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Scroll down for document section

Appendix H. Noise Measurement Report

HANKARD ENVIRONMENTAL
ACOUSTICS AND VIBRATION CONSULTING

DRILL NOISE MEASUREMENT REPORT

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PROJECT: Over the River – Drill Noise Measurements

DATE: July 6, 2006

Summary

Measurements of background noise levels and those from drilling operations were taken in and around the Parkdale area of the Arkansas River on June 24, 2006. These measurements were completed by Hankard Environmental at the request of the Over the River project.

There are no known local noise regulations that apply to the drilling noise levels, but the Colorado State Statute (Title 25, Article 12, Section 103) does mention that noise from construction projects are limited to the maximum noise levels specified for an "Industrial Zone". The same Statute also says that it is not applicable to non-profit entities for cultural type uses. Thus, a decision as to whether the State Stature applies or not needs to be made. Regardless of the State Statute, there are noise concerns by various agencies having to due with the effect of the drill noise on area wildlife, rafters, fishermen, etc. There is little data available that correlates a noise level to the effect.

The noise levels of the KLEMM KR802 and Bobcat TEI drills were measured in addition to some background levels and a nearby gravel pit. The KLEMM KR802 drill was measured while drilling vertically and the TEI drill was measured while drilling both vertically and horizontally. In addition to their own motors, both drills require a separate compressor and the KLEMM drill used a separate vacuum to minimize dust while the TEI drill used a water spray. Both drills had similar overall noise levels and will be audible along the river as well as across the river. The distance that the drills will be audible was not analyzed for this study, but one measurement found the drill noise to only be slightly audible at 1,100 feet along the highway. One of the primary concerns with the drill noise is its effect on bighorn sheep. One study in 1983 stated that overflights of single engine piston driven aircraft at 330 feet above the ground did not cause any response from bighorn sheep, but no other applicable studies have been located. Another concern with the drilling noise is its effect on humans around the river who are rafting, fishing, hiking, relaxing, etc. Additional analysis would be necessary to determine a more precise audible range, but preliminarily it could be said that drilling will be audible at distances of at least 1,000 feet.

Noise mitigation of the drilling operations is possible and could include acoustical shrouds around the drill or entire operation, mufflers, and quieter backup alarms. It is felt that the drilling operation noise levels could be significantly reduced, but the next step would be to define the goal (i.e.: locate bighorn sheep areas, define acceptable levels for bighorn sheep and on river activities) and then review the mitigation options that would achieve the goal.

Relevant Noise Terminology

The following provides some relevant noise terminology which includes some definitions and explanations of some of the more common terms.

A-Weighted Sound (dBA) - A-weighting network was developed and is applied to either measured or predicted noise levels to mimic the ear's varying sensitivity to frequency. Resulting noise levels are expressed in dBA. The following table shows the A-weighted noise levels of some common noise sources.

Typical Noise Levels

Noise Source	Noise Level (dBA)
Amplified rock band	115 – 120
Commercial jet takeoff at 200 feet	105 – 115
Community warning siren at 100 feet	95 – 105
Busy urban street	85 – 95
Construction equipment at 50 feet	75 – 85
Freeway traffic at 50 feet	65 – 75
Normal conversation at 6 feet	55 – 65
Typical office interior	45 – 55
Soft radio music	35 – 45
Typical residential interior	25 – 35
Typical whisper at 6 feet	15 – 25
Human breathing	5 – 15
Threshold of hearing	0 – 5

Change in Noise Level - A change in a noise level of 3 dB is considered to be the smallest perceptible change by a human. While a change of 5 dB is noticed by most everyone and a change of 10 dB most feel that the noise level was doubled or halved.

Decibel (dB) – A decibel is one-tenth of a Bel. For sound pressure levels, it is a measure on a logarithmic scale, which indicates the squared ratio of sound pressure to a reference sound pressure.

Equivalent Sound Level (L_{eq}) - The equivalent steady state sound level which in a stated period of time would contain the same acoustical energy as the time-varying sound level during the same period. The time period used for highway noise analysis is one hour. All noise levels described in this report are hourly, A-weighted L_{eq}'s.

Frequency (f) - The number of oscillations per second of a periodic wave sound expressed in units of Hertz (Hz). The value is the reciprocal (1/x) of the period of oscillations in seconds. The human ear is, in general, capable of detecting frequencies between 20 to 20,000 Hertz. The human ear is more sensitive to high frequency sounds than to low frequency sounds.

Noise – Unwanted sound, usually loud or unexpected.

