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P.O. Box 1266, New Ulm, Texas 78950

**Damage Investigation
Crescent 3D**

March 13, 2013

Bob Smith
Geokinetics

Subject: Turley Water well, 16423 CR 20 Ft Lupton, Colorado

Dear Mr. Smith,

You had requested Urban Seismic Specialists to conduct an investigation into the vibration damage complaint of the Turley Residence in Ft Lupton, Colorado, for the purpose of evaluating the potential for vibration damage from vibroseis activities conducted on the Crescent 3D seismic survey.

The data reviewed consisted of pictures that were obtained at Mr. and Mrs. Turley's residence on February 6, 2013 by our technician, John Kelley, as well as the monitoring data recorded during the vibroseis operations on December 30, 2011.

VIBROSEIS OPERATIONS AND GROUND VIBRATION

When the vibrators initiate their sweep the primary signal penetrates the sub surface layers. The individual vibrators generate these waves. As the waves propagate from the individual vibrators they combine to produce an array of sound waves that penetrate the earth's surface. These primary energy waves are projected downward into the earth. The type of energy the vibrators generate dissipates rapidly on the surface. The automatic trigger level on the seismographs was set to 0.020 in/sec. This is equal to the normal level of human perception of ground vibrations.

As seismic waves travel through an area, they generate particle motions that we call vibrations. The particle motion that we measure on the surface is similar to that of a cork bobbing on a water surface when a wave passes underneath. It is the speed of this particle motion that we measure with a seismograph.

U.S. Bureau of Mines RI 8507 (Report of Investigation) published in 1980 stated that the speed of ground vibration (particle velocity), which is measured by a seismograph, is considered to be the best measure of damage potential. The safe vibration criterion for structures was specified in the U.S. Bureau of Mines bulletin 656 which states:

“The safe vibration criterion is based on the measurement of individual components and if the particle velocity exceeds 2.0 inches per second, damage is likely to occur.”

Therefore, if damage is likely to occur above 2.0 in/sec, then below 2.0 in/sec is safe, so the reasoning went, and so 2.0 in/sec became known in blasting as the safe limit for modern one or two story residential structures. In the same bulletin, the US Bureau of Mines reported that it would normally take a particle velocity of 4.0 in/sec to cause “threshold damage”, i.e., opening of old cracks and creation of new cracks. This is mentioned because the same levels apply to water wells.

VIBRATION LEVELS:

Displacement is a measure of ground particle travel distance or location with respect to time. Particle velocity measures the speed of movement and acceleration is the rate of velocity changes. Vibration frequency is a measure of how many oscillations a ground particle makes per second of time. Frequency is reported in units of Hertz (Hz), which is cycles per second.

After considerable research, various governmental agencies and independent investigators have determined that Peak Particle Velocity (PPV) and the frequency of the ground motion are the best criteria for predicting structural damage. For instance, most states have adopted safe PPV limits ranging from 0.5 to 2.0 in/sec for commercial blasting operations. These limits are intended to prevent the onset of cosmetic damage in plaster-and-lath or gypsum-rock walls. Structural damage does not occur until PPV levels exceed 10 in/sec. The safe PPV limit for all types of buried pipes, recommended by the US Bureau of Mines is 5 in/sec (Siskind et al – 1993) Safe vibration limits mandated by the United States Office of Surface Mining are shown in Table 1.

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DAMAGE DESCRIPTION

The damages claimed by Mr. and Mrs. Turley relate to one location, the water well. The water well has been described by the owner as drilled in 2000, with a depth of 800 ft. It is accessed using a submersible pump (5 hp).

Our technician, John Kelley, arrived to discuss the claim, take pictures and also get a GPS position for the water well in order to ensure accurate distances to the nearest source points. Ms. Turley said that her son witnessed the vibe buggies working from the North to the South towards their property. By her recollection, this occurred in January or February of 2012. Our monitor was at their residence monitoring the closest source points on December 30, 2011. They also told him that the buggies crossed their property, and shook between the home and the water well. As you can see by the map, there were no source points located between the water well location and the home.

