The former United States Bureau of Mines (USBM) was the lead agency in studying blast effects on low-rise, residential type structures from 1910 until its closure in 1996. One of the principle objectives of the agency was to obtain a wide spectrum damage criterion that could be adopted by civil regulatory agencies in fashioning blasting regulations that would prevent threshold damage. Threshold damage refers to the most superficial, marginally visible, hairline cracking of interior wallboard such as that which develops in all homes independent of blasting (Siskind, 2000). Threshold damage is *not readily visible* to the homeowner and often requires the use of special lighting and magnifying lenses to be seen by researchers.

The USBM prepared three comprehensive reports over a period of 40 years that culminated in the publication of USBM Report of Investigation (RI) 8507 in 1980. This study involved new measurements and inspections that were combined with results of nine previous studies. In total, results of 718 blasts involving 150 structures were included. RI 8507 presents a criterion (Figure 1) that delineates safe blasting limits to prevent threshold vibration damage to low-rise, residential type structures for a wide-spectrum of frequencies.

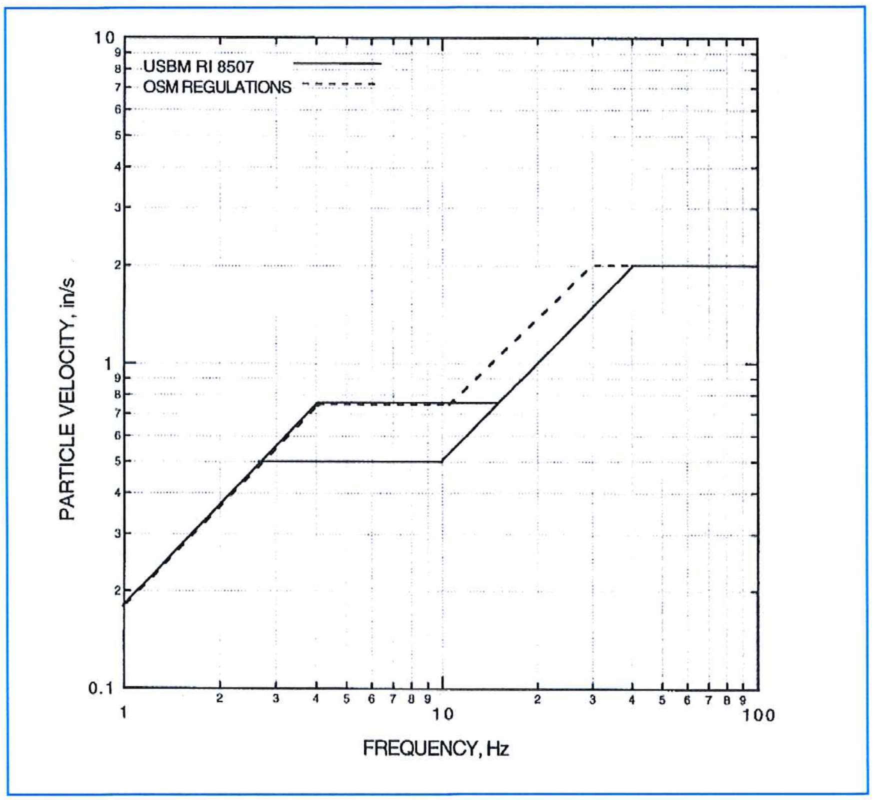


Figure 1: RI 8507 Threshold Damage Criterion

The limits imposed by this criterion are very conservative and contain a large margin of safety for the protection of the structure. For example, this publication concludes that high frequency ground vibration of 3.2 ips will cause threshold damage to only five out of 100 homes, i.e. a five percent statistical probability of threshold damage (USBM RI 8507, p.59). This damage would consist of marginally visible, hairline cracking of plaster or sheetrock wallboard. The lowest cracking value for crack extension in sheetrock from thousands of observations made by the USBM is 0.79 ips. No observations of threshold cracking have been observed or documented by either the USBM or other studies below 0.5 ips. "The USBM's inability to obtain positive cracking observations below 0.50 in/s was recognized during the preparation of the RI in 1980 (pp. 58 and 68). However, the cause and significance of this fact was only suspected at that time. The reason is now believed to be the universal existence of natural and cultural stresses affecting homes corresponding to vibrations of about 0.50 in/s and in some cases over 1.2 in/s" (Siskind, 2000, p. 41).

