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September 14, 2016

Raging River Quarry, LLC
3123 NE Harrison Street
Issaquah, Washington 98027

Attention: John Priebe

Subject: Revised Letter Report
Raging River Quarry
Geotechnical and Geological Hazard Evaluation GRDE15-0166
Preston, Washington
File No. 22534-001-00

INTRODUCTION

GeoEngineers, Inc. (GeoEngineers) has prepared this revised report to summarize our evaluation of potential geological hazards at the Raging River Quarry, LLC (the Quarry) in King County (County), Washington, and provide an opinion about associated risks to adjacent properties and public natural resources. The quarry is located off Preston--Fall City Road near Preston, Washington. The general project location is shown on the Vicinity Map, Figure 1, and shown relative to surrounding physical features on the Site Features map, Figure 2. This report was revised to include references to criteria from the National Fire Protection Association code and Washington State code with respect to blasting vibrations.

Our understanding of the project is based on a meeting with John Priebe of the Quarry and Galan McInelly, Chip Barnett and Ben Cashman of GeoEngineers at the GeoEngineers Redmond office on July 12, 2016, and a subsequent onsite meeting with Mr. Priebe and Mr. Cashman on July 19, 2016. Mr. Priebe provided various maps and documents pertinent to the project during our office meeting. We understand the Quarry is undergoing permitting through the County to expand the mining operation, and that the County requires a geotechnical and geological hazards evaluation of the property. The purpose of the evaluation is to address concerns expressed to the County by residents of neighboring properties that the quarry expansion may have adverse impacts on their properties and adjacent natural resources.

It is our understanding that the Quarry has owned the site since 1971 and has operated continuously in the Quarry for about 20 years. The Quarry was closed for about 13 years beginning in 1992 and was reopened about 2 years ago, with blasting operations resuming in spring of 2015. We understand the Quarry holds existing permits for 17 acres and desires to permit an additional 24 acres on an adjacent parcel to the SW. It is our understanding that the quarry was reopened in 2015 and is currently operated by Eastside Rock Products which has been producing aggregate resources from the quarry since spring of 2016. We understand that concerns were raised by neighbors during a community meeting in spring of

2016 that quarrying practices may create impacts to steep slopes and municipal and privately owned wells that draw groundwater from the local aquifers. We understand that some of the neighboring residents have asserted that blasting and other quarry operations have historically triggered landslides and erosional problems, and have negatively impacted the function of water wells and the quality of their water supply.

Planned Quarry Expansion

The initial phase of quarrying occupies 7.25 acres of excavation area in the current operation permit, and an additional 13.92 acres will be excavated in the expansion phase (see excavation plan, Attachment A). The anticipated quarry bottom of the initial phase varies between Elevations 250 and 270 feet, and between Elevations 265 and 280 feet for the expanded phase. By comparison, the existing quarry bottom excavation ranges between Elevation 270 and 280 feet and the reach of the Raging River that runs east of the Quarry property descends from approximate Elevation 210 feet to approximate Elevation 195 feet.

The planned depth of the excavation relative to existing grade will range from 120 to 280 feet deep. The shallowest portion of the proposed excavation will be in the southeastern corner of the expansion, and the deepest portion will be along the western margin of the quarry. The quarry walls will be benched every 25 to 40 feet in height with a 10-foot-wide bench. The quarry will maintain a minimum 50-foot setback from the property boundaries, an 80-foot buffer from wetlands, and a 200-foot riparian setback from the west bank of the Raging River. Per the guidelines set forth by the existing permit agreement between the Quarry and the County, the proposed east rim of the expansion will not cross the 300-foot elevation contour on the slope that descends eastward to the Raging River. The nearest residential improvement (swimming pool) is located approximately 50 feet from of the upper rim of the existing quarry. The nearest structure (a private home) is approximately 100 feet from the upper rim of the quarry. The extent of the planned expansion is shown on Figure 2, Site Features.

SCOPE OF WORK

Our services include a site visit to the quarry to document conditions, an evaluation of hazards and an opinion of relative risk to neighbors of the quarry. Specifically, our scope of work is as follows:

1. Office review of literature and data including pertinent maps, reports, and other available documents provided by the Quarry and available from public sources. This also includes acquisition and review of well logs from the Washington Department of Ecology (Ecology) well log online database.
2. Conduct a site reconnaissance to observe and document the conditions within and surrounding the quarry, focusing on critical areas including wellhead protection/critical aquifer recharge zones, steep slopes, and other areas of concern.
3. Evaluate blasting data provided by the client to provide an opinion about potential impacts to municipal and private wells constructed in the vicinity.
4. Evaluate blasting data provided by the client to provide a preliminary qualitative opinion about the potential impacts to stability of steep slopes at the site. A numerical slope stability modeling and analysis is not required at this time.
5. Prepare a draft letter report documenting our observations and opinions regarding the potential for blasting and other quarry operations to impact the stability of sloped areas and the local water supply.
6. Finalize our report after incorporating comments provided by Mr. Priebe.

SITE CONDITIONS

We completed a desktop review of the site by reviewing maps, reports and literature provided to us by the client, and by reviewing publically available information including geologic maps published by the Washington Department of Natural Resources, King County sensitive areas maps, LiDAR data obtained from King County GIS, and historical aerial imagery provided by Google Earth for years 1990, 2005, 2006, 2009, 2011, 2013, 2014, 2015 and 2016.

We completed an initial site visit on July 19, 2016 with John Priebe of the Quarry and performed a subsequent detailed site reconnaissance on July 27, 2015. We provide general topographic descriptions for the site followed by site specific observations of key landforms and features observed across the site.

Site Geology

The site is situated within 8 miles of the eastern margin of the Puget Lowland on the northern flank of the topographic highlands northeast of Issaquah, Washington. These highlands include Cougar Mountain, Squawk Mountain, Tiger Mountain, Taylor Mountain, Rattlesnake Ridge, Rattlesnake Mountain and Grand Ridge. The area has been impacted by tectonic deformation associated with the Cascadia Subduction Zone, and more locally by folding and faulting associated with the convergence of the Seattle, Raging River and Rattlesnake Mountain fault zones. The hills that make up the highlands are composed chiefly of andesitic volcanic rocks lying on top of older tightly folded rocks from the coastal plain of the North Cascade subcontinent that docked with Washington about 50 million years ago.

The area has also been impacted by episodic glaciation, with widespread glacial erosion and deposition throughout the past 2.4 million years. During the last continental glaciation, the Vashon stade of the Fraser glaciation, the Snoqualmie Valley to the north of the site was occupied by Glacial Lake Snoqualmie, a proglacial lake dammed by the rising topography of the Issaquah highlands to the south. The overflow water from the lake carved many of the present-day river valleys that dissect the mountain belt, including the Raging River Valley. As the glacier receded north, the glacial lake drained, and the present-day rivers became established in the former overflow channels, with some rivers flowing in the opposite direction of the ice age overflow water. The Raging River, for instance, now flows northeast toward the Snoqualmie River, while the glacial lake overflow that formed the canyon itself flowed southwest during glacial times. In the time following the last ice age, the landscape in the vicinity of the project site has been modified by landslides, stream erosion and deposition and human activity.

In general, the site is mapped as being underlain by relatively thin glacial deposits overlying bedrock in the upland area of the western portion of the site, and exposed bedrock on the steep slopes of the central and eastern portion of the site. The steep slopes make up the existing quarry area and the west Raging River valley wall. These slopes are veneered in places with isolated landslide deposits, particularly north and south of the quarry. Glacial deposits generally increase in thickness north of the site, where they outcrop in the steep slopes in these areas.

The geologic units mapped across the site by Dragovich, et al. (2007) include six primary units: (1) Holocene landslide deposits (Qls); (2) Pleistocene-age recessional glaciolacustrine (lake) deposits (Qgl_r); (3) Pleistocene-age lodgment till (Qgt_v); (4) Pleistocene-age advance glaciolacustrine deposits (Qgl_v); (5) a Miocene-Eocene-age basaltic dike intrusion (MEib); and (6) middle-Eocene-age volcanic tuff of the Tukwila Formation (Evt_t).

The landslide deposits consist of an unsorted and unstratified mix of angular clasts of bedrock and surficial deposits derived from upslope, and typically includes areas of irregular, hummocky topography at the bases of steep slopes. The glacial units mapped in the area were deposited during the retreat of the last continental glaciation, which occurred during the Quaternary period 13,000 to 15,000 years ago. Glacial till deposits are described as highly compacted, unsorted deposits containing subrounded to well-rounded clasts in a silty or sandy matrix, generally forming an undulating surface a few meters to a few tens of meters thick. Advance and recessional glaciolacustrine deposits are described as laminated to massive silt, clayey silt, and silty clay deposited in lowland or proglacial lakes during transitional periods between nonglacial and glacial periods. The advance glaciolacustrine deposits differ from the recessional glaciolacustrine deposits in that they are typically considerably more compacted and are generally stratigraphically lower. The underlying volcanic rocks of the Tukwila Formation consist of tuff and breccia with clasts of porphyritic andesite and dacite formed during the middle Eocene epoch between 34 and 56 million years ago. The flows have since been deformed by tectonic forces, including a NW-SE trending anticline north of the site, and two predominant sets of joints gently dipping to the south and steeply dipping to the west. A dike intrusion consisting of basalt is mapped near the southern boundary of the side and forms an east-plunging ridge that descends to the Raging River.

Surface Conditions

Desktop Study

In addition to reviewing geologic maps, we also reviewed critical areas maps, well data, aerial imagery, and a LiDAR digital elevation model (DEM) prior to visiting the site to gain a more complete understanding of the geologic and land use history of the site. The LiDAR data were processed to create hillshade models to help interpret landforms. Dragovich, et al. (2007) mapped Quaternary-age landslide deposits north, east, and south of the quarry property. We interpret hummocky topography that is consistent with former deep-seated landsliding from the LiDAR data. North of the quarry, we interpret a steep, east-facing scarp slope oriented approximately parallel to, and west of, 329th Avenue SE. The scarp slope is mapped by Dragovich, et al. (2007) as Vashon-age advance glaciolacustrine deposits, with Quaternary landslide deposits (Qls) mapped on the hummocky topography to the east of the scarp. The landslide deposits extend southward and east of the eastern boundary of the quarry property. At the southwest corner of the quarry property, another landslide deposit is mapped by Dragovich, et al. (2007) with a subdued convergent scarp area to the northwest. The underlying geology is mapped by Dragovich, et al. (2007) as volcanic tuff of the Tukwila Formation (Evt_t). The existing quarry area and the steep slope along the Raging River to the south of the quarry are also mapped as Tukwila Formation. The uplands to the west of the quarry appear generally flat on the LiDAR and are mapped as Vashon-age till (Qgt_v), with an isolated pocket of recessional glaciolacustrine deposits west of the quarry. The mapped geology, locations of steep slopes, and our interpreted landslide features based on LiDAR are shown on Figure 2, Site Features.

The majority of the site is mapped by King County as both erosion and landslide hazard area, particularly throughout the central portion of the property. The eastern boundary of the quarry property in the Raging River valley bottom is mapped by the County as Category 2 critical aquifer recharge area and also as a seismic hazard area. The mapped environmentally sensitive areas are shown on Figure 3.

Surface Reconnaissance

We conducted a surface reconnaissance of the quarry property and made drive-by observations of adjacent properties. During our reconnaissance we screened for slope features related to mass wasting and erosion such as exposed and raveling soils, scarps, steep gullies, hummocky topography, debris fans, areas of seepage or poor drainage conditions, disturbed vegetation and/or timber, and other features indicative of recent or past slope instability. For the purposes of discussion in this report, the site is divided into the following areas:

1. Existing quarry and surrounding slopes
2. Upland plateau west, northwest, and southwest of the quarry
3. Steep slope along the Raging River south of the quarry
4. Hummocky terrain at the southwest corner of the property
5. Steep slope and hummocky terrain along 329th Avenue SE, north of the quarry

Existing Quarry and Surrounding Slopes

The existing quarried area consists of two primary vertical face cuts into bedrock of the Tukwila Formation (Evt_t). These cuts delineate the southern and western boundaries at the southwestern corner of the present quarried area and form a right angle to one another. Both faces are benched with multiple tiers. The south face has three discontinuous tiers, and the west face has four discontinuous tiers over a total vertical height of about 250 feet.

The northern boundary of the existing quarried area is characterized by steep, forested southeast to east facing slopes that continue northward along 329th Avenue SE. The quarry operator has constructed a fill berm at the northeastern corner of the property to serve as a noise barrier for the neighborhood to the northeast. The eastern boundary of the quarried area descends over discontinuous forested steep slopes that transition to a flat terrace of the Raging River near the ends of 329th Avenue SE and Carmichael Road. Immediately southeast of the quarried area is a steep east-facing forested slope with bedrock exposed in discontinuous cliff bands that are up to 30 feet tall.

The nearest structure to the active quarry is a residence on the property at street address 32415 SE 58th Street, approximately 320 feet west of the active quarrying operations. The property is situated on the upland terrace area and consists of a house and a swimming pool. Hardscape surrounding the pool is within approximately 50 feet of the upper rim of the quarry. A chain link fence approximately follows the property line from the southwest to the northeast. A trail follows the west rim of the quarry in this location and consists of a bedrock cut along the west quarry margin. Thin (generally less than 4 feet thick) glacial overburden mantles the bedrock cut along the trail. East of the property at 32415 SE 58th Street, the trail descends a talus embankment into a forested area and terminates at the end of an old logging road that approaches the northwestern corner of the quarry property from the northwest. The logging road ends in a 12-foot-tall through-cut that is excavated in glacial deposits (till) and a flat landing that terminates at the crest of a steep, forested east-facing slope that is generally inclined at gradients up to 80 percent. A historic debris slide forms a narrow (approximately 15 feet wide) gully east of the old logging road, with a convergent scarp area of exposed raveling soils cut into the landing of the road. The debris slide gully is about 200 feet long, and is inclined at gradients of up to 75 percent. We understand from the Quarry that the slide was filled with rock material from the top to stabilize the feature. The head of the gully is vegetated with young alders and brush and appeared to be generally stable at the time of our visit.

A shallow landslide feature was observed north of the quarry's north property line. The landslide originated at the crest of a steep slope on the property at street address 5706 324th Place SE, approximately 300 feet northwest of the quarry property line. The steep slope is mapped by Dragovich, et al. (2007) as Vashon till overlying advance glaciolacustrine deposits. The feature appears to be approximately 60 feet wide and 275 feet long, and consists of a scarp and body consisting of bare raveling soils and a toe area of accumulated debris immediately north of the property line. We were not able to access the feature due to right-of-entry restrictions, and were therefore only able to observe the feature from a distance and remotely using aerial imagery. Based on historical aerial imagery, the landslide occurred sometime between July 2013 and July 2014. We understand the landslide occurred during a period in which no blasting operations were active in the quarry, and therefore occurred as a result of conditions unrelated to quarry operations. Based on our review of historical aerial imagery, significant timber harvest, vegetation removal, clearing, and grading activities occurred between 2009 and 2013 on the 5706 324th Place SE property upon which the landslide originated.

An access road ascends the northwestern, western, and southwestern rims of the quarried area, and switchbacks to the southwest at the south rim of the quarry. The access road ends in an hourglass-shaped cleared area on the upland plateau to the southwest of the active quarry area. The switchback marks the eastern extent of the cleared area, and the area is approximately 775 feet long by 150 feet wide. The area was logged in 2010 and is now mostly revegetated with brush. We understand that the Quarry had regraded the crest of the ridge that ascends to the upland plateau area to improve stability of the clearcut area and access road. A stand of mature timber was left unharvested along the eastern boundary of the clearcut to provide a barrier against potential for debris to migrate down the steep slope to the east.

Upland Plateau

The upland plateau area to the west and southwest of the active quarry consists of generally flat to slightly hummocky topography, characteristic of glacially overridden landscapes of the Puget lowland. The upland plateau is forested with mature timber consisting of an overstory dominantly of Douglas fir, cedar and big leaf maple. The upland plateau consists of relatively thin glacial deposits (predominantly Vashon till) overlying shallow bedrock. The area west of the active quarry expansion area consists of a wetland. The area to the southwest of the existing quarry limits makes up the majority of the planned quarry expansion area. The upland plateau terminates to the south along a steep-sided ravine that drains southeastward to the Raging River, and to the east along the western valley wall of the Raging River.

The upland plateau to the northwest of the quarry encompasses the neighborhood of SE 58th Street and 324th Place SE. The neighborhood consists of about ten residences within ¼ mile of the existing quarry.

