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October 28, 2019

Donnie Rose
President
R. A. Yancey Lumber Corporation
6317 Rockfish Gap Turnpike
Crozet, VA 22932

Subject Noise & Vibration Survey, Yancey Lumber Mill, Crozet, VA
Acentech Project No. 630191 – 2019 Update, v1.1

Dear Mr. Rose:

You are interested in assessing the mill's compliance with the county's noise ordinance. To that end, you have contracted us to perform a noise survey of the property for reporting to the county. For reference, Appendix C includes a brief glossary of terms and some additional information you may find helpful.

On Wednesday May 10, 2018 we met with representatives from Albemarle County to discuss the noise survey. During this discussion, the county indicated that you would also need to measure for compliance with the vibration standard also outlined in the county code. On Monday May 21 and Wednesday May 23, 2018, we measured noise and vibration at various points near the Yancey Lumber Corporation's property boundary to get a snapshot of the sound and vibration levels due to typical operations.

In the intervening year since this report was originally issued, the mill has refurbished the dust-fired boiler and brought it back online; this boiler was not operational at the time of the initial survey. Additionally, you have taken action to reduce noise levels of the boiler's induction fan, as well as some other equipment around the property. Nighttime sound levels were not measured or reported in the original report, but as the boiler runs continuously, nighttime sound levels are now included. On October 2, 2019 we repeated the noise survey measurements during daytime and nighttime operations. Note that vibration measurements were not repeated, or updated, as there were no apparent changes to major sources of vibration near the property boundaries.

This report summarizes the measurement results of our surveys.

MEASUREMENT METHODOLOGY

Sound

The Albemarle County code includes regulations for noise in chapter 18, section 4.18. This section outlines the necessary equipment, measurement procedure, and performance standard.

All sound measurements were made using an ANSI Type 1 compliant Sound Level Meters. The most recent sound measurements had laboratory calibration last dates of Nov 5, 2018 and June 4, 2019, both within their calibration period. Field calibration was performed at the start of each measurement day. In accordance with the county ordinance, sound level measurements were made at a height of 56" from the ground with a

duration of five minutes at each location to calculate the equivalent continuous sound level (L_{eq}). You may think of the L_{eq} as the energy-average sound level during the measurement period.

The daytime performance standard for sound levels is defined in the county code as 65 dBA for commercial receiving zone boundaries and 60 dBA for all rural, residential, and public receiving zone boundaries. The nighttime performance standard is defined as 65 dBA for commercial and 55 dBA for all other (rural etc.) receiving zone boundaries. Industrial receiving zones, of which there are none at your location, have a standard of 70 dBA for daytime and nighttime.

Vibration

The Albemarle County code includes regulations for vibration in chapter 18, section 4.14.2. This section defines the performance standards for vibration and the type of measurement needed for comparison to that standard.

Measurements were made using three seismic accelerometers mounted tri-axially (three perpendicular directions, one vertical and two horizontal). Laboratory calibrations of the three sensors were last performed in July and August of 2017, which was within their calibration period at the time of the measurements. Measurements were made on a solid and compacted surface to ensure valid readings. The recorded acceleration signals were processed to calculate a vector sum of the vibration waveform, and then time integrated to change acceleration into velocity, and converted into the vector summed Peak Particle Velocity (PPV) levels calculated for each location, per the county code.

The performance standard at residential district boundaries is .006 in/sec PPV for impulsive vibration (less than 100 events per minute) and .00 in/sec PPV for continuous vibration. Note that the continuous vibration level of .00 in/sec is the same as zero, or no allowable vibrations; we expect that this is not the intent of the code and it is incorrectly written.

The performance standard at all other boundaries including rural boundaries, which represent the majority of the boundary, is .030 in/sec PPV for impulsive vibration (less than 100 events per minute) and .015 in/sec PPV for continuous vibration.

Measurement Locations

The sound and vibration measurements were conducted at 19 locations at or near the property boundary, including two locations across the Rockfish Gap Turnpike (RT 250) as suggested by the county representatives.