Noise Receptors - Areas in which people are typically located, which include places such as residences, hotels, commercial buildings, parks, etc. Usually, one noise receptor location is

used to analyze an area unless the area is quite large and covers various distances from the roadway. The noise receptor is typically located on the façade of a structure that faces the noise source or roadway.

Pascal (Pa) – A unit of pressure (in acoustics, normally RMS sound pressure) equal to one Newton per square meter (N/m2). A reference pressure for a sound pressure level of 0 dB is 20 μPa (20 micro Pascal).

Sound – Caused by pressure fluctuations in the air. The range of sound pressures, which the human ear is capable of detecting, is very large (0.00002 to 200 Pascals). To facilitate easier discussion, sound pressures are described on a decibel (dB) scale.

Sound Absorption – This typically occurs when sound is converted to heat or another form of energy. A common sound absorptive material is fiberglass insulation.

Sound Pressure Level (SPL) – Sound pressure level in dB is equal to $10Log_{10}(p^2/p_o^2)$ where p is the instantaneous sound pressure and p_o is the reference sound pressure of 0.00002 Pa. This results in a scale of 0 dB (threshold of audibility) to 120 dB (threshold of pain).

Sound Reflection – The reflection of sound occurs when an object is able to significantly increase the impedance when compared to the surrounding air. This would require an object to be non-porous and to have enough density, stiffness and thickness.

Sound Transmission Loss (STL or TL) – The conversion of sound energy to another form of energy (usually heat) from one side of a barrier to the other.

Noise Measurements

Various noise level measurements were conducted on June 24, 2006 in and around the Parkdale section (US 50 mile marker 266) of the proposed Over the River project. The primary purpose of these measurements was to determine the acoustical differences between drill types and operations. Also, the measurements were taken to define background noise levels, and those from a nearby gravel pit. The following provides a description of the measurements and results.

Noise Measurement Procedures

All noise level measurements were conducted using a Larson Davis Model 824 sound level meter (SLM) which provides overall noise level information as well as the 1/3 Octave frequency band levels. This SLM is rated by the American National Standards Institute (ANSI) to be Type 1, which generally corresponds to an accuracy of ±1 dB. The SLM was field calibrated prior to any measurements and re-checked after the measurements and this calibration remained at 94.0 dB for the entire day. Each measurement was averaged over a period of about 30 to 180 seconds, which is sufficient for the type of noises that were measured.

Noise Measurement Specimens and Locations

There were five primary measurement groups which included: KLEMM KR802 drilling vertically into the ground, Bobcat TEI drilling vertically into the ground, Bobcat TEI drilling horizontally into a boulder, background levels without drill noise (along US50, river bank with calm waters, and riverbank with rapids), and gravel pit noise.

The KLEMM KR802 Drill had four primary noise sauces which were the drill bit making contact with the earth, the drill motor, compressor, and vacuum. The compressor and vacuum were located about 40 to 50 feet away from the drill itself. Winds during these measurements were light and should not have affected the results. Figure 1 provides the noise measurement layout in which this drill was used to drill a vertical hole.

The Bobcat TEI Drill had three primary noise sources which were the drill bit making contact with the earth, the drill/bobcat motor, and compressor. No vacuum is necessary for this drilling operation as water is used to keep the dust levels down. This drill was used to bore a hole vertically into the ground (See Figure 2) for one set of noise measurements and then later to bore a hole into the side of a boulder above the ground (See Figure 3). Winds during the vertical drilling were high and gusty from the east, but it is felt that accurate measurements were taken. During the horizontal boulder drilling measurements the winds were less gusty from the east and should not have affected the results.

Background measurements were made to represent three typical scenarios near the river. The first background measurement was along US 50 about 25 feet from the edge-of-pavement. Traffic during these measurements equated to about 360 vehicles per hour of which about 5% were heavy trucks. The second background measurement was taken near the riverbank with calm running waters and included some influence from vehicles along US 50. The third background measurement was again near the riverbank, but with rapidly flowing water over rocks.

Gravel Pit noise measurements were made at two locations (south and east) at or near the property line. It is unknown what equipment was operating at the time of these measurements. Typically a gravel pit will include one or two loaders, along with various conveyor belts, a rock crusher, haul trucks and possibly large generators and fans.

