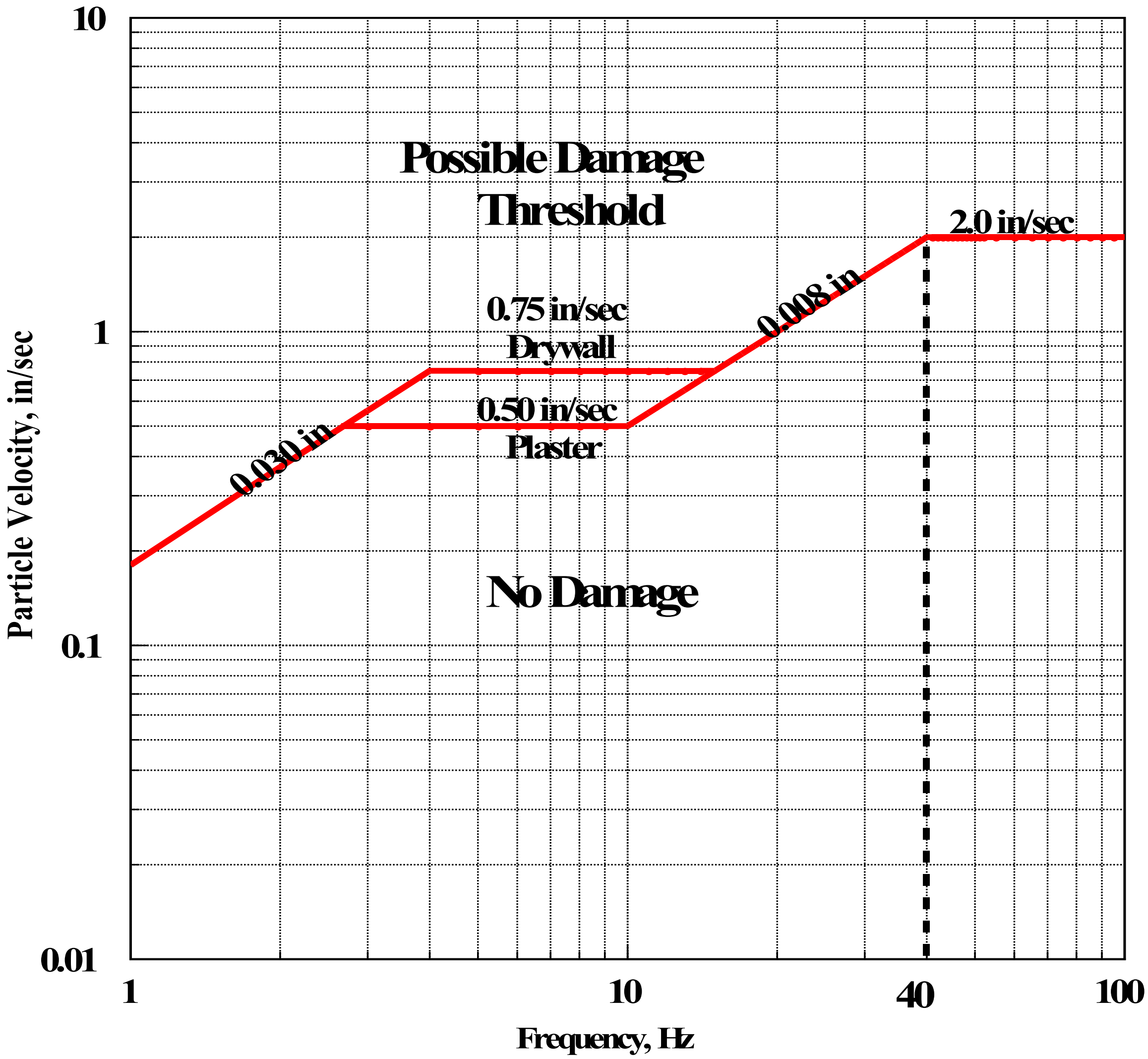

Figure 2. U.S. Bureau of Mines Vibration Criteria. Maximum Safe Values for Peak Particle Velocity (From RI-8507)

Below 40 Hz however, the maximum velocity decreases at a rate equivalent to a constant peak displacement of 0.008 inches. For intermediate frequencies (4 to 12 Hz), a 0.5 inch per second maximum particle velocity is the accepted level to preclude ‘threshold’ damage to the plaster-on-wood-lath interior portions of older structures. Threshold damage is defined by the USBM as the loosening of paint, small plaster cracks at joints between construction elements or the lengthening of old plaster cracks. A maximum of 0.75 inch per second is the accepted level for the protection of modern drywall interior construction between 4 and 12 Hz. The damage threshold is normally considerably higher for load-bearing or other structural portions of a house. An ultimate maximum displacement of 0.03 inches is recommended when frequencies below 4 Hz are encountered. Using this scheme, the Bureau was able to recognize the displacement-bound requirement for house responses to blast vibrations, and provide a smooth transition for intermediate frequency cases.

The frequency character of vibration events resulting from mine blasting is primarily a function of the local geologic conditions along with the particular blast design utilized. The frequency range for blasting at most mining applications is in the 10 to 100 Hz range at the distances that vibrations would be perceptible.

Air Vibration Criteria from USBM RI-8485

The USBM has also set forth airblast limits in its Report of Investigation RI-8485[2] "Structure Response and Damage Produced by Airblast from Surface Mining". Although the air vibrations produced by production blasting are typically referred to as noise levels, the USBM report recognizes that airblasts with frequencies below the threshold of human hearing (infrasonic) are capable of producing structural response. The most common example of infrasonic air vibrations that may produce structural response is wind rattling a window. Accordingly, the USBM has recommended limits based upon the frequency range of the recording system. The maximum allowable air-blast limits increase as the range of the recording system expands further below the audible frequency range of the human ear.

