

Appendix J
Blasting Plan and Impact Analysis

**Blasting Plan and Impact Analysis
Liberty Quarry
County of Riverside, California**

Prepared for:

**Granite Construction Company
38000 Monroe Street
Indio, CA 92203-9500**

Prepared by:

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

April 23, 2008

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I. Purpose

The purpose of this analysis is to evaluate the potential impact and determine guidelines for conducting the excavation and removal of materials with minimal disturbance to environmental areas of concern in the vicinity of the proposed Liberty Quarry.

II. Project Description

The Liberty Quarry Project proposes to mine over 270 million tons of aggregate materials over a 50-year period at a maximum rate of 5 million tons per year. The mining will be done in three phases with reclamation being done in Phase Four. The quarried 270 million tons will result in the development of an area of approximately 155 acres that has a proposed future land use as a raw water storage reservoir or open space habitat. Associated with the development of this project will be the construction of an aggregate processing facility, which will include crushing and screening components, two hot-mix asphalt plants, a ready mix concrete plant, a concrete recycling facility, an asphalt recycling facility, and related administration and support facilities. This analysis assumes there will be a maximum of one or two blasts per day to facilitate removal of the rock and a maximum of 10 blasts per week. While the quarry pit and most of the access road will be located in Riverside County, a small amount of blasting is necessary for the portion of the access road that is located in San Diego County.

III. Blasting and Ground Vibrations

Human perception and structural 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, this section is dedicated to educating the reader about the effects of blasting operations on the earth, the causes of blast vibrations, and how vibrations are measured.

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 quarry 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.

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.¹ 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 quarry, 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 a quarry, 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 quarry, but the small amount of energy remaining may produce perceptible vibrations at some distance.

In response to quarry 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 quarry 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.

¹ It is important to note that ground vibrations beyond the pit limits from quarry operations result from the detonation of explosive charges and not blast hole drilling. Blast hole drilling activities generate minimal ground vibrations that are imperceptible beyond a few feet from the drilling equipment.

Seismographs are used to measure the vibrations, and ensure that any applicable vibration standards and threshold 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 typically limit the maximum amount of vibration that can occur at any point, or particle, on the ground surface. The limit can be expressed in terms of peak particle displacement, peak particle velocity, or peak particle acceleration. Most academic or government studies and formal vibration standards for blasting, where such standards have been adopted, express limits in terms of 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.

IV. Blasting and Air Overpressure

Quarry blasting may also produce air-borne vibration. This section is dedicated to educating the reader about the effects of blasting operations in the atmosphere, the causes of air overpressure, and how air overpressure is measured.

Quarry-induced air-borne 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 quarry. Blasting 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.

Sound pressures can be measured with a variety of instruments, however not all instruments respond equally to both high frequency pressures called sound and low frequency, infrasonic pulses (1 to 20 Hz) that excite structures. The microphones employed by blasting seismographs measure sound pressures with a linear system, whereas noise level meters typically used to

measure sound employ A or C weighting scales. Figure 1 on the following page presents the time histories and frequency spectra for the same blast measured with three different recording systems, linear, C-weighted, and A-weighted. Graph (a) of figure 1 shows that the A and C weighting scales essentially filter out or attenuate energy in the low frequency range. Since most energy produced by blasting resides in the low frequency range as shown in graph (c) of Figure 1, the A and C weighted scales would record values below that of the linear system. Although A and C weighting systems are adequate for studying noise, they will not record the necessary information for correlation with structural response from blasting.

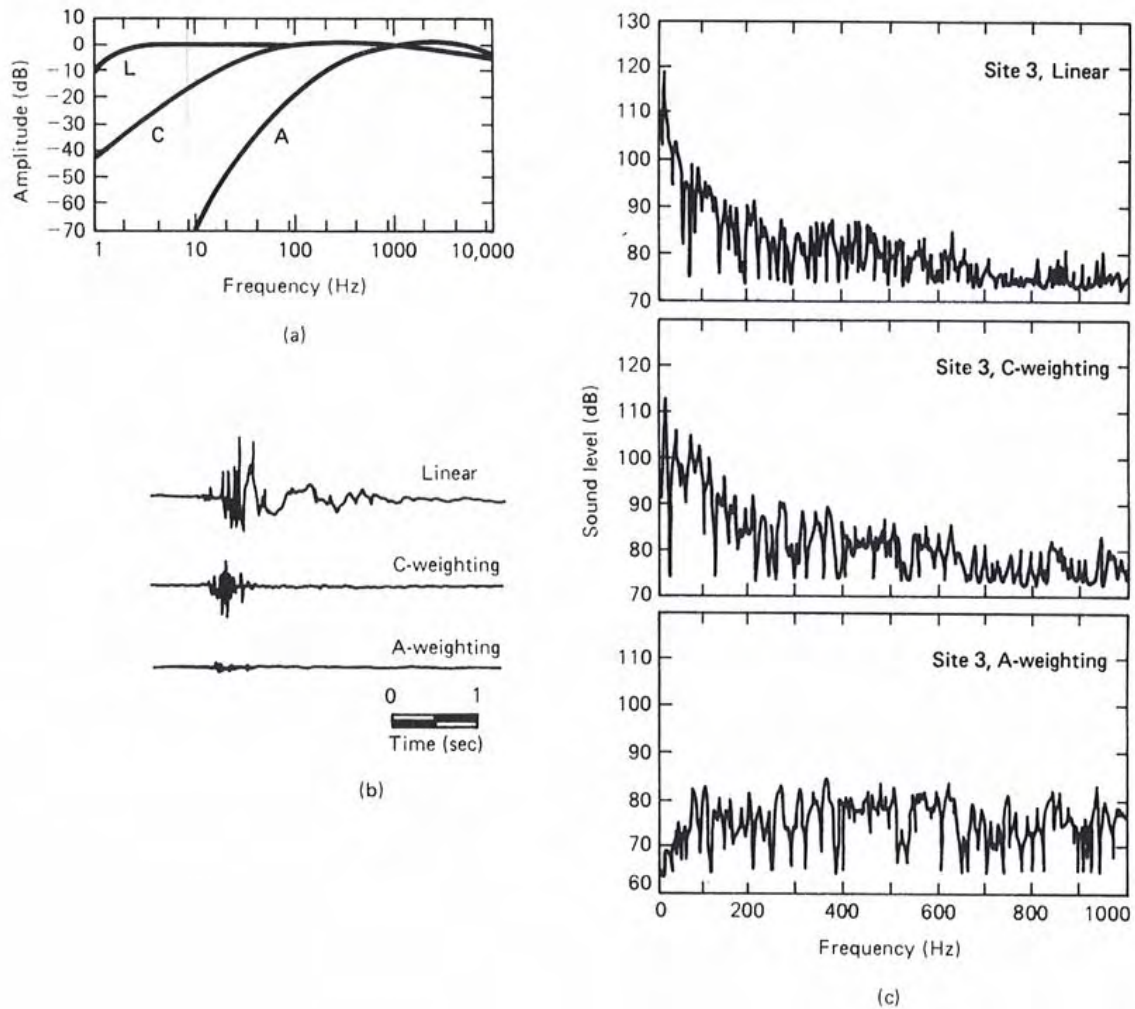


Figure 1 Effects of weighted filtering on air overpressure records (a) weighting scales (b) time histories (c) Fourier frequency spectra. (After Siskind and Summers, 1974 in Dowding, 1996)

Most air overpressures from blasting are measured in thousandths or ten thousandths of pounds per square inch (psi). As a matter of practice, most quarries generally limit off site air overpressures from blasting to 0.01 psi.

V. Ground Vibration Significance Criteria

Riverside County does not have any established ground vibration criteria for intermittent blasting activities such as would occur at the Liberty Quarry. The Riverside County General Plan establishes ground vibration policies for vibrations caused by passing trains, which would be considered a source that is continuous. Continuous vibrations are long duration events of several minutes. Vibrations resulting from blasting are considered to be transient because the vibration event is generally less than a second. A transient vibration is a vibration of short duration and as such, the Riverside County General Plan vibration policies do not apply. San Diego County does not have ground vibration standards.

In order to establish a rational ground vibration significance criteria it is necessary to examine the effects of ground borne vibrations on both structures and humans. As described in the following sections, the appropriate threshold of significance for the impacts of blast-induced ground vibrations caused by the proposed Liberty Quarry is 0.75 inches/second for structures, and 0.60 inches/second for human response.

A. Structural Response to Ground Vibration

The Noise Element of the Riverside County General Plan establishes certain ground vibration policies. For example, Policy N 15.3 prohibits “exposure of residential dwellings to perceptible ground vibration from passing trains as perceived at the ground or second floor. Perceptible motion shall be presumed to be a motion velocity of 0.01 inches/second over a range of 1 to 100 Hz.” Clearly, Policy N 15.3 addresses continuous ground vibrations caused by passing trains (and perhaps similar continuous vibration sources), but does not address intermittent ground vibrations caused by quarry-related blasts. Therefore, the 0.01 inches/second limit in Policy N 15.3 is not an appropriate threshold for determining the significance of potential impacts to structures here.

Fortunately, the U.S. Bureau of Mines (USBM) 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-8507² 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.

² 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 curve shown in Figure 2 which was entitled “Alternative Blasting Level Criteria”. This 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, which are typically the weakest portions of the structure, regardless of construction material.

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. 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 USBM ground vibration criteria were developed to protect the weakest portion of the structure regardless of structure type. The weakest portion of the structure is the plaster interior. The damage threshold is considerably higher for load-bearing or other structural portions of a house, such as concrete foundation walls, concrete slabs, wood members, etc. In the development of these criteria the USBM studied newer structures utilizing modern drywall interiors as well as older structures with plaster-on-lath interiors. Data used to develop the criteria was gathered from the response of single story residential structures as well as multi-story residential structures. The criteria are applied to wood framed structures and would be considered conservative for masonry or tilt-up structures. The USBM ground vibration criteria or its OSM equivalent is applied in over 25 U.S. states, territories, and even some foreign countries.

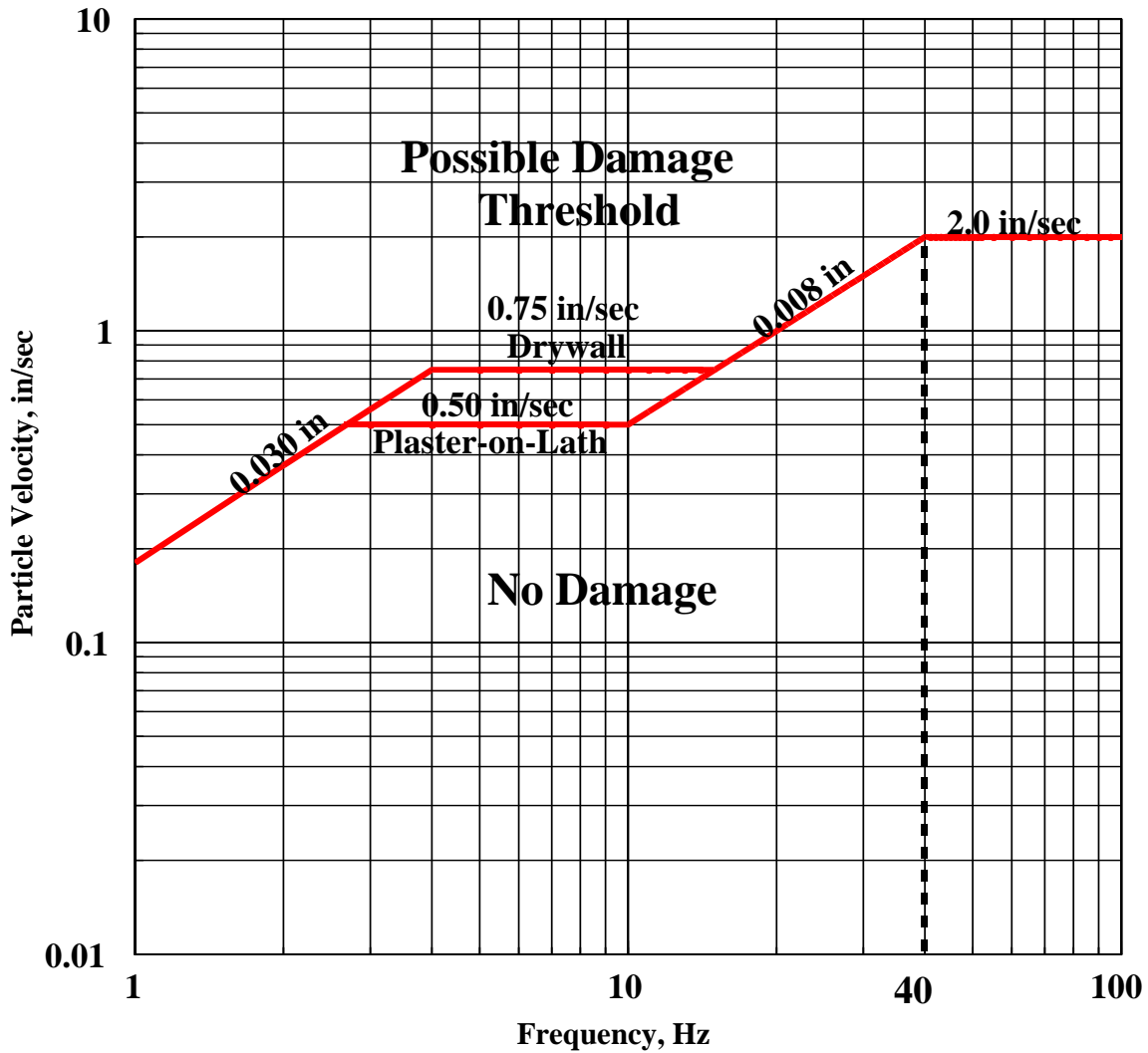


Figure 2 U.S. Bureau of Mines Vibration Criteria. Maximum Safe Values for Peak Particle Velocity (From RI-8507)

The frequency character of vibration events resulting from quarry blasting is primarily a function of the local geologic conditions along with the particular blast design utilized. The frequency range for blasting at most quarrying applications is in the 10 to 100 Hz range at the distances that vibrations would be perceptible. Data from the U.S. Bureau of Mines indicates that vibration frequencies from quarry blasting have a predominant number of occurrences in the 20 to 30 Hz range. Recent seismic data collected by Granite at their Rosemary quarry located not far from the Liberty quarry location shows that the frequency values at the peak range from 24 to 73 Hz. Given the granitic nature of the geology at the Liberty site, we would expect results similar to the Rosemary site. As shown in figure 2, at a frequency range of 20 to 40 Hz. Damage thresholds for all structures, including drywall and plaster-on-lath range from 1.0 in/sec to 2.0 in/sec.