Not long after that, she said that her water turned a brownish color and had an odor to it. She said that she had called Anadarko to report the problem, and someone made an initial contact. Ms. Turley did not mention the name of the initial contact. After that, the water seemed to clear up, so she contacted someone to let them know that her water was better.

The following summer (approximately June or July 2012), a new swamp cooler was installed on the home. It wasn't long before a white colored deposit began to form on the outside of the new cooling unit. The owner stated that she was scraping off large deposits as early as September 11, 2012. Ms. Turley stated that she has waiting to see if the condition would clear up, but it hasn't. She also stated that she has contacted Anadarko many times (10 to 12), and they just recently sent a letter. She stated that prior to the seismic survey, she made sure to cover the well with a 55 gallon drum and secure it with T-posts to be sure that it was noticed.

16423 CR 20, Ft. Lupton, Colorado



Figure 1 - Turley Residence



Figure 2 Turley water well and residence.



Figure 3 View of water well from Turley residence.

CONCLUSIONS

The damage that was claimed by Mr. and Mrs. Turley was located only in one area, the water well. The damage being claimed is one that involves water quality. Her initial claim was that the water had changed color, and had an odor; however that condition did go away with time. The remaining condition is that of the water leaving a white deposit, and since we did not perform water testing, we can't be certain of the exact nature of the deposit; however, typically deposits of this nature are a result of hard water. Hard water is water with a high mineral content, particularly calcium and magnesium. It is unknown what the condition of the home water supply was prior to the claim. No damage was claimed within the residence in any form.

Damage relating to vibration or ground motion is progressive by nature, meaning that the structures with the weakest bonds will be damaged first, and those structures with the strongest bonds will be damaged last.

** The closest source point to the Turley water well was source point 54631622, which was located 403 ft. from the north side of the water well at 16423 CR 20. This source point was monitored; however, since it was such a large distance, the monitor placed his seismograph at a closer distance to the vibe buggies to ensure that he was adequately record the surface energy being produced. The monitoring technician placed his seismograph at a point 135 ft southeast of 54631622, at that location that would ensure all adequate coverage for both the home and water well at 16423 CR 20. At, that point, the distance to the water well is 256 ft. to the southwest, and

the distance to the residence is 308 ft. The Peak Particle Velocity measured at the seismograph location was 0.060 in/sec. A wave form from the monitor record has been attached to this report. Source point 54631623 was also monitored in the same fashion. The monitoring technician set up at a location 110 ft south of the source point. At the seismograph location, he was set up 354 ft. northeast of the water well, and 270 ft northwest of the residence. The peak particle velocity recorded at that distance was .225 in/sec.

It is a standard industry practice to monitor structures which are located closest to the source point, and given the distance from the source point to the structures at 16423 CR 20, the home and the water well location did not have a seismograph placed directly at them. In circumstances like this one, we can utilize data collected during our monitoring operations to calculate the Peak Particle Velocity at a structure located farther away. We accomplish this using a known distance from a source point to a seismograph, and the recorded PPV, as well as the known distance to the Turley residence, or water well. In looking at the data recorded during the monitoring of the source points at 16423 CR 20 on 12/30/2011, a Peak Particle Velocity of .060 in/sec was recorded at a distance of 161 ft. The calculation can be made using the following formula.

$$\text{Estimated PPV} = \left[\left(\frac{X}{Y} \right)^{1.5} \right] \times PPV$$

X = Distance from Seismograph to Energy Source (161 ft.)

Y = Distance from Energy Source (VP 54631622) to 16423 CR 20 (Turley water well 403 ft.)

PPV = Recorded PPV at a distance of 161 ft.

Therefore, the estimated PPV at the Turley water well would be calculated as:

$$\text{Estimated PPV} = \left[\left(\frac{161}{403} \right)^{1.5} \right] \times .060 \text{ in/sec} = 0.015 \text{ in/sec}$$

Utilizing the same calculation, we calculated the Peak Particle Velocity for next source point 54631623.

X = Distance from Seismograph to Energy Source (110 ft.)

Y = Distance from Energy Source (VP 54631623) to 16423 CR 20 (Turley Water Well.) (450 ft.)