The safe air-blast limits recommended by the USBM were determined by analyzing structural response and damage from many applicable studies. Based on a minimal probability of the most superficial type of damage in residential-type structures, any of the following represent safe maximum airblast levels:

Table 1. Air Borne Vibration Criteria recommended in USBM RI-8485

Lower Frequency Limits of Measuring System	Maximum Level in dB
0.1 Hz high-pass system	134 dB
2 Hz high-pass system	133 dB
5 or 6 Hz high-pass system	129 dB
c- slow (events not exceeding 2 sec duration)	105 dB

The USBM concluded that the single best airblast descriptor is the 2 Hz system. These recommendations have been accepted by many states. The maximum safe airblast level set forth by USBM RI-8485 for this type of system is 133 dB (0.01295 psi).

The recommended limits listed in Table 1 were compared to a composite of five impulsive noise studies for human tolerance in the USBM report. Based upon these studies, the USBM concluded that these recommended airblast limits would provide annoyance acceptability to 95% of the population for 1 to 2 events per day.

Structural damage as a result of air overpressure is generally conceded to not be possible without extensive window breakage, as the glass is the weakest portion of a structure's exterior where this

[2] Siskind, David et. al. (1980). Structural Response and Damage Produced by Airblast from Surface Mining (Report of Investigation 8485). U.S. Bureau of Mines, Washington, D.C.

pressure acts. Windowpanes are designed to safely withstand changes of 1.0 psi (170 dB) when properly installed, and even in the worst situation a pane should be able to withstand 0.1 lbs/in^2 (150 dB). Air overpressures from blasting rarely exceed 0.01 psi (130 dB). This level is about one one-hundredth of the overpressure that a window can safely withstand.

Commonwealth of Pennsylvania Vibration Regulations

Blasting operations in the Commonwealth of Pennsylvania are regulated by the Pennsylvania Department of Environmental Protection. Effective July 14, 2001, amendments were made to Pennsylvania Department of Environmental Protection blasting regulations, Code 25 Licensing of Blasters and Storage Handling and use of Explosives, Chapter 211.151 Blasting Activity. These amendments include updates to both ground vibration and air overpressure resulting from blasting.

I. Ground Vibration – The use of a modified U.S.B.M. R.I. 8507 was adopted. The modification was the elimination of the 0.75 in./sec. limit in the frequency range of 3 – 15 Hz with the rest of the criteria as established.
II. Air Overpressure – The recommended limits in U.S.B.M. R.I. 8485 were adopted.

Research on the Effects of Blasting on Wells and Groundwater

The primary concern of homeowners when blasting is nearby is the effect of blasting on the various structures comprising the homeowner's residence. A typical concern is the effect of blasting on the integrity (i.e. quality and quantity) of their water supply system. Homeowners envision blasting as the fracturing of rock and usually assume that since they felt the vibrations at a great distance, the fracturing of rock must also occur at this distance. Most homeowners then worry about a diminished water supply or contamination to their water supply.

The fundamental factor in determining the safety of underground structures such as wells is whether there has been permanent deformation (cracking) of the rock at the well. The only important mechanism, by which permanent deformation of rock can occur, as a result of the detonation of explosives, is the phenomenon known as cratering (discussed in Blasting and Vibrations section). Cracking of the rock near the borehole filled with explosives occurs within approximately 30 borehole diameters. For example, the maximum borehole diameter to be used at this proposed operation would be 4.5 inches, therefore the zone of cracked rock around the borehole would be approximately 135 inches or 10.38 feet. This is well within the boundary of the mining operation and therefore not a concern.

In addition to the extensive studies performed on cratering, there have also been studies completed on the effect of vibration intensities on water supply systems. <u>A study by Berger (1980) suggests that peak particle velocities of 2.0 in/sec or less do not cause irreversible aquifer damage nor cause damage to any well components.</u> In fact, particle velocities as high as 3.34 in/sec were found to have no effect in this study.

A second issue with homeowners is that the blasting may have somehow introduced chemicals from the explosive into the groundwater. There have been many studies completed on the effects of blasting on groundwater. Bond (1975), Berger (1980), Sneddon (1981), and Beaver (1984) to name a few, have all concluded that there is no significant long-term chemical or mineralogical changes observed in groundwater that could be attributed to blasting. In the study performed by Bond, water samples were taken in the same hole that explosives were detonated in and no change in water quality due to the decomposition products of the explosives could be discerned from the analysis.

Human Perceptibility to Vibrations

The startling effect of blast vibrations must not be underestimated when considering human tolerance to vibration in structures. Blasters and their consultants often use seismographs to perform field demonstrations for concerned residents in their structures. The vibrations produced by normal activity are measured within a structure and compared to the levels resulting from blasting. Normal man-made vibration levels in a structure frequently exceed those produced by blasting by a factor of ten. But when the vibration source is familiar and the vibrations are expected, as with most common structure vibrations, people are much less alarmed than when ground vibrations from blasting arrive unexpectedly.

Human tolerance to vibration decreases not only when it occurs within their residential structures, but also when the cause of the vibration is not readily apparent or anticipated. Human reaction is dependent on the duration and amplitude of the vibration event, as well as innumerable other factors beyond the blaster's control. Human perception to vibrations can be as low as 0.02 in/sec, well below any criteria for structural damage. Because of this great human subjectivity complaints about blast vibrations can not be totally eliminated. Discernible vibrations however, are by no means criteria for possibility of structural damage.