Based on the USBM study, the appropriate threshold of significance for impacts to structures caused by blast-induced ground vibrations from Liberty Quarry is 0.75 inches/second. At the frequencies expected from Liberty Quarry, this ground vibration threshold can be expected to protect all structures, regardless of construction type.

B. Human Response to Ground Vibration

1. Riverside County General Plan

The Noise Element of the Riverside County General Plan establishes ground vibration criteria and policies to protect sensitive land uses. The General Plan also lists possible human reactions to various ground vibration levels, as follows:

Table 1 [Riverside County General Plan Table N-3] Human Reaction to Typical Vibration Levels	
Vibration Level Peak Particle Velocity (inches/second)	Human Reaction
0.0059-0.0188	Threshold of perception, possibility of intrusion
0.0787	Vibrations readily perceptible
0.0984	Continuous vibration begins to annoy people
0.1968	Vibrations annoying to people in buildings
0.3937-0.5905	Vibrations considered unpleasant when continuously subjected and unacceptable by some walking on bridges.
Source: Caltrans, 1992	

The General Plan human reaction table shows likely human reactions to continuous vibrations caused, for example, by passing trains or traffic. As such, it is not directly relevant in establishing significance criteria for human reaction to intermittent ground vibrations caused by quarry-related blasts from the proposed Liberty Quarry.

As noted in the table, the General Plan human reaction table was derived from a 1992 Caltrans study. In a more recent study prepared for Caltrans, researchers developed the following human response table specifically for blast-induced ground vibrations:

Table 2. [Caltrans 2004 Table 21] Human Response to Blasting Ground Vibration

Average Human Response	PPV (in/sec)
Barely to distinctly perceptible	0.02-0.10
Distinctly to strongly perceptible	0.10-0.50
Strongly perceptible to mildly unpleasant	0.50-1.00
Mildly to distinctly unpleasant	1.00-2.00
Distinctly unpleasant and to intolerable	2.00-10.00

Jones & Stokes, 2004, *Transportation- and construction-induced vibration guidance manual*. June. (J&S 02-039.) Sacramento, CA. Prepared for California Department of Transportation, Noise, Vibration, and Hazardous Waste Management Office, Sacramento, CA.

Because this table was specifically developed to address human response to blast-induced ground vibrations, it is more useful than the General Plan in determining the significance of the Liberty Quarry blast-induced ground vibrations. However, in order to determine whether the 2004 Caltrans study is the most appropriate significance criteria, it is necessary to compare that table with other available studies.

2. *Other Studies*

The majority of the studies done on human tolerance to vibrations have been of steady-state sources, meaning that the amplitude and frequency of the vibration remain constant over the test period. This type of testing is usually performed with vibrations lasting much longer than the vibrations from a typical mine or quarry blast event. The purpose of these studies is usually to determine the vibration levels that people can perform tasks at a reasonable level of comfort, or to set occupational exposure limits for activities such as working in an office, traveling in an airplane, driving an automobile, or operating heavy equipment. Conclusions are drawn about the effects of vibration on the human body.

Based on available research, blast vibrations are certainly not detrimental to the human body, and the short period of time over which they occur does not produce physical fatigue. For these reasons, most studies of human response to vibration cannot be related to blast vibrations. However, three important facts become apparent from these studies. First, people can perceive

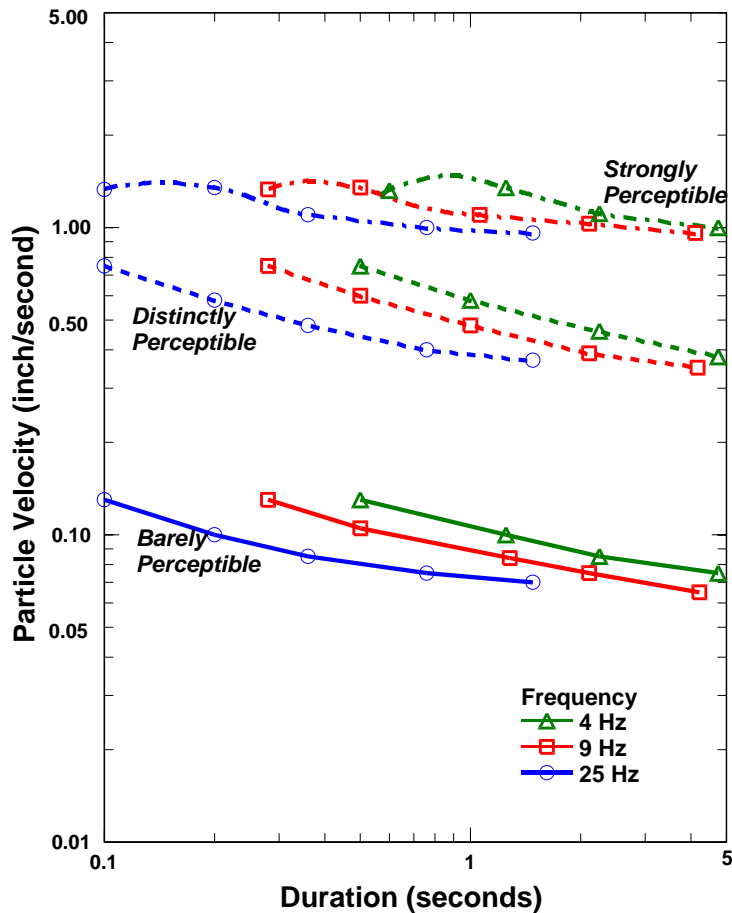


Figure 3. Human Response to Transient Vibrations of Various Frequency and Duration (from Wiss & Parmelee, 1974).

exposed to vibrations of various duration and amplitude, at frequencies between 2.5 and 25 Hz, and asked to characterize their perception of the vibrations. Four levels of subjective human response to vibration were categorized: “Barely Perceptible, Distinctly Perceptible, Strongly Perceptible, and Severe”. The mean response to the three lower categories is shown in Figure 4 for three tested frequencies. The mean response to the “Barely Perceptible” category is the level which half of the people tested could not perceive vibrations below. The mean for each of the other categories was found similarly. Clearly human tolerance to vibration decreases as the duration of the vibration increases. The mean response curves for each frequency considered in Figure 4 are asymptotic; that is, they each approach a constant minimum level, or asymptote, as the duration increases, and each category has a common asymptote. These asymptotes provide a convenient method of assigning a subjective criterion to human response to transient vibrations that is independent of frequency or duration. Figure 5 depicts both the asymptotic mean

vibrations over an extremely wide range of amplitudes, frequencies, and durations. Second, individual response to a given vibration level is highly subjective and varies not only with each individual but also on a daily basis. Third, it is also dependent upon many factors unrelated to the vibration event.

Blast induced ground vibration is not a steady state vibration, but rather a transient vibration. A transient vibration is a vibration that begins near its maximum level, quickly decreases in amplitude, and usually becomes imperceptible after just a few seconds. Figure 4 is derived from a study of subjective human response to transient vibrations completed by Wiss and Parmelee in 1974. The Wiss and Parmelee study involved subjecting forty people to transient vertical vibrations while standing on a test platform. Each person was

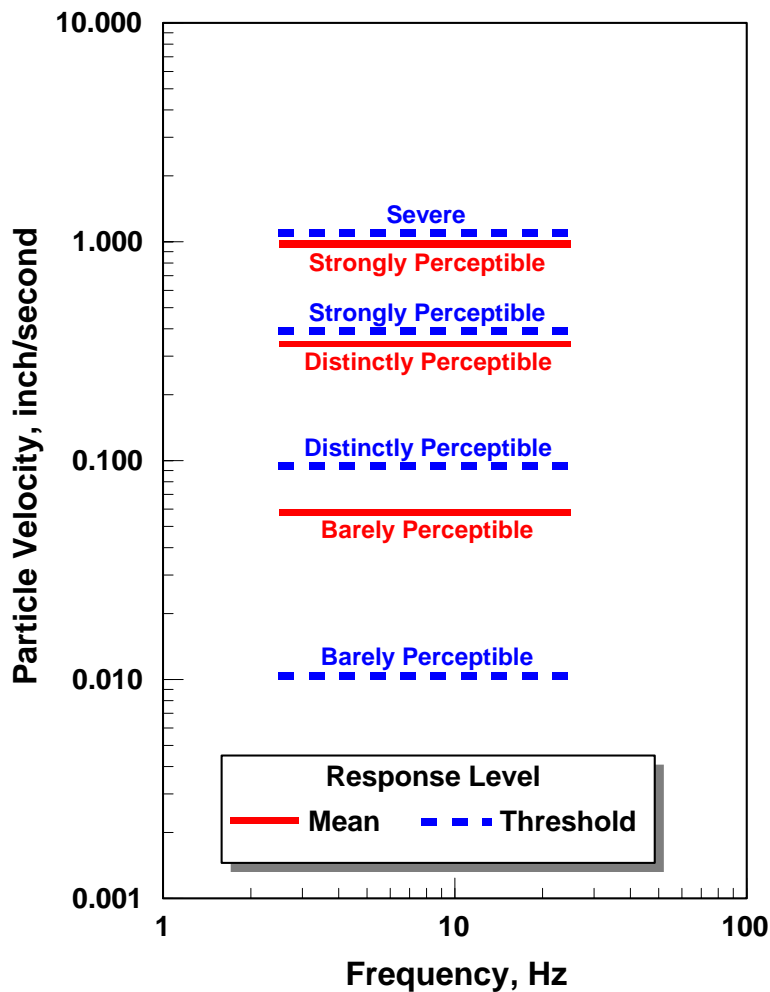


Figure 4. Generalized Human Response to Transient Vibrations (from Wiss & Parmelee, 1974).

they are in their homes, however, their classification of the vibration levels may. While no studies have been able to adequately account for all the variables affecting the response of people in their homes to blast vibrations, it is reasonable to conclude that the tolerance to vibrations would occur at levels lower than those found in laboratory environments.

response levels and the threshold response levels from the Wiss and Parmelee study. The threshold response levels are the levels cited by the most sensitive of the test subjects for each vibration category.

The Wiss and Parmelee study was based on people standing and being subjected to vertical vibrations. Studies involving people in various body positions have found good correlation to the data from standing tests, suggesting that body position may not influence a persons sensitivity to vibration. The threshold levels defined by the broken lines in Figure 5 are generally accepted as quite conservative for both transient and steady state vibrations under most conditions.

Most scientific studies regarding human perceptibility to steady state and transient vibrations have been conducted in laboratories and other controlled environments. The levels at which people may perceive vibration will not change when

In order to gain a better insight to the levels of vibration which evoke complaints from homeowners, the USBM calculated the ground vibrations necessary to produce structure response similar to that measured during an airblast study (USBM RI-8485, discussed later in this report). These calculated ground vibrations levels were then correlated to the human annoyance curves generated through the airblast study. The result of this correlation is shown graphically in Figure 6. The 95 percentile curve represents the level at which there would be 95% confidence in the data that if ground vibration levels reached 0.60 in/sec approximately 5% of the population would consider this to be very annoying.