Steep Slope along Raging River

Steep forested slopes define much of the southeastern and eastern limit of the planned quarry expansion. The slopes are generally east to south facing and range from approximately Elevation 210 to 520 feet. The slopes are typically forested with mature timber up to 4 feet diameter breast height (dbh). The slopes we observed are typically inclined at gradients of 80 percent or steeper, with a discontinuous near-vertical cliff band (Evt_t) up to 50 feet tall. The slope is generally planar in form, with the exception of a steep headwall of convergent topography near the north end, and a smaller convergent hollow near the south end. The slopes descend continuously to the left (west) bank of Raging River. In general, no evidence of recent or active instability was observed on the slopes. Mature trees were generally observed to be in the upright growth position with no distress evident from slope wasting. We did not observe seepage or springs or indications of hydrophilic vegetation on the slope during our reconnaissance. The southeastern corner of the proposed quarry expansion consists of a steep south-facing slope that is coincident with the lower reach of the drainage that delineates the south limit of the expansion. The slope makes up the sidewall of an inner gorge through this portion of the drainage, with evidence of recent minor sloughing into the drainage. The slopes in this area are typically inclined to 75 percent or steeper and vegetated with mature timber up to 3 feet dbh.

Hummocky Terrain at Southwest Corner

We interpret hummocky terrain in the LiDAR hillshade model at the southwest corner of the quarry property that is consistent, in our opinion, with morphology of an ancient, large deep-seated landslide. A multi-use trail that utilizes a former railroad grade accesses the toe of this feature, with several through-cuts across lobate features near the toe. We observed colluvium consisting of a silty sand matrix with abundant large boulder clasts scattered throughout. The landslide feature is forested with mature timber dominated by Douglas fir, cedar, big leaf maple, cottonwood and alder up to 3 feet dbh. Timber was generally observed to be growing upright in the vertical growth position. In general, we did not observe evidence of recent or historic slope movement. We also did not observe indications of distress in the trail such as cracked pavement or other obvious deformations.

Steep Slope and Hummocky Terrain North of Quarry

A steep, scalloped scarp slope exists north of the quarry property and is situated roughly parallel to 329th Avenue SE. The slope is generally east facing and ranges from approximate Elevation 300 to 500 feet. The slope is forested with mature timber and has several exposures of glacial soils (mapped as advance glaciolacustrine deposits). We were not able to access the slopes directly due to right-of-entry limitations, however we observed from a distance that they appear to be consistent in character with a scarp of a steep deep-seated landslide complex. The area at the toe of the scarp including the alignment of 329th Avenue SE is generally hummocky and consistent with ancient deep-seated landslide topography. This area is mapped by Dragovich, et al. (2007) as ancient landslide deposits (Figure 2).

BLASTING RISK ANALYSIS

General

Tolerable Peak Particle Velocity from Construction Activities (i.e. Blasting)

Peak particle velocity (PPV) is the generally accepted measure for assessing the potential for damaging vibrations produced by a wide variety of energy sources. Empirical studies show that the PPV associated with ground vibrations is generally inversely and exponentially proportional to the distance from the source vibration. In other words, the PPV decreases very rapidly with distance from the source vibration. For example, the PPV measured at a distance of 100 feet from the source will be approximately 0.1 percent of the PPV measured at the source for typical construction-related vibrations. More specifically, the PPV attenuates to about one-third for the doubling of distance from source (ISEE 1998). So if the PPV is 1 inch per second at 250 feet, the PPV would be approximately 0.33 inch per second at 500 feet). The attenuation can vary based on geologic factors. Because of the exponential rate of energy decay with distance from the source, variations in subsurface material type typically have a very minor to negligible effect on PPV, in comparison with source distance.

Tolerable PPV limit for three structural classes have been proposed by Hudson and Harrison (1997) and are summarized in the following table.

TABLE 1. TOLERABLE PPV LIMIT FOR THREE STRUCTURAL CLASSES (HUDSON AND HARRISON 1997)

Type of Structure	Tolerable PPV Limits (in/sec)
Residential masonry buildings	0.5 to 1
Retaining walls, bridge abutments, industrial buildings	4
Lined and unlined rock tunnels	17 to 24

These thresholds are relatively consistent with other literature, but it is important to note that the residential structures referenced are masonry which can be more sensitive to vibrations. It is our opinion that the values for residential structures could be somewhat conservative since most modern houses are timber-framed and less susceptible to vibrations. In addition, these criteria do not account for distance from the blasting.

Other references indicate that slightly higher peak particle velocities are deemed acceptable for residential structures. For example, a PPV of 2 inches per second is generally considered a threshold value for inducing damage to residential structures while a PPV of 0.5 inches per second has been proposed as a threshold value for, "old residential structures in very poor condition" (Wiss 1981). Similarly, a PPV of 2 inches per second is generally considered a threshold value for inducing damage to residential structures located near construction sites and quarry blasting operations (ISEE 1998).

By way of comparison, a PPV of 0.02 inches per second is considered the threshold for human perception of motion, a PPV of 5.4 inches per second would be expected to cause minor damage to an average house subjected to quarry blasting vibrations, a PPV of 20 inches per second would be expected to cause minor damage to nearly all houses, and crack generation in old concrete is anticipated at approximately 375 inches per second (ISEE 1998).

The acceptable threshold PPV for residential structures are further refined to account for damage based on the frequency of the vibrations and the PPV as proposed by the U.S. Bureau of Mines (Siskind, et al. 1980). These criteria, referred to as USBM RI 8507, were developed based on measured structure amplifications and damage summaries as correlated with blasting related frequencies and peak particle velocities. These criteria are widely employed for the protection of residential structures against quarry blast induced vibrations (see USBM RI 8507 Safe Levels of Blasting Vibration for Houses graphic below).

For instance, the National Fire Protection Association (NFPA) adopted standards for blasting in NFPA 495 (2013) based on the graph of frequency versus PPV presented in USBM RI 8507 (Siskind, et al. 1980). The NFPA standard also provides the option to use prescribed scaled distance equations for three distance zones (0 to 300 feet, 301 to 1,000 feet and equal to or greater than 1,001 feet) if blasts are not monitored using a seismograph.

The Washington Administrative Code (WAC) Chapter 296-52 provides safety standards for possession, handling, and use of explosives, including criteria for ground vibrations protective of dwellings and other structures. In WAC 296-52-67065(1), the maximum limits for peak particle velocities versus distance are established and are to be verified using seismographs. Alternatively, the seismographs are used to monitor and establish that vibration frequency versus PPV remain within acceptable ranges presented in graphs.

Table 2 summarizes the WAC 296-52 PPV limits based on seismograph measurements to be obtained from three mutually perpendicular directions, with the maximum applied to each of these measurements. The basis for blast design needs to be included in the blasting plan for this option.

TABLE 2. PEAK PARTICLE VELOCITY LIMITS BASED ON MONITORING (WAC 296-52)

Distance from Blasting Site	Maximum Allowable Peak Particle Velocity
0 to 300 feet	1.25 inches per second
301 to 5,000 feet	1 inch per second
5,001 feet and beyond	0.75 inches per second

The frequency versus maximum PPV method in WAC 296-52-67065(1)(a) presents two graphs of frequency versus PPV. The two graphs vary slightly, but the second plot is more comprehensive and is consistent with graph presented in USBM RI 8507 (Siskind, et al. 1980) and shown below in Graph 1.

The second alternative in WAC 296-52 is to use the Scaled Distance formulas prescribed in WAC 296-52(1)(b) for the three distance zones, and are to be followed if the blasting operation does not use seismographs to monitor each blast for compliance.

Effects of Blasting on Water Wells and Aquifers (section from FHWA 1991)

Frequently, when blasting occurs in a region and either water wells or the aquifer appear to undergo a change, the blasting is cited as the cause. However, under normal blasting circumstances this is only remotely possible. Although vibration has frequently been blamed for problems that occur in wells, recent investigations by the US Bureau of Mines indicate that blasting has little or no effect and that vibration below 2.0 inch per second will not cause damage to a well.

The principal effect of blasting on water wells that are close is that temporary turbidity may occur in the well. This condition passes quickly and is a temporary annoyance rather than a persistent problem. Fracturing around a blasthole is limited to a radius of 20 to 40 blasthole diameters. For a six inch hole this is 10 to 20 feet.

Blast Data

We reviewed blast reports prepared by Aggregate Resource Drilling, LLC for four recent blasting events that occurred in March (two events), May, and June of 2016 (ARG 2016a, b, c and d). The blast reports include details of the layouts, depths, and charge size, and blast data acquired from arrays of seismographs setup around the quarry to monitor the vibrations generated during the blasting events. Copies of the blasting reports are presented in Attachment B. The following Table 3 summarizes the reported blast data:

TABLE 3. SUMMARY OF BLAST DATA

Date and Time of Blast Shot	Seismograph ID	Max Explosive Weight (lb/delay)	Distance from Blast (feet)	Max PPV (in/sec)
3/8/16 3:05 pm	3615	206	648	0.395
	3617	206	997	0.315
	3618	206	No data	No data
3/23/16 3:06 pm	3617	113	838	0.145
	3618	113	766	0.0850
5/23/16 3:16 pm	3615	34	811	0.160
	3616	34	951	No data
	3618	34	1,076	0.0600
	3619	34	1,344	No data
	7077	34	1,642	0.0659
6/21/16 3:08 pm	3615	89	1,330	0.100
	3616	89	1,089	0.215
	3618	89	864	0.145
	3619	89	1,020	0.320

Blasting Risk Assessment

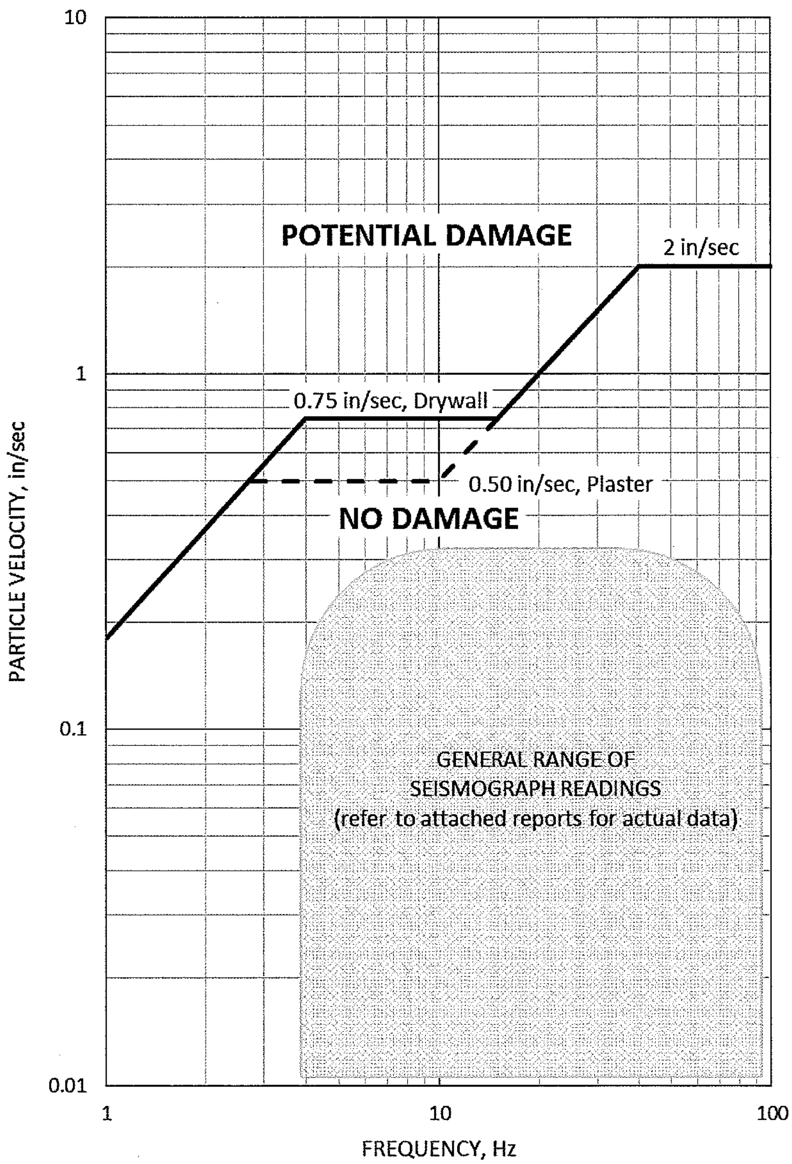
General

For risk assessment purposes, we evaluated the available blasting data with respect to the amount of vibration energy generated and proximity to nearby improvements (e.g. houses, wells) and geologic hazard areas (e.g. landslide and erosion hazard areas), as summarized in the following sections.

Residential Structures

The following graphic presents the recent blasting data using the USBM criteria that are incorporated into WAC 296-52 for safe blasting based on a plot of frequencies and peak particle velocities. Both frequencies and peak particle velocities are plotted using logarithmic scales (log-log plot) that allow straight line plotting of the boundary between vibrations that result in no damage and vibrations that could cause potential damage. Therefore, the graph below appears to show that the monitored blasting is approaching the boundary of potential damage, but the highest readings are only about 65 to 80 percent of the criteria for potential damage of plaster and lath walls (i.e. the most sensitive element of structures not typically found in modern homes).

GRAPH 1. USBM RI 8507 SAFE LEVELS OF BLASTING VIBRATION FOR HOUSES (SISKIND, ET AL. 1980)



Therefore, the reported blasting vibrations (ARG 2016a, b, c and d) as summarized in the graph are significantly less than would be needed to produce damaging vibrations at the seismograph locations. The reported data did not exceed the threshold limits of potential damage as recommended by WAC 296-52 for either 1) simple distance versus PPV criteria (e.g. much less than 1 inch per second for distances ranging from 300 to 1,000 feet) or 2) the more refined approach by using the frequency versus PPV criteria.

Groundwater and Well Performance

We reviewed locations and logs of wells within the proximity of the perimeter of the proposed quarry area and planned expansion using the Ecology online well database (Ecology 2016). We also reviewed wellhead protection zones and critical aquifer recharge areas mapped by King County. In general, the regional groundwater flow in the uplands to the west of the site is from south to north. A Category 3 critical aquifer recharge area is mapped by King County in the low valley bottom area along the eastern margin of the quarry property. The critical aquifer recharge area does not overlap with the existing quarried area or planned expansion area. There are no wellhead protection zones mapped within one half of a mile of the site perimeter.

Approximately 58 wells were initially identified to be within about 1 mile of the existing quarry and planned expansion based on the Ecology well database (Ecology 2016). In most cases, the accuracy of the locations of the wells as recorded on their respective logs is limited to the centroid of the corresponding quarter-quarter section. In many cases, multiple wells correspond to the same quarter-quarter section centroid. As data allowed, we correlated well ownership to individual property parcels (and homes) to refine individual well locations to the greatest extent practicable. In general, wells completed in the upland area west of the quarry were completed into bedrock, whereas wells completed in the Raging River valley bottom were completed in alluvium. The completion details for 18 wells within approximately 1,000 feet of the existing quarry and proposed expansion are summarized on the following Table 4.

TABLE 4. NEARBY WELL COMPLETION DETAILS

Well ID	Date Constructed	Well Diameter (inches)	Well Depth (feet)	Approx. Wellhead Elevation (feet, NAVD88)	Static Water Level (feet bgs) [1]
88236	12/26/1988	6	250	n/a	"flowing"
88269	4/20/1987	6	98	n/a	69
90323	6/13/1987	6	114	n/a	"flowing"
91481	n/a	48	8	n/a	6
92119	7/25/1984	6	378	n/a	241
92668	7/29/1986	6	140	n/a	32
92798	6/25/1985	6	70	n/a	35
93085	10/19/1984	6	47	n/a	19
93433	6/25/1987	6	118	n/a	14
93683	n/a	8	236	n/a	225
235923	2/24/2000	8	103	n/a	58
94346	4/21/1983	6	92	500	25
96010	9/12/1985	6	368	430	285
96514	3/29/1984	6	293	n/a	"flowing"
286577	n/a	6	91	n/a	"flowing"
97955	5/22/1987	6	261	n/a	"flowing"
98804	4/5/1985	6	220	n/a	"flowing"
286136	2/10/1970	n/a	359	n/a	165

Notes:

[1] bgs = below ground surface; static water level as reported on well completion log.

As reported by FHWA (1981) "Vibration levels below 2.0 inches per second are not sufficient to cause damage to water wells." Based on the available blasting data it is our opinion that the nearby wells would not be damaged by the recent reported blasting vibrations (ARG 2016a, b, c and d) since the highest PPV within 650 feet of the basting was less than 0.4 inches per second.