Proposed Mine Location and Blast Information

Figure 1 in Appendix A is a Google Earth image that shows the location of the proposed mine. The yellow polygon represents the furthest limit of the proposed mining activity which would include blasting. Figure 1 also includes the six closest off-site structures to the proposed blasting labeled A through F as denoted by the red balloons. The green balloons on the figure show the location of five court-approved appellant/objectors. The location of the proposed mine limits was provided by Tim Gourley with Tract Engineering.

Since blasting is not yet taking place at the proposed mine, it is necessary to evaluate a scenario regarding the effects of blasting on the surrounding structures. The distance from the mining limits to each receptor was determine through the Google Earth software. The table 1 below gives the closest distance from the mining limits to each receptor shown in Figure 1.

Table 1 – Closest Distance to Mining Limit

Off-Site Receptor	Distance, Feet
Point A	1898
Point B	2273
Point C	2082
Point D	1913
Point E	1126
Point F	1298
Donald Weaver Property	2600
Blackman Structure - 1072 Meadowlark Lane	4865
Rumpf Structure – 401 North Main Street	5815
Struble Structure – 509 Wells Avenue	6658
Weaver/Garret Structure – 3978 Murray Creek Road	6651

A Module 16 Blast Plan has not been submitted to the Pennsylvania Department of Environmental Protection as of the date of this report. Chad Welsh with AccuBlast Explosives has developed a preliminary Blast Plan using the Module 16 format as shown in Appendix B of this report. Depending on the geologic deposit, the material will be quarried as construction aggregate or dimension stone. Four different blast loading plans are proposed based on hole diameter and depth. The loading plans using the smaller diameter and shallower hole depth will be used for dimension stone. The key aspect of the proposed plan as it pertains to ground vibration and air overpressure is that the proposed plan limits the explosive weight/delay to 261 lbs. and also limits all designs to a scaled distance of 70 or greater.

Projected Ground and Air Vibration Levels

The previous sections have presented research on vibration levels for the protection of structures around the perimeter of the site. Since blasting is not yet taking place at the mine, it will be necessary to predict the level of blast-induced ground and air vibration levels from the blasting operations for comparison to this research. Over the years several authors have published prediction formulae or graphs for this purpose. These prediction formulae relate peak particle velocity to scaled distance. Scaled distance is the distance from the explosive charge to the recording location, in feet, divided by the square root of the charge weight, in pounds. The cubed root of the charge weight is used for the prediction of air overpressure.

Ground vibrations or seismic waves decay with distance. Ground vibrations from typical blasting in most geologic settings decay or attenuate to about 1/3 their former value for each doubling of distance. For example, at 200 feet the vibration is about 1/3 as intense as it is at 100 feet. Because vibration waves attenuate in a fairly regular manner it is possible to predict them within acceptable accuracy.

Peak particle velocity prediction formulas exist to calculate vibration intensity levels at a particular location based upon attenuation factors, charge weight, and distance from the blast to the location of concern. The following equation[3] is one such example that has been successfully employed for many years.

$$PPV = 242\left(\frac{D}{\sqrt{W}}\right)^{-1.6}$$ **Equation 1**

Where: PPV= Peak particle velocity (in/sec)
D = Distance from blast to structure (feet)
W = Maximum lbs. of explosives/delay

In addition to vibration energy that travels through the ground, blasting also causes vibrations in air that will leave the blast site area. Similar to ground vibration energy, air vibrations also decay with distance, however they do not do so as rapidly. Air vibrations from most types of blasting decay at a rate of 6.6 dB per doubling of distance. This is reflected in the following equation for predicting air overpressures from blasting.

$$P = 1.0\left(\frac{D}{\sqrt[3]{W}}\right)^{-1.1}$$ **Equation 2**

Where: P= Peak air overpressure (psi)
D = Distance from blast to structure (feet)
W = Maximum lbs. of explosives/delay

Prediction Analysis

Utilizing Equation 1 and 2 above, it is possible to estimate the expected ground vibration and air overpressure based upon the closest distance to the receptor and the maximum explosive weight/delay. The proposed blast plan from Accublast proposes a maximum explosive weight/delay of 261 lbs. Table 1 shows the closest distance to each receptor from the mining limits. Table 2 below shows the maximum expected ground vibration (column 2) and air overpressure (column 4) based on Equation 1 and 2 respectively.

[3] 17th Edition ISEE Blasters Handbook, (1998), Cleveland, OH, pg. 601

Table 2 – Estimated Ground Vibration and Air Overpressure at Off-Site Receptor Locations

Off-Site Receptor	Estimated Ground Vibration (in/sec)	% of (0.75 in/s) Ground Vibration Limit	Estimated Air Overpressure (lbs/in^2)	% of (0.01295 psi) Air Overpressure Limit
Point A	0.12	16	0.0019050	14.7
Point B	0.09	12	0.0015623	12.0
Point C	0.10	13.3	0.0017206	13.2
Point D	0.12	16	0.0018885	14.6
Point E	0.27	36	0.0033831	26.1
Point F	0.22	29.3	0.0028934	22.3
Donald Weaver Property	0.07	9.3	0.0013475	10.4
Blackman Structure 1072 Meadowlark Lane	0.03	4	0.0006764	5.2
Rumpf Structure 401 North Main Street	0.02	2.6	0.0005559	4.3
Struble Structure 509 Wells Avenue	0.016	2.1	0.0004790	3.7
Weaver/Garret Structure 3978 Murray Creek Road	0.016	2.1	0.0004796	3.7

For the prediction analysis, comparisons are made to the criteria for maximum safe values of ground vibration and air overpressure (0.75 in/sec PPV and 0.01295 psi air overpressure for the residential/commercial structures as shown on page 5 and 6 of this report. Columns 3 and 5 show the percent of these limits for the estimated ground vibration and air overpressure values in columns 2 and 4 respectively.