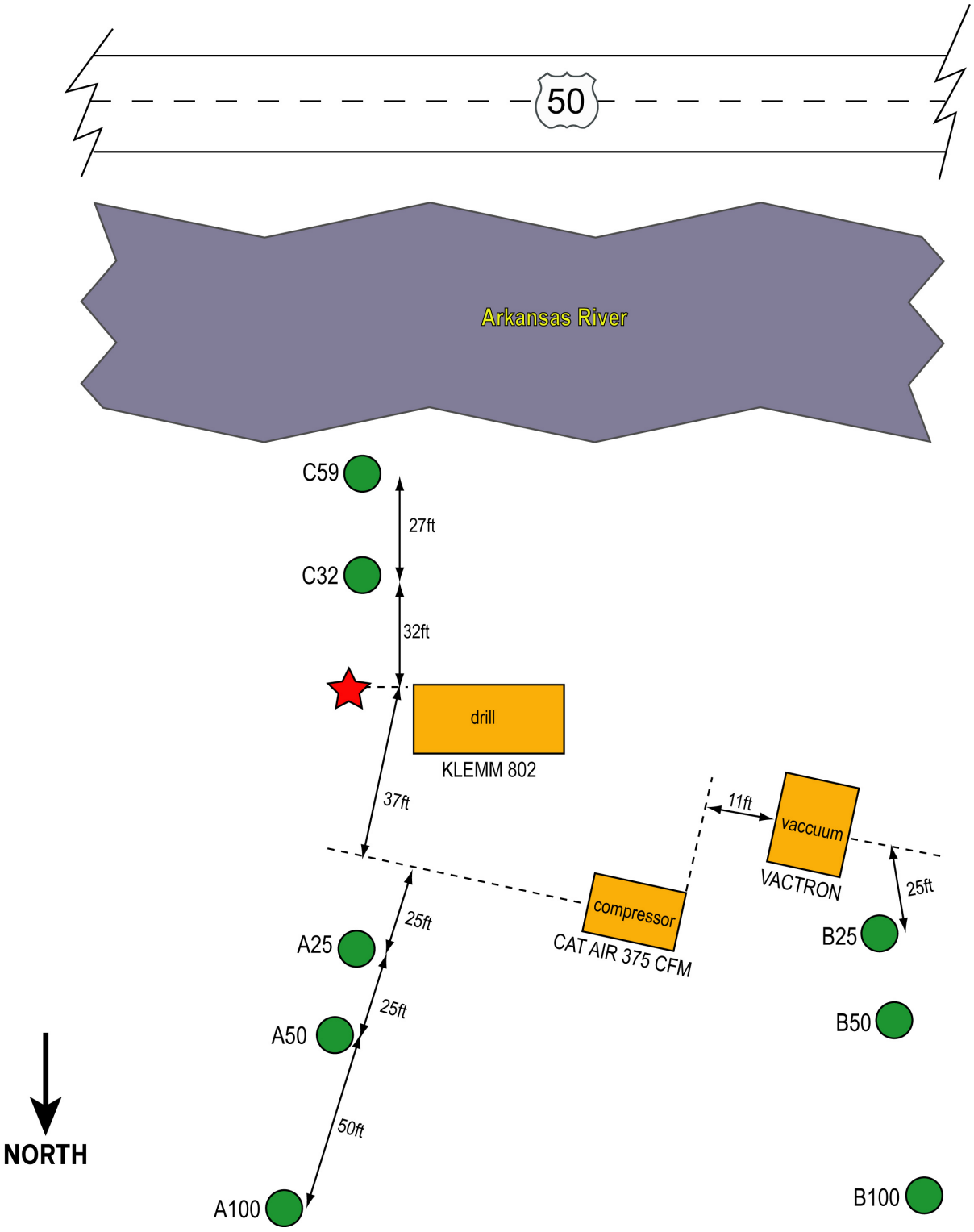

Figure 1: Layout of Noise Measurements for KLEMM KR802 Drilling Vertically

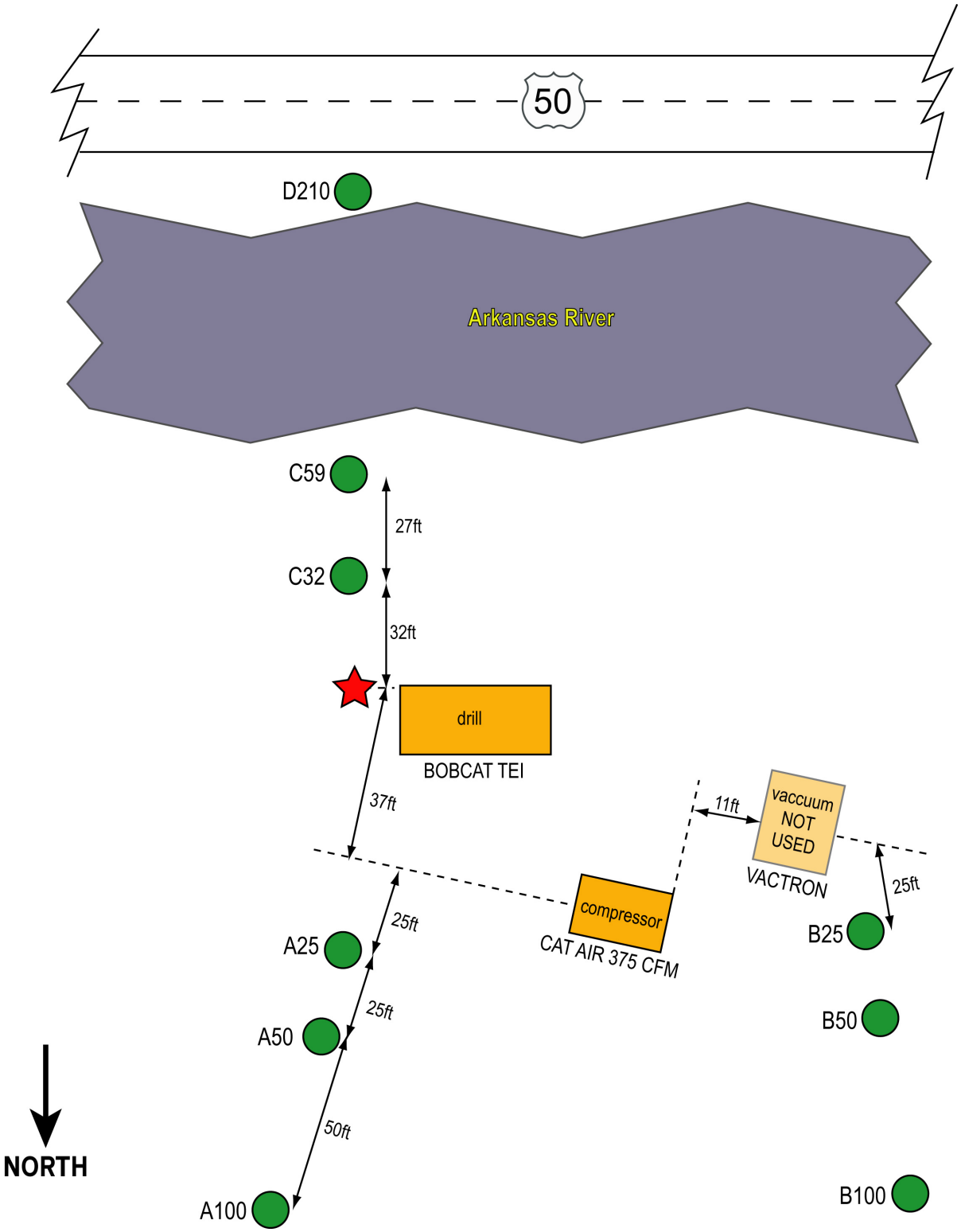

Figure 2: Layout of Noise Measurements for Bobcat TEI Drilling Vertically

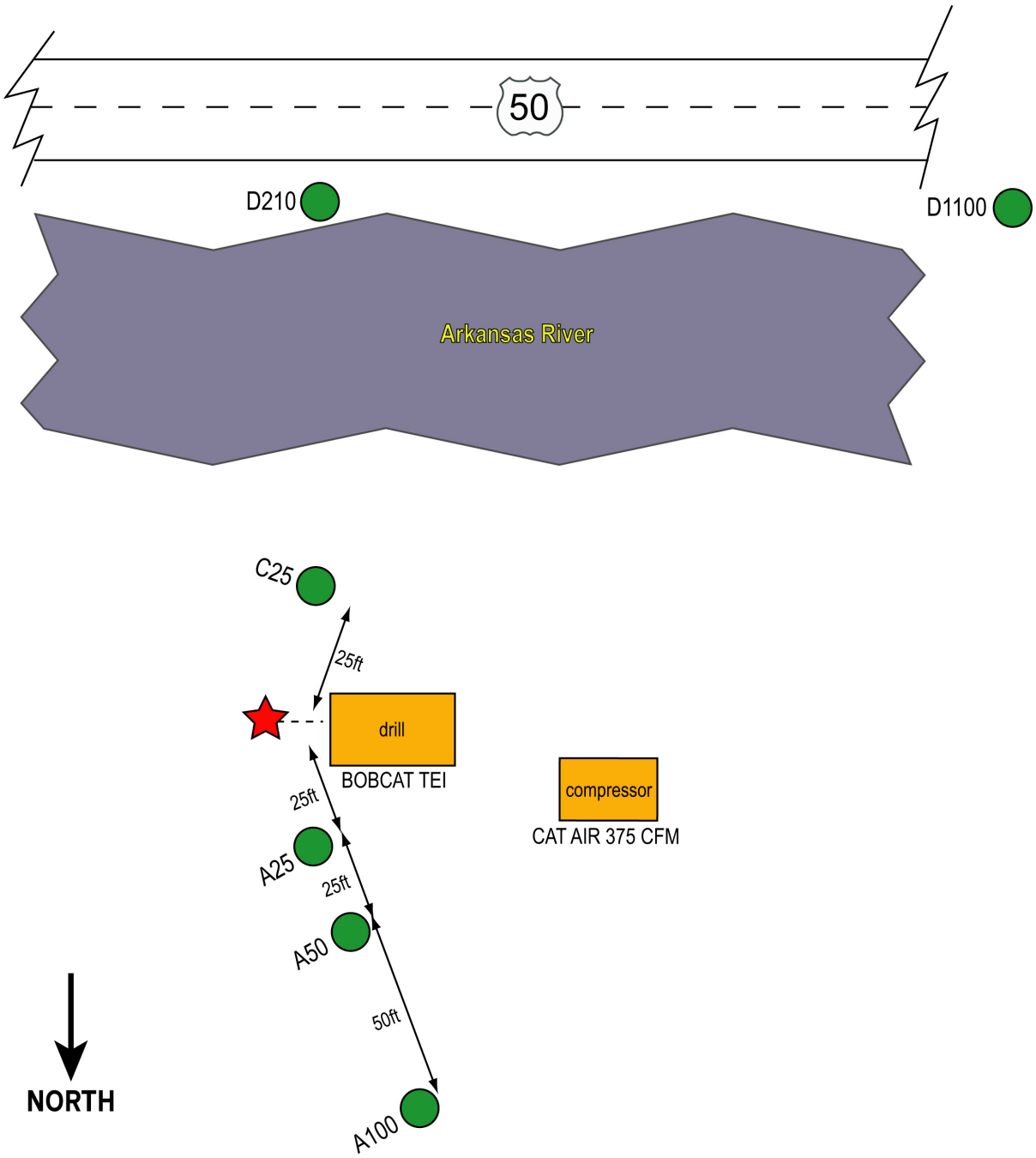

Figure 3: Layout of Noise Measurements for Bobcat TEI Drilling Horizontally into Boulder

Noise Measurement Results

A comparison of the overall noise level of a vertical drilling operation between the KLEMM KR802 and TEI is shown in Figure 4. The TEI drill is slightly louder (< 5 dBA) directly away from the drilling operation, but the KLEMM drill is louder (1 to 7 dBA) in the other locations. The reason could be due to the use of the vacuum with the KLEMM operation which was partially shielded from the first set of measurements. No data was taken for the KLEMM drill on the other side of the river. Further discussion regarding the frequency content of these drills is provided below.