PPV = Recorded PPV at a distance of 110 ft.

$$\text{Estimated PPV} = \left[\left(\frac{110}{450} \right)^{1.5} \right] \times .225 \text{ in/sec} = 0.027 \text{ in/sec}$$

The actual monitored values of .060 in/sec, for source point 54631622, and .225 in/sec for source point 54631623 are values which are considered safe to water wells, and their associated equipment. It should also be noted that the values recorded on this project were well within industry and regulatory limits established to prevent damages to any residential structures or water wells. Water wells have been known to produce cloudy water from time to time, typically during times of drought, when the water well's area of production can cave in from high water production and little replenishment to the aquifer. Water wells by their very nature are not always permanent fixtures, and can fail as a result of many factors such as, where the well was drilled, the substrate that the producing area of the well is in, the types of components utilized in completing the well, and how those components match the geology of the well.

The initial water well damage claimed by Mrs. Turley was that the well had become brownish in color, and had developed an odor. The second claim by Mrs. Turley came after the water had cleared up; however, the water had apparently reached a hard water status, and as result began leaving heavy white deposits on the newly installed swamp cooler. In this case, we cannot state with certainty what the condition of the water quality was prior to vibroseis activity. We can only verify that the well is currently working, and it is producing a white deposit. It is certain however, that the recorded Peak Particle Velocity values for this location were not even close to the values that it would take to cause physical damage to the water well, or to the geology of the aquifer the well is located in.

After vibration activities are done, it is common for many homeowners to believe that they have circumstances, such as a water well problem, that are a result of vibration activity. It is just not possible for this extremely low level of vibration energy to cause damage to a water well of this nature.

After careful and extensive review of the data received during the monitoring of this location, our finding is that the damage alleged by Mrs. Turley is not related to the vibroseis activity that occurred on the Crescent 3D project.

Best Regards,

A handwritten signature in black ink, appearing to be 'Jan Moles', written over the 'Best Regards,' text.

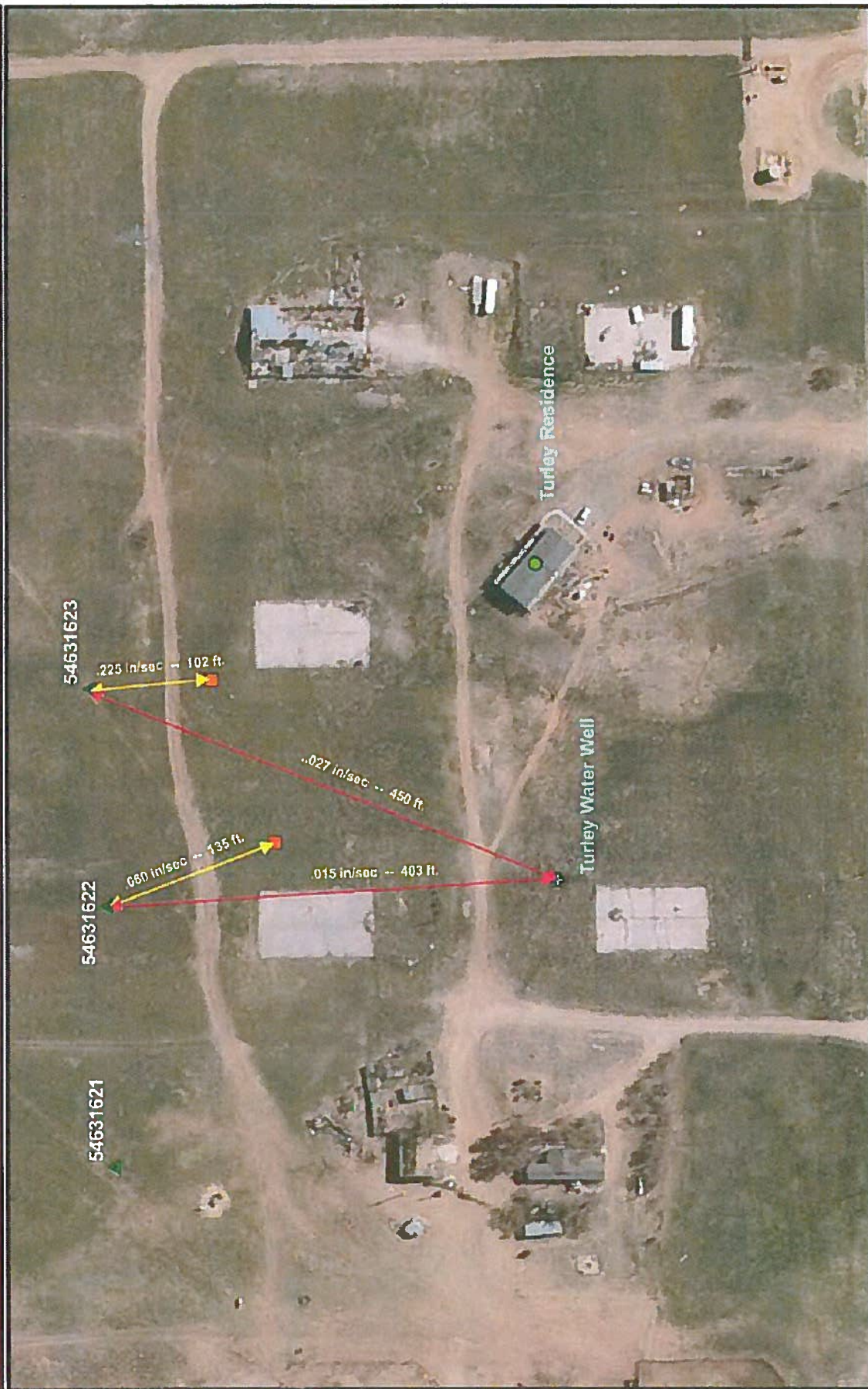
Jan Moles
Urban Seismic Specialists Inc.