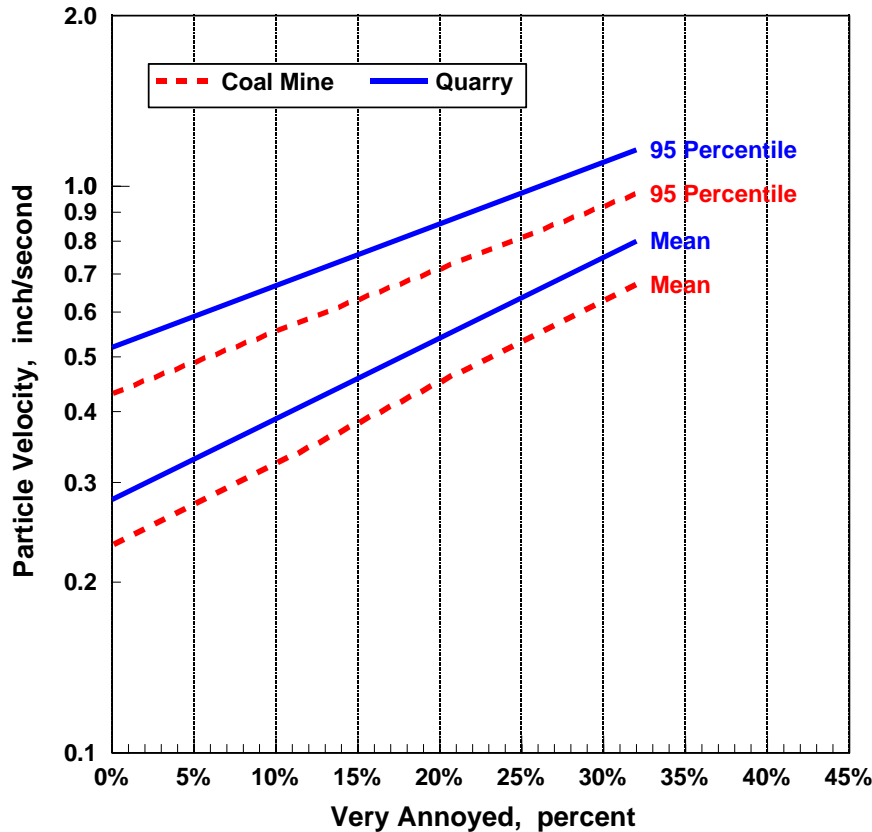


Figure 5. Reactions of Persons Subjected to Blasting Vibration in their Homes (from RI-8507).

95% confidence in the data that if ground vibration levels reached 0.60 in/sec approximately 5% of the population would consider this to be very annoying.

This data, although based on calculated ground vibration levels, may be the most valid predictor of homeowner response to blast vibrations. It is based on human response to not only perceived vibration in their homes, but also the house rattle and other associated sounds produced by vibration in a residential structure. This data also considered the fear homeowners feel concerning property damage.

3. Conclusion Regarding Human Response Significance Threshold

Comparing the research described in the preceding section with the 2004 Caltrans study, the appropriate significance threshold for measuring the human response to blast-induced ground vibrations from the proposed Liberty Quarry is a peak particle velocity of 0.60 inches/second. This threshold falls at the lower end of the “strongly perceptible to mildly unpleasant” average response in the 2004 Caltrans table, while still encompassing the 95th percentile of responses discussed in the USBM report.

VI. Air Overpressure Significance Criteria

Like most, if not all jurisdictions, Riverside and San Diego Counties do not have an official standard regulating air overpressures from blasting. In order to establish a rational air overpressure significance criteria it is necessary to examine the effects of quarry blast-induced air overpressure on both structures and humans. As described in the following sections, the appropriate threshold of significance for the impacts of blast-induced air overpressure caused by the proposed Liberty Quarry is 0.01295 pounds per square inch (psi) for structures, and 0.01 psi for human response.

A. Structural Response to Air Overpressure

The USBM has set forth airblast research and recommendations in its Report of Investigation RI-8485³ “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.

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 pressure acts. Windowpanes are designed to safely withstand changes of 1.0 psi when properly installed, and even in the worst situation a pane should be able to withstand 0.1 psi. Air overpressures from blasting rarely exceed 0.01 psi, about one one-hundredth of the overpressure that a window can safely withstand. In RI-8485, the USBM consensus was that damage was improbable below 0.03 psi. The USBM however, recommended that the air overpressure limit be set at 0.01295 psi for a 2 Hz recording system. This limit was recommended based upon human reaction rather than damage considerations as will be discussed in the following paragraphs.

Therefore, the appropriate threshold of significance for structural response to blast-induced air overpressure is 0.01295 psi.

B. Human Response to Air Overpressure

Since noise levels due to blasting are generally very low frequency (approximately 2 to 25 Hz), the human ear does not detect the total energy associated with the overall linear sound energy. Based upon research on blasting, the typical fundamental frequency (the frequency where the majority of sound energy is located) for a blast is at the 20 to 25 Hz range, below the level of human hearing.

Little research has been done on the subjective human reactions to blast noise, although annoyance studies have been made for sonic booms and other impulsive source and applied to blasting. As part of the development of the air overpressure criteria by the USBM, researchers

³ 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.

not only had to consider the structural effect of the air overpressure limit but also determine if the limit would be acceptable in terms of annoyance. In studying the limits for air overpressure annoyance, the USBM compared blasting to previous government studies of sonic booms and artillery fire.

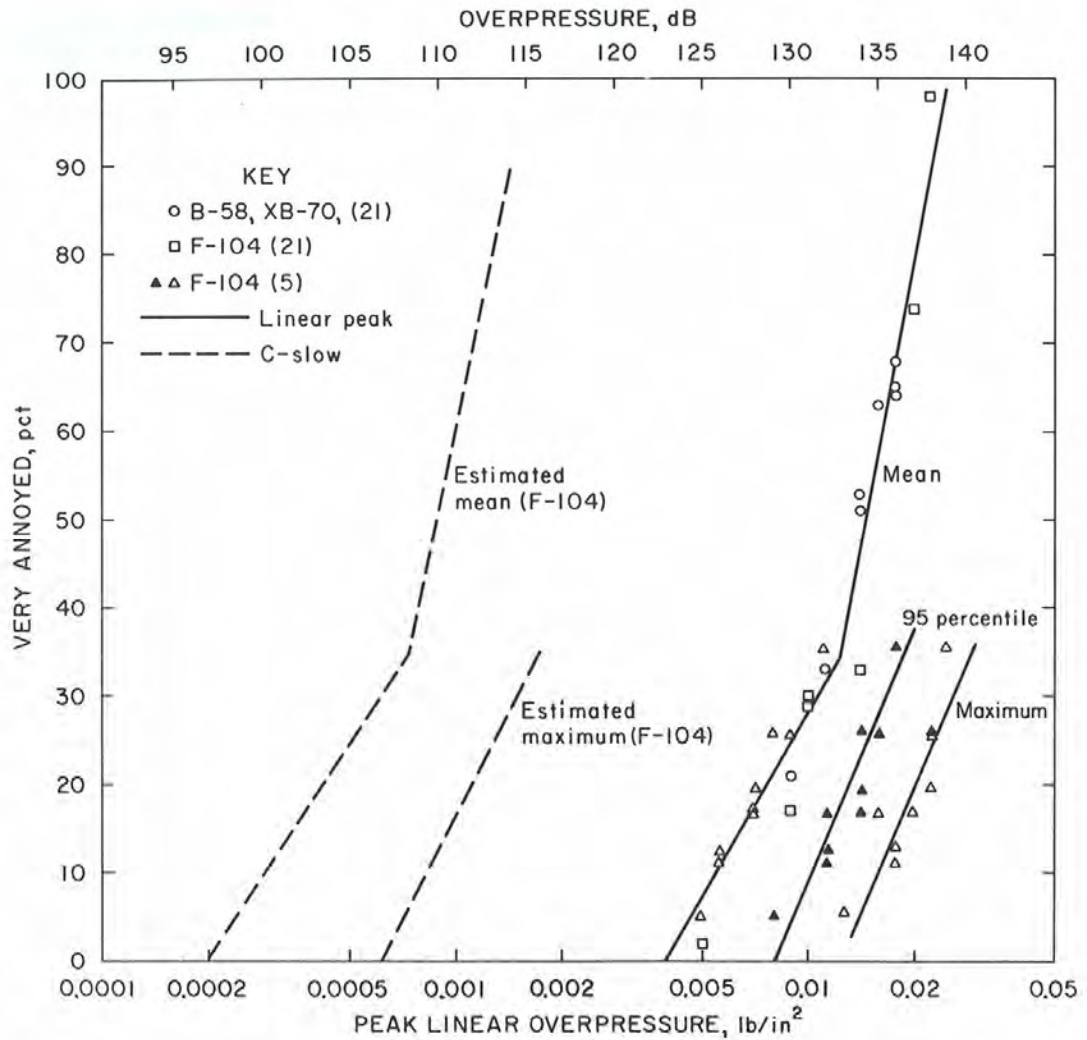


Figure 6. Population very annoyed by sonic boom-produced house rattles (after Siskind).

Figure 3 above shows the results of one study that was utilized for comparison by the USBM. The study was conducted in Oklahoma City and consisted of an average of eight booms per day for six months. Utilizing the 95 percentile line, there would be 95 % confidence in the data that at 0.01 psi blast-induced air overpressure would be acceptable to all but 5% of the population.

Therefore, the appropriate threshold of significance for human response to blast-induced air overpressure is 0.01 psi.

VII. Projected Ground and Air Vibration Levels

The previous sections have presented research on vibration and air overpressure levels for the protection of structures and humans around the perimeter of the site. Since Liberty Quarry is not yet in operation, 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 equation⁴ is one such example that has been successfully employed for many years.

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

Where PPV= Peak particle velocity (in./sec.)

D = Distance from blast to structure (feet)

W = Maximum lbs. of explosives/delay

⁴ 17th Edition ISEE Blasters Handbook, (1998), Cleveland, OH, pg. 601

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.

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

Where P= Peak air overpressure (psi)

D = Distance from blast to structure (feet)

W = Maximum lbs. of explosives/delay

Since the quarry is not yet in operation it is necessary to evaluate three possible scenarios regarding the effects of blasting on the surrounding structures. The scenarios address the three planned mining phases of the quarry project. Figure 1 attached to appendix A of this report shows a map that represents these three scenarios. Predicted values of peak particle velocities and air overpressure levels are made between 35 receptor locations and the closes blasting areas of the three mining phases. The location of the 35 receptor locations are shown in Figure 2 attached to appendix A of this report. For the prediction analysis, comparisons are made to the criteria for maximum safe values of ground vibration and airblast, 0.60 in/sec PPV and 0.01 psi air overpressure respectively. Predicted air overpressure levels assume a straight line between source and receptor.

A. Projected Levels for Phase One

Phase One will require blasting to establish an access road, develop a sediment pond in the southwest corner of the project and develop quarrying areas in the central and northern portions of the site. Based upon the maps in Figures 1 and 2, the distance from the 35 potential receptor locations to the closest blasting areas are given in Tables 1 through 3 in appendix B for the three blasting areas of the Phase I Mining Plan.

Appendix C of this report contains the Blast Plan for the Liberty Quarry prepared bt Granite Construction Company. Addressing the access road development, it is assumed a crawler type, air-trac drill will be utilized due to the steep slope and conditions of the terrain. We are assuming cut depths from 20 feet to 40 feet and use of a 3½ –inch diameter hole based on the information contained in Appendix A attached to the Blast Plan. The Blasting Plan also indicates a bulk explosive with a 0.82 g/cc density will be utilized to blast the granitic material. Based upon this information, explosive charge weights are expected to vary from 54 lbs to 125.5 lbs.

For the settling pond area and bench development area in the north and central mining areas of the site, a 40-foot cut is specified in the Drill and Blast Plan. The assumption has been made that a 6½-inch diameter hole will be used resulting in a charge weight of 629 lbs. We assume a bulk product with a 0.82 g/cc density will be used.

Based upon the distances calculated from figures 1 and 2, and the charge weights calculated based upon the Blast Plan, equations 1 and 2 were utilized to predict the resulting peak particle velocities and air overpressure levels at the receptor locations. Tables 1 through 3 in appendix B display the predicted values for blasting to establish an access road, develop a sediment pond in the southwest corner of the project and develop quarrying areas in the central and northern portions of the site.

The expected ground vibrations and air overpressures in this scenario are well below the significance thresholds previously discussed in this report for all receptor locations during the Phase 1 Access Road and Settling Pond activities. During Phase 1 Bench Development, the expected ground vibrations and air overpressures are all expected to be well below the limits discussed in this report, with the exception of Receptor Location No. 19, which is predicted to have a ground vibration PPV of 1.21 in/sec. This PPV is nearly twice the human response significance threshold (0.60 in/sec), and could be above the structural response significance threshold depending on the frequency content of the vibration energy (See Figure 2 and accompanying text).