Steep Slopes

We understand the quarry expansion will encompass steep slopes along the southern and eastern margins of the planned expansion area. Many of the slopes in these areas are between 200 and 250 feet tall, and are inclined in excess of 70 percent. However, these slopes are generally controlled by bedrock of the Tukwila Formation and, on the basis of our field reconnaissance, aerial photo review, and LiDAR review, they appear to have been historically stable slopes. Excavation of the quarry to the north and west of these slopes will, in our opinion, likely have little effect on the inherent stability of these slopes, as the area of disturbance will be sloped inward toward the quarry and contained within the confines of the quarry walls. In our opinion, the proposed 200-foot riparian setback from the west bank of the Raging River where it extends above the 300-foot elevation contour will be sufficient to reduce risk of sediment delivery to the Raging River. Furthermore, excavation of earth materials from the opposing sides of steep slopes would reduce driving forces acting on the steep slopes and reduce potential groundwater elevations within the slope. Therefore, it is our opinion that the proposed expansion activities would not likely adversely affect the global stability of the slopes.

Both the PPV and the amplitudes of the waves as they pass through the ground are key to potential slope movement. Similar to the PPV, the amplitudes of the waves attenuate with distance. It is our opinion that the amplitudes of displacement resulting from an appropriately designed blast program should be relatively low and the potential for triggering slope movements are low.

CONCLUSIONS AND RECOMMENDATIONS

There is no known history of shallow or deep-seated landsliding as a result of blast-induced vibrations within or in proximity to the quarry, either along the slopes below the residences or along the slopes facing the Raging River. The shallow landslide on the property of 5706 324th occurred during a period in which no blasting operations were active in the quarry, and therefore occurred as a result of conditions unrelated to quarry operations. Similarly, the large deep-seated landslides to the north and south of the Quarry property that have been interpreted by us using LiDAR are older than the oldest trees that are in the vertical growth position in these areas (greater than 100 years old) and are not related to Quarry operations.

Based on our understanding of the blasting operations and drawing on published damage thresholds, it is our opinion that the blasting operations are in general accordance with industry standard blasting practices as outlined in the National Fire Protection Association Explosive Materials Code, the U.S. Bureau of Mines RI 8507 (Siskind, et al. 1980), and the Washington Administrative Code 296-52. It is our opinion that the maximum allowable vibration criteria in WAC 296-52 is an appropriate risk reduction measure to evaluate/monitor the seismograph readings of blast-induced vibrations at the site and vicinity. Provided that PPV are maintained below these criteria at the locations of areas of concern (e.g. homes, wells, slopes, landslide areas), it is our opinion that the planned quarry blasting expansion will not adversely affect these areas. Each blast should be sized based on the distance to the nearest sensitive structure.

The slopes facing the Raging River are predominantly underlain by rock and do not appear to have been subject to failures from prior blasting at the quarry. It is our opinion that likelihood of failures in the slope facing the Raging River is low, assuming that future blasting is accomplished in a manner consistent with past practices. Therefore, it is our opinion that the planned setbacks are adequate to minimize the risk of inducing landslides or sediment conveyance to the river. We recommend that the steep slopes in the vicinity of active timber harvest, blasting, and excavation be routinely inspected for signs of instability or disturbance caused by these practices.

Timber harvest activities completed in the upland plateau area and along the tops of the steep slopes prior to expansion of the quarrying operation should be completed in general accordance with State forest practices guidelines and regulations and should utilize best management practices to limit fugitive debris from traveling from the area of disturbance and down the slope.

LIMITATIONS

We have prepared this report for the exclusive use of Raging River Quarry, LLC and their authorized agents. This information is based on a desktop study and a site visit for the project.

The purpose of our services was to review published data and perform a site reconnaissance as a basis for developing an opinion about potential impacts of blasting to stability of steep slopes near the site, to nearby improvements, and to municipal and private wells constructed in the vicinity. Within the limitations of scope, schedule and budget, our services have been executed in accordance with accepted practices in the fields of geology and geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix A titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

REFERENCES

Aggregate Resource Drilling, LLC (ARG) (2016a). Blast Report, Raging River Quarry, March 8, 2016.

Aggregate Resource Drilling, LLC (ARG) (2016b). Blast Report, Raging River Quarry, March 21,2016.

Aggregate Resource Drilling, LLC (ARG) (2016c). Blast Report, Raging River Quarry, May 23, 2016.

Aggregate Resource Drilling, LLC (ARG) (2016d). Blast Report, Raging River Quarry, June 21,2016.

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

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Wiss, J.F. (1981). "Construction Vibrations: State-of-the-Art." *Journal of the Geotechnical Engineering Division*, ASCE, Vol. 107, No. GT2, 167-181.

We trust that this letter meets your needs at this time. Please contact Galan McInelly at 425.861.6000 if you have questions regarding the content of this letter, or if you require additional information.

Sincerely,
GeoEngineers, Inc.

State of Washington
Engineering Geologist
1584
Licensed Geologist
Craig F. Erdman

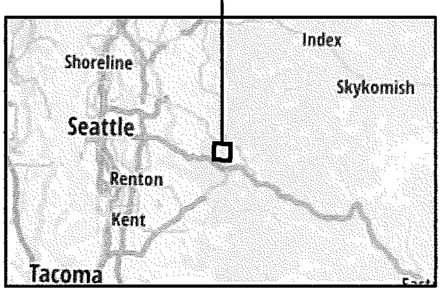
Craig F. Erdman, LG, LEG
Senior Engineering Geologist

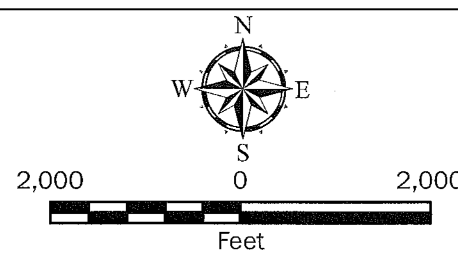
Shaun D. Stauffer, PE
Principal Geotechnical Engineer

FOR GWM
Galan McInelly, LG, LHG, LEG
Principal Geologist

BHC:CMK:GWM:cam

Attachments:
Figure 1 – Vicinity Map
Figure 2 – Site Features
Figure 3 – Environmentally Sensitive Areas
Figure 4 – Topographic Map
Attachment A: Excavation Plan
Attachment B: Blast Reports
Appendix A: Report Limitations and Guidelines for Use





Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

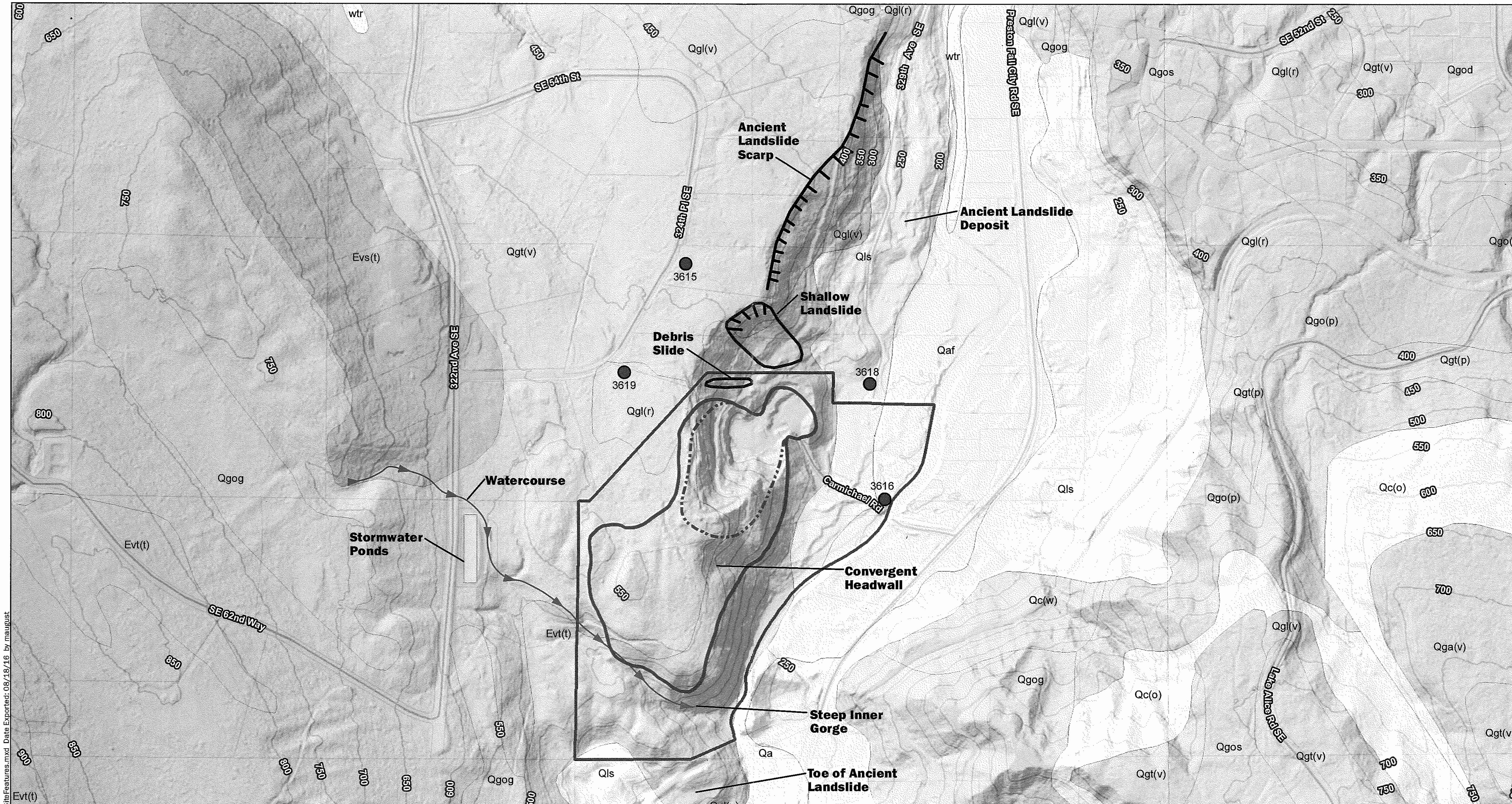
Vicinity Map

Raging River Quarry
Location

GEOENGINEERS

Figure 1

P:\22\22534001\GIS\MXD\2253400100_VicinityMap.mxd Date Exported: 08/16/16 by maugust



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Notes:
1. The locations of all features shown are approximate.
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Data Source: King County GIS, ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- Qls - Quaternary mass-wasting deposits
- Qa, Qaf, Qc(o) - Quaternary alluvium
- Qga(v), Qgl(r), Qgl(v), Qgo(p), Qgod, Qgog - Pleistocene continental drift
- Qc(w) - Pleistocene glacial and nonglacial deposits
- Ec(t) - Tertiary continental sedimentary rocks
- Evs(t) - Tertiary volcanic and sedimentary rocks
- Evt(t) - Tertiary fragmental volcanic rocks
- 3616 Seismometer Location for June 2016 Blast Shot
- Quarry Property
- Existing Quarry Limits
- Proposed Quarry Expansion Limits

N W E S

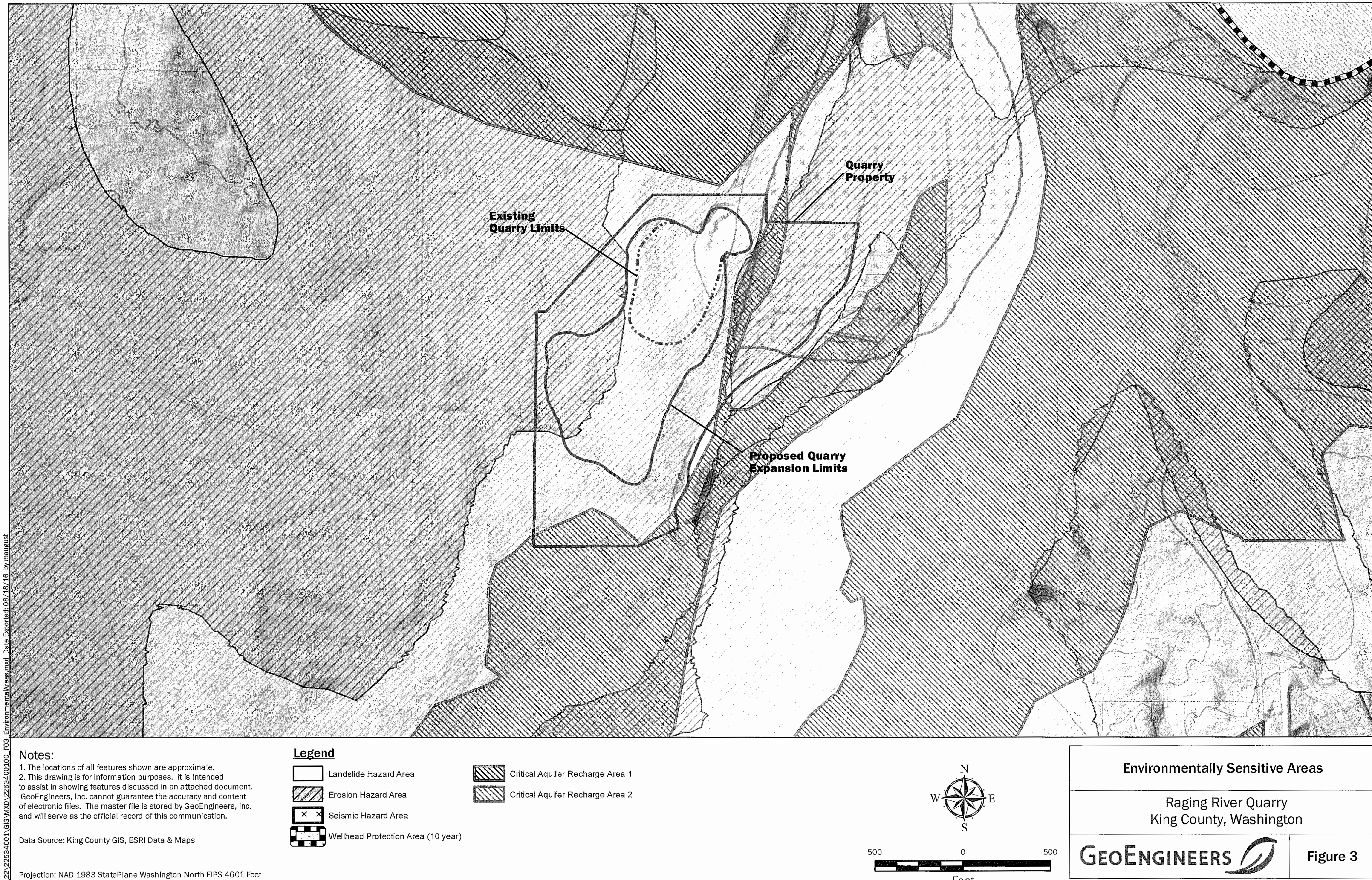
500 0 500
Feet

Site Features

Raging River Quarry
King County, Washington

GEOENGINEERS

Figure 2



P:\22\22534001\GIS\MXD\2253400100_F03_EnvironmentalAreas.mxd Date Exported: 08/18/16 by maugust

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: King County GIS, ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