Crescent 3D - Monitor Summary and Damage Claim Analysis
Turkey CR 20, Ft Lupton, Colorado (water well)

Claim Details	Closest Source	Distance to Structure	Calculated PPV (in/s)	Source Type	Distance to Seismograph	Recorded PPV (in/s)	Date	Serial Number	Event Number	Time	Rad (in/s)	Rad (ft/s)	Vert (in/s)	Vert (ft/s)	Trans (in/s)	Trans (ft/s)	Vector Sum (in/s)	File Name
Turkey water well 16423 CR 20 Fort Lupton, CO	54631622	403 ft.	0.016	Vibrocoils	941 ft.	0.060	12/30/2011	5133	003	0.330	0.055	17.000	0.060	25.600	0.420	28.400	0.060	5133201112300921003.DTB
	54631623	450 ft.	0.026	Vibrocoils	110 ft.	0.220	12/30/2011	5133	004	0.392	0.230	13.400	0.195	37.000	0.080	15.000	0.245	5133201112300921004.DTB
	54631623	450 ft.	0.027	Vibrocoils	110 ft.	0.225	12/30/2011	5133	005	0.372	0.235	14.200	0.195	37.000	0.075	16.000	0.250	5133201112300921005.DTB
	54631621	474 ft.	0.000	Vibrocoils														

Crescent 3D - Damage Claim Analysis
Turley Water well - 16423 CR 20 Ft Lupton, CO
Anadarko