Conclusion

Based upon a review of the mine plan, Google Earth imagery, potential blast designs, and empirical formulas, the Minard Mine will produce perceptible levels of ground vibration and air overpressure at locations close to the mine. Perceptible vibrations however, are by no means criteria for possibility of structural damage, nor should they be considered an acceptable threshold of significance for human response. The levels of ground vibration and air overpressure expected from the mining operation are significantly below the regulatory limits established by the Commonwealth of Pennsylvania and will provide protection to off-site structures and wells.

It is our recommendation that ground vibration and air overpressure be monitored with digital seismographs at the closest residential/commercial structures. The data should be closely analyzed and logged into a spreadsheet program to track the readings and to build a dataset that can be used to further track the frequency of the vibration time histories, predict the vibration levels, and make adjustments to the blast plan as blasting progresses.

A Monitoring Plan such as that contained in Appendix C should be implemented. All data should be reviewed periodically and if necessary, the blast size and pattern be adjusted. In our opinion, Bishop Brothers can develop the Minard Mine with no adverse effect on surrounding structures and wells from ground vibration or air overpressure.

Respectfully submitted,

Vibra-Tech Engineers, Inc.

Douglas Rudenko

Douglas Rudenko, PG
Senior Vice President

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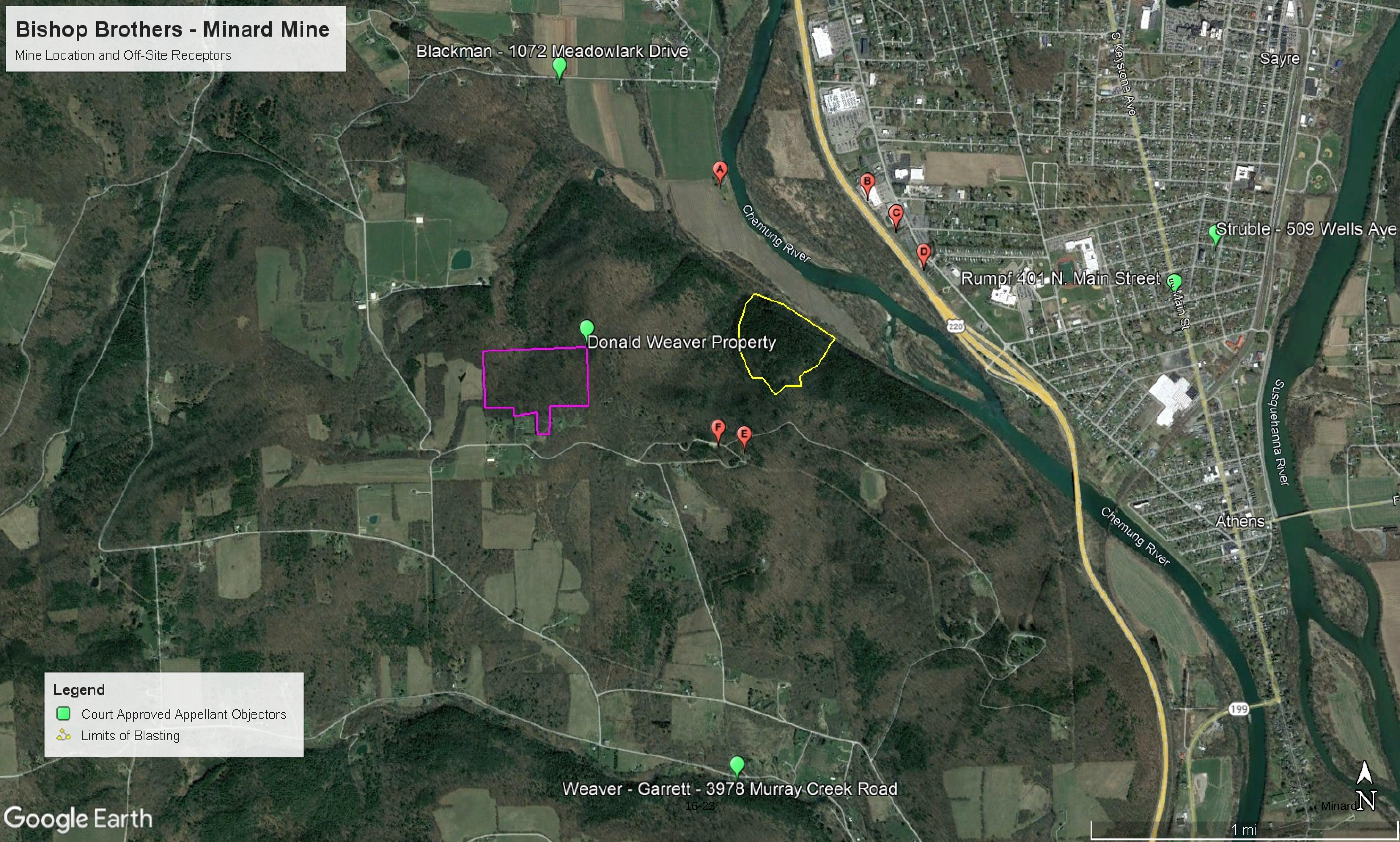
APPENDIX A
MINE LOCATION AND OFF-SITE RECEPTOR MAP



Bishop Brothers - Minard Mine
Mine Location and Off-Site Receptors
Blackman - 1072 Meadowlark Drive
Sayre
S Keystone Ave
A
B
C
D
Chemung River
Struble - 509 Wells Ave
Rumpf 401 N. Main Street
Main St
220
Donald Weaver Property
F
E
Susquehanna River
Athens
Chemung River
199
Legend
Court Approved Appellant Objectors
Limits of Blasting
Weaver - Garrett - 3978 Murray Creek Road
16-23
Minard
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Google Earth