B. Projected Levels for Phase Two

Phase Two will continue development of the central and northern areas of the quarry. An explosive product with a 0.82 g/cc density will again result in a charge weight of 629 lbs. This is based on utilization of a 6½-inch diameter hole as the sixty foot benches continue to be developed.

Table 4 in Appendix B lists the closest distance blasting would occur to the receptor locations in Phase 2 along with the predicted ground vibrations and air overpressures levels. With one exception, these levels would all be within the acceptable thresholds for human and structural response discussed in the previous sections and therefore would not have any adverse effect on surrounding structures and communities. The exception is Receptor Location No. 19, which is expected to have a ground vibration PPV of 0.979 in/sec. This PPV is above both the human response significance threshold (0.60 in/sec) and could be above the structural response significance threshold depending on the frequency content of the vibration energy (See Figure 2 and accompanying text).

C. Projected Levels for Phase Three

Phase Three will consist of moving the aggregate processing plant to the Phase Two quarry floor and development of the quarry benches to the area underneath the settling pond in the southwest corner. As in Phase II, 6½-inch diameter holes will be drilled to develop 60-foot benches. An explosive product with a 0.82 g/cc density will again be utilized.

Table 5 in Appendix B lists the expected ground vibrations and air overpressures levels for Phase Three. The predicted ground vibrations and air overpressures in this scenario (Phase Three) would all be within the acceptable significance thresholds discussed in the previous sections and therefore would not have any adverse effect on surrounding structures and communities.

D. Summary of Impacts of Projected Ground and Air Vibration Levels

Phase 1 activities would have no adverse impacts on surrounding structures or human perceptions, with the exception noted regarding ground vibration impacts at Receptor Location No. 19 during Phase 1 Bench Development activities. By utilizing equation 1, the potential ground vibration impacts at No. 19 during the Bench Development activities may be mitigated to below the significance threshold (0.60 in/sec) by adjusting the blast design to a scaled distance of greater than 43.

The Square Root Scaled Distance, or simply Scaled Distance, relates ground vibration amplitude to explosive charge weight and distance from the blast. 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. 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. By utilizing equation 1, a scaled distance of 43 or greater will result in a particle velocity below 0.60 in/sec. In order to determine the proper charge weight to utilize for a given distance the known distance and scaled distance of 43 can be substituted in the following equation.

$$W = \left(\frac{D}{SD} \right)^2 = \left(\frac{691}{43} \right)^2 = 258 \quad \text{Equation 3}$$

Where W = Maximum lbs. of explosives/delay
D = Distance from blast to Receptor Location No. 19 (feet)
SD = Scaled distance

By utilizing the equation 3, the potential ground vibration impacts at No. 19 can be successfully mitigated to below the significance threshold (0.60 in/sec). Explosive charge weights must be reduced according to equation 3 when blasting activities come within 1068 feet of No. 19.

Phase 2 activities would have no adverse impacts on surrounding structures or human perceptions, with the exception noted regarding ground vibration impacts at Receptor Location No. 19. The potential ground vibration impacts at No. 19 during Phase 2 activities may be mitigated to below the significance threshold (0.60 in/sec) by adjusting the blast design to a scaled distance of greater than 43.

Phase 3 activities would have no adverse impacts on surrounding structures or human perceptions.

Conclusion

Based upon our site visit, review of the quarry plan and maps, and the given assumptions on typical blast designs that might be employed, Vibra-Tech has projected ground and air vibration levels that could result for the closest blasting area to each receptor location. Based on empirical formulas, the Liberty Quarry will produce perceptible levels of ground vibration and air overpressure at some locations close to the quarry. Vibration levels at locations greater than 2 miles from the blasting areas should not be perceptible. 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 projected ground and air vibration levels are within the realm of ambient levels experienced by structures on a daily basis and below the threshold levels known to cause cosmetic damage in structures. A Blasting Plan such as that contained in Appendix C and a Monitoring Plan such as that contained in Appendix D should be implemented. All data should be reviewed periodically and if necessary the blasting size and pattern may be adjusted.

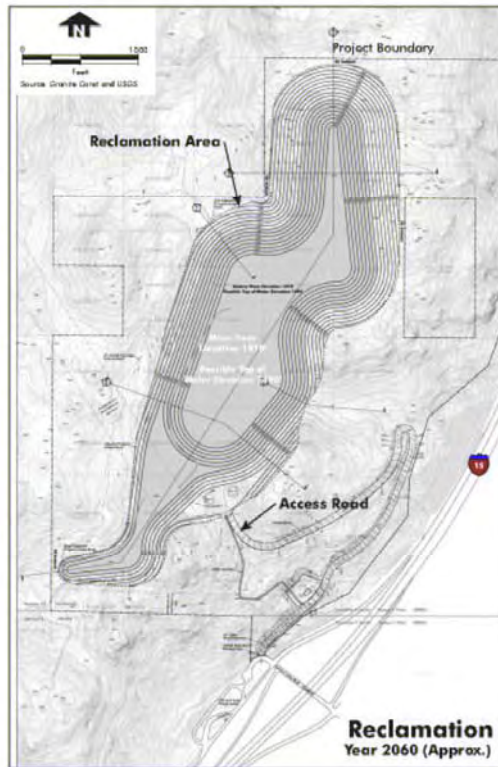
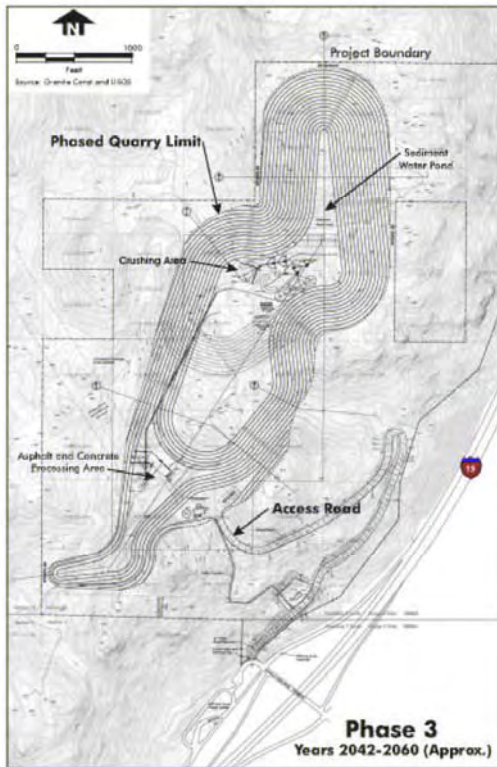
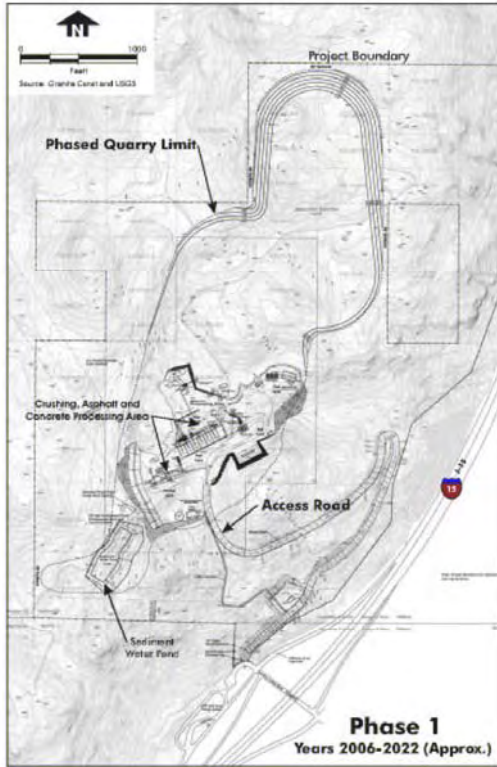
In addition, it is highly unlikely that ground vibrations from the controlled blasting events at the Liberty Quarry will be felt by residents in the City of Temecula. In our opinion, Granite Construction Company can develop the Liberty Quarry with no adverse effect on surrounding structures and residents from ground or air vibrations.

Respectfully submitted,
Vibra-Tech Engineers, Inc.



Douglas Rudenko
Vice President

APPENDIX A
MINING PHASES AND RECEPTOR LOCATION FIGURES



Phased Mining and Reclamation

Granite Construction Company
Riverside County, California



Figure 1

Receptor Locations

Geopix Construction Company
Riverside County, California

- LEGEND**
- Quarry Boundary
 - Approximate Center of Proposed Processing Facility
 - Distance in Miles from Processing Facility
 - Receptor Location and Number

Point Information

Description (generic)	UTM Location (Zone 11, meters)
1. Boulder Inlet/Chualar Blvd	482715.87, 3108874.29
2. Boulder Inlet/Valley East	482715.87, 3108874.29
3. Rainbow Residences	485277.71, 3169987.31
4. Rainbow Residences	485277.71, 3169987.31
5. Horro's MEK Station	484072.66, 3700805.16
6. Taramula Residences	485238.43, 3700303.48
7. Deluz Residence	482947.00, 3702415.43
8. Deluz MEK Station	484632.86, 3700889.66
9. Call Boy/removed Wildlife Crossing	487428.22, 3701777.67
10. Call Boy/removed Wildlife Crossing	484191.33, 3169988.51
11. Call Boy/removed Wildlife Crossing	484191.33, 3169988.51
12. Call Boy/removed Wildlife Crossing	484191.33, 3169988.51
13. Call Boy/removed Wildlife Crossing	484191.33, 3169988.51
14. UMER Site 1	484712.87, 3700012.20
15. UMER Site 2	484524.12, 3702527.48
16. UMER Site 3	486232.66, 3701972.04
17. UMER Site 4	486232.66, 3701972.04
18. UMER Site 5	486232.66, 3701972.04
19. UMER Site 6	486232.66, 3701972.04
20. UMER Site 7	486232.66, 3701972.04
21. UMER Site 8	486232.66, 3701972.04
22. UMER Site 9	486232.66, 3701972.04
23. UMER Site 10	486232.66, 3701972.04
24. UMER Site 11	486232.66, 3701972.04
25. UMER Site 12	486232.66, 3701972.04
26. UMER Site 13	486232.66, 3701972.04
27. UMER Site 14	486232.66, 3701972.04
28. UMER Site 15	486232.66, 3701972.04
29. UMER Site 16	486232.66, 3701972.04
30. UMER Site 17	486232.66, 3701972.04
31. UMER Site 18	486232.66, 3701972.04
32. UMER Site 19	486232.66, 3701972.04
33. UMER Site 20	486232.66, 3701972.04
34. UMER Site 21	486232.66, 3701972.04
35. UMER Site 22	486232.66, 3701972.04
36. UMER Site 23	486232.66, 3701972.04
37. UMER Site 24	486232.66, 3701972.04
38. UMER Site 25	486232.66, 3701972.04
39. UMER Site 26	486232.66, 3701972.04
40. UMER Site 27	486232.66, 3701972.04
41. UMER Site 28	486232.66, 3701972.04
42. UMER Site 29	486232.66, 3701972.04
43. UMER Site 30	486232.66, 3701972.04
44. UMER Site 31	486232.66, 3701972.04
45. UMER Site 32	486232.66, 3701972.04
46. UMER Site 33	486232.66, 3701972.04
47. UMER Site 34	486232.66, 3701972.04
48. UMER Site 35	486232.66, 3701972.04
49. UMER Site 36	486232.66, 3701972.04
50. UMER Site 37	486232.66, 3701972.04
51. UMER Site 38	486232.66, 3701972.04
52. UMER Site 39	486232.66, 3701972.04
53. UMER Site 40	486232.66, 3701972.04
54. UMER Site 41	486232.66, 3701972.04
55. UMER Site 42	486232.66, 3701972.04
56. UMER Site 43	486232.66, 3701972.04
57. UMER Site 44	486232.66, 3701972.04
58. UMER Site 45	486232.66, 3701972.04
59. UMER Site 46	486232.66, 3701972.04
60. UMER Site 47	486232.66, 3701972.04
61. UMER Site 48	486232.66, 3701972.04
62. UMER Site 49	486232.66, 3701972.04
63. UMER Site 50	486232.66, 3701972.04
64. UMER Site 51	486232.66, 3701972.04
65. UMER Site 52	486232.66, 3701972.04
66. UMER Site 53	486232.66, 3701972.04
67. UMER Site 54	486232.66, 3701972.04
68. UMER Site 55	486232.66, 3701972.04
69. UMER Site 56	486232.66, 3701972.04
70. UMER Site 57	486232.66, 3701972.04
71. UMER Site 58	486232.66, 3701972.04
72. UMER Site 59	486232.66, 3701972.04
73. UMER Site 60	486232.66, 3701972.04
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75. UMER Site 62	486232.66, 3701972.04
76. UMER Site 63	486232.66, 3701972.04
77. UMER Site 64	486232.66, 3701972.04
78. UMER Site 65	486232.66, 3701972.04
79. UMER Site 66	486232.66, 3701972.04
80. UMER Site 67	486232.66, 3701972.04
81. UMER Site 68	486232.66, 3701972.04
82. UMER Site 69	486232.66, 3701972.04
83. UMER Site 70	486232.66, 3701972.04
84. UMER Site 71	486232.66, 3701972.04
85. UMER Site 72	486232.66, 3701972.04
86. UMER Site 73	486232.66, 3701972.04
87. UMER Site 74	486232.66, 3701972.04
88. UMER Site 75	486232.66, 3701972.04
89. UMER Site 76	486232.66, 3701972.04
90. UMER Site 77	486232.66, 3701972.04
91. UMER Site 78	486232.66, 3701972.04
92. UMER Site 79	486232.66, 3701972.04
93. UMER Site 80	486232.66, 3701972.04
94. UMER Site 81	486232.66, 3701972.04
95. UMER Site 82	486232.66, 3701972.04
96. UMER Site 83	486232.66, 3701972.04
97. UMER Site 84	486232.66, 3701972.04
98. UMER Site 85	486232.66, 3701972.04
99. UMER Site 86	486232.66, 3701972.04
100. UMER Site 87	486232.66, 3701972.04
101. UMER Site 88	486232.66, 3701972.04
102. UMER Site 89	486232.66, 3701972.04
103. UMER Site 90	486232.66, 3701972.04
104. UMER Site 91	486232.66, 3701972.04
105. UMER Site 92	486232.66, 3701972.04
106. UMER Site 93	486232.66, 3701972.04
107. UMER Site 94	486232.66, 3701972.04
108. UMER Site 95	486232.66, 3701972.04
109. UMER Site 96	486232.66, 3701972.04
110. UMER Site 97	486232.66, 3701972.04
111. UMER Site 98	486232.66, 3701972.04
112. UMER Site 99	486232.66, 3701972.04
113. UMER Site 100	486232.66, 3701972.04