Cracks in construction components such as interior wallboard and plaster walls are not static but undergo hourly and seasonal cyclical changes in response to fluctuations in temperature, humidity, wind and other factors. For example, Dowding (2000) obtained data from full-time monitoring of a crack at the joint of two sheets of drywall in a test house (see Figure 2). Crack movement due to changes in weather was 3.5 times larger than those produced by blasting with a maximum vibration level of 0.75 inches per second (ips). It would require a vibration intensity of about 5.7 ips to have the same total effect on the change in dimension as a complete weather cycle (Dowding, 2000).

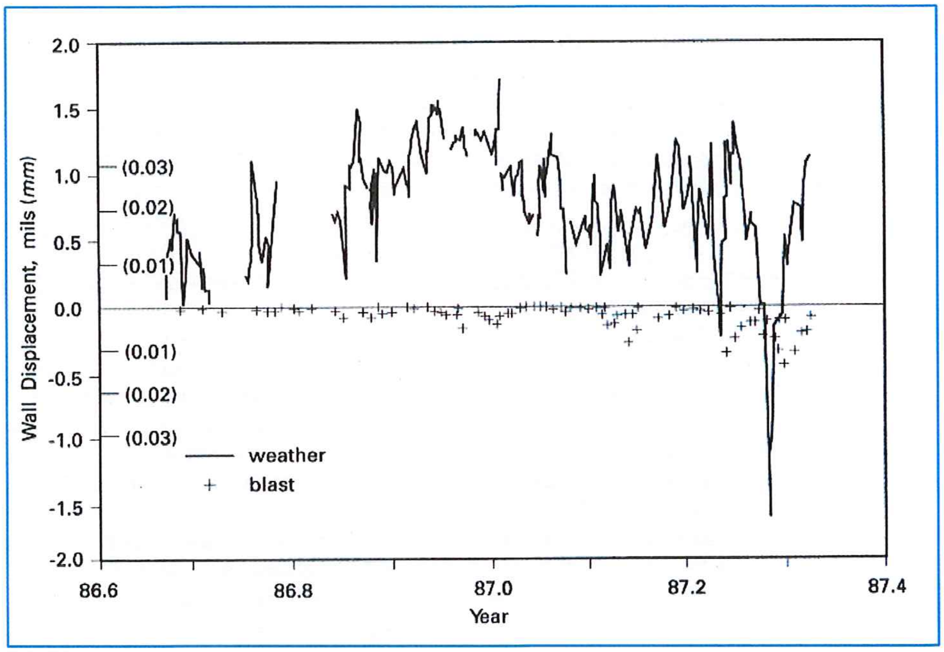


Figure 2: Comparison of Crack Displacements produced by weather changes (continuous line) and blasting vibrations with maximum particle velocity of 0.75 ips