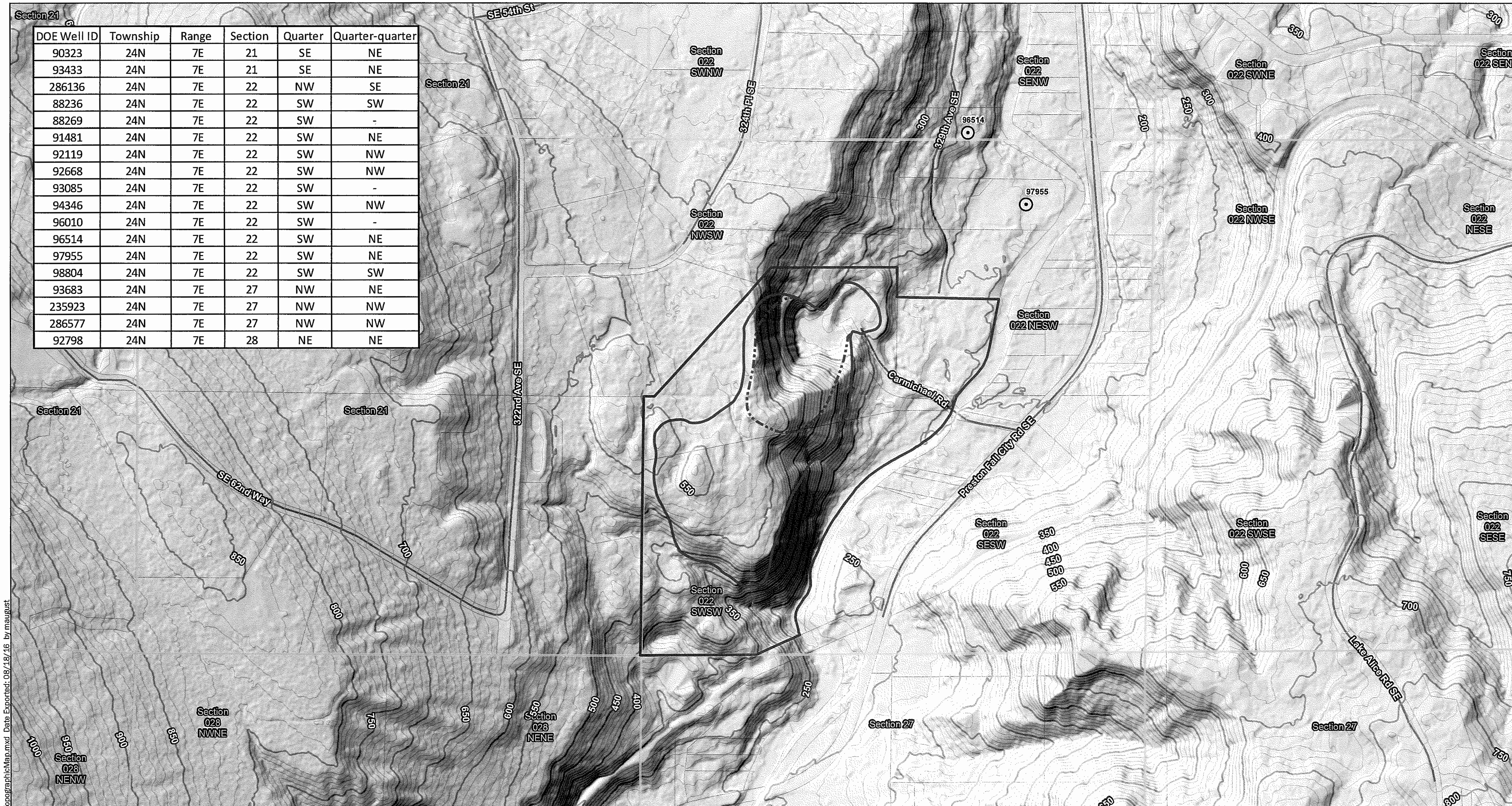
Landslide Hazard Area
Erosion Hazard Area
Seismic Hazard Area
Wellhead Protection Area (10 year)
Critical Aquifer Recharge Area 1
Critical Aquifer Recharge Area 2

Environmentally Sensitive Areas

Raging River Quarry
King County, Washington

GeoEngineers

Figure 3



DOE Well ID	Township	Range	Section	Quarter	Quarter-quarter
90323	24N	7E	21	SE	NE
93433	24N	7E	21	SE	NE
286136	24N	7E	22	NW	SE
88236	24N	7E	22	SW	SW
88269	24N	7E	22	SW	-
91481	24N	7E	22	SW	NE
92119	24N	7E	22	SW	NW
92668	24N	7E	22	SW	NW
93085	24N	7E	22	SW	-
94346	24N	7E	22	SW	NW
96010	24N	7E	22	SW	-
96514	24N	7E	22	SW	NE
97955	24N	7E	22	SW	NE
98804	24N	7E	22	SW	SW
93683	24N	7E	27	NW	NE
235923	24N	7E	27	NW	NW
286577	24N	7E	27	NW	NW
92798	24N	7E	28	NE	NE

Notes:
1. The locations of all features shown are approximate.
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Data Source: King County GIS, ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- Well Locations from Provided Coordinates
- Quarry Property
- Existing Quarry Limits
- Proposed Quarry Expansion Limits

N W E S

500 0 500
Feet

Topographic Map

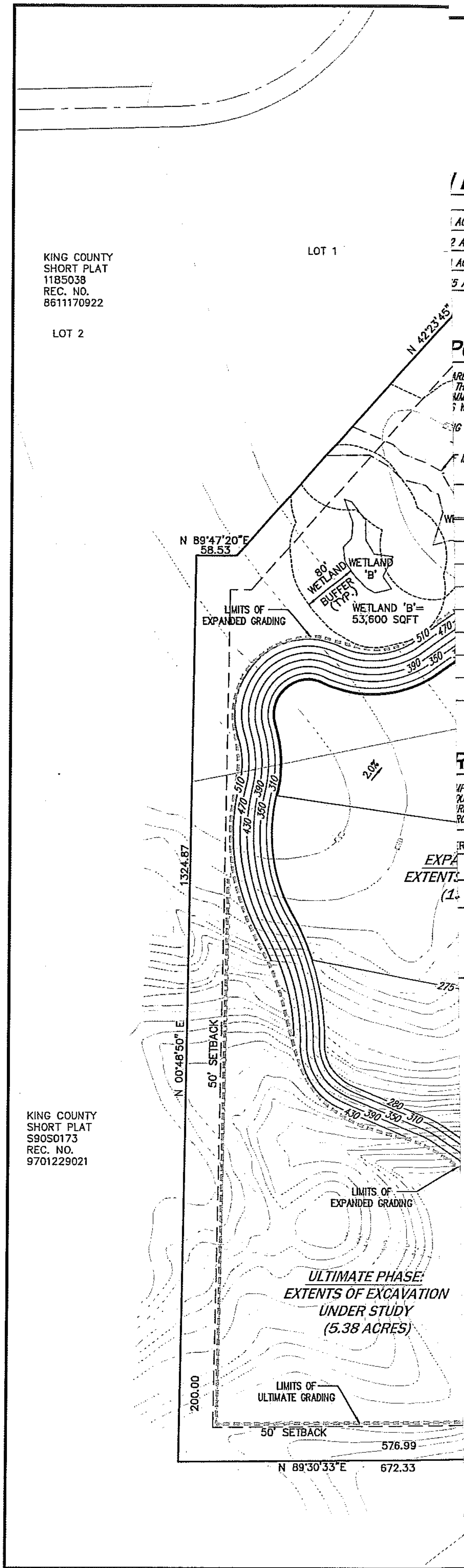
Raging River Quarry
King County, Washington

GeoEngineers

Figure 4

P:\22\22534001\GIS\MXD\2253400100_F04_TopographicMap.mxd Date Exported: 08/18/16 by maugust

Attachment A
Excavation Plan



LIMITS

ACRES	1,240,700 CY
2 ACRES	4,092,500 CY
ACRES	TO BE DETERMINED
5 ACRES	TO BE DETERMINED

PONDS- SIZING CALCULATIONS

AREA IS APPROXIMATELY 7.25 ACRES AND IS TRIBUTARY TO A SERIES OF INFILTRATION THAT DISPERSES APPROXIMATELY 200 FEET FROM THE RIVER'S EDGE. THE MMODATE 7.25 ACRES OF AN OPEN MINING AREA. LIMITS OF THE OPEN MINING AREA S WITHOUT ONE OF THE FOLLOWING:

IG AREAS ON A 1:1 RATIO (ACRE:ACRE) TO LIMIT THE OPEN MINING AREA TO A TOTAL

F INFILTRATION PONDS TO ACCOMMODATE THE INCREASE IN OPEN MINING AREA.

IE-OUT	SURFACE AREA (SQFT)	DEPTH (FT)	VOLUME (CFT)
264.72	1,000	4.2	5,000
263.15	1,600	4.2	8,000
224.52	1,400	2.3	3,500
212.88	3,060	4.1	13,770
212.00	2,475	3.0	8,663
211.80	2,275	4.2	11,375
210.60	2,750	3.2	9,625
209.22	360	2.8	1,080
TOTAL:	14,920	TOTAL:	61,013

RAGING

IPLEMENTED IN A MANNER SUCH THAT THE ECOLOGICAL STRUCTURE AND FUNCTION QUIVALENT TO THE STRUCTURE AND FUNCTION BEFORE AVERAGING. THE TOTAL AREA REA IS CONTIGUOUS, AND AVERAGING DOES NOT REDUCE THE REQUIRED BUFFER RCENT.

R	EX. AREA	PRO. BUFFER	PRO. AREA
	64,050 SQFT.	VARIES, 40' MIN.	64,050 SQFT.
	47,870 SQFT.	80' MIN.	47,870 SQFT.

PROPERTY LINE
DEVELOPMENT SETBACK
WETLAND AREA (FLAGGED)
WETLAND BUFFER
EXISTING CONTOUR
INITIAL PHASE CONTOUR
ULTIMATE PHASE CONTOUR
PHASING LIMITS (INITIAL AND ULTIMATE)
INFILTRATION POND
CULVERT
ROCKERY RETAINING WALL
PAVED ASPHALT
QUARRY OFFICE
QUARRY SCALE
RECLAIMED AREA (~1.05 ACRES)

SCALE: 1" = 100'

0 50 100 200

NO. | REVISIONS | DATE

STACIA L. BLOOM — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

CORE DESIGN
14711 NE 29th Place Suite 101
Bellevue, Washington 98007
425.885.7877 Fax 425.885.7963
ENGINEERING · PLANNING · SURVEYING

EXCAVATION PLAN
RAGING RIVER QUARRY

JOHN PRIEBE ET AL.

3132 NE HARRISON ST
ISSAQUAH, WA 98029

DATE	JULY 2015
DESIGNED	SLB
DRAWN	SLB
APPROVED	SLB

KEVIN J. VANDERZANDEN
PROJECT MANAGER

SHEET C3.01 OF 5

PROJECT NUMBER 10001

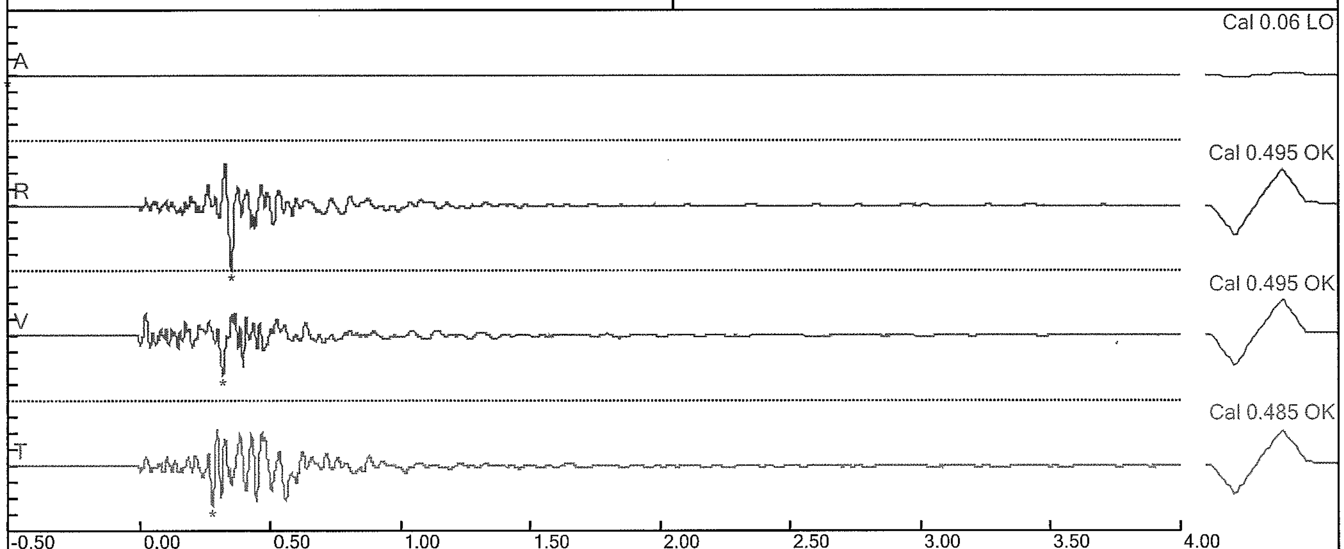
J:\2010\10001\18\ENGINEERING\FINAL\SHEETS\10001 C301.DWG 8/7/2015 4:18 PM

Attachment B
Blast Reports

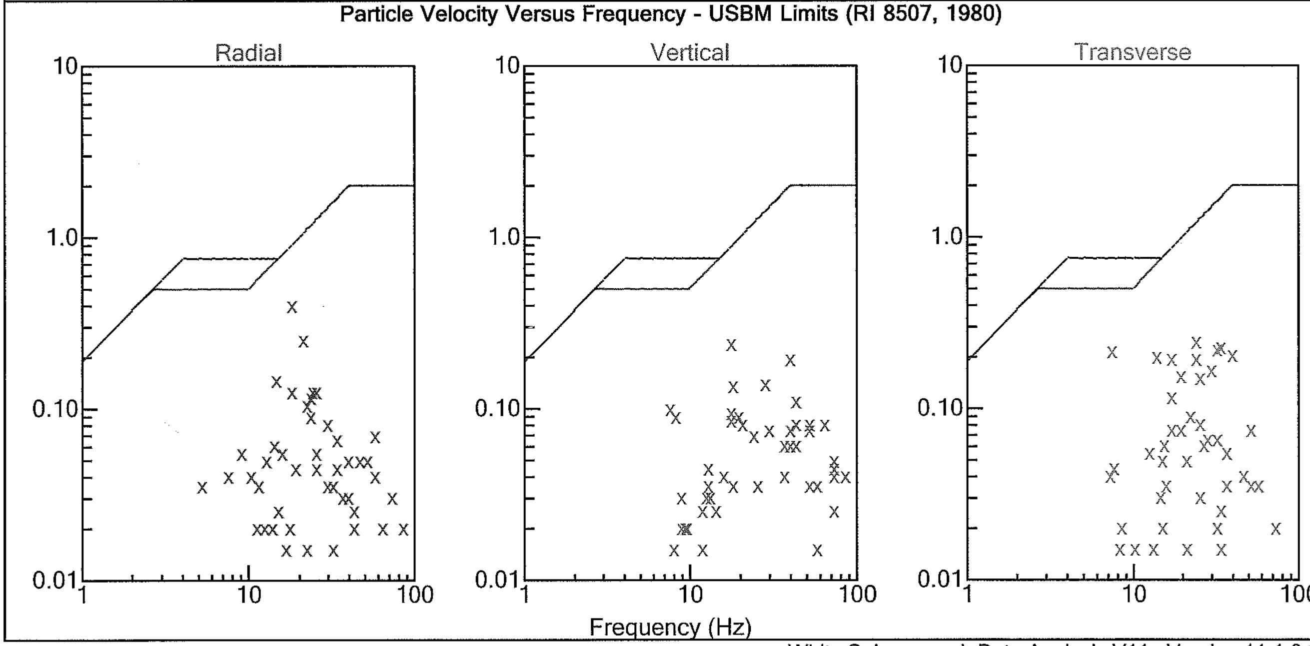
AGGREGATE RESOURCE INDUSTRIES, INC.

Aggregate Resource Drilling, LLC	File: 36152016030815O2152.dtb
Job 6032.01, Raging River Quarry	Number: 152
GPS of Seismograph: N47.540055°, W-121.894886°	Date and Time: 3/8/2016 3:02:00 PM
GPS of Shot: N47.547637°, W-121.904960°	SN: 3615
Hole Diameter: 3.5 in. / Hole Depth 59 - 64 ft	Seismic Trigger: 0.0400 in/sec
Hole Count: 28 / Spacing 10 x 10 ft	Air Trigger: 142 dBL
Stemming: 10 - 15 ft / Water Depth: 0 - 20 ft	Sample Rate: 1024
Weather: 45°, Wind 7 mph E, Overcast	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 0.5 Second
Seismograph Set up: Gilbert Salgado	Seismic Range: 2.50 in/s
	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 5.70

Peaks and Frequencies	Graph Information
PPV Maximum: 0.395 in/sec (0.3516 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: <100 dBL	Acoustic Scale: 126 dBL
Radial: 0.395 in/sec @ 18.2 Hz (0.3516 sec)	Seismic Scale: 0.400 in/sec (0.100 in/sec/div)
Vertical: 0.240 in/sec @ 17.6 Hz (0.3184 sec)	Time Intervals: 0.50 sec
Transverse: 0.245 in/sec @ 24.3 Hz (0.2773 sec)	
Last Calibration Date: 4/7/2015	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)



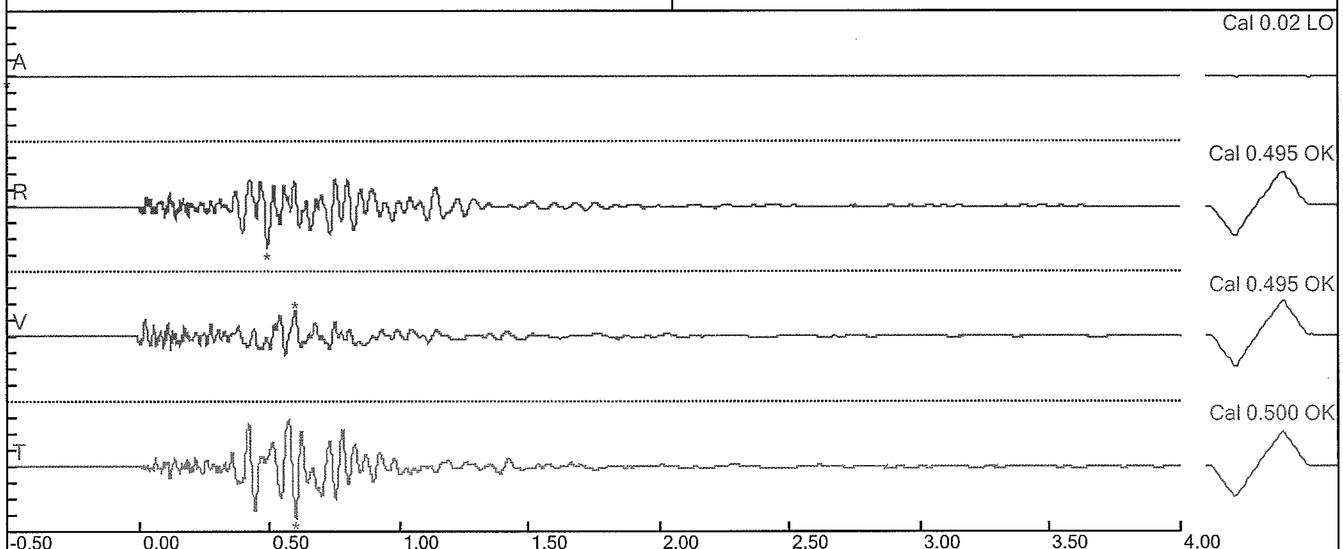
White Seismograph Data Analysis V11 - Version 11.1.0.90

AGGREGATE RESOURCE INDUSTRIES, INC.