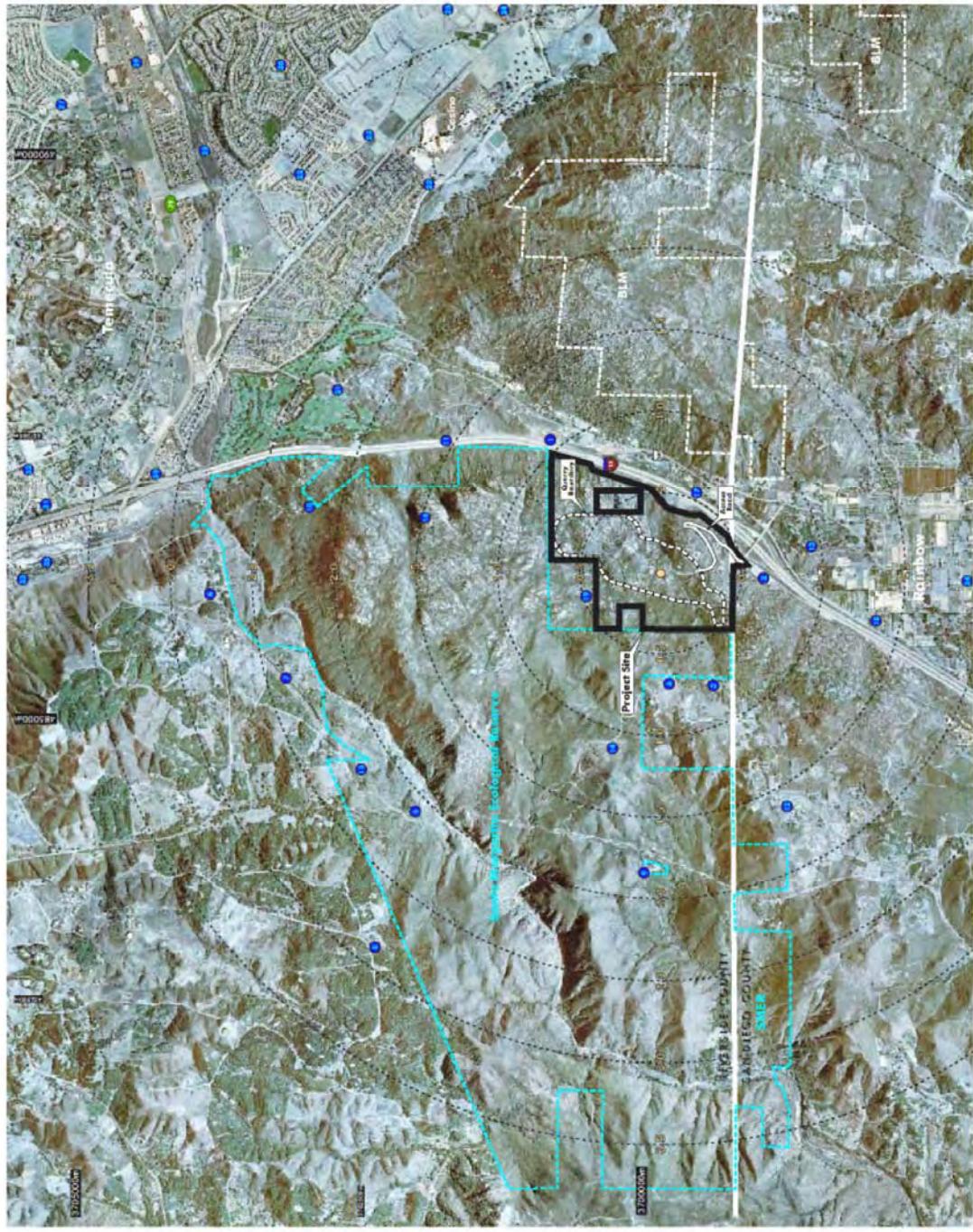
Note: All receptor locations are from Riverside Water United School District watershed boundary. 18.33 mile from City of Perris Water Treatment Plant - 4th Quality Treatment Facility #42



Source: USGS, 1:250,000 Scale, 1999
 Aerial Photo, 1:250,000 Scale, 1999
 Digitized, 2000

LILBURN
 CONSULTING
 DATE: 06/07

Figure 2



APPENDIX B
PREDICTED PPV AND AIR OVERPRESSURE VALUES

Granite Construction Company - Liberty Quarry

Phase 1 – Access Road

Predicted Values of Peak Particle Velocities and Air Overpressure For Each Receptor Location

Receptor Location	Distance Feet	Charge Weight Pounds	Predicted PPV	% Criteria (0.60 in/sec)	Predicted PSI	% Criteria (0.01 psi)
1	4159	125.5	0.019	3.12	0.00061	6.15
2	728	125.5	0.304	50.72	0.00418	41.80
3	3151	125.5	0.029	4.86	0.00083	8.34
4	3208	125.5	0.028	4.73	0.00082	8.18
5	10720	125.5	0.004	0.69	0.00022	2.17
6	13584	125.5	0.003	0.47	0.00017	1.67
7	12157	125.5	0.003	0.56	0.00019	1.89
8	14291	125.5	0.003	0.43	0.00016	1.58
9	8699	125.5	0.006	0.96	0.00027	2.73
10	10536	125.5	0.004	0.71	0.00022	2.21
11	6906	125.5	0.008	1.39	0.00035	3.52
12	7118	125.5	0.008	1.32	0.00034	3.40
13	2062	125.5	0.058	9.59	0.00133	13.30
14	5548	125.5	0.012	1.97	0.00045	4.48
15	11282	125.5	0.004	0.63	0.00021	2.05
16	7185	125.5	0.008	1.30	0.00034	3.37
17	863	125.5	0.232	38.63	0.00347	34.66
18	4226	125.5	0.018	3.04	0.00060	6.04
19	3368	125.5	0.026	4.37	0.00078	7.75
20	11961	125.5	0.003	0.58	0.00019	1.92
21	10383	125.5	0.004	0.72	0.00022	2.25
22	14637	125.5	0.003	0.42	0.00015	1.54
23	14125	125.5	0.003	0.44	0.00016	1.60
24	15295	125.5	0.002	0.39	0.00015	1.47
25	16131	125.5	0.002	0.36	0.00014	1.38
26	17386	125.5	0.002	0.32	0.00013	1.27
27	21334	125.5	0.001	0.23	0.00010	1.02
28	17139	125.5	0.002	0.32	0.00013	1.29
29	20383	125.5	0.001	0.25	0.00011	1.07
30	15020	125.5	0.002	0.40	0.00015	1.50
31	16844	125.5	0.002	0.33	0.00013	1.32
32	18742	125.5	0.002	0.28	0.00012	1.17
33	18851	125.5	0.002	0.28	0.00012	1.17
34	6570	125.5	0.009	1.50	0.00037	3.72
35	18270	125.5	0.002	0.29	0.00012	1.21

Table 1

Granite Construction Company - Liberty Quarry

Phase 1 – Settling Pond

Predicted Values of Peak Particle Velocities and Air Overpressure For Each Receptor Location

Receptor Location	Distance Feet	Charge Weight Pounds	Predicted PPV	% Criteria (0.60 in/sec)	Predicted PSI	% Criteria (0.01 psi)
1	6464	125.5	0.009	1.54	0.00038	3.78
2	1432	125.5	0.103	17.18	0.00199	19.86
3	1536	125.5	0.092	15.36	0.00184	18.39
4	2063	125.5	0.057	9.58	0.00133	13.29
5	10072	125.5	0.005	0.76	0.00023	2.32
6	14097	125.5	0.003	0.44	0.00016	1.60
7	12090	125.5	0.003	0.57	0.00019	1.90
8	13541	125.5	0.003	0.47	0.00017	1.68
9	7288	125.5	0.008	1.27	0.00033	3.32
10	11597	125.5	0.004	0.60	0.00020	1.99
11	8721	125.5	0.006	0.95	0.00027	2.72
12	5437	125.5	0.012	2.03	0.00046	4.58
13	3079	125.5	0.030	5.05	0.00086	8.56
14	4549	125.5	0.016	2.70	0.00056	5.57
15	10758	125.5	0.004	0.68	0.00022	2.16
16	8311	125.5	0.006	1.03	0.00029	2.87
17	3322	125.5	0.027	4.47	0.00079	7.87
18	4511	125.5	0.016	2.74	0.00056	5.62
19	3998	125.5	0.020	3.32	0.00064	6.42
20	14554	125.5	0.003	0.42	0.00015	1.55
21	12189	125.5	0.003	0.56	0.00019	1.88
22	17040	125.5	0.002	0.33	0.00013	1.30
23	16688	125.5	0.002	0.34	0.00013	1.33
24	18041	125.5	0.002	0.30	0.00012	1.22
25	18861	125.5	0.002	0.28	0.00012	1.17
26	19890	125.5	0.002	0.26	0.00011	1.10
27	23484	125.5	0.001	0.20	0.00009	0.92
28	19393	125.5	0.002	0.27	0.00011	1.13
29	22688	125.5	0.001	0.21	0.00010	0.95
30	16132	125.5	0.002	0.36	0.00014	1.38
31	17825	125.5	0.002	0.30	0.00012	1.24
32	19795	125.5	0.002	0.26	0.00011	1.10
33	19477	125.5	0.002	0.26	0.00011	1.12
34	7230	125.5	0.008	1.29	0.00033	3.35
35	18936	125.5	0.002	0.28	0.00012	1.16

Table 2

Granite Construction Company - Liberty Quarry

Phase 1 – Bench Development

Predicted Values of Peak Particle Velocities and Air Overpressure For Each Receptor Location

Receptor Location	Distance Feet	Charge Weight Pounds	Predicted PPV	% Criteria (0.60 in/sec)	Predicted PSI	% Criteria (0.01 psi)
1	2524	629	0.151	25.19	0.00192	19.22
2	3524	629	0.089	14.77	0.00133	13.32
3	3272	629	0.100	16.63	0.00144	14.45
4	2630	629	0.142	23.59	0.00184	18.37
5	8501	629	0.022	3.61	0.00051	5.06
6	10032	629	0.017	2.77	0.00042	4.21
7	8698	629	0.021	3.48	0.00049	4.93
8	12497	629	0.012	1.95	0.00033	3.31
9	7981	629	0.024	3.99	0.00054	5.42
10	7109	629	0.029	4.80	0.00062	6.15
11	4089	629	0.070	11.64	0.00113	11.31
12	7368	629	0.027	4.54	0.00059	5.92
13	4531	629	0.059	9.88	0.00101	10.10
14	4468	629	0.061	10.10	0.00103	10.26
15	8450	629	0.022	3.64	0.00051	5.09
16	3760	629	0.080	13.31	0.00124	12.40
17	2202	629	0.188	31.34	0.00223	22.34
18	6804	629	0.031	5.15	0.00065	6.46
19	691	629	1.201	200.18	0.00799	79.93
20	10602	629	0.015	2.53	0.00040	3.96
21	7548	629	0.026	4.37	0.00058	5.76
22	12680	629	0.011	1.90	0.00033	3.26
23	12612	629	0.012	1.92	0.00033	3.28
24	14846	629	0.009	1.48	0.00027	2.74
25	15438	629	0.008	1.39	0.00026	2.62
26	15656	629	0.008	1.36	0.00026	2.58
27	18894	629	0.006	1.01	0.00021	2.10
28	14873	629	0.009	1.47	0.00027	2.73
29	18192	629	0.006	1.07	0.00022	2.19
30	11640	629	0.013	2.18	0.00036	3.58
31	13408	629	0.010	1.74	0.00031	3.06
32	15342	629	0.008	1.40	0.00026	2.64
33	15319	629	0.008	1.41	0.00026	2.64
34	9472	629	0.018	3.04	0.00045	4.49
35	14744	629	0.009	1.50	0.00028	2.76