Legend

- Well
- Damage Location
- Seismic Point

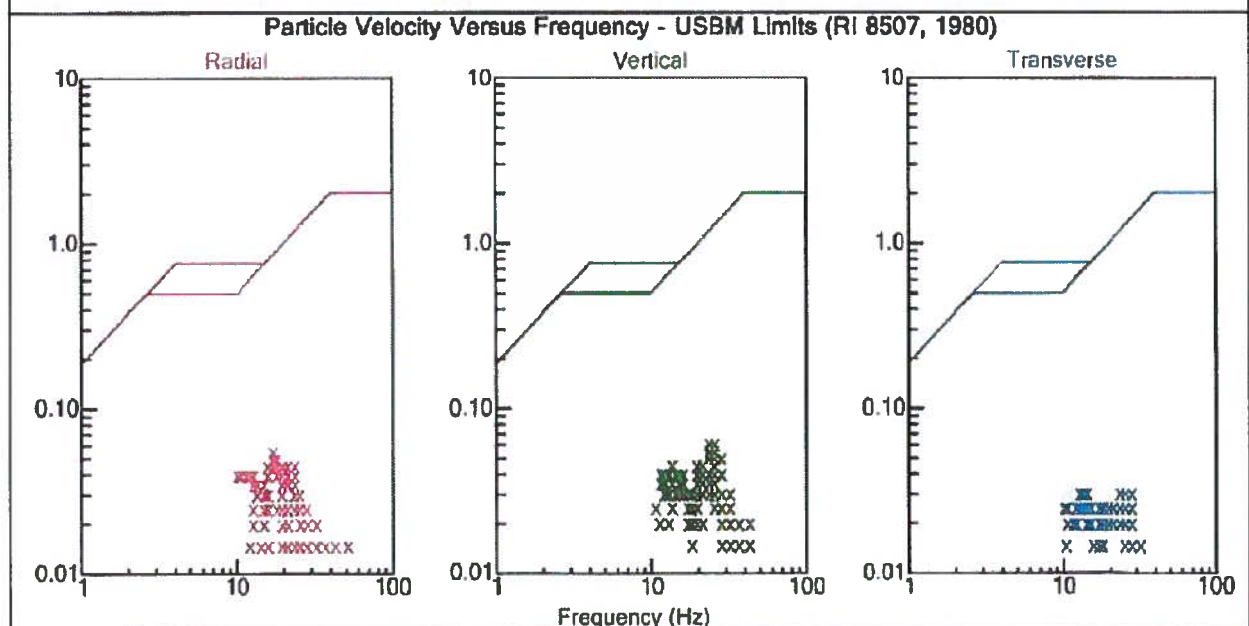
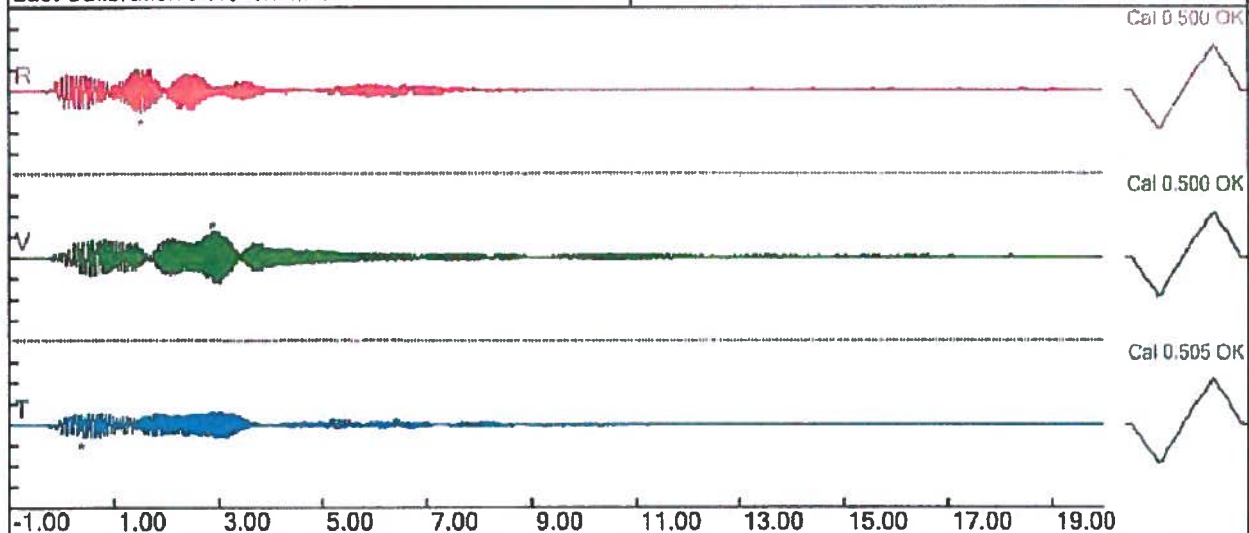


Crescent 3D - Monitor Record Summary **Set up in Pasture 264 ft NW of NW corner** **of White Two story house w/ green Trim**