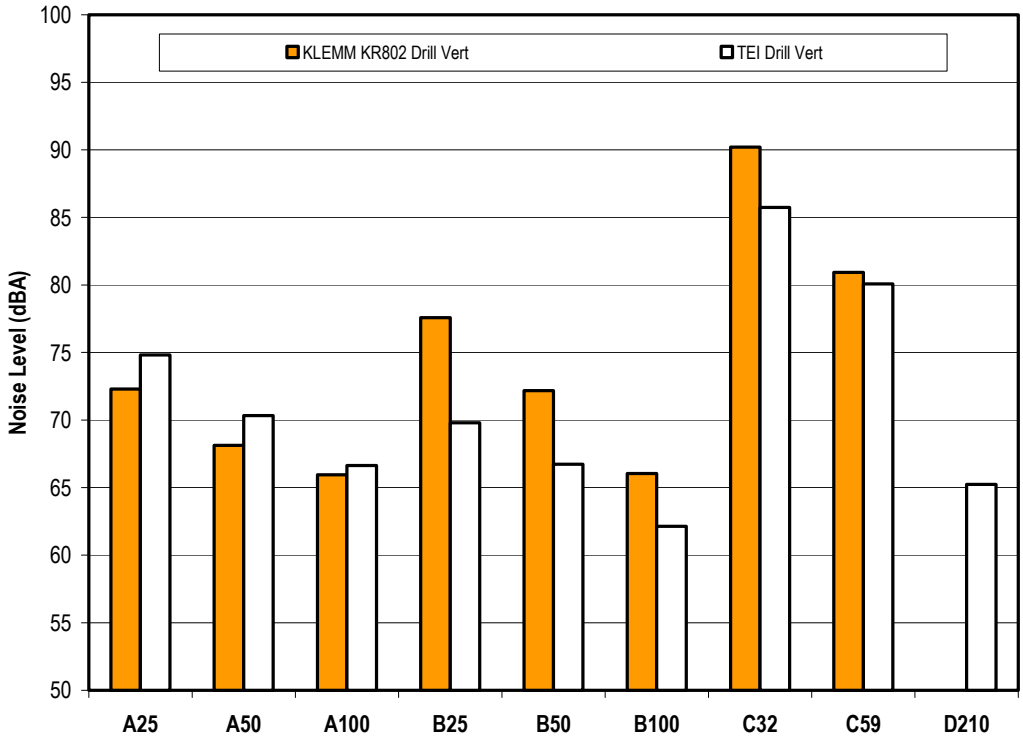

Figure 4: Comparison of the KLEMM KR802 and Bobcat TEI Vertical Drilling Noise – June 24, 2006

The next comparison is of the noise levels when using the TEI drill to drill vertically into the ground and drill horizontally into a boulder. Figure 5 shows this comparison of the overall levels. The horizontal drilling operation is typically 5 to 10 dBA louder than the vertical drilling except on the other side of the river. This could be due to much of the higher frequency noise from the drill bit itself being reflected off the boulder away from this measurement location.

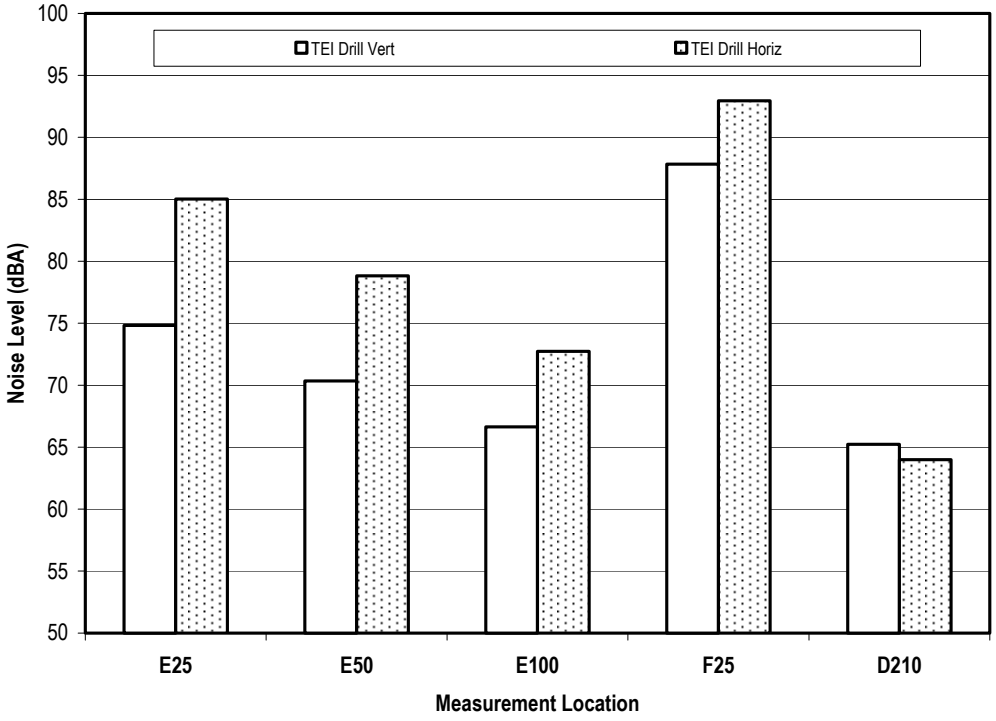

Figure 5: Comparison of Vertical and Horizontal Drilling Noises Using the Bobcat TEI Drill – June 24, 2006

The third overall comparison is of the typical background noise levels to that of drill and US 50 traffic noises as shown in Figure 6. "On US 50" means the drill is on the highway side of the river and this is what people on the highway 25 feet away from the operation would hear. Clearly this will be an audible event for people passing by the drill operation along the highway with levels 10 to 20 dBA louder than the measured background levels. Though not shown graphically, the when the drill is located on the north side of the river the drill noise levels will still be audible, but overall levels similar to that of the existing highway levels. "On River" means the drill is on the bank of the river in the immediate vicinity (approximately 50 to 60 feet from drilling), and this could be what rafters, kayaks, and fishermen would hear. Overall, the drill noise will be very audible along the river within about 300 feet of the drilling operation. Noise levels were also attempted to be measured 1,100 feet downwind of the drilling operation, though they were slightly audible the drill noise levels were at or below the background levels (0 to 10 dBA lower). The audibility was not analyzed as a part of this project.