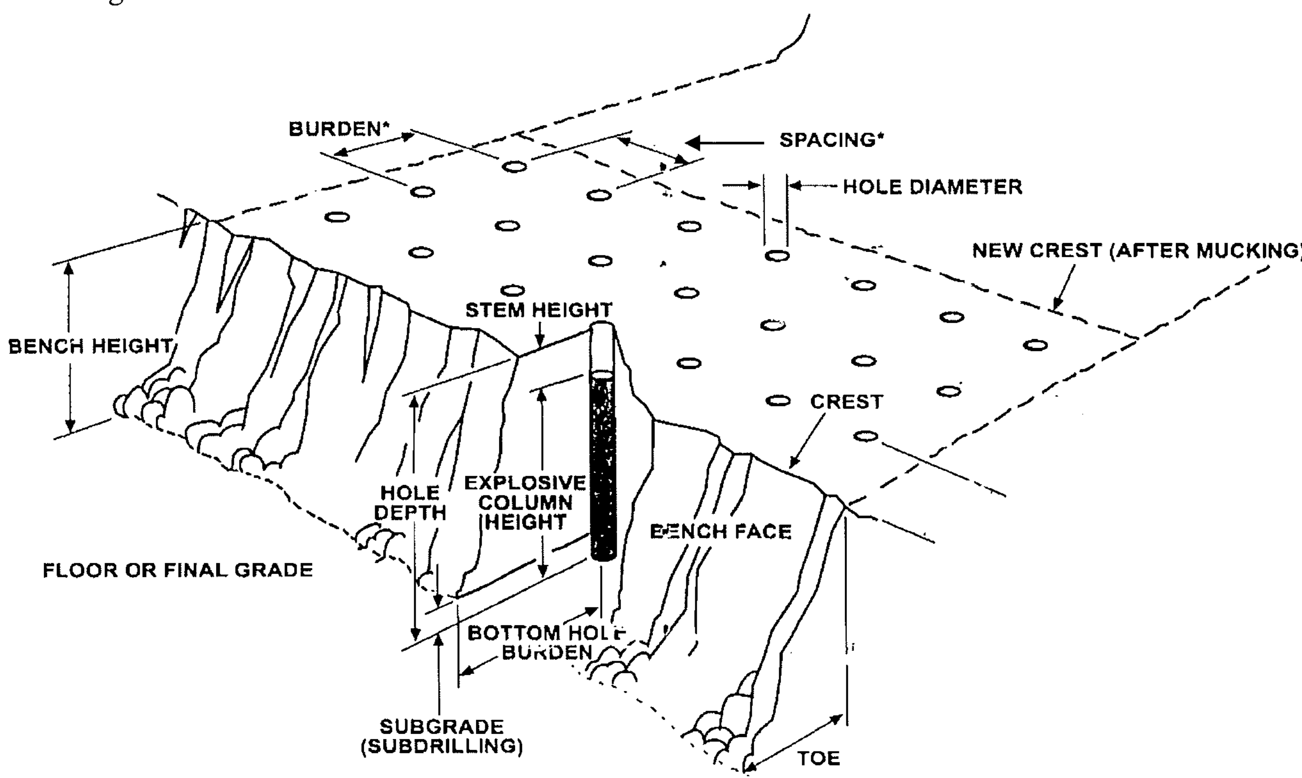
A blast design has been preliminarily planned for the site and presented on the following pages. Due to the hundreds of variables for which only the blaster has control, Continental Placer Inc. cannot and will not assume responsibility for the results of the blasting. The proposed design is only a recommendation based on historical records. All aspects of the blast design, including burden, spacing, geometry and delays, as well as consideration for geological variations, are the responsibility of the blaster in charge. The potential impacts from flyrock, dust and gases will be contained in the quarry and, more specifically, in the blast zone. Blast zone means the area beyond the blast area that may be influenced by blasting operations.

Hilltop Energy has been routinely blasting in the quarry (16 times in 2014) with a drill hole diameter of 6.25 inches; with a face burden of 17 feet and spacing between drill holes of 16 feet. This pattern will continue to be used in the expansion area as long as the blaster-in-charge deems it appropriate. Depending on the depth of the hole, each hole may have up to four explosive decks with approximately four to five feet of stemming separating the decks. The number of explosive decks will determine the pounds of explosives detonated in any one delay period; the greater the number of decks the fewer pounds of explosives detonated per delay period. The nearest residence to the expansion area will be approximately

250 feet and this will not be until Phase 5, which is many tens of years into the future. The calculations presented below are based on the quarry highwall being 250 feet from that residence.

DuPont's attenuation calculation was used for the analyses and to plot the graph shown in Figure 3 using the proposed blasting design. The graphs show the effect of distance upon peak particle velocity using the 200 pounds per delay in blasting. The closest any blast will be is approximately 250 feet. The graphs show that at 250 feet using 200 pounds of explosives per delay the vibration is 1.62 inches per second. This vibration intensity is well within the USBM guidelines of 2.0 inches per second at frequencies higher than 40 hertz.

Blast Design
Bench Height = 52 feet
Drill Hole Diameter = 6.25 inches
Burden = 17 feet
Spacing = 16 feet
Explosive Column Height = 44 feet
Stem Height = 8 feet



The weight of explosives in each delay will be approximately 200 pounds (average density 1.20 grams/cubic centimeter).