Source Point: 54631622
Distance: 135 ft.
Number of Vibes: 3
Drive Level: High

File: 5133201112300921003.dtb
 Number: 003
 Date: 12/30/2011
 Time: 09:21
 SN: 5133
 Seis. Trigger: 0.030 in/sec
 Air Trigger: 142
 Sample Rate: 512
 Duration: 20.0 Seconds
 Pre-Trigger: 1.00 Seconds
 Gain: 2.0x
 Voltage: 6.6

Peaks and Frequencies	Graph Information
PPV Maximum: 0.060 in/sec (2.8867 sec)	Duration: -1.000 s To: 20.000 s
Radial: 0.055 in/sec @ 17.0Hz (1.5215 sec)	Seismic Scale: 0.20 in/sec (0.050 in/sec/div)
Vertical: 0.060 in/sec @ 25.6Hz (2.8867 sec)	Time Intervals: 2.00 sec
Transverse: 0.030 in/sec @ 28.4Hz (0.3848 sec)	
Last Calibration Date: 9/21/2011	

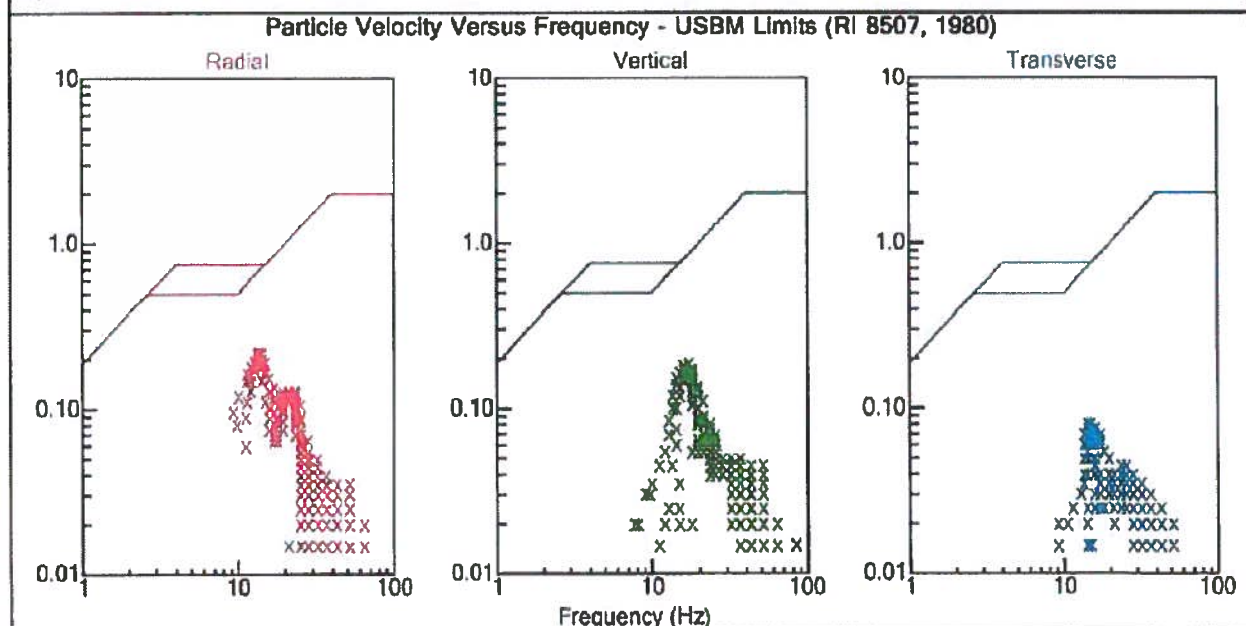
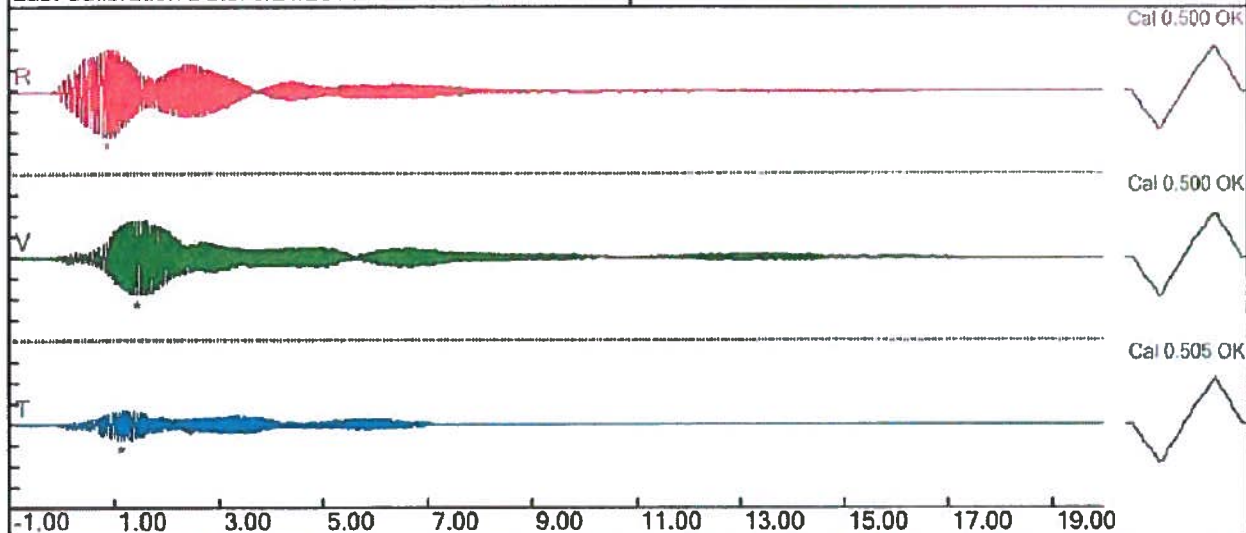