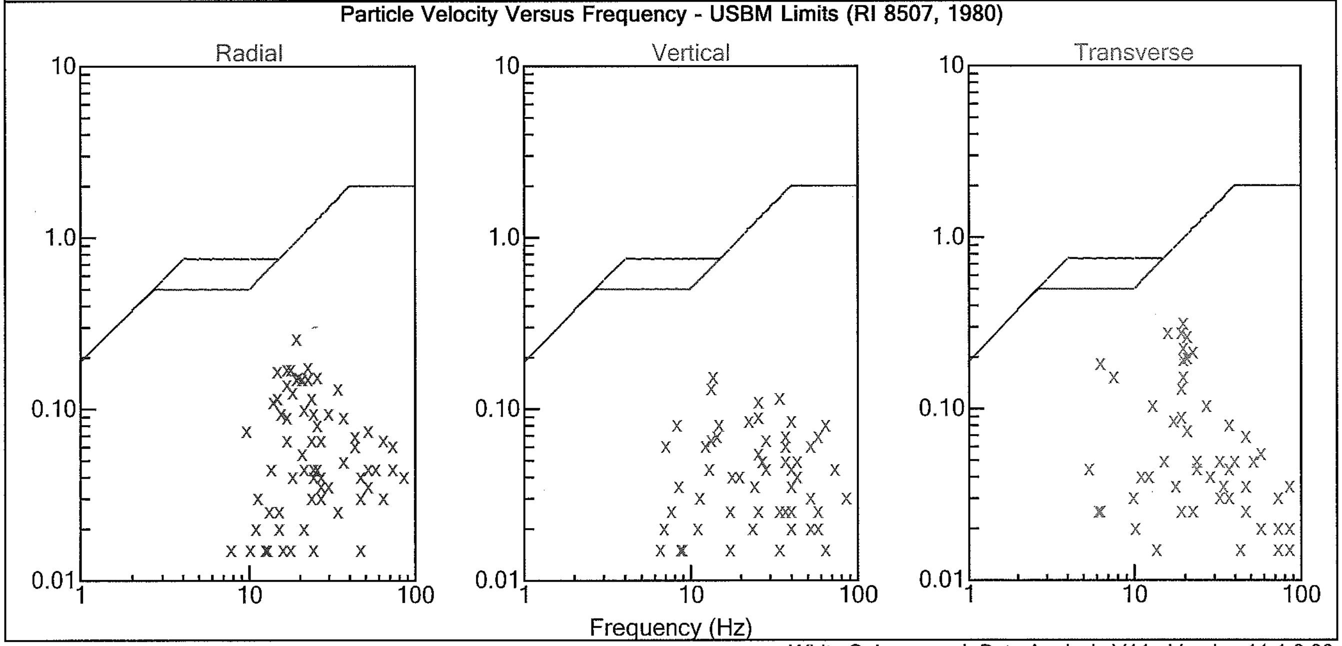
Aggregate Resource Drilling, LLC
Job 6032.01, Raging River Quarry
GPS of Seismograph: N47.546642°, W-121.901185°
GPS of Shot: N47.547637°, W-121.904960°
Hole Diameter: 3.5 in. / Hole Depth 59 - 64 ft
Hole Count: 28 / Spacing 10 x 10 ft
Stemming: 10 - 15 ft / Water Depth: 0 - 20 ft
Weather: 45°, Wind 7 mph E, Overcast
BIC: Eric Jennings
Seismograph Set up: Gilbert Salgado

File: 36172016030815O5188.dtb
Number: 188
Date and Time: 3/8/2016 3:05:00 PM
SN: 3617
Seismic Trigger: 0.0400 in/sec
Air Trigger: 142 dBL
Sample Rate: 1024
Duration: 4 Seconds
Pre-Trigger: 0.5 Second
Seismic Range: 2.50 in/s
Acoustic Range: 142 dBL
Gain: 2.0x
Voltage: 6.20

Peaks and Frequencies	Graph Information
PPV Maximum: 0.315 in/sec (0.5977 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: <100 dBL	Acoustic Scale: 126 dBL
Radial: 0.260 in/sec @ 18.9 Hz (0.4912 sec)	Seismic Scale: 0.400 in/sec (0.100 in/sec/div)
Vertical: 0.155 in/sec @ 13.4 Hz (0.5957 sec)	Time Intervals: 0.50 sec
Transverse: 0.315 in/sec @ 19.6 Hz (0.5977 sec)	
Last Calibration Date: 5/14/2015	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

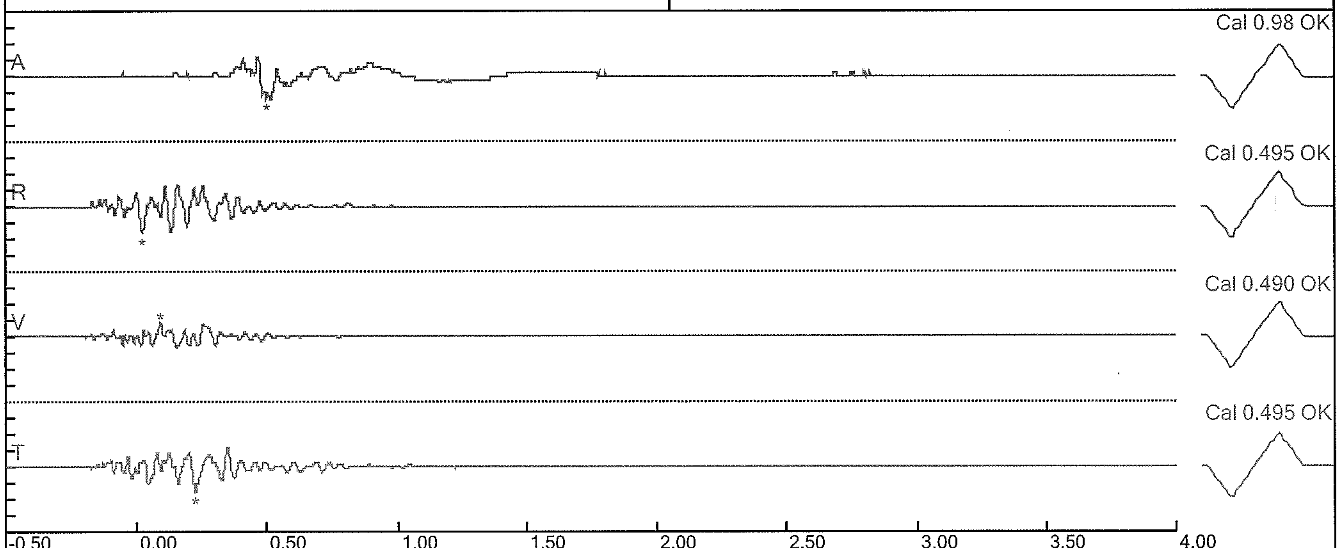


White Seismograph Data Analysis V11 - Version 11.1.0.90

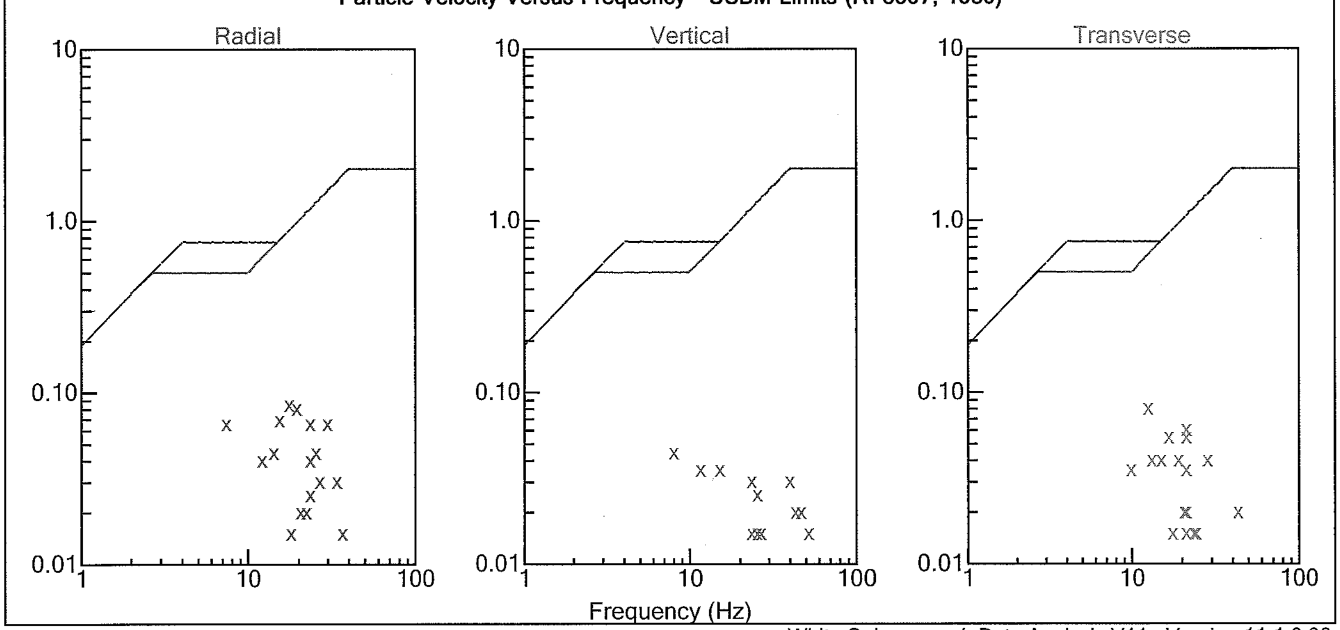
AGGREGATE RESOURCE INDUSTRIES, INC.

Aggregate Resource Drilling, LLC	File: 36182016032415O2208.dtb
Job 6032.02, Raging River Quarry	Number: 208
32415 SE 58th St	Date and Time: 3/24/2016 3:02:00 PM
GPS of Seismograph: N47.548710°, W-121.907661°	SN: 3618
GPS of Shot: N47.547166°, W-121.90555	Seismic Trigger: 0.0400 in/sec
Hole Diameter: 3.5 in. / Hole Depth 20-40 ft	Air Trigger: 142 dBL
Hole Count: 60 / Spacing 10 x 10 ft	Sample Rate: 1024
Stemming: 10 - 15 ft / Water Depth: 0 - 40 ft	Duration: 4 Seconds
Weather: 45°, Wind 9.2 mph S, Overcast	Pre-Trigger: 0.5 Second
BIC: Eric Jennings	Seismic Range: 2.50 in/s
Seismograph Set up: Brandon Miller	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 6.20

Peaks and Frequencies	Graph Information
PPV Maximum: 0.0850 in/sec (0.0234 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 117 dBL @ 9.1 Hz (0.5020 sec)	Acoustic Scale: 126 dBL
Radial: 0.0850 in/sec @ 17.6 Hz (0.0234 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.0450 in/sec @ 8.0 Hz (0.0918 sec)	Time Intervals: 0.50 sec
Transverse: 0.0800 in/sec @ 12.4 Hz (0.2246 sec)	
Last Calibration Date: 1/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)



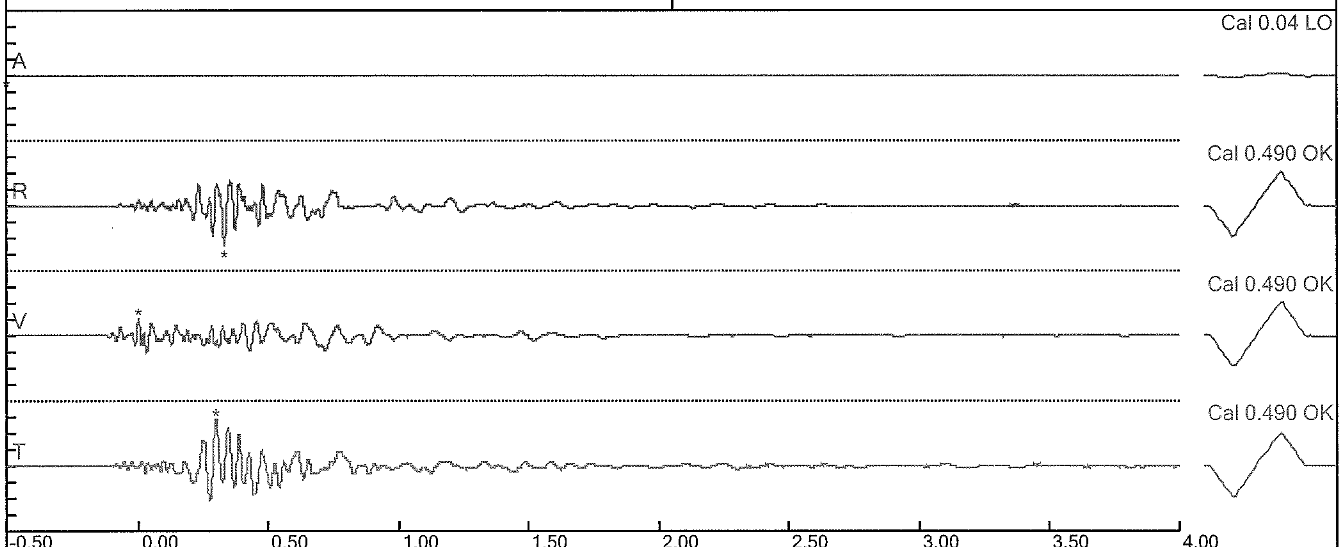
White Seismograph Data Analysis V11 - Version 11.1.0.90

AGGREGATE RESOURCE INDUSTRIES, INC.