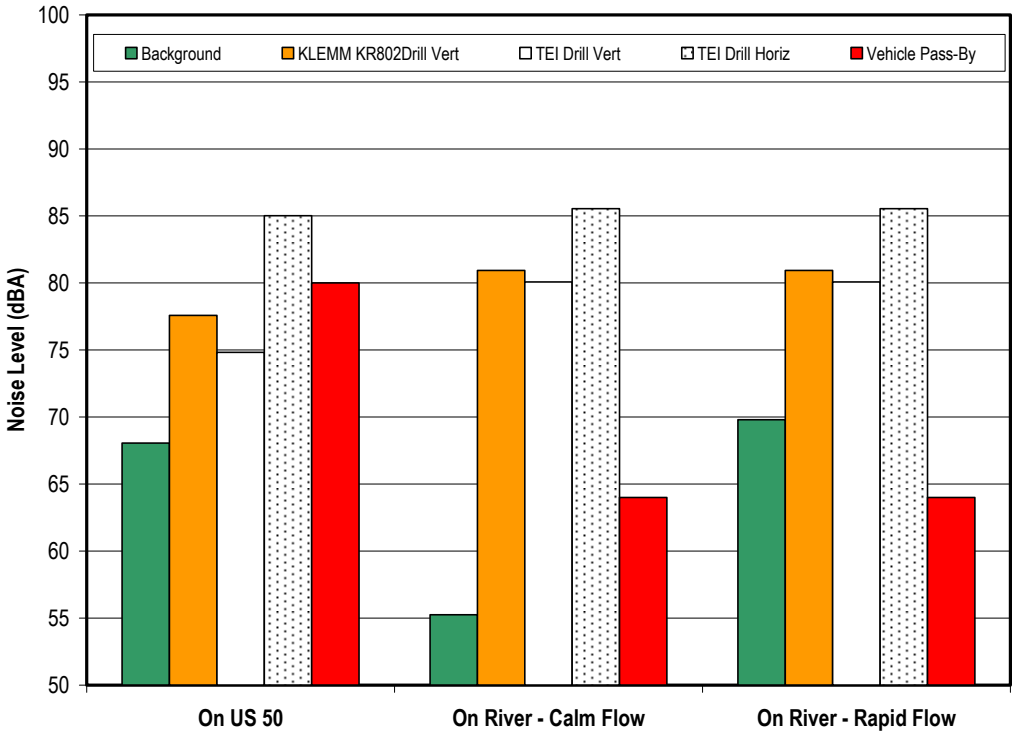

Figure 6: Comparison of Common Background Noise Levels with Drilling and Vehicle Noise Levels – June 24, 2006

The fourth comparison is of the frequency contents of the KLEMM and TEI drills. The TEI drill is louder in the lower frequencies (100 to 500 Hz) and the KLEMM drill is louder in the higher frequencies (500 to 2000 Hz). In looking at sound quality, the KLEMM drill would be considered less desirable due to the higher levels in the speech interference range. Conversely, the TEI drill is louder in the lower frequencies which are not considered as irritating, but there are "peaks" in this range in which a "beating" is more audible. This beating frequency may have been due to the TEI drill getting into hard rock whereas the KLEMM drill did not, per discussion with one of the drill operators.