For Phase 5, closest structure not under the control of the quarry will be no closer than 250 feet. The Scaled Distance to this structure is 17.68. Scaled distance (D_s) is a factor relating similar blast effects from various size charges of the same explosive at various distances. Scaled distance, referring to blasting effects, is obtained by dividing the distance of concern *(D)* by a fractional power of the weight of the explosive materials *(W)*.

$$\textit{Scaled Distance } Ds = D/W^{1/2}$$

We used the following formula to calculate the expected Peak Particle Velocity (PPV):

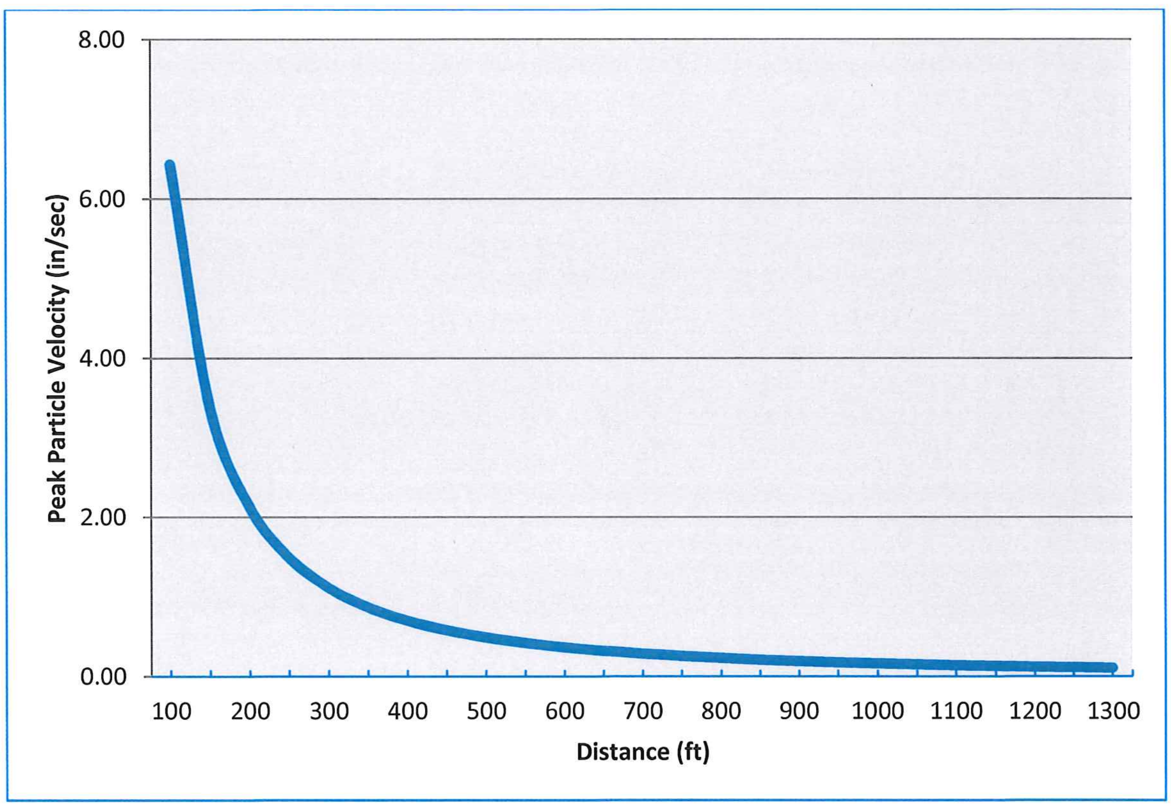
$$PPV = 160\ (Scaled\ Distance)^{-1.6}$$

The following table shows the results of our calculation at various distances. PPVs are expressed in inches per second. Figure 3 shows how quickly blast induced ground vibrations attenuate.