Table 3

Granite Construction Company - Liberty Quarry Phase 2

Predicted Values of Peak Particle Velocities and Air Overpressure For Each Receptor Location

Receptor Location	Distance Feet	Charge Weight Pounds	Predicted PPV	% Criteria (0.60 in/sec)	Predicted PSI	% Criteria (0.01 psi)
1	2728	629	0.133	22.25	0.00176	17.65
2	3240	629	0.101	16.89	0.00146	14.61
3	3676	629	0.083	13.80	0.00127	12.71
4	2989	629	0.115	19.22	0.00160	15.96
5	8715	629	0.021	3.47	0.00049	4.92
6	10265	629	0.016	2.67	0.00041	4.11
7	8904	629	0.020	3.35	0.00048	4.80
8	12621	629	0.012	1.92	0.00033	3.27
9	8190	629	0.023	3.83	0.00053	5.27
10	7348	629	0.027	4.56	0.00059	5.93
11	4329	629	0.064	10.63	0.00106	10.62
12	7788	629	0.025	4.15	0.00056	5.57
13	4702	629	0.056	9.31	0.00097	9.70
14	4584	629	0.058	9.70	0.00100	9.97
15	8641	629	0.021	3.52	0.00050	4.97
16	3998	629	0.072	12.07	0.00116	11.59
17	2302	629	0.175	29.19	0.00213	21.27
18	6662	629	0.032	5.33	0.00066	6.61
19	785	629	0.979	163.23	0.00695	69.47
20	10834	629	0.015	2.45	0.00039	3.87
21	7782	629	0.025	4.16	0.00056	5.57
22	12925	629	0.011	1.85	0.00032	3.19
23	12850	629	0.011	1.86	0.00032	3.21
24	15009	629	0.009	1.45	0.00027	2.71
25	15652	629	0.008	1.36	0.00026	2.58
26	15898	629	0.008	1.33	0.00025	2.54
27	19137	629	0.006	0.99	0.00021	2.07
28	15119	629	0.009	1.44	0.00027	2.68
29	18438	629	0.006	1.05	0.00022	2.16
30	11878	629	0.013	2.11	0.00035	3.50
31	13648	629	0.010	1.69	0.00030	3.00
32	15581	629	0.008	1.37	0.00026	2.60
33	15556	629	0.008	1.37	0.00026	2.60
34	9199	629	0.019	3.18	0.00046	4.63
35	14982	629	0.009	1.46	0.00027	2.71

Table 4

Granite Construction Company - Liberty Quarry Phase 3

Predicted Values of Peak Particle Velocities and Air Overpressure For Each Receptor Location

Receptor Location	Distance Feet	Charge Weight Pounds	Predicted PPV	% Criteria (0.60 in/sec)	Predicted PSI	% Criteria (0.01 psi)
1	3947	629	0.074	12.32	0.00118	11.76
2	1425	629	0.377	62.88	0.00361	36.05
3	1520	629	0.340	56.71	0.00336	33.58
4	2064	629	0.209	34.76	0.00240	23.99
5	9136	629	0.019	3.22	0.00047	4.67
6	12559	629	0.012	1.93	0.00033	3.29
7	10688	629	0.015	2.50	0.00039	3.93
8	12830	629	0.011	1.87	0.00032	3.21
9	7277	629	0.028	4.63	0.00060	6.00
10	9655	629	0.018	2.94	0.00044	4.39
11	6339	629	0.035	5.77	0.00070	6.98
12	5413	629	0.045	7.43	0.00083	8.31
13	3072	629	0.110	18.40	0.00155	15.49
14	4460	629	0.061	10.13	0.00103	10.28
15	9606	629	0.018	2.97	0.00044	4.42
16	6298	629	0.035	5.83	0.00070	7.03
17	1823	629	0.254	42.40	0.00275	27.50
18	4478	629	0.060	10.07	0.00102	10.23
19	1691	629	0.287	47.81	0.00299	29.87
20	12066	629	0.012	2.06	0.00034	3.44
21	9832	629	0.017	2.86	0.00043	4.31
22	14523	629	0.009	1.53	0.00028	2.80
23	14187	629	0.010	1.59	0.00029	2.88
24	15743	629	0.008	1.35	0.00026	2.57
25	16501	629	0.007	1.25	0.00024	2.44
26	17377	629	0.007	1.15	0.00023	2.30
27	21018	629	0.005	0.85	0.00019	1.87
28	16898	629	0.007	1.20	0.00024	2.37
29	20184	629	0.005	0.90	0.00020	1.95
30	14176	629	0.010	1.59	0.00029	2.88
31	15960	629	0.008	1.32	0.00025	2.53
32	17886	629	0.007	1.10	0.00022	2.23
33	17868	629	0.007	1.10	0.00022	2.23
34	7255	629	0.028	4.65	0.00060	6.02
35	17297	629	0.007	1.16	0.00023	2.31

Table 5

**APPENDIX C
BLAST PLAN
GRANITE CONSTRUCTION COMPANY
SEPTEMBER 14, 2007**

BLAST PLAN

Granite Construction Company
38000 Monroe Street
Indio, California 92203

Project

Liberty Quarry
Temecula, California

Date

9/14/07

LIBERTY QUARRY BLASTING PLAN

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1. DEFINITIONS

Air Blast - An airborne shock wave or acoustic transient generated by an explosion.

Blast Area - The area of a blast within the influence of flying objects, gases, and concussion.

Back Break - Rock broken beyond the limits of the last row of holes in a blast.

Blaster - A qualified person in charge and responsible for the loading and firing of a shot.

Blasting Log - A written record of information about a specific blast as may be required by law or regulation.

Blast Site - The area where explosive material is handled for loading the blast holes. The area includes the perimeter of blast-holes and 50 feet in all directions from loaded holes or holes to be loaded.

Burden - The distance from the borehole and the nearest free face or the distance between boreholes measured perpendicular to the spacing. Or the total amount of material to be blasted by a given hole, usually measured in cubic yards or tons.

Decks - An explosive charge separated from other charges in the blast-hole by stemming or an air cushion.

Delay - A distinct pause of predetermined time between detonation or initiation impulses, to permit the firing of explosive charges separately.

Free Face - A rock surface exposed to air or water that provides room for expansion upon fragmentation; sometimes called open face.

Flyrock - Rocks propelled from the blast area by the force of an explosion.

Hangfire - The detonation of an explosive charge at some non-determined time after its normally designed firing time.

Misfire - A blast or specific borehole that failed to detonate as planned. Also, the explosive materials that failed to detonate as planned.

Non-electric Detonator - Detonators that do not require the use of electrical energy to function.

Spacing - The distance between boreholes. In bench blasting, the distance is measured parallel to the face and perpendicular to the burden.

Warning Signal - A visible or audible signal that is used for warning personnel in the vicinity of the blast area of an impending explosion.

2. INTRODUCTION

Liberty Quarry is a hard granite rock quarry. Blasting is necessary to extract the rock for further processing. Rock is removed by establishing a series of benches and slopes. Blasting operations involve drilling along the mining face and the placement and detonation of charges. The blasted rock is then taken to the primary crusher for further processing.

2.1. QUARRY SITE

The site consists of approximately 411 vacant acres of rugged hillside located 3 miles west of the City of Temecula, CA; just west of I-15. Elevations range from 1300 feet msl to 1200 feet msl. The site is accessed through the I-15 and Rainbow Valley Boulevard intersection.

2.2. ADJACENT SENSITIVE STRUCTURES AND FACILITIES

The site is bordered by vacant land. The closest residence is approximately 2000 feet west of the southwest corner of the mine. This structure is a single family dwelling. The Santa Margarita Ecological Reserve borders the site to the west and north and SDG&E has an existing 230-kv electrical transmission line that crosses the southern portion of the site.

3. EXPLOSIVES HANDLING PROCEDURES

3.1. DELIVERY OF EXPLOSIVES

The transporting, handling, storage, and use of explosives, blasting agents, and blasting equipment shall be directed and supervised by a qualified Blast Officer. The blasting contractor will notify the Mine Safety Personnel, at least twenty-four (24) hours in advance of expected delivery time and make arrangements for the Mine Safety Personnel to:

- A. Meet the explosive hauling vehicle;
- B. Inspect vehicle for compliance with transportation regulations;
- C. Escort vehicle to designated storage magazines.

3.2. TRANSPORTATION OF EXPLOSIVES

The blasting contractor and/or the explosive delivery company must show evidence of compliance of the following requirements: 1) current enrollment in the **California BIT Program** 2) maintain a current **USDOT HAZMAT Certificate of Registration** 3) maintain a current **California HAZMAT Transportation License** 4) maintain a general liability insurance policy for explosive transportation for not less than \$ 5,000,000. All vehicles and explosive transport magazines are to conform to all Federal, State and local regulations associated with the transportation and handling of explosives.

The blasting contractor and/or the explosive delivery company must show evidence of compliance with the following requirements: 1) copy of driver's current CDL with HAZMAT endorsement, 2) current enrollment in the California PULL NOTICE Program, 3) current enrollment in a drug screening program according to USDOT CFR Title 49 regulations. All drivers of explosive laden vehicles shall be properly trained and licensed in accordance with all Federal, State and local agencies and regulations.

3.3. USE and HANDLING

The blasting contractor shall possess the following:

- A. A current Explosive License or Permit issued by the BATF&E for the proper classification of operation.
- B. Current "Responsible Persons" and "Employee Possessor" forms for all applicable personnel.
- C. Current "Certificate of Eligibility" for all applicable personnel.
- D. A current MSHA Identification Number.
- E. Current Part-46 training and refresher training documentation.
- F. A current CAL-OSHA Identification Number.
- G. Current training documentation.

The use and handling of all explosive materials shall be done by fully trained and experienced personnel. All Blasters shall possess a current blasting license issued by CAL-OSHA and be experienced in quarry blasting. All of the blasting contractor's employees must be trained in accordance with CAL-OSHA and MSHA requirements and possess certification of such training.

The blasting contractor shall provide and maintain, on site, all required and necessary **Material Safety Data Sheets** for inspection and use in the event of an emergency.

All unused explosive material shall be removed from the blast site at the end of shift and secured in proper storage facilities or properly removed from the premises.

3.4. STORAGE OF EXPLOSIVES

All storage of explosive materials shall be with BATF&E, CAL-OSHA, MSHA and Riverside County Sheriff Department's approval. All explosive storage requirements shall be adhered to in accordance with all Federal, State and local regulations. All permits and licenses must be formally issued before storage shall be permitted. The blasting contractor shall be required to maintain a general liability insurance policy for not less than \$ 1,000,000 per occurrence.

4. MINE BLASTING PLAN

4.1. GENERAL OBJECTIVE

Processing the granite deposit into construction aggregates requires the use of heavy equipment and controlled bench blasting.

4.2. ROCK TYPE AND CHARACTERISTICS

The type of rock indigenous to this area is granite. The characteristics of granite are as follows:

- Specific gravity = 2.5 to 2.9
- Density = 168 lbs. /cu. ft.; 2.02 ton/cu. yd.

4.3. PRE-BLAST PROCEDURES

4.3.1. Blast Site Preparation

The blast site shall have unobstructed access for emergency services, mining equipment, and vehicle entry. All hazards, such as, loose boulders, under-cuts, and trip fall hazards, shall be noted or resolved before drilling begins.

4.3.2. Drilling Operations

The drilling pattern shall be determined by the size and depth of area to be excavated, distance to adjacent developments, geology of the rock formations and the size of required equipment. See Appendix A for typical blast pattern calculations.

Typical drill pattern calculation:

- Hole burden= 20 to 40 times the hole diameter
- Hole spacing= 1 to 1.8 times the burden
- Subdrill= 0.2 to 0.5 times the burden
- Minimum Bench Height= 3 times the burden

Adjustments shall be made after each blast to achieve the optimum hole size/drill pattern ratio to maximize production while minimizing fly-rock and ground vibration.

Drilling Procedures:

- Driller is to drill clean holes with substantial collars to maintain the integrity of the hole.
- Driller shall complete a daily “drill log” and submit such log to their Supervisor.
- Driller is to check each hole for voids, water and any obstruction that might interfere with the loading of such hole. Driller is to notate such information on daily “drill log” and mark such hole for easy recognition.