The measurement locations are detailed in Appendix A1 and Appendix A2. The appendices show the same measurement locations, with A1 having a map background and A2 having satellite imagery, both pulled from Google Maps. Best efforts were made to measure at the property line, but some locations were inaccessible. In those cases, the measurements were done at a location closer to the sound and vibration sources of your site.

MEASUREMENT RESULTS

Due to ongoing activity during business hours at the mill, we were unable to measure ambient sound levels at most locations. However, at many of those locations, we observed the dominant source of sound to be due to mill activity and the measured sound levels are likely to be representative. The locations where we were able to measure ambient sound levels without intrusion from the mill, the ambient sound levels were typically dominant. The weather during all measurements was sunny, with no precipitation, and no noticeable wind.

Sound Levels – Daytime

The daytime measurement results are shown in the table in Appendix B1 and reported as A-weighted overall levels, where L_{eq} is the five-minute equivalent continuous sound level as per the county code. Ambient sound levels were only measurable during a 30-minute shutdown at noon and only near the Route 250 where activity and equipment that remains on during the shutdown is inaudible.

For the measurement locations away from Route 250 (NV1 – NV14) we were unable to make ambient measurements due to site activity. However, site activity generally dominated the sound levels at those locations and the measurements are representative of the source. At these locations, mill operations, forklifts, log loader, and onsite truck activity generally dominated the sound levels, but specific notes for each measurement location are in the table.

For measurement locations near the road (NV15 – NV19) we were able to measure ambient sound levels near Route 250 and verify that road noise is indeed dominant, with energy averaged ambient sound levels around 74 dBA without mill operation. The ambient sound levels fluctuate due to the amount of traffic on Route 250, so they may be higher or lower for any given five-minute period. Note that NV15, NV18, and NV19 likely have source sound levels below the 60 dBA criterion, while NV16 and NV17 may have levels above the 60 dBA due to proximity of the debarking activity.

The measured sound levels exceeded the daytime criterion defined by the county (60 dBA) at NV1, NV5, NV9, NV10, and NV15 – NV19. However, after adjusting for ambient, we expect that sound levels due to mill operation only exceeded the 60 dBA at NV1, NV5, NV9, NV10, NV16, and NV17.

Sound Levels - Nighttime

The nighttime measurement results are shown in the table in Appendix B2 and reported as A-weighted overall levels. Again, L_{eq} is the five-minute equivalent continuous sound level as per county code. Ambient sound levels were not measurable because the limited nighttime operations at the mill are continuous.

The measured sound levels exceeded the nighttime criterion defined by the county (55 dBA) at NV2, NV9, and NV15 – NV19. NV2 sound levels were dominated by boiler fan noise, while NV9 sound levels were dominated by boiler operations; so these locations need little-to-no ambient correction and do exceed the county's nighttime noise ordinance of 55 dBA. However, we expect that sound levels due to mill operations at NV15 – NV19 would have been in compliance with the ordinance after considering the much higher ambient sound levels of Route 250.

Vibration

The measurement results are shown in the table in Appendix B3 and reported as Peak Particle Velocity (PPV) levels in units of inches per second. This table shows the maximum PPV, typical PPV, and the continuous PPV during the 5-minute measurement period for each location. For the purposes of reporting the measured vibrations we have defined Max PPV as the highest level, typical PPV as the median level (50^{th} percentile), and continuous PPV as a lower level that is always present (1^{st} percentile – the level exceeded 99% of the time, basically the minimum measured level for short duration measurements). Vibration levels are not included for NV8 and NV10 locations because the ground was too soft for an accurate measurement.

For non-residential boundaries, all vibration measurements (NV1 – NV14, a mix of rural and highway commercial) were within the continuous and impulsive criteria defined by the county.

For residential boundaries, the continuous vibration criterion was exceeded at all relevant locations (NV15 – NV19), because the county's criterion is effectively zero. The typical impulsive levels exceeded the residential impulsive criterion only at NV17, while the maximum impulsive levels exceeded the criterion at all

five locations. NV17 vibrations were highest due to the debarking equipment operation, but note that contributions due to traffic were similar to that of NV15 and NV19.