Table 1: Predicted Peak Particle Velocities

Distance to Structure	Pounds Per Delay	Scaled Distance	Peak Particle Velocity
100	200	7.07	7.00
150	200	10.61	3.66
200	200	14.14	2.31
250	200	17.68	1.62
300	200	21.21	1.21
350	200	24.75	0.94
400	200	28.28	0.76
450	200	31.82	0.63
500	200	35.36	0.53

Figure 3: Peak Particle Velocity Attenuation



Most structures contain cracks caused by strong environmental and cultural forces regardless of the presence of blasting. Strains in construction components are produced by the gravitational loads carried by bearing walls, the shrinking and swelling of construction materials as they cure or in response to changes in the weather, differential foundation settlement caused primarily by changes in soil moisture, sub-standard construction practices and/or materials and household activities such as door slamming, nail pounding, jumping etc. A summary of peak particle equivalent strains from non-blasting forces, extracted from Siskind (2000, p. 59) is presented in Table 2.

Table 2: Particle Velocity Equivalent Strains Produced by Household Activities and Environmental Changes

Vibration or response source	Magnitude	Equivalent ground vibration velocity, in/s	References
Temperature, outside	Δ10°F	1.0 - 3.2	Stagg (1984)
	Δ10°F	0.5 - 1.7	Siskind (1996)
	Δ18°F	>0.34	White (1993)
Temperature and humidity cycles	not specified	1.75 - 5.0	Fang (1976)
		0.75-2.6	Dowding (1996)
Humidity	10 pct	1.0 - 2.4	Stagg (1984)
Wind	20 mph	0.6 - 2.6	Stagg (1984)
	50 mph	1.1 - 6.7	Sutherland (1968)
Traffic	4-t truck driving over a 1-in plank at 63 ft	≈0.24	Thoenen (1942)
	not specified	0.04 - 0.20	Fang (1976)
Human activity:	slamming front door	0.15 - 1.9	Stagg (1984)
	closing door	0.35 - 0.50	Aimone (1987)
	walking	0.1	Aimone (1987)
	pushing on wall	0.025 - 0.36	Fang (1976)
	pushing on wall	0.6 - 2.4	White (1993)
	jumping & walking	0.10 - 0.50	Stagg (1984)
	jumping	0.15 - 0.9	White (1993)
	walking (long span floor response)	0.16 - 0.74	Dowding (1996)

AIR OVERPRESSURE

In typical blasting applications, explosives are inserted into holes drilled into the bedrock. When the explosives are detonated they immediately create rapidly expanding, high pressure gases. These gases create stress waves that are transmitted through the bedrock. The blast gases are confined and the energy produced will break the rock. As the gases continue to expand, the result is a release of energy into the atmosphere referred to as airblast or air overpressure. Airblast is also created by the outward movement of the blasted rock. This energy is measured in decibels (dB) or pounds per square inch (psi) and is simply pressure in excess of the ambient air pressure.

Air overpressure consists of air transmitted sound pressure waves that move outward from an exploding charge. A well confined explosive charge creates pressure waves with frequencies that are predominantly less than 20 hertz (Hz), with a relatively small amount of energy having frequencies above 20 Hz. The portion of air blast that falls below 20 Hz is typically about 70% and the portion that is above 20 Hz is typically about 30%. However, air blast is influenced by many different things, the most common are the pounds of explosives detonated per delay period, distance from blast site to the area of concern, quarry highwall height and orientation, blast hole stemming, burden and spacing of blast holes and weather conditions. These influences could alter the typical percentages above and below 20 Hz. The human ear responds to frequencies above 20 Hz, but filters out frequencies below 20 Hz. Buildings respond predominantly to frequencies in the range 2 to 20 Hz. Because air overpressure from blasting consists of frequencies that are substantially below 20 Hz, air over-pressure levels are measured with a meter that measures frequencies in the range 2 to 250 Hz on a decibel (Linear) (or dBL) scale.