Crescent 3D - Monitor Record Summary **Set up in Pasture 234 ft NW of NW corner** **of White Two story house w/ green Trim**

Source Point: 54631623
Distance: 102 ft.
Number of Vibes: 3
Drive Level: High

File: 5133201112300924004.dtb
 Number: 004
 Date: 12/30/2011
 Time: 09:24
 SN: 5133
 Sels. Trigger: 0.030 in/sec
 Air Trigger: 142
 Sample Rate: 512
 Duration: 20.0 Seconds
 Pre-Trigger: 1.00 Seconds
 Gain: 2.0x
 Voltage: 6.6

Peaks and Frequencies	Graph Information
PPV Maximum: 0.220 in/sec (0.8828 sec)	Duration: -1.000 s To: 20.000 s
Radial: 0.220 in/sec @ 13.4Hz (0.8828 sec)	Seismic Scale: 0.40 in/sec (0.100 in/sec/div)
Vertical: 0.185 in/sec @ 17.0Hz (1.4531 sec)	Time Intervals: 2.00 sec
Transverse: 0.080 in/sec @ 15.0Hz (1.1504 sec)	
Last Calibration Date: 9/21/2011	



Crescent 3D - Monitor Record Summary
Set up in Pasture 234 ft NW of NW corner
of White Two story house w/ green Trim

Source Point: 54631623
Distance: 102 ft.
Number of Vibes: 3
Drive Level: High

File: 5133201112300925005.dtb

Number: 005
Date: 12/30/2011
Time: 09:25
SN: 5133
Seis. Trigger: 0.030 in/sec
Air Trigger: 142
Sample Rate: 512
Duration: 20.0 Seconds
Pre-Trigger: 1.00 Seconds
Gain: 2.0x
Voltage: 6.6

Peaks and Frequencies	Graph Information
PPV Maximum: 0.225 in/sec (0.9258 sec)	Duration: -1.000 s To: 20.000 s
Radial: 0.225 in/sec @ 14.2Hz (0.9258 sec)	Seismic Scale: 0.40 in/sec (0.100 in/sec/div)
Vertical: 0.195 in/sec @ 17.0Hz (1.5566 sec)	Time Intervals: 2.00 sec
Transverse: 0.075 in/sec @ 15.1Hz (1.0547 sec)	
Last Calibration Date: 9/21/2011	