To put these vibration levels into perspective we can reference the ANSI standard for human exposure to vibration[1]. The standard defines the threshold of perception in humans to be roughly equal to the impulsive criterion defined in the county code for residential boundaries at 0.006 in/sec PPV. Comparing the reported levels with the ANSI reference, the continuous and typical impulsive vibration levels generally fall well below the threshold of perception for vibration. Note also that there are no sensitive receivers at the measurement locations and that we would expect additional reductions as vibrations propagate over larger distances to human receivers.

For reference at residential boundaries, this ANSI standard also defines a site-multiplying factor to apply for different types of use and times of day. Between the hours of 7AM to 10PM for residential receivers it recommends a site multiplying factor between 1.4 and 4, meaning the suggested limit would move from 0.006 in/sec to between 0.0084 in/sec and 0.024 in/sec, which are greater than all measured levels, with the exception of maximum levels at NV17, which is at the RT 250.

NEW EQUIPMENT SOUND LEVELS

A new sorting and stacking building is being constructed near NV1 and NV2. We understand that construction of the building has already begun with roughly half of the sorting equipment in place and the stacking equipment already operational. We also understand that this equipment will have a final construction similar to the existing sorting and stacking building on the Southeast side of your site. Because we cannot easily predict the noise due to this future equipment, we are instead relying on sound and vibration radiated from the existing sorting and stacking building to estimate the sound level at NV1 and NV2 once the new building is complete.

Using sound levels measured at the multiple distances from the existing building, we estimate the new building would produce sound levels of 66 dBA at NV1 and 60 dBA at NV2. The resulting change in sound level would be about 2 dBA higher at both NV1 and NV2, as shown in Table 3.

Table 3: Estimated Sound Level after Sorter and Stacker building is complete

Measurement Location	Current Sound Level L_{eq} (dBA)	Estimated Sound Level of New Building, L_{eq} (dBA)	Estimated Total Sound Level, L_{eq} (dBA)
NV1 (~30' to New Bldg.)	69	66	71
NV2 (~120' to New Bldg.)	61	60	63

The typical vibration level at the same distance from the building would be 0.0045 in/s at NV1 and 0.0014 in/s at NV2. We do not expect a significant change in typical PPV vibration levels because the typical levels are so similar to current typical levels, as shown in Table 4.

Table 4: Estimated Typical PPV Vibration Level after Sorter and Stacker building is complete

Measurement Location	Current Typical PPV (in/sec)	Estimated Typical PPV of New Building (in/sec)	Estimated Typical PPV (in/sec)
NV1 (~30' to New Bldg.)	0.0045	0.0045	0.0045
NV2 (~120' to New Bldg.)	0.002	0.0004	0.002

[1] ANSI S2.71-1983 (r2006), Guide to Evaluation of Human Exposure to Vibration in Buildings.

FOLLOW-UP WORK

New Building Verification

We previously planned to verify the sound levels of the new building once it is complete. In our initial meeting with the county, they did not believe it would be necessary. Should it become necessary, we are available to complete that task as previously outlined.

Mitigation Recommendations

Because some of the sound and vibration levels do not comply with the county code, they may require additional information, investigation, or mitigation. We are available to respond to requests from you or the county as additional services.

I hope this provides you with the information you need at this time. If you have any questions, please contact me at 434-218-0759.