•

4.4. BLAST WARNING SIGNS/SIGNALS

Blasting signs reading "Blasting Area" shall be conspicuously placed along the edge of any blasting area that comes within 100 feet of any public road right-of-way, and at the point where any other road provides access to the blasting area; and at all entrances to the permit area from public roads or highways.

The blasting contractor shall post at all entrances to the facility a sign designating the sequence and type of pre-blast and post-blast warning signals.

A typical warning signal uses an air horn as follows;

WARNING SIGNAL	Five minutes prior to blast <i>"A one-minute series of long audible signals"</i>
BLASTING SIGNAL	One minute prior to blast <i>"A series of short audible signals"</i>
ALL CLEAR SIGNAL	Following blast site inspection <i>"One prolonged audible signal"</i>

4.5. PRE-BLAST NOTIFICATION AND SURVEY

4.5.1. Notification

At least 30 days before initiation of blasting, the blasting contractor or their agent shall notify, in writing, all residents or owners of dwellings or other structures located within 1 mile of the permit area of upcoming ongoing blasting operations. Resident/owner notifications shall include the following information:

- A. The blasting contractor's name, address and telephone number.
- B. That a pre-blast survey is available at no charge.
- C. The purpose of the pre-blast survey.
- D. Requests for a pre-blast survey must be made in writing and sent directly to the blasting contractor.
- E. A 24-hour notification of actual date and approximate time of blast is available before a blasting event.

4.5.2. Survey

Upon receipt of a request for a pre-blast survey, the blasting contractor or their agent shall complete a pre-blast inspection and prepare a report that documents the existing condition of the structure and surrounding facilities. An updated survey of any additions, modifications, or renovations shall be performed by the contractor if requested by the resident or owner.

4.5.3. Written Report

The written report of the survey shall be signed by the person who conducted the survey. Copies of the report shall be provided to the person requesting the survey. If the person requesting the survey disagrees with the contents and/or recommendations contained therein, he or she may submit to the operator a detailed description of the specific areas of disagreement. Disagreements will be noted in the report. Any surveys requested more than 10 days before the planned initiation of blasting shall be completed by the contractor before the initiation of blasting.

4.6. BLASTING PROCEDURES

4.6.1. Blast Site Inspections

The blasting contractor shall inspect the blast area for potential hazards. Inspected areas include but are not limited to;

- A. The immediate blast area,
- B. The high-wall face, and
- C. The geology of the rock to identify;
 - 1. Mud seams,
 - 2. Potential slide areas,
 - 3. Voids,
 - 4. Loose rocks,
 - 5. Fractures, or
 - 6. Any rock mass defects.

4.6.2. Employee Safety Meeting

Before loading operations begin, the blaster-in-charge shall direct that a safety meeting be held for all blasting contractor's employees on site. Information regarding the hazards observed during the pre-blast inspection as well as pertinent safety instructions shall be given to the workers. The blaster-in-charge shall issue directives and supervision to all blasting contractor's employees as to their responsibility and duties for the day. The blaster-in-charge shall be the man-in-charge of the blast site. The blaster-in-charge shall assume all responsibilities and perform all duties as required under the CAL-OSHA and MSHA regulations.

4.6.3. Blast Site Security

The blast site shall be barricaded and/or designated as off-limits to quarry personnel during loading operations. All access entry points onto the blast site shall be barricaded and monitored. Markers, barricades, signs and/or barrier tape shall be used to designate the blast site. Entry into the blast site by unauthorized personnel shall be prohibited. Only the blaster-in-charge or his agent shall have the authority to grant permission for

entry onto the blast site. No quarry equipment shall encroach within 50 feet of the designated blast site.

4.6.4. Loading Holes

All loading of explosives shall be under the direction and supervision of the blaster-in-charge. The blaster-in-charge shall be responsible for the following:

- A. Type of explosive used,
- B. Quantity of explosive used,
- C. Actual placement of explosives in hole,
- D. Delay timing of shot,
- E. Back-filling or stemming of each hole,
- F. Tie-in an/or hookup of the initiation system,
- G. Coordination of personnel evacuated in blast area,
- H. Blast area security,
- I. Activation of the warning signals,
- J. Detonation of the shot,
- K. Post-blast inspection, and
- L. Handle any unexpected or unusual events such as;
 - 1. Fly-rock incidents,
 - 2. Personal injuries,
 - 3. Equipment or structure damage, or
 - 4. Misfires or hangfires.

The blaster-in-charge shall make provisions in loading techniques to achieve a stable vertical back-wall face. The use of pre-splitting, post-splitting, decking, increased back-row delay timing and other acceptable methods shall be used to minimize back-break and heavy toe.

4.6.5. Initiation Systems

All down-hole-delay and surface-delay detonators used to initiate a blast shall be of a non-electric shock-tube system. Detonation cord shall not be used on the surface to tie-in or hook-up a shot.

4.6.6. Blasting Hours

Blasting shall occur between the hours of 10:00 am and 6:00 pm, Monday through Saturday. No blasting is allowed after sunset.

4.6.7. Pre-Blast Notifications

The contractor shall be responsible for all required notifications. The blasting contractor shall notify the following;

- A. All regulatory agencies requiring notification,
- B. All law enforcement agencies requiring notification,
- C. All emergency services requiring notification,
- D. Designated quarry personnel requiring notification, and
- E. All residents or owners requesting notification

4.6.8. Blasting Warning Signals

A pre-determined signaling system shall be established before blasting is to commence. All warning systems must meet CAL-OSHA, MSHA and quarry operator's requirements. A typical warning signal uses an air horn as follows;

WARNING SIGNAL	Five minutes prior to blast <i>"A one-minute series of long audible signals"</i>
BLASTING SIGNAL	One minute prior to blast <i>"A series of short audible signals"</i>
ALL CLEAR SIGNAL	Following blast site inspection <i>"One prolonged audible signal"</i>

Sufficient security guards shall be stationed around the blast area to prevent access. Guards are to have direct communication with the blaster-in-charge, by direct line-of-sight or through radio communication. Guards must be able to notify the blaster-in-charge immediately if the secured area has been breached. The blast will be aborted until the area has been cleared.

4.6.9. Controlled Blasting Techniques

The blasting contractor shall take all necessary steps and use all available blasting techniques to limit the adverse effects of fly rock, misfires, ground vibration and air blast. The use of seismographs at the nearest structures shall be used and monitored to ensure compliance with Federal, State, and local regulations.

The limitation for ground vibration and air blast shall be governed by the limits set forth by the United States Department of the Interior, Office of Surface Mining Reclamation and Enforcement (OSMRE) and the United States Bureau of Mines (USBM).

4.7. POST-BLAST PROCEDURES

4.7.1. Post-Blast Re-Entry

- A. Only the blasting contractor shall be allowed to re-enter the blast area.
- B. Re-entry shall be allowed after the smoke, fumes and dust have cleared.
- C. The shot shall be checked for any safety concerns or unusual occurrences such as a misfire, hangfire or unsafe geology.
- D. The blaster-in-charge shall authorize the “All Clear” signal to be sounded, only after the area is deemed safe-to-enter.

4.7.2. Misfire Prevention

The best way to prevent a misfire is to become thoroughly familiar with the causes and follow good blasting practices. Common causes of misfires are the following;

- A. Poor connections,
- B. Electric and non-electric detonators,
- C. Mixing detonators from different manufacturers,
- D. Improper hook-ups between detonators,
- E. Improper delay timing,
- F. Premature energy path disruption,
- G. Explosive column-shift cutoff,
- H. Inferior products, and
- I. Human error.

4.7.3. Misfire Disposal

If a misfire occurs, the disposal shall be handled by;

- A. Staying out of the blast site for at least 30 minutes following electric or non-electric blasting.
- B. An experienced individual familiar with the explosive materials and initiation systems used in the blast.
- C. An individual trained in the proper techniques for handling, neutralizing and disposing of the explosives in a safe manner.
- D. Personnel who has firsthand knowledge of how the blast was loaded or must have accurate records and data giving detailed information on the type, weight, and location of all explosive materials and initiation system components used.
- E. Personnel who can analyze all information completely and create a plan of action to safely handle, neutralize, and dispose of the explosives involved.
- F. An individual familiar with the specific Federal, State, and local regulations governing the handling of misfires.

4.7.4. Blasting Records

The blaster-in-charge shall complete a Blasting Record after each blast that identifies the following;

- A. Customer Name,
- B. Date/**Time** of blast,
- C. Location of the blast,
- D. Timing Diagram,**
- E. Drill pattern,
- F. Hole diameter,
- G. Stemming type and depth,**
- H. Sub-drill depth,**
- I. Total number of holes in blast,
- J. Hole depths,
- K. Distance and direction to nearest structure,**
- L. Scaled distance,
- M. Maximum pounds per delay,
- N. Typical hole diagram,**
- O. Description of products used in blast including;
 - 1. Manufacturer's name,
 - 2. Product name,
 - 3. Product size,
 - 4. Product quantity used, and
- P. Location of seismometer (distance & direction from shot)**
- Q. Ground vibration and air overpressure results**
- R. Date of last Manufacturer's calibration**
- S. Blaster's signature

The Blast Record shall contain all the information required to re-create the blast site, locate blast holes and shot/loading details. The Blast Record is a legal document and must meet the Federal, State, and local regulation regarding the documentation of a blast.

5. **REFERENCES**

California Fire Code, §7701 – 7704, 2000

California Health & Safety Code, § 12100, 2007

Mineral Resources, 30 CFR 816.61 – 816.68, 2007

Riverside County Code of Regulatory Ordinances, § 787.2, 2000, § 9.52, 2006.

Explosives and Rock Blasting, Atlas Powder Company, 1987

APPENDIX A

Typical Blast Pattern Calculations

DESCRIPTION	TYPICAL PRODUCTION SHOT		TYPICAL DEVELOPMENT SHOT	
	FACTOR	UNIT	FACTOR	UNIT
Hole Diameter	6.5	IN	3.5	IN
Burden	15.0	FT	8.0	FT
Spacing	15.0	FT	8.0	FT
Hole Depth	60.0	FT	40.0	FT
Stem Depth	12.8	FT	6.8	FT
Sub-Drill Depth	6.0	FT	3.2	FT
Depth of explosives	53.3	FT	36.4	FT
Production/Hole	500	CY	95	CY
	1,300	TON	247	TON
Number of Holes/Shot	16		30	
Production/Shot	8,000	CY	2,844	CY
	20,800	TON	7,396	TON
Shot Surface Area	3,600	SF	1,920	SF
ANFO Density	0.82		0.82	
Primer Density	1.30		1.30	
Primer Quantity	2.0	UNITS	2.0	UNITS
Primer Weight	1.0	LB	0.5	LB
Explosives/Hole	629	LBS	125.5	LBS
Explosives/Shot	5.0	TON	1.9	TON
Powder Factor	1.25	LBS/CY	1.31	LBS/CY

APPENDIX D
BLAST VIBRATION MONITORING PLAN
VIBRA-TECH ENGINEERS, INC.
FEBRUARY 22, 2008

**Blast Vibration Monitoring Plan
Liberty Quarry
County of Riverside, California**

Prepared for:

**Granite Construction Company
38000 Monroe Street
Indio, CA 92203-9500**

Prepared by:

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

February 22, 2008

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 on February 17, 2000 will be used at all times to monitor ground vibration and air overpressures resulting from blasting operations at the Liberty Quarry.
- 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. ± 1 dB.
 - 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: 2×10^{-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 two instruments that meet the requirements set forth above.

B. Instrumentation Setup Procedures

- 1) In order to document compliance, an instrument will be located at the closest structure of concern. The instruments will be placed on the ground between the closest blast hole to be detonated and these locations.

Ground Vibration Measurements

- a) Sensor placement – The sensor should be placed on or in the ground on the side of the structure towards 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.
 - 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 Liberty Quarry Blasting Plan and Impact Analysis, dated February 22, 2008 lists 34 receptor locations. (Blasting Plan and Impact Analysis, Appendix A.) Eleven of these receptor locations are residences, ranging from less than one mile to more than 3.5 miles from the Project boundary. Six of these locations are located in the Santa Margarita Ecological Reserve (“SMER”), and range from approximately 1.5 miles to approximately 2.5 miles from the Project boundary. The remaining receptor locations consist of various other types of land uses, including an uninhabited structure on the Project Boundary, the Rainbow exit along I-15, the Border Patrol checkpoint along I-15, a callbox along I-15, a cellular tower northeast of the Project site, and a site along Rainbow Valley Road. (See Blasting Plan and Impact Analysis, Appendix A.)