APPENDIX B
PROPOSED BLAST PLAN IN MODULE 16 FORMAT

Module 16: Large Noncoal Blast Plan

(Chapter 211/§§ 77.561/77.562/77.563/77.564)

☐ **New**
☐ **Revised**

Permittee Bishop Brothers Construction_
Permit No. ______________________
Mine Name Minard quarry____________
County Bradford_________________
Township Athens_________________

Blasting Contractor ____

Blasting Contractor ATF Permit License No. ______________________

An application for proposed blasting shall contain a blasting plan for the proposed permit area, explaining how the applicant intends to comply with §§ 77.561-77.565 (relating to use of explosives) and including the following; drilling patterns, including size, number, depths and spacing of holes, charge and packing of holes, types of initiation and detonation controls, sequence and timing of firing holes, and scaled distance. Persons responsible for blasting operations at a blasting site shall be familiar with the blasting plan and site-specific performance standards (25 Pa. Code Chapter § 77.453).

A permit issued under the Noncoal Surface Mining and Conservation and Reclamation Act (52 P. S. §§ 3301-3326), and the regulations promulgated thereunder (25 Pa. Code Chapter 77), authorizing blasting activity shall act as a blasting activity permit issued under 25 Pa. Code Chapter 211. An application for a blasting activity permit shall be prepared by a blaster and shall include information needed by the Department to determine compliance with applicable laws and regulations and conditions necessary to ensure that the proposed blasting activity complies with the applicable statutes and 25 Pa. Code Chapter 211. (25 Pa. Code Chapter § 211.121, 25 Pa. Code Chapter § 211.124).

Sections 16.1 through 16.12 and Sections 16.14 through 16.17 must be submitted with the permit application. Section 16.13 (relating to public notice of blasting schedule) must be submitted prior to blast plan approval. There shall be no blasting until a blast plan has been approved by the Department.

There is a fee required under 25 PA Code Chapter § 77.106 for each blast plan application. Please refer to: https://www.dep.pa.gov/Business/Land/Mining/BureauofDistrictMining/Pages/Fees.aspx for the most current fee rates.

Is the fee being submitted with the application?

☐ Yes ☐ No

16.1a Blast Loading Plan 1 (§ 77.453)

	Hole DIA.	MAX # HOLES	MAX # ROWS	BURDEN		SPACING		HOLE DEPTH		STEMMING	
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	TYPE
A	1.5-2	400	20	2	8	.5	8	2	20	2	water
B	1.5-2.5	300	20	2	8	2	8	2	20	2	cuttings/stone
C	2.5-3.5	300	20	3	12	3	12	4	50	3	cuttings/stone
D	3.5-4.5	300	20	5	14	5	14	5	50	4.5	cuttings/stone
E											

Maximum explosives weight per delay (less than 8ms) 261_____ Minimum Scaled Distance 70__________

Specific Type of Explosives det cord, dynomite, anfo, case product, emulsion products______________________

Method of blast initiation Electric ☒ Non-Electric ☐ Other ☐

Explain Other ____

Comments:

A	1.5-2 inch holes for det cord holes will be stemmed with water for dimensional stone blasting also all cord will be covered with sand to meet dep standards All blast shots will be desinged to maintain a air blast no greater then 133 dbl and a scaled distance no less 70 monitored by a seismograph located at the nearest dewlling in proportion to the blast
B	2 ft min stemming in holes 1.5-2 in. 3 ft min stemming in holes 2-2.5 in. diameter holes All blast shots will be desinged to maintain a air blast no greater then 133 dbl and a scaled distance no less 70 monitored by a seismograph located at the nearest dewlling in proportion to the blast
C	3 ft min stemming in holes 2.5-3 in diameter up to 10 ft deep. With hole depths greater and diameters from 3 - 3.5in. 4ft min stemming and 4ft would be the min spaceing and burden All blast shots will be desinged to maintain a air blast no greater then 133 dbl and a scaled distance no less 70 monitored by a seismograph located at the nearest dewlling in proportion to the blast
D	4.5 ft min stemming on holes 3.5 in. 5 ft min stemming on holes larger then 3.5 in All blast shots will be desinged to maintain a air blast no greater then 133 dbl and a scaled distance no less 70 monitored by a seismograph located at the nearest dewlling in proportion to the blast
E	

16.1b Blast Loading Plan 2 (§ 77.453)

	Hole DIA.	MAX # HOLES	MAX # ROWS	BURDEN		SPACING		HOLE DEPTH		STEMMING	
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	TYPE
A											
B											
C											
D											
E											

Maximum explosives weight per delay (less than 8ms) ________ Minimum Scaled Distance ____________

Specific Type of Explosives ____

Method of blast initiation Electric ☐ Non-Electric ☐ Other ☐

Explain Other ____

Comments:

A	
B	
C	
D	
E	

16.2 ***Peak Particle Velocity and Airblast Limits*** **(§§ 211.151 (c),(d))**

Blasts shall be designed and conducted to meet the maximum allowable peak particle velocity indicated by Figure 1 of 25 PA Code Chapter 211.151 (c) and not exceed the noise levels specified in Table 1 of 25 PA Code Chapter 211.151 (d) at the closest building not owned or leased by the permittee or its customer.