Sincerely,

Acentech Incorporated

Bill Yoder
Senior Staff Scientist

Appendix A1: Map of Measurement Locations

Appendix A2: Imagery of Measurement Locations

Appendix B1: Daytime Sound Level Measurement Results, 2018 & 2019

Measured Daytime Sound Levels Around the Property Boundary					
Measurement Location	2018 Measured L_{eq} (dBA)	2019 Measured L_{eq} (dBA)	2019 w/o Amb. L_{eq} (dBA)	Conditions	Notes for 2019 measurements (Sources given in order of dominance)
NV1	68.2	68.8	--	A, B	Forklifts, mill building
NV2	59.4	61.5	--	A, B	Mill building
NV3	58.6	57.5	--	A, B	Forklifts, truck, mill building
NV4	56.5	54.0	--	A, C	Forklifts, Rt. 250
NV5	61.7	62.1	--	A, B	Dust drop motor, forklifts
NV6	59.8	66.8	--	A, B	Forklifts, trucks
NV7	45.8	48.5	--	A, C	Forklifts, I-64
NV8	54.7	53.9	--	A, B	Forklifts, motor noise
NV9	64.8	64.1	--	A, B	Boiler fan, chipper, dust feed
NV10	69.6	63.4	--	A, B	Mill building
NV11	59.5	57.9	--	A, B	Debarker, mill building
NV12	61.9	56.5	--	A, B	Mill building
NV13	55.9	54.0	--	A, C	Truck at mill, I-64
NV14	64.5	59.3	--	A, B	Log loader, truck at mill
NV15	70.2	74.1	< 64	D, E	Rt. 250 dominates, debarking quieter and intermittent
NV16	70.4	72.1	< 62	D, E	Rt. 250 dominates, debarking is intermittent
NV17	80.5	76.6	< 73	D, E	Rt. 250 dominates, debarking is intermittent
NV18	71.2	73.8	< 64	D, E	Rt. 250 dominates, debarking quieter and intermittent
NV19	71.8	71.7	< 62	D, E	Rt. 250 dominates, debarking quieter and intermittent

A - Ambient was unmeasurable, the mill never shut down or activity never stopped.
B - Measured level was observed to be due to the mill, not strongly impacted by ambient.
C - Measured level was observed to be due to the mill and ambient.
D - Measured level was observed to be due to ambient, not strongly impacted by the mill.
E - Applying ambient corrections following the ordinance's correction table.

Appendix B2: Nighttime Sound Level Measurement Results, 2019

Nighttime Sound Levels Around the Property Boundary				
Measurement Location	2019 Measured L_{eq} (dBA)	2019 w/o Amb. L_{eq} (dBA)	Conditions	Notes for 2019 measurements (Sources given in order of dominance)
NV1	51.9	--	A, C	Rt. 250 and boiler fan equally dominant.
NV2	56.0	--	A, B	Boiler fan, bugs
NV3	52.6	--	A, B	Boiler fan, bugs
NV4	47.0	--	A, D	Rt. 250, bugs
NV5	47.4	--	A, D	I-64, bugs
NV6	50.9	--	A, C	Boiler fan, I-64, bugs
NV7	50.3	--	A, D	I-64, bugs.
NV8	51.3	--	A, C	I-64, boiler fan, bugs.
NV9	61.5	--	A, B	Boiler fan, scroll motor? at the mill building
NV10	49.9	--	A, B	Boiler fan, mill building, bugs
NV11	50.9	--	A, B	Mill building, I-64, bugs
NV12	52.1	--	A, C	I-64, bugs, boiler fan
NV13	52.0	--	A, D	I-64, bugs
NV14	51.8	--	A, C	Rt. 250, I-64, bugs, boiler fan
NV15	63.6	< 54	A, D, E	Rt. 250, I-64, bugs
NV16	70.0	< 60	A, D, E	Rt. 250, I-64, bugs
NV17	65.2	< 55	A, D, E	Rt. 250, I-64, bugs
NV18	66.3	< 56	A, D, E	Rt. 250, I-64, bugs
NV19	65.7	< 56	A, D, E	Rt. 250, I-64, bugs

A - Ambient was unmeasurable, the mill never shut down or activity never stopped.
B - Measured level was observed to be due to the mill, not strongly impacted by ambient.
C - Measured level was observed to be due to the mill and ambient.
D - Measured level was observed to be due to ambient, not strongly impacted by the mill.
E - Applying maximum 10dB correction allowed by the ordinance's correction table since mill is not dominant.