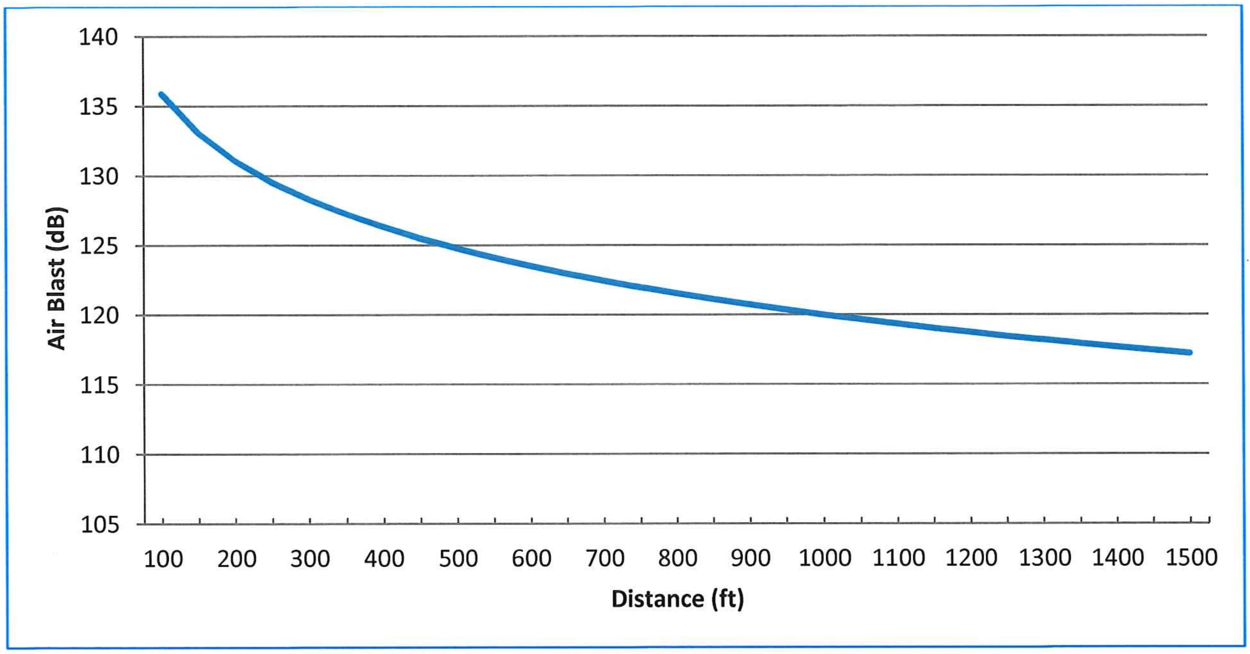
USBM RI 8485 (Siskind et al., 1980) presents results of new analyses as well as a summary of 18 older studies of airblast damage risks. Although a few observations of very minor damage were found at overpressures equivalent to 134 dB, most of the studies concluded that 140 dB represents a reasonable, i.e. conservative, threshold for glass and plaster damage. Most regulatory agencies follow the more recent Office of Surface Mining (OSM) recommended limit of 134 dB that contains a very large safety factor equivalent to fifty percent of the historical limit. Overpressure criteria currently used in the blasting industry are presented in Table 3.

Table 1: Typical Overpressure Criteria

3.0 psi	(180 dB)	-	possible structure damage
1.0 psi	(171 dB)	-	general window breakage
0.1 psi	(151 dB)	-	occasional window breakage
0.029 psi	(140 dB)	-	long-term history of application as a safe project specification
0.0145 psi	(134 dB)	-	Office of Surface Mining recommendation

The OSM recommendation of 134 decibels for blasts equates to approximately a 28 mile per hour gust of wind. The air overpressure attenuation curve presented below (Figure 4), developed from the proposed blast design, shows how the blast induced air overpressure decreases at greater distances from the source. At 250 feet from the shot the air overpressure is calculated to be 129.5 dB, which is significantly under the OSM recommendation and equates to approximately 22 mile per hour gust of wind.

Figure 4: Attenuation of Air Overpressure with Distance from Blast



In summary, Hanson, with Hilltop Energy has been implementing best management practices in the existing operation and will continue to do so in the proposed mine expansion area. The best management practices have and will continue to include compliance with the performance standards outlined in United States Bureau of Mines (USBM) Report of Investigation (RI) 8507 and USBM RI 8485. The blasting plan for the expansion area will emulate the ongoing plan and it has considered the environmental effects of blasting, geologic considerations, blast design, drilling operations, explosive loading, and blast confinement.