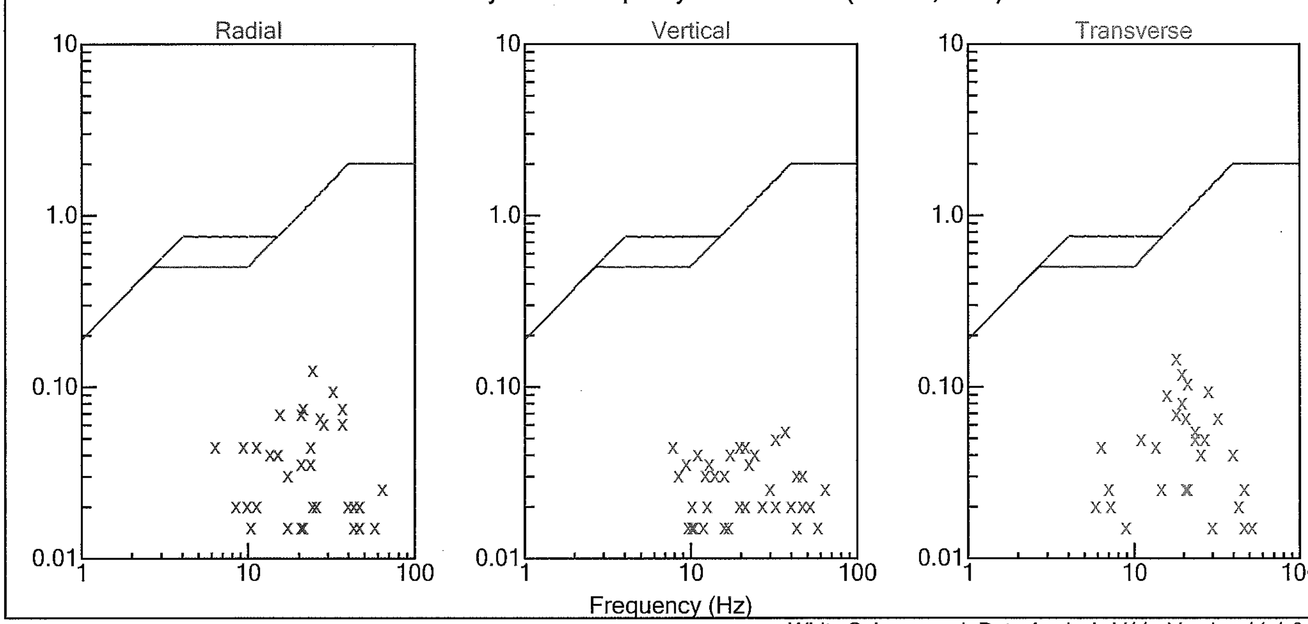
Aggregate Resource Drilling, LLC
Job 6032.02, Raging River Quarry
5730 329th Ave SE
GPS of Seismograph: N47.548549°, W-121.902828°
GPS of Shot: N47.547166°, W-121.90555°
Hole Diameter: 3.5 in. / Hole Depth 20-40 ft
Hole Count: 60 / Spacing 10 x 10 ft
Stemming: 10 - 15 ft / Water Depth: 0 - 40 ft
Weather: 45°, Wind 9.2 mph S, Overcast
BIC: Eric Jennings
Seismograph Set up: Brandon Miller

File: 3617201603241504207.dtb
Number: 207
Date and Time: 3/24/2016 3:04:00 PM
SN: 3617
Seismic Trigger: 0.0400 in/sec
Air Trigger: 142 dBL
Sample Rate: 1024
Duration: 4 Seconds
Pre-Trigger: 0.5 Second
Seismic Range: 2.50 in/s
Acoustic Range: 142 dBL
Gain: 2.0x
Voltage: 6.20

Peaks and Frequencies	Graph Information
PPV Maximum: 0.145 in/sec (0.2979 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: <100 dBL	Acoustic Scale: 126 dBL
Radial: 0.125 in/sec @ 24.3 Hz (0.3301 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.0550 in/sec @ 36.5 Hz (0.0020 sec)	Time Intervals: 0.50 sec
Transverse: 0.145 in/sec @ 18.2 Hz (0.2979 sec)	
Last Calibration Date: 5/14/2015	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)



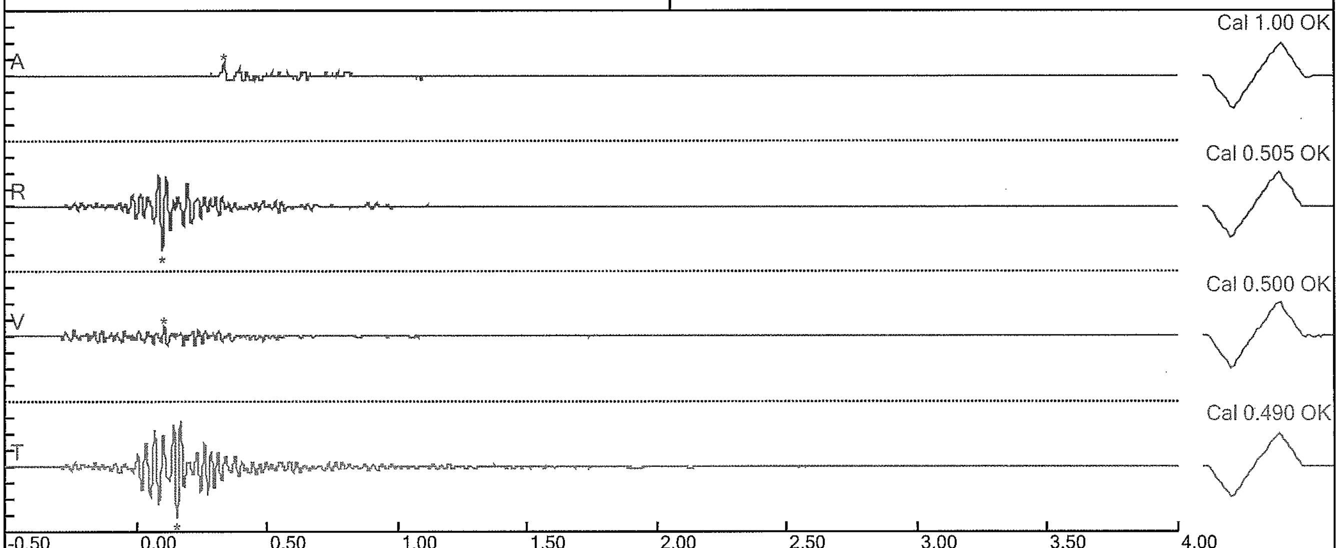
White Seismograph Data Analysis V11 - Version 11.1.0.90

AGGREGATE RESOURCE INDUSTRIES, INC.

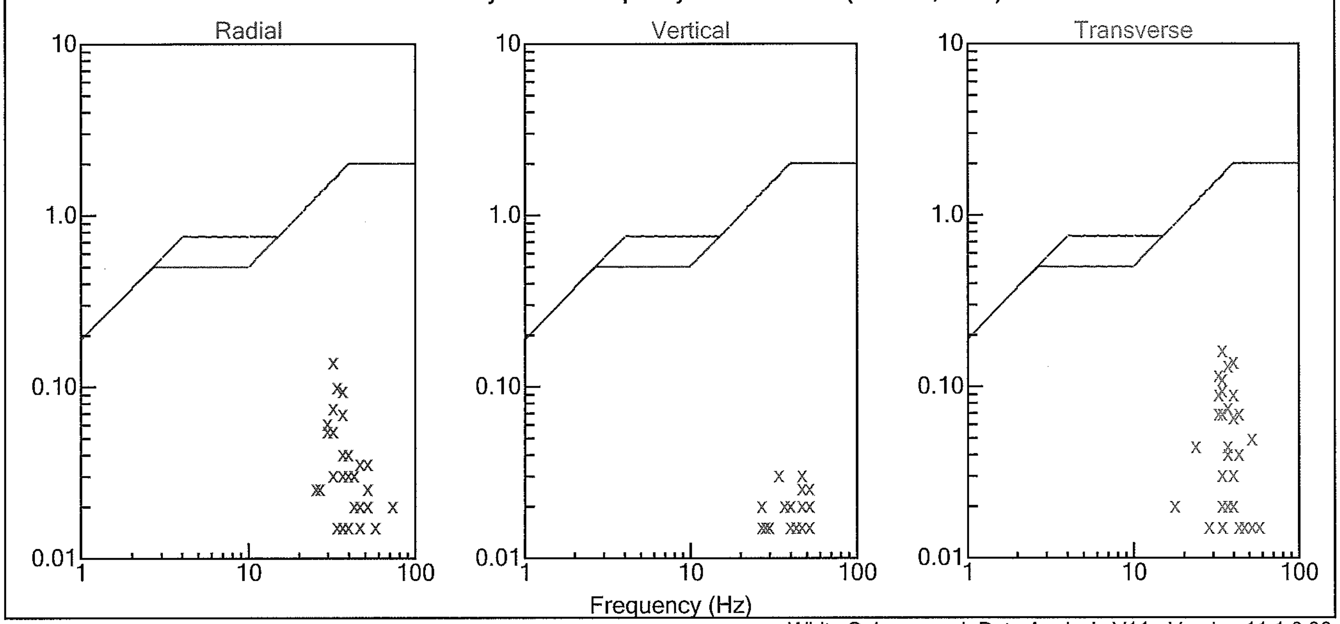
Aggregate Resource Drilling, LLC
Job 6032.04, Raging River Quarry
Garden Fence about 100 ft away
GPS of Seismograph: N47.548537°, W-121.902957°
GPS of Shot: N47.547166°, W-121.90555°
Hole Diameter: 3.5 in. / Hole Depth 8 - 19 ft
Hole Count: 33 / Spacing 10 x 10 ft
Stemming: 10 - 15 ft / Water Depth: 0 - 3 ft
Weather: 45°, Wind: 5 mph NNW, Overcast
BIC: Eric Jennings
Seismograph Set up: Benjamin Cartledge

File: 3615201605231516191.dtb
Number: 191
Date and Time: 5/23/2016 3:16:00 PM
SN: 3615
Seismic Trigger: 0.0400 in/sec
Air Trigger: 142 dBL
Sample Rate: 1024
Duration: 4 Seconds
Pre-Trigger: 0.5 Second
Seismic Range: 2.50 in/s
Acoustic Range: 142 dBL
Gain: 2.0x
Voltage: 6.20

Peaks and Frequencies	Graph Information
PPV Maximum: 0.160 in/sec (0.1553 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 112 dBL @ 42.6 Hz (0.3359 sec)	Acoustic Scale: 126 dBL
Radial: 0.140 in/sec @ 32.0 Hz (0.0996 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.0300 in/sec @ 46.5 Hz (0.1055 sec)	Time Intervals: 0.50 sec
Transverse: 0.160 in/sec @ 34.1 Hz (0.1553 sec)	
Last Calibration Date: 4/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)



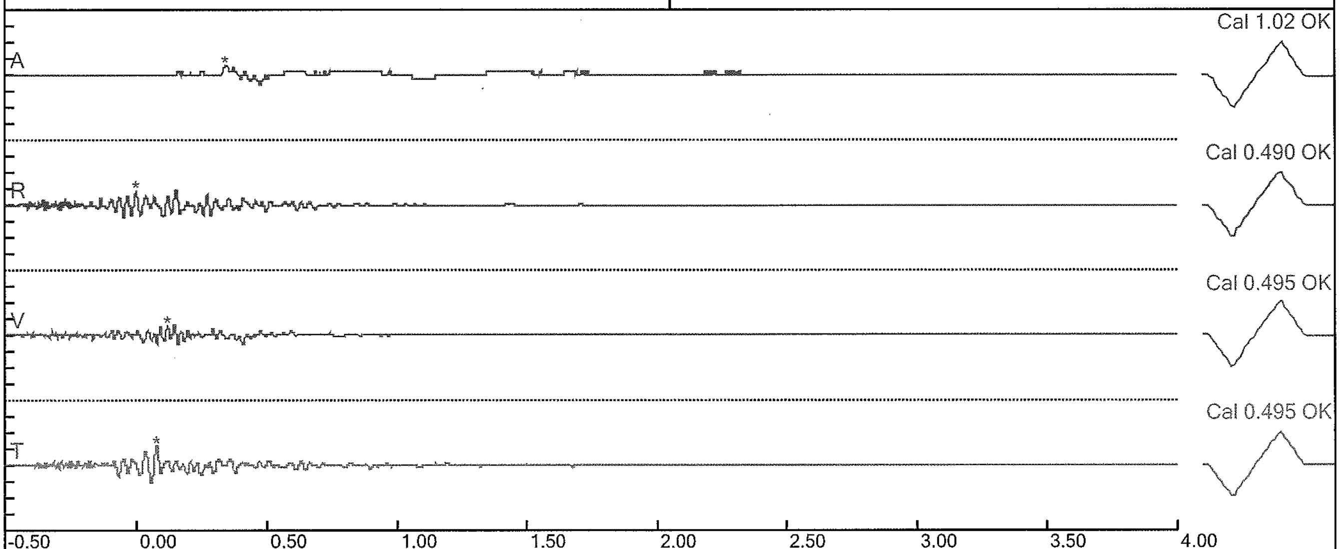
White Seismograph Data Analysis V11 - Version 11.1.0.96

AGGREGATE RESOURCE INDUSTRIES, INC.

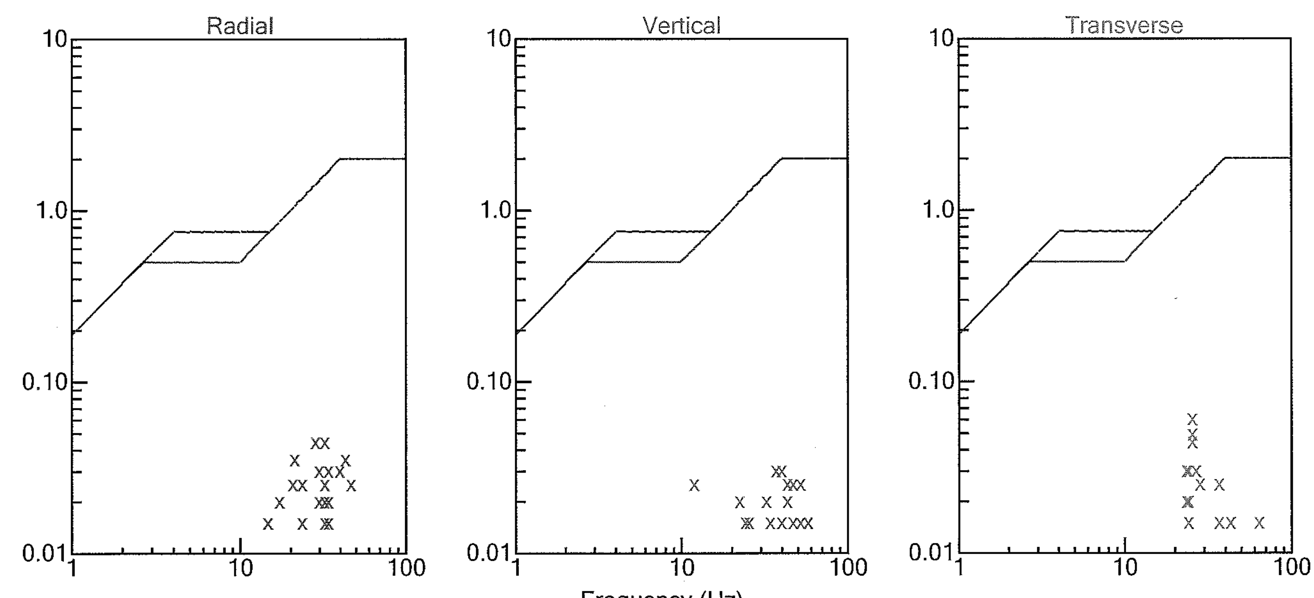
Job: 6032.04 Raging River Quarry
Entrance, Left Side
GPS of Seismograph: N47.546443°, W-121.901314°
GPS of Shot: N47.547166°, W-121.905550°
Hole Diameter: 3.5 in. / Hole Depth: 7 - 20 ft
Hole Count: 38 @ Spacing 09x09 ft.
Stemming: 15 ft. / Water Depth: 3 ft.
Weather: 45°, wind 5 mph NNW, Overcast
BIC: Eric Jennings
Seismograph Set Up: Benjamin Cartledge & Juan Salgado

File: 3618201605231510223.dtb
Number: 223
Date and Time: 5/23/2016 3:10:00 PM
SN: 3618
Seismic Trigger: 0.0400 in/sec
Air Trigger: 142 dBL
Sample Rate: 1024
Duration: 4 Seconds
Pre-Trigger: 0.5 Second
Seismic Range: 2.50 in/s
Acoustic Range: 142 dBL
Gain: 2.0x
Voltage: 6.10

Peaks and Frequencies	Graph Information
PPV Maximum: 0.0600 in/sec (0.0781 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 110 dBL @ 9.4 Hz (0.3379 sec)	Acoustic Scale: 126 dBL
Radial: 0.0450 in/sec @ 32.0 Hz (0.0010 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.0300 in/sec @ 39.3 Hz (0.1191 sec)	Time Intervals: 0.50 sec
Transverse: 0.0600 in/sec @ 25.6 Hz (0.0781 sec)	
Last Calibration Date: 1/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