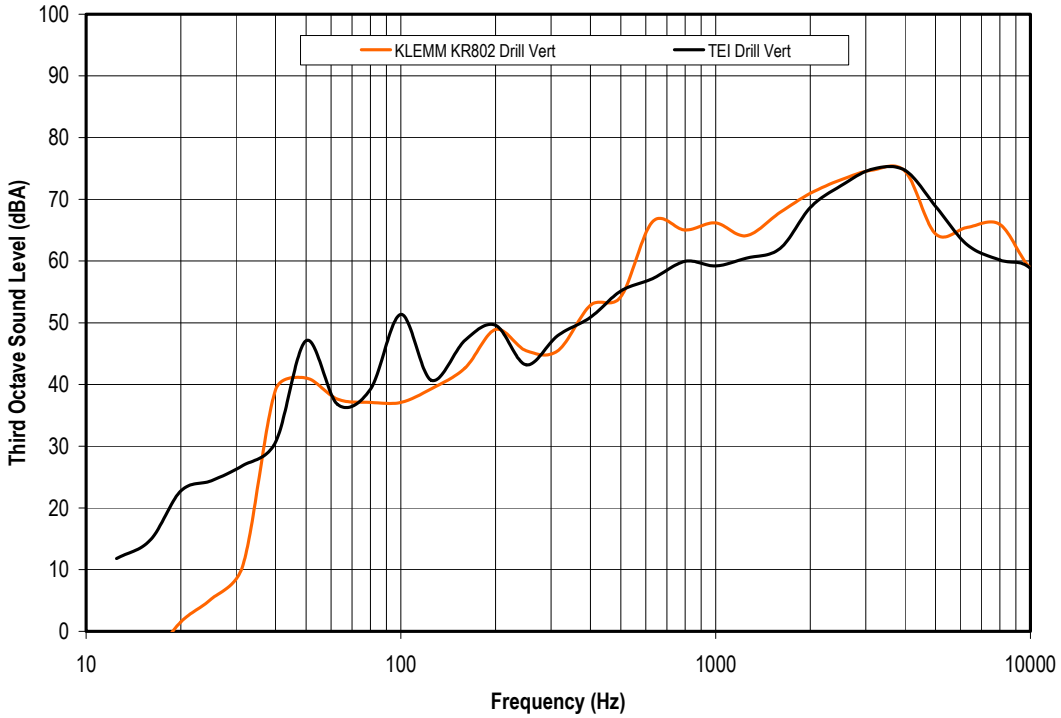

Figure 7: Frequency Spectrum Comparison of the KLEMM KR802 and TEI Drills – June 24, 2006

The Colorado State Statute (25-12-103) states that "construction projects" are limited to the maximum noise level within the "Industrial Zone", which is 80 dBA between 7:00 a.m. and 7:00 p.m. Between these hours, the noise level can be increased up to 90 dBA for 15 minutes during a one-hour period. The maximum drill noise levels measured along the river range from about 80 to 90 dBA, which louder than the Statute permits. The duration of the drilling noise could exceed the 15 minutes allowed, thus some noise mitigation may be necessary. With that said, the same Statute also states that it is not applicable to non-profit entities for cultural type uses. Thus, the State noise regulations may not even apply. Some determination as to the maximum level permissible will need to be made.

Gravel pit noise levels were measured at the property line, which were around 47 to 48 dBA on the south and west sides. It is unknown if the pit was in full operation, though some activity was audible. This particular pit has significant berming (10 to 20 feet tall) around the pit which helped reduce the noise levels. In the right wind conditions, the noise level of the pit could be very audible at the river, but based on these measurements the pit is probably not very audible at the river.

BLM Cultural Information Redaction Notes
Christo and Jeanne-Claude *Over the River* Design and Planning Report

BLM is required to protect cultural resources and information on public lands under the National Historic Preservation Act (Section 304). On 12/19/2007, BLM-RGFO redacted the following cultural sections from the OTR report for delivery to EIS cooperating agencies:

Table 5.8-1; page 5-183
Appendix G pp 803-840

Appendix I. Supporting Data

Appendix I. OTR Supporting Data

Below is a list of the GIS data used in preparation of this OTR Report. These data are presented on one DVD provided in this appendix.

All data, except for aerial imagery, are presented by data source, in ESRI shapefile format with FGDC compliant XML metadata describing how and when the data were collected, along with a projection file describing the coordinate system details.

Aerial imagery was collected from three sources. The 1999 ½-foot pixel resolution aerial imagery, collected by M.J. Harden, covers the portions of the Arkansas River where OTR fabric panels are located. The 2005 1-m pixel resolution aerial imagery, provided by the USDA Farm Service Agency, covers a 3-mile buffer of Arkansas River for the entire Arkansas River corridor between the OTR County Line Area and the OTR Parkdale Area. Colorado Hillshade was created by JFSA using USGS 30-m DEM.

Data presented by data source:

1. Bureau of Land Management
2. Colorado Department of Transportation
3. Colorado Division of Wildlife
4. Colorado State Parks
5. David Evans Associates
6. Fremont County
7. Golder and Associates
8. Hankard Environmental
9. JFSA
10. Natural Resource Conservation Service
11. US Forest Service
12. US Geological Survey

Aerial imagery:

1. 1999 ½ Foot Resolution Aerial Imagery
2. 2005 1 Meter Resolution Aerial Imagery
3. Colorado Hillshade

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