The potential impacts associated with blasting have been identified and discussed, specifically; ground vibrations, air blast, flyrock, dust and, gas, and blasting within 250 feet of any dwelling. We have also discussed the blasting area, the anticipated peak particle velocity at the nearest residential receptor, a description of an average production shot which includes but is not limited to: the blast layout, the expected spacing and burden, and the average number of pounds per delay.

hilltop energy inc.

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DWD
A SUBSIDIARY OF D. W. DICKEY & SON, INC.

4/19/2013

Hanson Aggregates, Inc.

Michael Lewis – Environmental Manager

P.O. Box 513

4800 Jamesville Road

Jamesville, N.Y. 13078

Dear Mike,

Based on our discussion on 4/17/2013 concerning blast design by Hilltop Energy, Inc. the following procedures are followed:

1. A determination is made whether this is a new quarry, a new area in an existing quarry or a continuation of the existing bench.
2. GPS readings are taken at all the non-owned structures closest to the location of the blast area. Based on the distances and directions from blast expected vibrations will travel a determination is made on how many seismographs will be set and the locations where they will be set.
3. The blasting pattern to be used could be the existing pattern or changed based on the size blast hole, type explosives to be used (density), number decks in blast hole, pounds of explosives per 8ms.,scaled distance to non-owned structures, geology of rock, core sample results if any were done and a predicted ppv using the Sauls Engineers, Inc. Vibration Prediction Formulas program.
4. The blast results such as fragmentation, back break on face, stemming sufficient, air blast reading and were the seismograph ppv readings close to what was predicted are reviewed by blaster to see if any changes are required. Based on the results a blast design change will be made to minimize the effects on the neighbors.
5. Hilltop Energy, Inc checks with Quarry Supt. to see if any scaled distance restriction is in the mining permit so as to stay in compliance with the DEC.
6. Hilltop Energy Inc. follows all the requirements of the New York State Dept. Of Labor and MSHA.

If I can be of any further assistance feel free to contact me at 315 – 778 – 4098.

David Paro
David D Paro
Sales/Tech. Rep.
Hilltop Energy Inc.

Fallenz Res.

Sauls Engineers, Inc
Vibration Prediction Formulas

Vibration Prediction(Use for Missed Shots) — PPV = 160 (SD)^-1.6

DISTANCE	WEIGHT	Actual Scaled Distance	PPV
2226	581	92	0.11

Scale Distance Formula — W = (DISTANCE / SD)^2

DISTANCE	SD	WEIGHT
2226	92	585

Actual Scale Distance — Sd = (DISTANCE /SQRT(W))

DISTANCE	WEIGHT	Actual Sd
2226	581.43	92

Ground Vibration Prediction — PPV = K (SD)^-1.6

CONSTANT	SD	PPV
153	92	0.11

Ground Transmission Constant (K) — K = (PPV) (SD)^1.6

PPPV	SD	CONSTANT
0.11	92	153

Powder Factor — LBS/C.Y. = LBS. HOLE / C.Y. HOLE

HOLE DIA.	DEPTH	STEM.	BURDEN	SPACING	EX DENSITY	LB / C.Y.
6.25	46	8	16	16	1.26	1.46

DYNO NOBEL INC.

Memo

To: LARRY CLARK – SUPERINTENDENT HANSON HONEOYE FALLS

From: PAUL NICHOLS

CC:

Date: 10/6/2015

Re: BLAST DESIGN AND DISCUSSION

Larry,

Dyno Nobel utilizes blasting practices and techniques that fall with-in the guidelines and parameters that are established by the NYS DEC and MSHA regulations. All shots fired by DYNO Nobel in NYS are monitored with seismographs at the closest non-owned structure to the location of the blast. In addition, we offer our customers additional seismograph monitoring if other locations become a question. With this being said we will use shot history in assisting with complying to vibration and airblast limits placed on mines for future shots in the same area.

As blasting conditions change, with respect to vibration measurements and airblast measurements, a modification of the existing blast design takes place so as to minimize these effects on neighboring structures.

If a mine is to go into a new area and start mining, we look at this as a new customer and the process starts with us completing a new Risk Assessment of the area and we design our shots according to the information obtained during this process. I have included a sample of our Risk Assessment and highlighted in red areas of concern. This form, once completed is forwarded and reviewed, prior to shots being laid out, to our technical department for approval.