The Department may establish an alternative peak particle velocity or airblast level if it determines that an alternative standard is appropriate or if the owner and lessee, if leased to another party, of a structure located on the permit area have each signed a waiver releasing the vibration limit. The waiver shall be clear, knowing and specific. (attachment(s) **NOTE:** *Additional review time will be necessary if the applicant submits a waiver for an alternative peak particle or airblast limit at a structure.*

16.3 ***Will the sequence and timing of hole detonation be determined by considering factors such as geology, direction and proximity of homes or other structures, permit boundaries, or the locations of underground or overhead utilities.*** **(§ 77.453)** ☒ Yes ☐ No

16.4 ***Will the loading of holes be determined by considering factors such as geology, direction and proximity of homes or other structures, permit boundaries, or the locations of underground or overhead utilities.*** **(§ 77.453)** ☒ Yes ☐ No

16.5 ***Blasting near Dwellings, Public Buildings or Schools*** **(§ 77.564(g)(3))**

Will blasting occur within 1,000 feet of any dwelling, public building or school? ☐ Yes ☒ No

Indicate distance to the nearest dwelling or structure, neither owned nor leased by Permittee, from the area where blasting will occur. 1150 feet

16.6 If blasting will occur within 1,000 feet of any public building or school, explain how notification required by 25 Pa Code § 77.564(g)(3) will be made.

16.7 Will blasting be conducted within 300 feet of an occupied dwelling? (§ 77.564(g)(4)) ☐ Yes ☒ No

16.7a If blasting is proposed within 300 feet of an occupied dwelling provide a notarized written waiver from the owner each dwelling specifying the distance blasting may occur to the dwelling (**Note:** If the waiver includes an increase in the peak particle velocity limits or in the airblast limits, in 25 Pa Code Section 211.151(c) and (d), the alternative limits must be specified in the waiver). (Attachment) (§ 77.564(g)(4))

16.8 Will blasting will be conducted within 800 feet of any public road? (§ 77.564(g)(1)) ☐ Yes ☒ No

16.8a If blasting will be conducted within 800 feet of any public road describe the precautions that will be taken to protect the travelling public (can be submitted as an attachment): (§ 77.564(g)(1))

16.9 ***Blast Area*** **(§§ 77.564(d)(1), 77.564(e))**

Describe how the blast area as defined in 25 Pa Code Section 211.101 will be determined, the procedures for notification of all persons who may have access to the blast area, and how the blast area will be secured and safeguarded (can be submitted as an attachment):

The blaster in charge will determing the size of the blast area. The quarry foreman will notify all the miners. All acess point to the quarry will be blocked and all miners will be counted and moved to a designated area determined by the blaster in charge for the duration of the blast The blaster will give 3 audible warnings prior to detonateing the blast and one audible all clear horn after the blaster has determined the blast area to be safe after the all clear horn the blaster in charge will notify the foreman that the quarry is safe to enter and resume work

16.10 ***Underground Mines*** **(§ 77.551)**

Will blasting occur within 500 feet to any point over or adjacent to an active or abandoned portion of an active underground mine? ☐ Yes ☒ No

If yes attach completed MSHA form. ***(Attachment)***

16.11 ***Underground Utility Lines*** **(§ 211.181-182)**

Will blasting be conducted within 200 of feet Underground Utility Lines? ☐ Yes ☒ No

If underground utililities are located within 200 feet of the area where blasting will occur, attach a copy of the notification sent to the owner(s) (submit as an attachment).

If there are any requests for waiver of any of the provisions of 211.182 attach copies of any agreements with the owner(s) of the utilities (submit as an attachment).

16.12 ***Streams*** **(§ 73 P.S. s 166(d)**

If blasting will occur within 100 feet of any streams, identify the stream and indicate the distance blasting will occur from the stream.

Stream: ______________________ Distance: ______________________

16.13 ***Public Notice of Blasting Schedule*** **(§ 77.563)**

Submit the following to the Department prior to the initiation of blasting.

a) A Copy of the public notice of the blasting schedule that is published in a newspaper of general circulation in the locality of the area where blasting will occur (submit as an attachment)

b) A List of the Local governments and public utilities that are located within 1,000 feet of the area where blasting will occur, who received copies of the blasting schedule. (**Note:** These shall be sent a copy of the blasting schedule.) (submit as an attachment)

16.14 ***Explosive Storage*** **(§ 87.65(a)(11))**

Will explosives be stored within the proposed blasting area? ☐ Yes ☒ No
If "yes" provide current explosives storage security plan number. ______________________
If no explain the disposition of explosives materials used for this project.

____

____

____

16.15 *Blast Plan Preparer* (§ 211.124(a))

The PA licensed blaster who prepared this application must print and sign name below. (General or Surface Mining Authorization Only)

Licensed Blaster ______________________________
Print

Licensed Blaster ______________________________ Date _______ Blaster's license Number **BL-**______
Sign (General or Surface Mining Authorization)

16.16 *Permittee Authorization Representative* (§ 77.107)

The permittee or an authorized representative of the permittee must print and sign name below.

Permittee or Authorized Representative ______________________________
Print

Permittee or Authorized Representative ______________________________ Date __________
Sign

16.17 ***Map*** (attachment-delineates where blasting will occur and the area within 1,000 feet of where blasting will occur.) (If explosives are going to be stored on the mine site, the location of the explosives storage must be included on the map.) **The map should accurately show, at a minimum, permit boundaries, the locations of streams, gas wells and lines, other undrground utilities, overhead utilities and the nearest dewllings and other structures. (§§ 211.124(7)), (77.454(a)(9)**

16.18 List of attachments (Check all that apply)

- ☐ Dwelling Waiver
- ☐ Road Precaution Description
- ☐ Blast Area Security Plan
- ☐ MSHA Form
- ☐ Utility Notification
- ☐ Blast Schedule Public Notice
- ☐ Map
- ☐ Other ______________________________
- ☐ Other ______________________________

Department Use Only:

DEP Blasting Inspector ______________________________
Print

DEP Blasting Inspector ______________________________ Date ________
Sign

Recommendation - ☐ Approval ☐ Disapproval

Comments:

APPENDIX C
BLAST VIBRATION MONITORING PLAN

Blast Vibration Monitoring Plan
Bishop Brothers - Minard Mine
Athens Township, Bradford County, Pennsylvania

Prepared for:

Christopher D. Jones, Esquire
GRIFFIN, DAWSEY, DEPAOLO & JONES
101 Main Street
Towanda, PA 18848

Prepared by:

Vibra-Tech Engineers, Inc.
109 E. First Street
Hazleton, PA 18201
1-800-233-6181

September 4, 2024

Blast Monitoring Plan

A. Instrumentation Requirements

1) A direct reading velocity seismograph that adheres to the performance specifications for blasting seismographs adopted by the International Society of Explosives Engineers will be used at all times to monitor ground vibration and air overpressures resulting from blasting operations at the Minard Mine.