In order to ensure that the criteria set forth in the Blasting Plan and Impact Analysis are met across the range potentially sensitive nearby land uses, all blasts should be monitored from at least one residence, one SMER site, and one of the other receptor locations described in Appendix A of the Blasting Plan and Impact Analysis. While it would be preferable to monitor each blast from the closest receptor in each category (i.e., No. 19 “Project Boundary” (other), No. 3 “Rainbow Residence SW of Site” (residence), and No. 14 “SMER Site 1” (SMER), the actual monitoring locations should be determined based on site accessibility, the presence of sensitive receptors (human or structural), and location to the Project boundary.

Application of Particle Velocity and Air Overpressure Control

The ground vibration and air overpressure control limits for structures and human response are detailed in the Blasting Plan and Impact Analysis Report, and are summarized below. If the blasting operations at the Liberty Quarry exceed the referenced control limits for any single axis of any blast, Granite Construction and their blasting contractor shall cease all blasting activities and submit a report to the County. The report shall give the blast design parameters and seismographic data and include any necessary proposed corrective action, which in their opinion will reduce vibration intensity.

Ground Vibration and Air Overpressure Acceptable Limits			
Ground Vibration		Air Overpressure	
Structural	Human Response	Structural	Human Response
0.75 in/sec	0.6 in/sec	0.01295 psi	0.01 psi

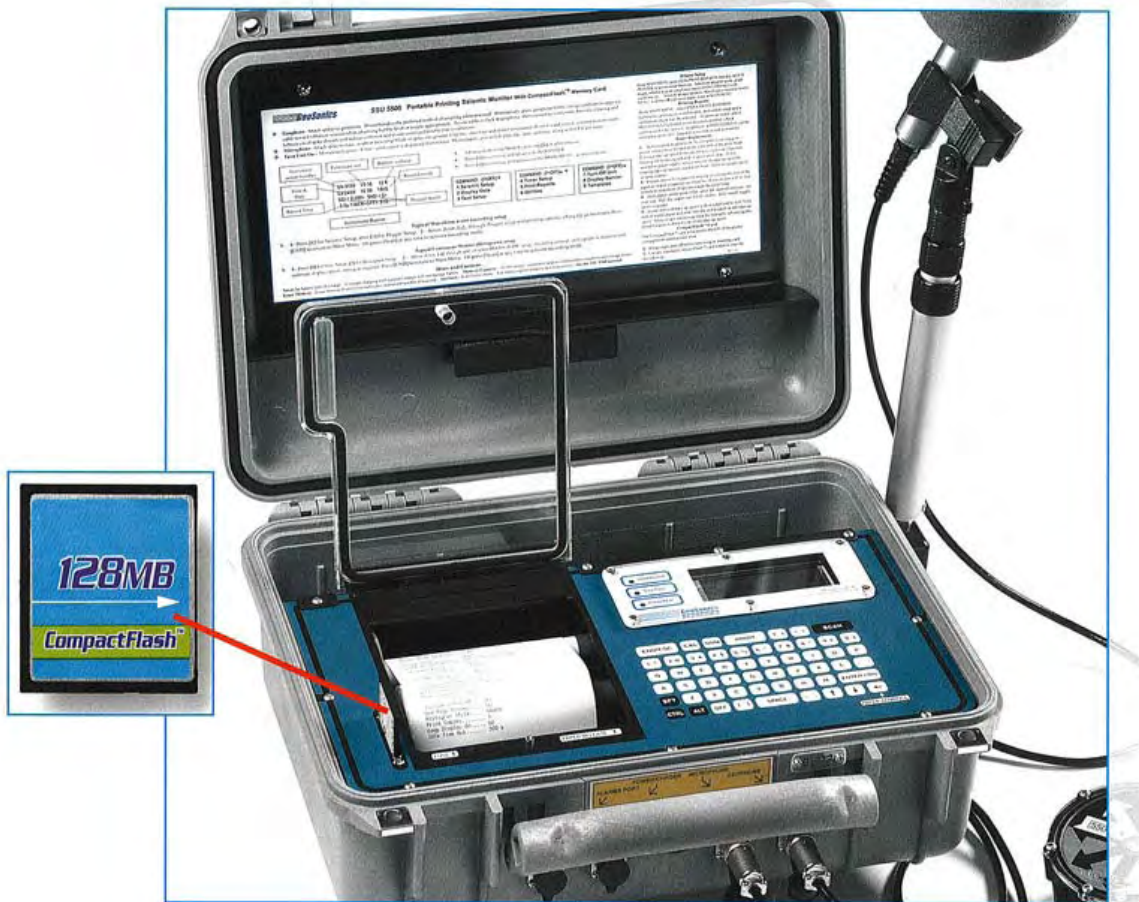
APPENDIX A

BLAST VIBRATION MONITORING INSTRUMENTATION SPECIFICATIONS

SSU 5500

Portable Printing Seismic Monitor with CompactFlash™ Media Card

The benefits are very clear!



- Convenient, versatile and complete vibration & sound monitoring system
- Removable 128 MB CompactFlash™ memory card for storing 10,000 full waveform events
- Data from the card can be transferred using any compact PC card slot (internal or USB)
 - Large thermal printer
 - Standard QWERTY keyboard
 - Basic compliance reporting software package included



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Call us today for more information or to request a 10-day free trial!

Specifications on Back 

SSU 5500

The SSU 5500 is a convenient, easy to use complete vibration and sound monitoring system. Its most significant feature is the removable 128 MB CompactFlash™ memory card. The card greatly increases memory allowing the 5500 to record 10,000 full waveform events regardless of recording time. Data from the card can be transferred using any compact flash PC card slot (internal or USB). It has a tough, weather resistant case, full QWERTY-style keyboard and heavy-duty twist-lock metal cable connectors. External ports allow the case to remain closed during monitoring operations. A large thermal printer provides for instant reports in the field. The 2-hertz high-pass microphone and all other standard accessories fit easily into the case. The four-line LCD makes on-site programming easy and permits the user to view results on-screen. The integrated timer will turn the unit on and off at pre-selected times to conserve battery power. The timesaving template utility can be used to store repetitive setup configurations.

The SSU 5500 has three recording modes: 1) triggered - either seismic or sound, 2) continuous (histogram) and 3) sustained trigger. Sustained trigger mode delays processing and permits real time collection of contiguous 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 and reporting software package can be used for 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!

Features & Specifications



Removable 128 MB CompactFlash™ memory card able to record 10,000 full waveform events.



A full QWERTY keyboard, 80 character LCD screen and thermal printer make the SSU 5500 very user friendly.



Instrument connection ports come standard with caps to protect connective pins.

STANDARD FEATURES:

- Removable 128 MB CompactFlash™ data card with 10,000 event memory regardless of record type or size.
- Four-line by 20-character LCD for on-site data display.
- Full QWERTY-style keyboard with shortcut buttons.
- 42 column facsimile-style printer.
- Heavy-duty twist-lock metal cable connectors.
- Internal, rechargeable lead acid batteries.
- Flexible interface and extensive options available for custom configurations.

GENERAL SPECIFICATIONS:

- Weight: 22.2 lbs (10.1 kg)
- Dimensions: 16 x 13 x 6.75 in (41 x 33 x 17 cm).
- Operating Temperature: 0 to 130° F (-18 to 54° C).
- One (1) year warranty on parts and labor.
- Extended warranties and service contracts also available.
- 42 column thermal linehead printer with motor-drive take-up; up to 140 events per roll of paper.

RECORDING MODES:

Seismic Trigger:

- Resolution: 0.0025 in/sec. (0.06 mm/sec).
- Printout graph time scaling: From 0.5 to 5 inches for 1 second (5 second recording).
- 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 samples / second / channel.
- Recording Intervals: 1 to 15 seconds.
- Accuracy: 5% within one year (multipoint calibration within 3%).
- Calibration: Internal dynamic.
- 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 1 dB within one year (multi-frequency calibrated).
- Calibration: Internal electronic.
- Recording Intervals: Selectable: 1, 2, 5, 10, 15, 30 and 60 seconds.
- Printout, list: Prints highest peak particle velocity and maximum overpressure during selected intervals.
- Printout, graph: Histogram of highest PPV and air overpressure as a bar graph with optional summary printed based on selected number of intervals per summary.

Sound Trigger:

Continuous (Histogram):

Sustained Trigger:

STANDARD FEATURES (Continued):

- Two (2) independent threshold alarm output ports.
- External geophone meets ISEE density recommendations.
- Toughest weather resistant structural case on the market.
- Six (6) template locations for recording set up data.
- Imperial and metric operation.
- Free standard analysis and compliance software.
- 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.



GeoSonics®

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Ph. 800-992-9395 Fax 724-934-2999
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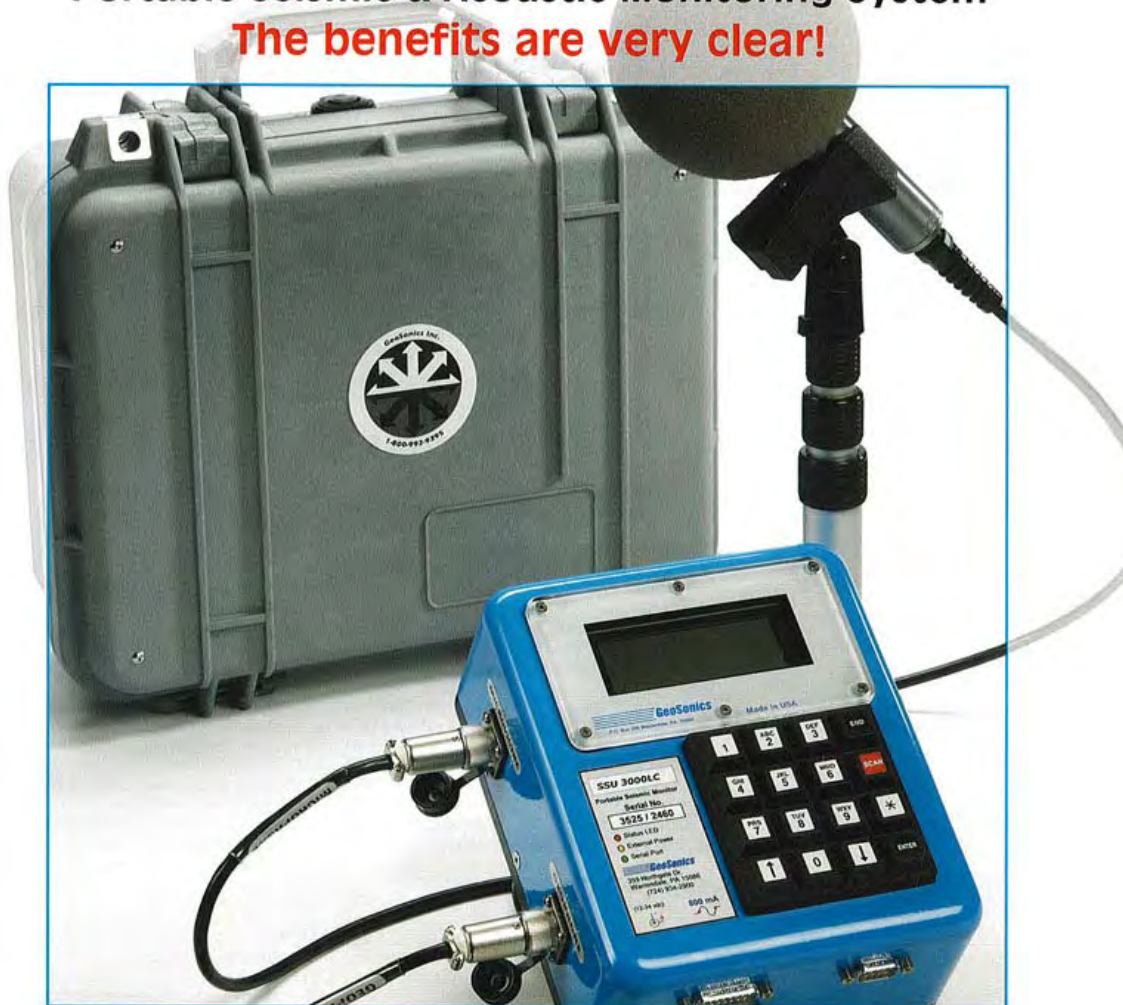


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SSU 3000LC

Portable Seismic & Acoustic Monitoring System

The benefits are very clear!



- Convenient, versatile and complete vibration & sound monitoring system
- Simple, small design & easy to use
- Heavy-gauge aluminum enclosure with baked-enamel finish
- Heavy duty twist-lock metal cable connectors
- Flexible interface and extensive options for custom configurations
- Basic compliance reporting software package included
- Designed & manufactured in the USA



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Call us today for more information or to request a 10-day free trial!

Specifications on Back

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.

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.

Sound Trigger:

Recording Intervals: 1 to 15 seconds.
 Accuracy: 5% within one year (multi-frequency calibrated).
 Calibration: Internal dynamic.
 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).
 Multiple Event Recordings: Consecutive waveform recordings up to 4.2 minutes.

Sustained Trigger:

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.



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APPENDIX E
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