Should you have any questions or if I can be of further assistance please feel free to contact me at 315.408.3899.

Paul Nichols

Dyno Nobel Inc.

Pre-Blast Risk Assessment

Name of Parent Company: ______________________

Name of Project: ______________________

Address of Project: ______________________

County or locality of Project: ______________________

Customer phone number
Customer FAX number
Customer contact, manager, or point person
Customer phone number
Name and job title of person doing the assessment:
Site from which project will be serviced:
Site Manager:
Sales Manager:
Blaster/Blasters:
Expected shot size (pounds)
Expected pounds per delivery
One-way miles from servicing site to project
Borehole diameter
Borehole depth
Burden
Spacing
Predicted vibration at closest non-customer owned structure
Expected hours Dyno Nobel equipment operators will be in transit and on job
Expected hours Dyno Nobel blaster will be in transit and on job
Expected number of shots/month
Projected duration of project
Name and distance to construction or mine's equipment or structures
Name and distance to closest non-mine or construction company owned structure
GPS points for closest structure ______________ ______________
GPS points for blast area ______________ ______________
Distance to buried or overhead utilities or gas

lines
If a contract driller is to be employed, will the drilling company sign a drilling contract
Is this blasting site to be drilled by or under the direction of Dyno Nobel
Is it anticipated that vibration levels will exceed governing code
Does the customer require the 8-MS rule to be applied
Are there fines for shutting down the utility
Are there any problems in securing the blast site
Are there limits to blast times
Are there traffic flow concerns
Are there fines for shutting down traffic
Is the blast area elevation higher than nearby structures, roads, or railways
Is the rock to be blasted massive or hard to break
Are there any underground workings, ie., auger holes, etc
Is the rock to be blasted seamy or irregularly jointed
Does the rock pitch in a manner to cause blasting difficulties
Can the area and blasts be designed to start on high sides of seams
Does the rock have mud seams or caves
Will Dyno Nobel be responsible for oversize rock or loss of production
Are the benches stable to ensure safety for the drillers
Are there any overhanging materials that might cause danger to drillers or blast crew
Will the blast area be under water at any time during the drilling or loading process
Will the terrain cause concerns of protecting Dyno Nobel equipment
Are there any animal, reptile, or insect concerns
Will the customer provide proper stemming material
Will the blast site require matting
If blast mats are to be used, will all Dyno Nobel's SOPs ,matting procedures be followed
Will the customer provide an new area to be laid out by the blaster on blast day
Will the customer or drilling company provide an accurate and timely drill log
Is the customer's equipment sized properly to easily dig the blasted material
Will the customer allow borehole diameters to be properly sized for the job
Will the customer allow proper patterns to be employed
Will the Dyno Nobel blaster design and lay out the shots
Will Dyno Nobel SOPs be followed
In the event SOPs will not be followed, will a "Hold Harmless" agreement be signed
Will the customer allow proper stemming heights
Is there newly poured concrete to be considered
Will fines be levied for overbreak of the walls or floors
Are there known air blast issues at this account
Are there known vibration concerns at this account
Are there known neighbor problems at this account
Is this area of the country known to be highly litigious
Are lightening storms prevalent in this area of the country

Are there other weather concerns, i.e., sleet, fog, ice, rain, or snow to be considered
Are water samples required before or after the blast
Are there a concern for off-site blast fumes, smoke, or dust
Will blast designs be drawn on a separate page
Will a hand-drawn map showing structures, equipment, POI, etc be included
Will an "Additional Insured" status be desired by the customer
Is it possible to obtain a "Hold Harmless" agreement
Are there impediments to this job being done safely and professionally
Has blaster/blasters had input into the assessment
Is the customer willing to use "Best Practices" to complete the job drilling and blasting phase
Will a Credit Application be forthcoming
Has site manager had input into the assessment
Has sales manager had input into the assessment
Are there any known pay problems with this potential customer
Will the customer try to cast the blasted rock
Will the customer desire to drill angled holes
Is all paperwork available and complete, i.e., ground control plan, SMP 61, etc
Will the blaster be able to communicate with the site manager by phone or radio