2) All seismographs shall be considered approved only if the instrument meets the following criteria, as suggested by the International Society of Explosives Engineers:

   a) For ground vibration measurements, the instrument shall have a frequency response range from 2 – 250 hertz, within zero to -3 dB of an ideal flat response.

   b) For ground vibration measurements, the instrument shall have an accuracy of ± 5 pct. or ±0.02 in/sec, whichever is larger between 4 and 125 Hz.

   c) For air overpressure measurements, the instrument shall have a flat frequency response over the range of 2 to 250 hertz, -3dB at 2 Hz. ± 1dB.

   d) For air overpressure measurements, the instrument shall have an accuracy of ± 10 pct. Or ± 1 dB, whichever is larger between 4 and 125 Hz.

   e) The digital sampling rate shall be 1000 samples/sec or greater, per channel.

3) The instrument shall be capable of measuring and recording particle velocity in three mutual perpendicular directions.

4) The instrument shall have a seismic range from 0.02 to 4.0 inches per second for ground vibration measurements.

5) The instrument shall have a pressure range from approximately .001 to .012 pounds per square inch (psi) [approximately 106 dB to 138 dB, re: $2x10^{-9}$ psi] for air overpressure measurements.

6) The instrument shall be capable of performing a dynamic field calibration during monitoring and should be calibrated in accordance with the manufacturer's recommendations on a yearly basis.

7) Appendix A of this Blast Vibration Monitoring Plan gives the specifications of an instrument that meets the requirements set forth above.

B. Instrumentation Setup Procedures

1) In order to document compliance, an instrument will be located, at a minimum, at the closest residential/commercial structure. The instrument will be placed on the ground between the closest blast hole to be detonated and these locations.

   If a property owner does not give permission for the monitoring to be conducted on their property then the seismograph should be placed at a location between the blast area and the property that did not provide permission (a closer distance to the blast).

   <u>Ground Vibration Measurements</u>

   a) Sensor placement - The sensor should be placed on or in the ground on the side of the structure closest to the blast, or in line with the blast

   b) Location relative to the structure – Sensor placement should ensure that the data obtained adequately represents the vibration levels received at the structure being protected. The sensor should be placed within 10 feet of the structure or less than 10% of the distance from the blast, whichever is less.

      i) The sensor must be nearly level.
      ii) The longitudinal channel should be pointing directly at the blast.
      iii) Where access to the structure and/or property is not available, the sensor should be placed closer to the blast in undisturbed soil.

   c) Sensor coupling – Depending on the anticipated ground vibration acceleration levels spiking, burial, or sandbagging of the geophone may be appropriate depending on conditions.

      i) Burial, the preferred method, is excavating a hole that is no less than three times the height of the sensor, spiking the sensor to the bottom of the hole, and firmly compacting soil around and over the sensor.
      ii) Spiking entails removing the sod, with minimal disturbance of the soil and firmly pressing the sensor with the attached spike(s) into the ground.
      iii) Sand bagging requires removing the sod with minimal disturbance to the soil and placing the sensor on the bare spot with a sandbag over top. Sandbags should be large and loosely filled with about 10 pounds of sand. When placed over the sensor the sandbag profile should be as low and wide as possible with a maximum amount of firm contact with the ground

   d) Ground Vibration Trigger Level - The trigger level should be programmed low enough to trigger the instrument from blast vibrations and high enough to minimize the occurrence of false events. The level should be slightly above the expected background vibrations of the area. A good starting level is 0.05 in/sec.

   e) Record the full waveform. It is not recommended that the continuous recording option available on many seismographs be used for monitoring blast-generated vibrations. If the blast vibration is not sufficient to trigger the instrument a monitor log should be printed to show that the instrument was on and monitoring during the date and time that the blast occurred. A dynamic sensor check should also be part of the permanent record.

Air Overpressure Measurements

a) Microphone placement - The microphone should be placed along the side of the structure nearest the blast, or in line with the blast.

   i) The microphone should be mounted near the geophone with the manufacturer's windscreen attached.
   ii) If practical, the microphone should not be shielded from the blast by nearby buildings, vehicles or other large barriers. If such shielding cannot be avoided, the horizontal distance between the microphone and shielding object should be greater than the height of the object above the microphone.
   iii) If placed too close to a structure, the air blast may reflect from the house surface and record higher amplitudes. Structure response noise may also be recorded. Placing the microphone near a corner of the structure can minimize reflection.

2) Document the location of the seismograph. This includes the name of the structure and where the seismograph was placed on the property relative to the structure. Any person should be able to locate and identify the exact monitoring location at a future date.

3) Know and record the distance to the blast. The horizontal distance from the seismograph to the blast should be known to at least two significant digits. For example, a blast within 1000 feet would be measured to the nearest tens of feet and a blast within 10,000 feet would be measured to the nearest hundreds of feet.