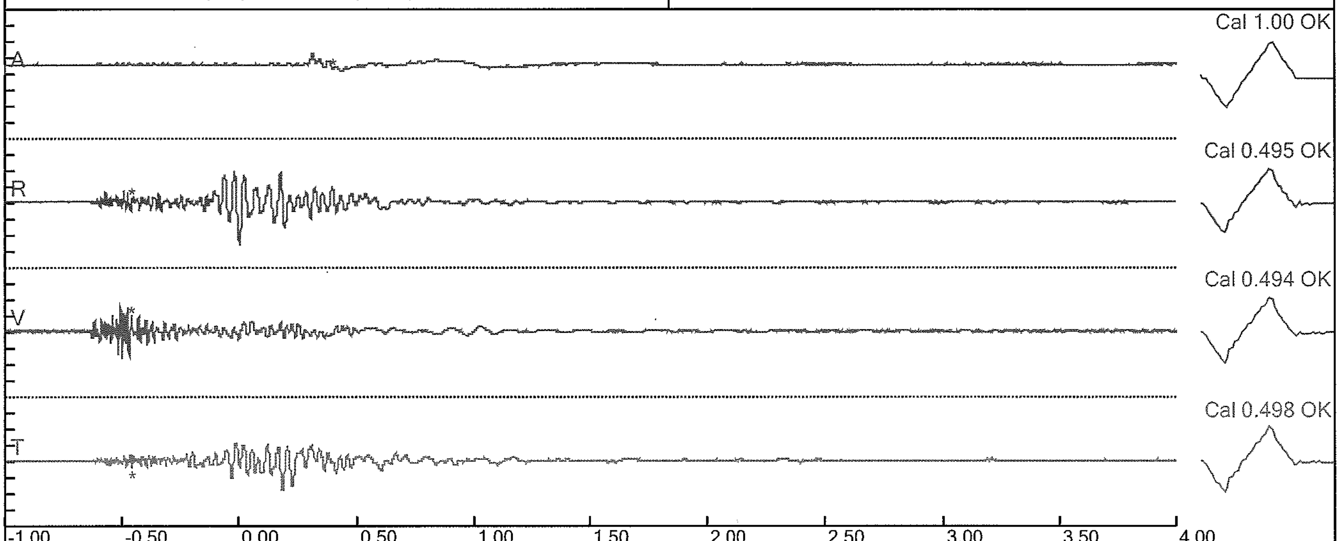


White Seismograph Data Analysis V11 - Version 11.1.0.96

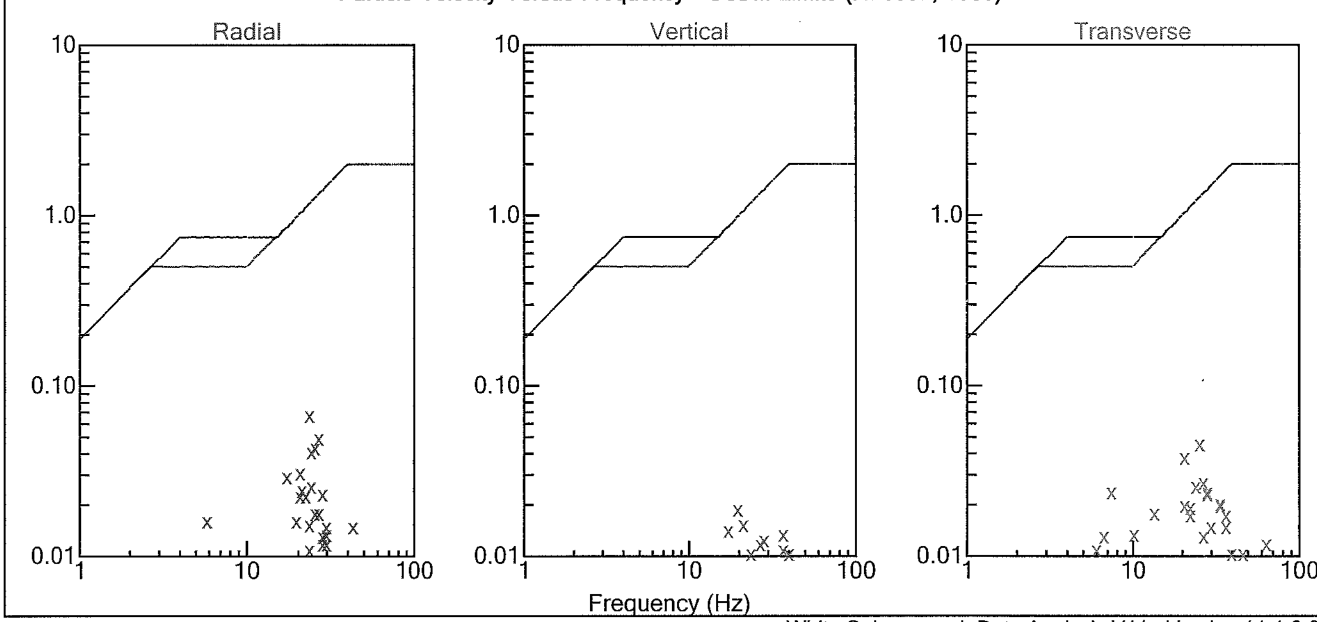
AGGREGATE RESOURCE INDUSTRIES, INC.

Job: 6032.04 Raging River Quarry	File: 707720160523151317082.evt
Green cable box behind mail boxes	Number: 0082
GPS of Seismograph: N47.547184°, -121.900403°	Date and Time: 5/23/2016 3:13:17 PM
GPS of Shot: N47.547166°, W-121.905550°	SN: 7077
Hole Diameter: 3.5 in. / Hole Depth: 7 - 20 ft	Seismic Trigger: 0.0500 in/sec
Hole Count: 38 @ Spacing 09x09 ft.	Air Trigger: 130.0 dBL
Stemming: 15 ft. / Water Depth: 3 ft.	Sample Rate: 1024
Weather: 45°, wind 5 mph NNW, Overcast	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 1.0 Second
Seismograph Set Up: Benjamin Cartledge & Juan Salgado	Seismic Gain: 10.2in/sec
	Acoustic Gain: 148.2 dBL
	Voltage: 6.27

Peaks and Frequencies	Graph Information
PPV Maximum: 0.0659 in/sec (-0.4551 sec)	Duration: -1.000 s To: 4.000 s
Acoustic: 115.9 dBL @ 0.0 Hz (0.3975 sec)	Acoustic Scale: 126.0 dBL
Radial: 0.0659 in/sec @ 22.3 Hz (-0.4551 sec)	Seismic Scale: 0.100 in/sec (0.0250 in/sec/div)
Vertical: 0.0184 in/sec @ 19.0 Hz (-0.4580 sec)	Time Intervals: 0.50 sec
Transverse: 0.0447 in/sec @ 24.4 Hz (-0.4551 sec)	
Seis Calibration Date (SN): 6/8/2015 (7077)	
Air Calibration Date (SN): 6/8/2015 (7077)	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

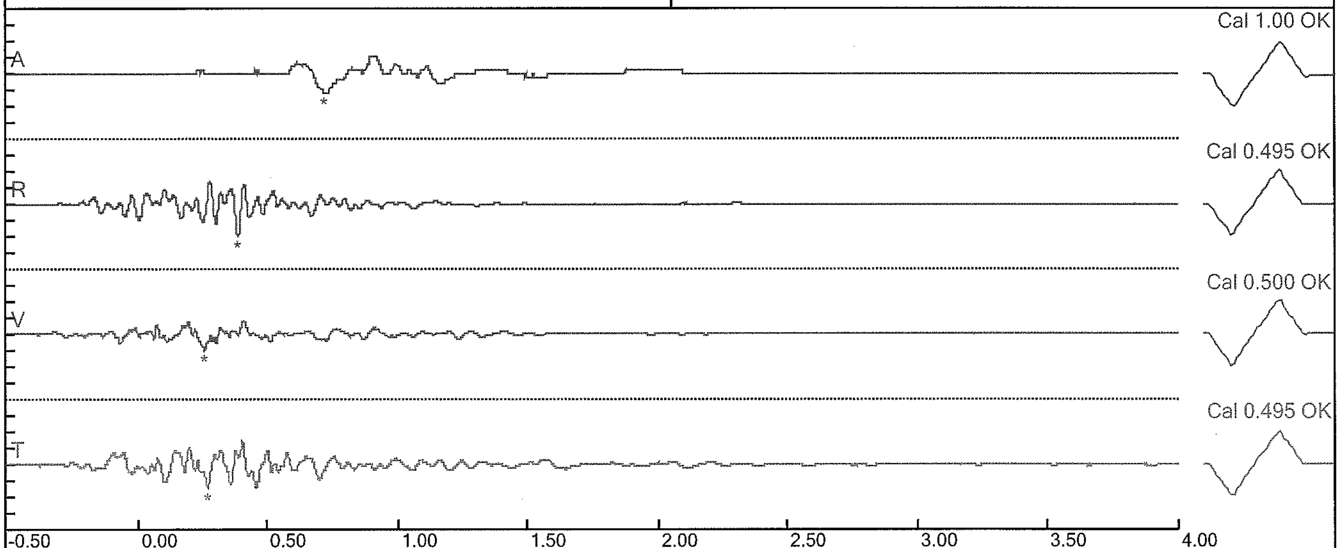


White Seismograph Data Analysis V11 - Version 11.1.0.96

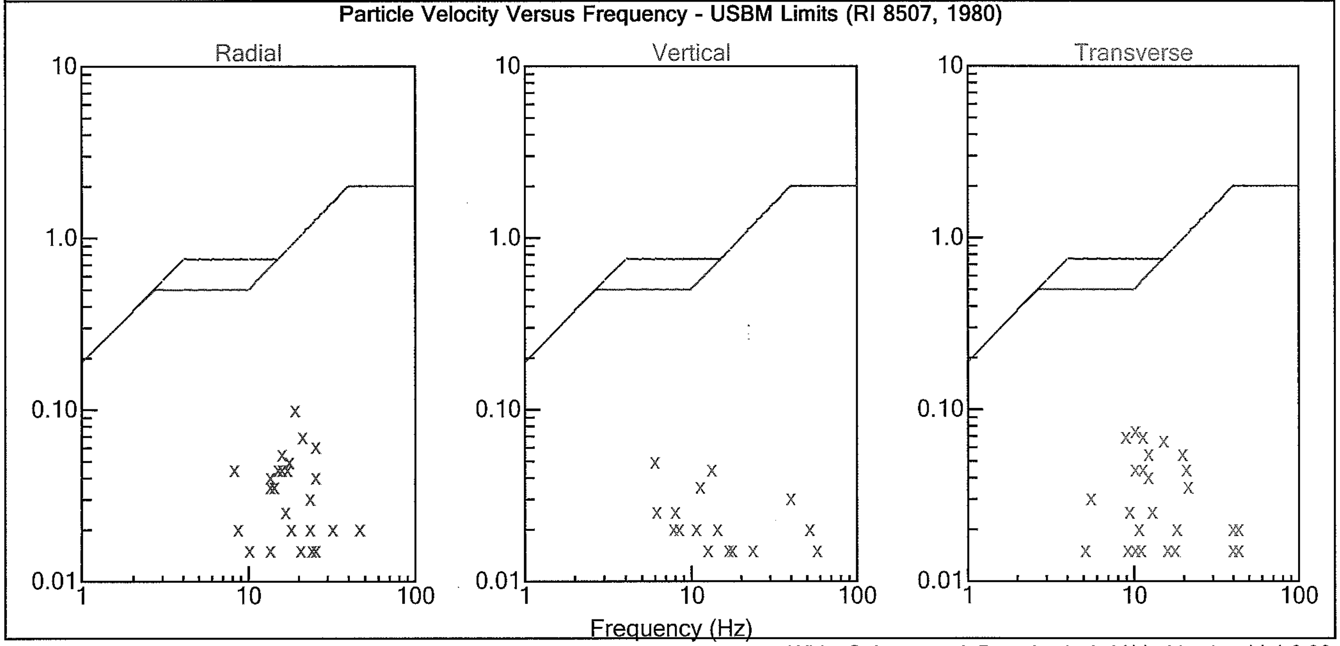
AGGREGATE RESOURCE INDUSTRIES, INC.

Job: 6032.05 Raging River Quarry	File: 36152016062115081 93.dtb
40' NE of entry gate 5610 324th PL	Number: 193
GPS of Seismograph: N47.550702°, W-121.906857°	Date and Time: 6/21/2016 3:08:00 PM
GPS of Shot: N47.547166°, W-121.905550°	SN: 3615
Hole Diameter: 3.5 in. / Hole Depth: 29 - 36 ft	Seismic Trigger: 0.0400 in/sec
Hole Count: 72 @ Spacing 09x09 ft.	Air Trigger: 142 dBL
Stemming: 15 ft. / Water Depth: 3 ft.	Sample Rate: 1024
Weather: 45°, wind 5 mph V, Clear	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 0.5 Second
Seismograph Set Up: Gilbert Salgado	Seismic Range: 2.50 in/s
	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 6.20

Peaks and Frequencies	Graph Information
PPV Maximum: 0.100 in/sec (0.3877 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 116 dBL @ 4.1 Hz (0.7207 sec)	Acoustic Scale: 126 dBL
Radial: 0.100 in/sec @ 18.9 Hz (0.3877 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.0500 in/sec @ 6.0 Hz (0.2578 sec)	Time Intervals: 0.50 sec
Transverse: 0.0750 in/sec @ 10.0 Hz (0.2705 sec)	
Last Calibration Date: 4/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

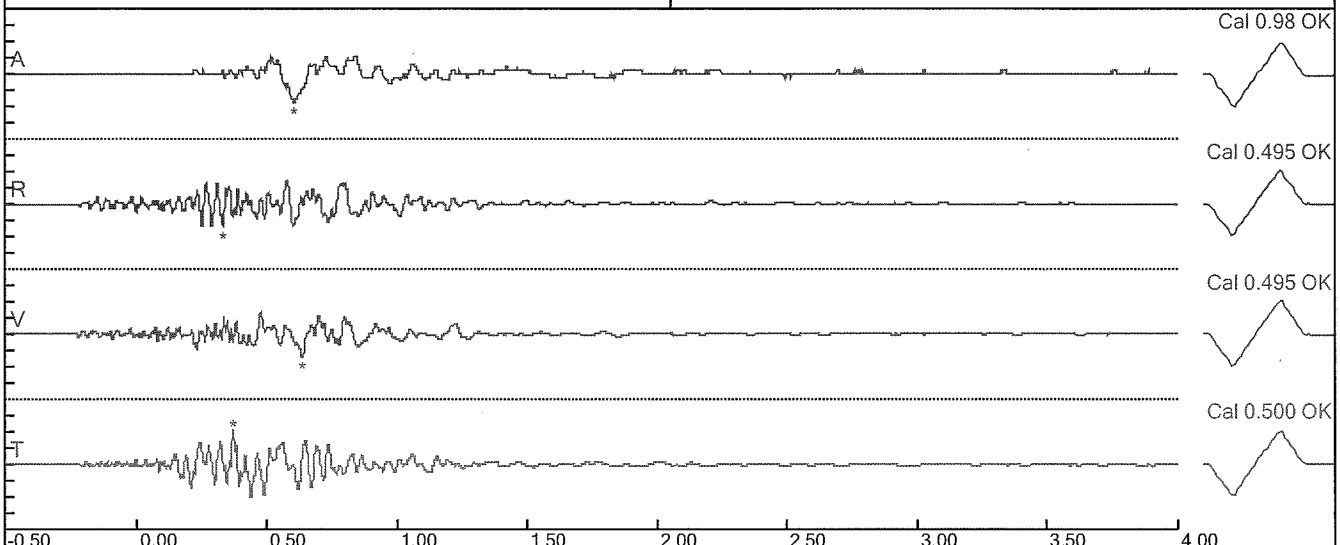


White Seismograph Data Analysis V11 - Version 11.1.0.98

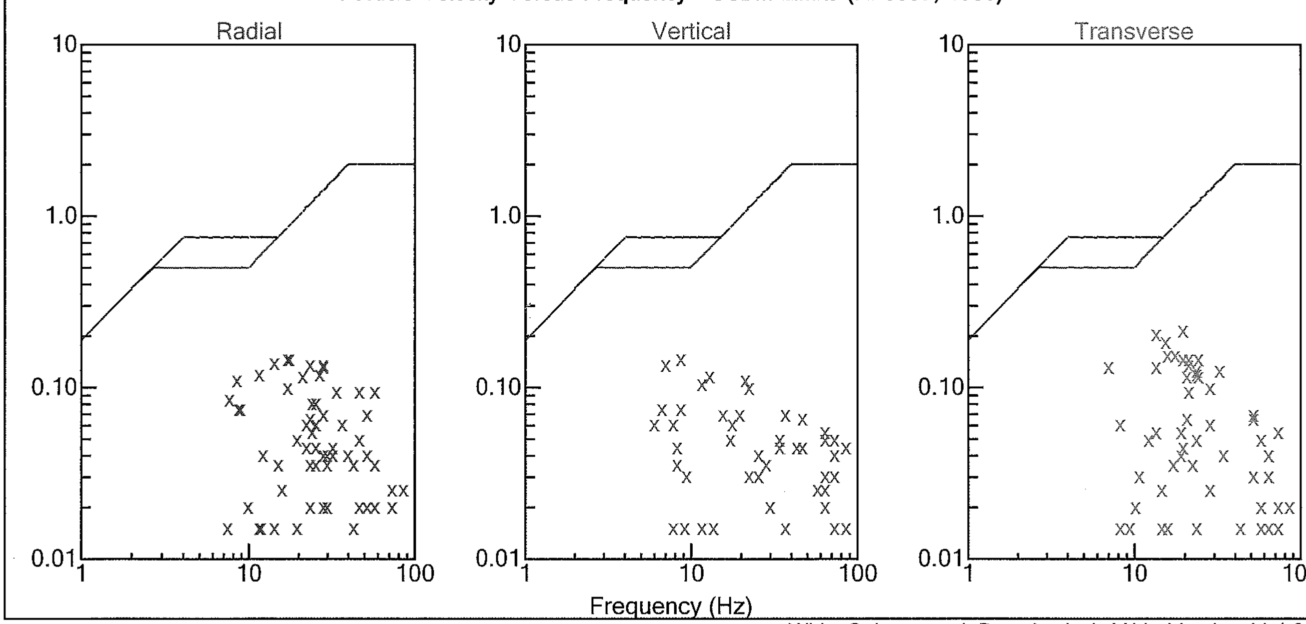
AGGREGATE RESOURCE INDUSTRIES, INC.