C. Receptor Locations and Frequency of Monitoring

The Minard Mine Blast Impact Analysis, dated September 4, 2024 lists six (6) residential/commercial locations surrounding the proposed mine location. The closest of these receptor locations will be chosen as the compliance monitoring location and will be based on the location of each blast. In order to ensure that the criteria set forth in the Blast Impact Analysis are met, vibration measurements using a tri-axial digital seismograph need to be taken at the closest residential/commercial property. Additional seismographs can be deployed at other locations if required or requested.

Application of Particle Velocity and Air Overpressure Control

The ground vibration and air overpressure control limits for the receptors are detailed in the Blast Impact Analysis Report. If the blasting operations at the Minard Mine exceed the referenced control limits for any single axis of any blast, Bishop Brothers and their blasting contractor shall cease all blasting activities and submit a report to the Pennsylvania Department of Environmental Protection. The report shall give the blast design parameters and seismographic data and include any necessary proposed corrective action, which in their opinion will reduce the ground vibration or air overpressure intensity.

APPENDIX A

SSU 3000LC

The SSU 3000LC is a convenient, easy to use and complete vibration and sound monitoring system designed with the user in mind. Key features include an enhanced tactile keypad, heavy-duty twist-lock metal cable connectors and a heavy-gauge aluminum enclosure with baked enamel finish. The four-line by 20-character LCD and menu-driven programming makes on-site setup easy and permits the user to view numerical waveform data and monitoring results in the field. The timesaving template utility can store repetitive setup information for quickly deployed instruments with pre-defined configurations. The internal lead-acid battery is long lasting and easily charged using the included AC adapter. An integrated timer turns the unit on and off at pre-selected times to conserve battery power. The 2-hertz, high-pass microphone and all other accessories fit easily into the tough, structural-resin carrying case.

The SSU 3000LC has three recording modes: 1) triggered – either seismic or sound, 2) continuous (histogram) and 3) sustained trigger. The internal memory can store up to 220, 1-second events. Sustained trigger mode delays processing and permits collection of consecutive 15-second intervals of waveform data up to a cumulative total of approximately 4.2 minutes. Data can be collected in either imperial (US customary) or metric units. The included basic compliance software package can be used for data analysis and preparation of standard or customized reports.

GeoSonics® is a leader in seismograph innovation, design, manufacturing and vibration consulting. Because we use the equipment we design, a user-friendly interface, ruggedness and reliability are not just goals – they are standards.

GeoSonics®…always a step ahead!


Easily accessible serial ports for external communications. LEDs show data transmittal status. External power supply port. In-line fuse for internal circuitry protection.

Instrument connection ports come standard with caps to protect connecting pins when not in use.

Heavy-duty twist-lock metal cable connections are standard design features on all GeoSonics® seismographs.

Features & Specifications

STANDARD FEATURES:
- External geophone meets ISEE density recommendations.
- Four-line by 20-character LCD and 16-key alphanumeric keypad for on-site setup and data display.
- Heavy-gauge aluminum case & baked enamel finish.
- Heavy-duty twist-lock metal cable connectors.
- Internal, rechargeable lead acid batteries.
- External LED indicators for charging & recording status.
- Flexible interface for custom configurations.
- Two (2) independent threshold alarm output ports.

GENERAL:
- Weight (With Case) .... 14.7 lbs (6.7 kg)
- Dimensions (With Case) .... 12.3 in x 13.5 in x 5.0 in (31.1 cm x 34.3 cm x 12.7 cm)
- Weight (Without Case) .... 4.5 lbs (2.1 kg)
- Dimensions (Without Case) .... 8.7 in x 7.0 in x 3.6 in (22.1 cm x 17.8 cm x 9.2 cm)
- Operating Temperature: 0 to 130° F (-18 to 54° C).
- One (1) year warranty on parts and labor.

STANDARD FEATURES (Continued):
- PC serial port interface for downloading events data.
- Up to 220, 1-second waveform data recordings (up to 50, 5-second waveform data recordings).
- GPS acquisition feature (NEMA 108 compatible).
- Six (6) template locations for recurring set up data.
- Imperial and metric operation.
- Basic compliance reporting software package included.
- Designed & manufactured in the USA.

OPTIONAL ACCESSORIES:
- Hydrophones (instrument modifications required).
- Accelerometers to 50 g's or higher (instrument modifications required).
- Amplifiers (10x-100x).
- Optically isolated dual alarm control for dialers, pagers and remote alarm notifications.
- Advanced seismic analysis software package.
- Extended warranties & service contracts.
- Numerous custom configurations – call for details.

RECORDING MODES:

Seismic Trigger:	Resolution:	0.0025 in/sec. (0.06 mm/sec.).
	Range:	Up to 5.120 in/sec. (130 mm/sec.)(other ranges available).
	Frequency Response Range:	2 to 250 Hz (3 dB) / 2 to 1,000 Hz (Nyquist).
	Sampling Rate:	Up to 2,000 / second / channel.
	Recording Intervals:	1 to 15 seconds.
	Accuracy:	5% within one year (multi-frequency calibrated).
	Calibration:	Internal dynamic.
Sound Trigger:	Range (Linear):	78 to 142 dB (other ranges available).
	Frequency Range (3 dB):	2 to 250 Hz (3 dB) / 2 to 1,000 Hz (Nyquist).
	Accuracy:	±10% or 1dB within one year (multi-frequency calibrated)
	Calibration:	Internal electronic.
Continuous (Histogram):	Vibration Data:	Peak particle velocity and frequency for L, T & V.
	Recording Intervals:	Selectable: 1 to 60 seconds.
	Sound Data (Linear):	78 to 142 dB (other ranges available).
Sustained Trigger:	Multiple Event Recordings:	Consecutive waveform recordings up to 4.2 minutes.

GeoSonics

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