Job: 6032.05 Raging River Quarry	File: 3616201606211507074.dtb
entry of quarry, 5' south of sign	Number: 074
GPS of Seismograph: N47.546643°, W-121.901197°	Date and Time: 6/21/2016 3:07:00 PM
GPS of Shot: N47.547166°, W-121.905550°	SN: 3616
Hole Diameter: 3.5 in. / Hole Depth: 29 - 36 ft	Seismic Trigger: 0.0500 in/sec
Hole Count: 72 @ Spacing 09x09 ft.	Air Trigger: 119 dBL
Stemming: 15 ft. / Water Depth: 3 ft.	Sample Rate: 1024
Weather: 45°, wind 5 mph V, Clear	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 0.5 Second
Seismograph Set Up: Gilbert Salgado	Seismic Range: 2.50 in/s
	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 6.00

Peaks and Frequencies	Graph Information
PPV Maximum: 0.215 in/sec (0.3682 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 119 dBL @ 5.1 Hz (0.6035 sec)	Acoustic Scale: 126 dBL
Radial: 0.145 in/sec @ 17.0 Hz (0.3291 sec)	Seismic Scale: 0.400 in/sec (0.100 in/sec/div)
Vertical: 0.145 in/sec @ 8.6 Hz (0.6357 sec)	Time Intervals: 0.50 sec
Transverse: 0.215 in/sec @ 19.6 Hz (0.3682 sec)	
Last Calibration Date: 11/3/2015	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

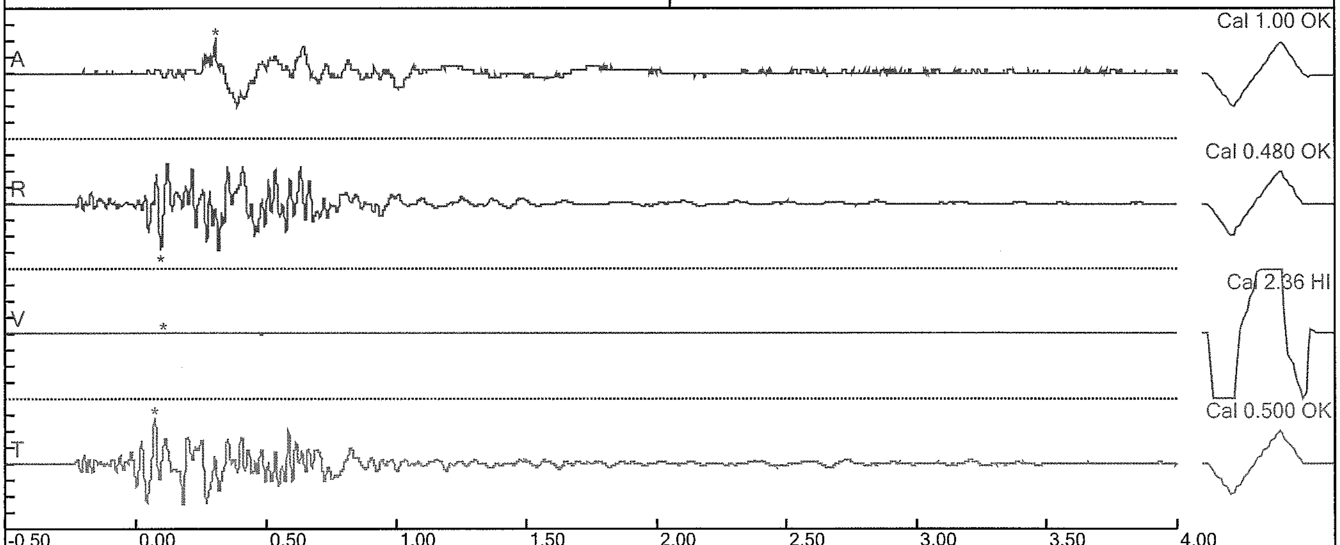


White Seismograph Data Analysis V11 - Version 11.1.0.98

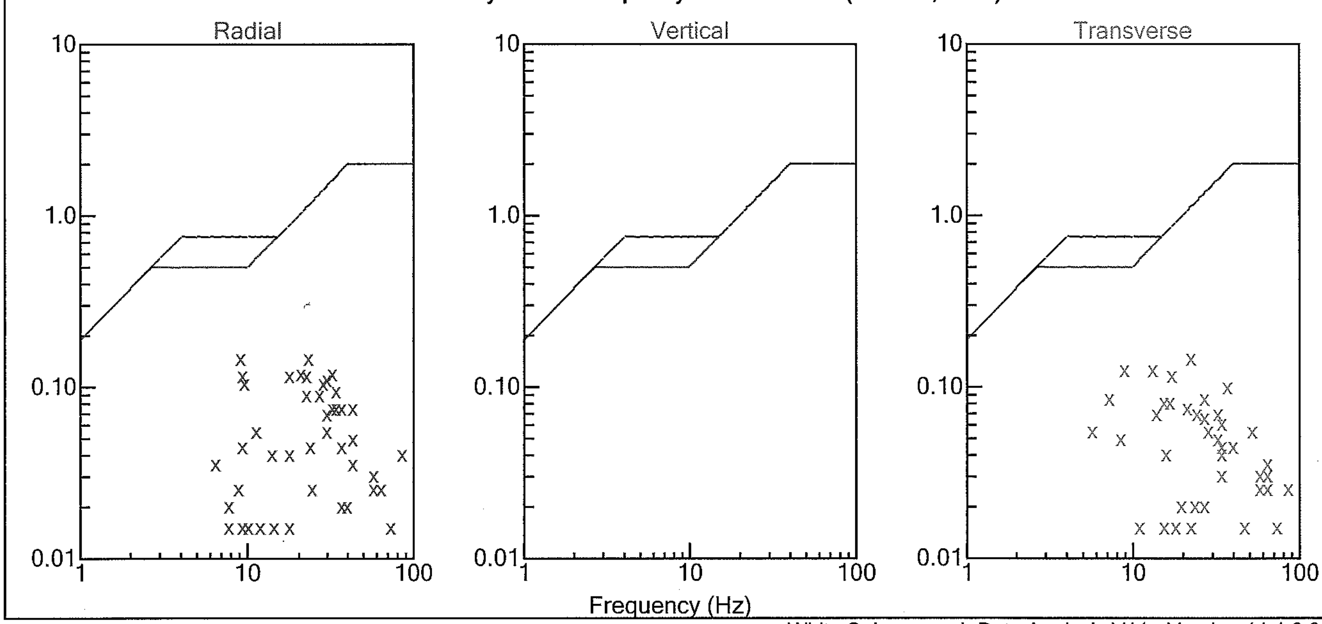
AGGREGATE RESOURCE INDUSTRIES, INC.

Job: 6032.05 Raging River Quarry	File: 3618201606211501226.dtb
end of culdisac 5730 329th AVE SE	Number: 226
GPS of Seismograph: N47.548626°, W-121.902788°	Date and Time: 6/21/2016 3:01:00 PM
GPS of Shot: N47.547166°, W-121.905550°	SN: 3618
Hole Diameter: 3.5 in. / Hole Depth: 29 - 36 ft	Seismic Trigger: 0.0400 in/sec
Hole Count: 72 @ Spacing 09x09 ft.	Air Trigger: 142 dBL
Stemming: 15 ft. / Water Depth: 3 ft.	Sample Rate: 1024
Weather: 45°, wind 5 mph V, Clear	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 0.5 Second
Seismograph Set Up: Gilbert Salgado	Seismic Range: 2.50 in/s
	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 6.00

Peaks and Frequencies	Graph Information
PPV Maximum: 0.145 in/sec (0.0996 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 121 dBL @ 5.9 Hz (0.3076 sec)	Acoustic Scale: 126 dBL
Radial: 0.145 in/sec @ 23.2 Hz (0.0996 sec)	Seismic Scale: 0.200 in/sec (0.0500 in/sec/div)
Vertical: 0.00500 in/sec @ 0.0 Hz (0.1084 sec)	Time Intervals: 0.50 sec
Transverse: 0.145 in/sec @ 22.2 Hz (0.0752 sec)	
Last Calibration Date: 1/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)

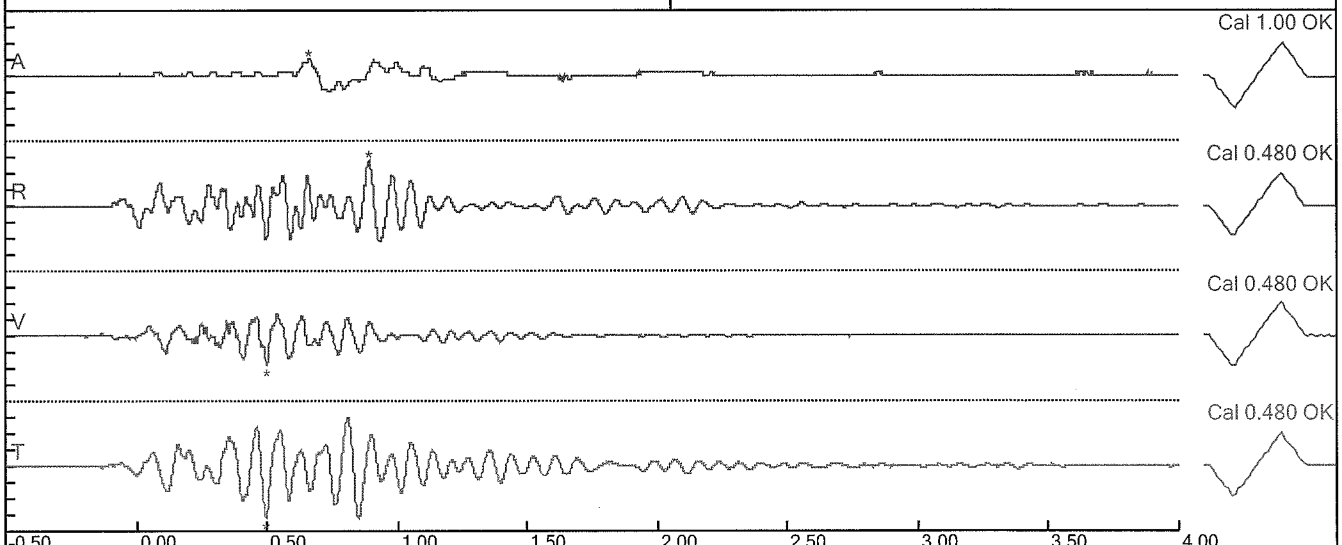


White Seismograph Data Analysis V11 - Version 11.1.0.98

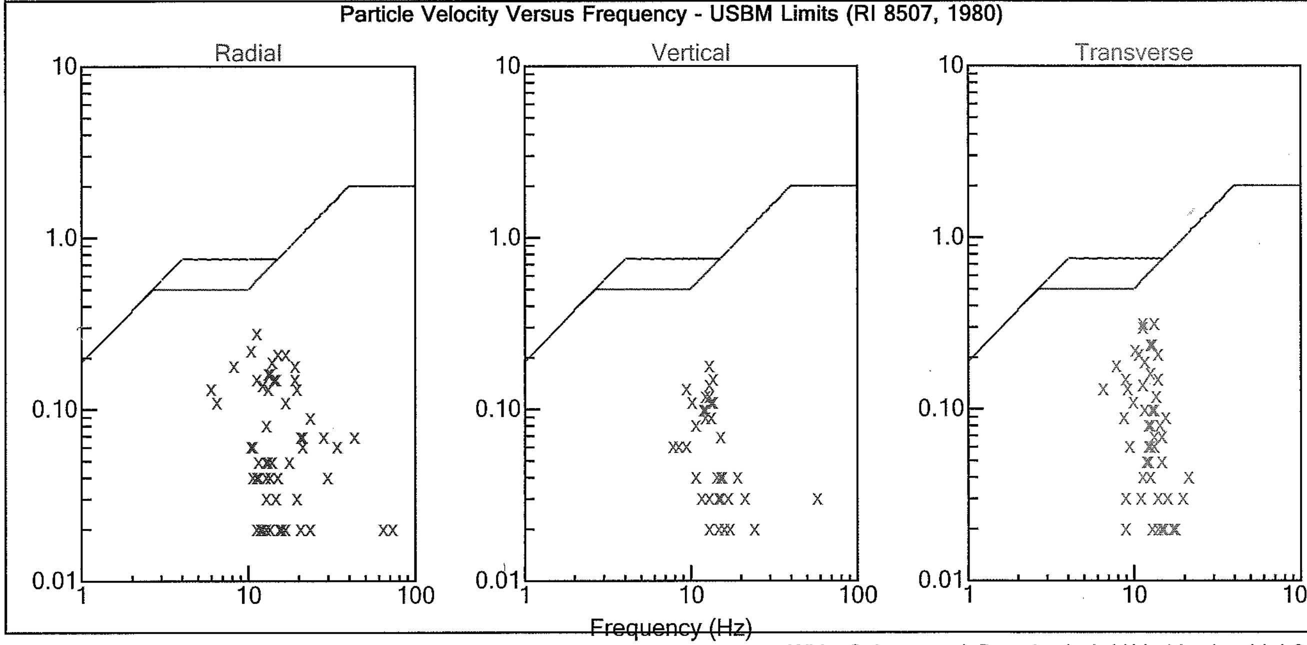
AGGREGATE RESOURCE INDUSTRIES, INC.

Job: 6032.05 Raging River Quarry	File: 3619201606211507142.dtb
Left side of driveway entrance, 5706 324th PL	Number: 142
GPS of Seismograph: N47.549641°, W-121.907482°	Date and Time: 6/21/2016 3:07:00 PM
GPS of Shot: N47.547166°, W-121.905550°	SN: 3619
Hole Diameter: 3.5 in. / Hole Depth: 29 - 36 ft	Seismic Trigger: 0.0900 in/sec
Hole Count: 72 @ Spacing 09x09 ft.	Air Trigger: 142 dBL
Stemming: 15 ft. / Water Depth: 3 ft.	Sample Rate: 1024
Weather: 45°, wind 5 mph V, Clear	Duration: 4 Seconds
BIC: Eric Jennings	Pre-Trigger: 0.5 Second
Seismograph Set Up: Gilbert Salgado	Seismic Range: 5.00 in/s
	Acoustic Range: 142 dBL
	Gain: 2.0x
	Voltage: 6.10

Peaks and Frequencies	Graph Information
PPV Maximum: 0.320 in/sec (0.4961 sec)	Duration: -0.500 s To: 4.000 s
Acoustic: 114 dBL @ 7.1 Hz (0.6602 sec)	Acoustic Scale: 126 dBL
Radial: 0.280 in/sec @ 11.3 Hz (0.8896 sec)	Seismic Scale: 0.400 in/sec (0.100 in/sec/div)
Vertical: 0.180 in/sec @ 12.8 Hz (0.4990 sec)	Time Intervals: 0.50 sec
Transverse: 0.320 in/sec @ 13.1 Hz (0.4961 sec)	
Last Calibration Date: 1/26/2016	



Particle Velocity Versus Frequency - USBM Limits (RI 8507, 1980)



White Seismograph Data Analysis V11 - Version 11.1.0.98

APPENDIX A
Report Limitations and Guidelines for Use

APPENDIX A
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geological Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of Raging River Quarry, LLC and authorized agents. This report may be made available to the local governmental agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geologic study is unique, each geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geological practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Raging River Quarry project as described in this report. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.