Appendix B3: Daytime Vibration Measurement Results, 2018

Measured Tri-axial Peak Particle Velocity (PPV) Vibration Levels Around the Property Boundary				
Location	**Max Impulsive PPV (in/sec)**	**Typical Impulsive PPV (in/sec)**	**Continuous PPV (in/sec)**	**Notes**
Non-Residential Boundaries	**Criterion .030 in/sec**		**Criterion .015 in/sec**	
NV1	0.0077	0.0045	0.0023	Max PPV was due to forklift activity.
NV2	0.0063	0.0020	0.0016	Max PPV was due to forklift activity.
NV3	0.0070	0.0047	0.0036	Max PPV was due to forklift activity.
NV4	0.0041	0.0024	0.0020	No visible activity.
NV5, NV6	0.0084	0.0056	0.0044	Forklift and truck activity.
NV7	0.0021	0.0011	0.0006	No visible activity.
NV8	--	--	--	Ground was too soft for an accurate measurement
NV9	0.0037	0.0022	0.0012	Boom lift active at boiler.
NV10	--	--	--	Ground was too soft for an accurate measurement.
NV11	0.0025	0.0015	0.0008	Log loader activity, idling trucks at weigh station.
NV12	0.0030	0.0013	0.0009	Log loader activity, idling trucks at weigh station.
NV13	0.0037	0.0022	0.0014	Log loader activity, idling trucks at weigh station.
NV14	0.0054	0.0004	0.0003	Log loader activity, idling trucks, traffic pass-by.
Residential Boundaries	**Criterion .006 in/sec**		**Criterion .00 in/sec**	
NV15	0.0157	0.0039	0.0019	Max PPV was due to traffic pass-by.
NV16	0.0108	0.0050	0.0030	Max PPV was due to traffic pass-by.
NV17	0.0308	0.0099	0.0053	PPV primarily due to debarking equipment.
NV18	0.0070	0.0038	0.0018	Max PPV was due to traffic pass-by.
NV19	0.0217	0.0030	0.0016	Max PPV was due to traffic pass-by.

APPENDIX C – GLOSSARY & LAY TERMS

C1. GLOSSARY OF TERMINOLOGY

We understand that acoustic terminology may confusing. The following is a brief glossary of some acoustical terms used in this report that you may find useful.

Accelerometer
A vibration sensor that directly measures the acceleration (rate of change of velocity) of a surface.

Ambient Sounds
The sounds due to environmental, traffic, or other nearby sources that are unrelated to the source(s) being measured.

dB = decibels, dBA = decibels, A-weighted
Decibels (abbreviated dB) are used to measure the relative loudness of sound, based on a logarithmic scale. For reference, normal human speech is in the range of 65 decibels, painful rock music or aircraft noise may be as loud as 130 decibels. A-weighting filters the sound in a way that is similar to human hearing, and hence dBA levels are often referenced in various acoustical standards. Note that a 10dB increase in sound is associated with a perceived doubling in sound level.

Hz = Hertz, frequency
The frequency of a sound or vibration in cycles per second. Low frequency is associated with bass and are low pitch, while higher frequencies are high pitched.

Leq
The equivalent continuous sound level, or energy-average sound level, over a defined measurement period. Note that the sound level may be higher or lower during the measurement period.

Receiver
The location or person(s) receiving the sound or vibration. In this case, the county's ordinances requires that measurements be made at the receiving property boundaries.

Sound Level Meter
A device used to measure the sound level at a given location. Often these are required to meet a specific class/type 0, 1, or 2 to indicate a minimum performance of the meter, where 0=Lab, 1=Precision, 2=Industrial.

Source
The equipment or operations being measured for compliance with the county's ordinances. In this case, the source is the lumber mill and related activity.

C2. SOUND IN LAY TERMS

The magnitude, or loudness, of sound waves (pressure oscillations) is described quantitatively by the terms sound pressure level, sound level, or simply noise level. The magnitude of a sound is measured in decibels, abbreviated as dB. Decibels are used to quantify sound pressure levels just as degrees are used to quantify temperature and inches are used to quantify distance. The faintest sound level that can be heard by a young healthy ear is about 0 dB, a moderate sound level is about 50 dB, and a loud sound level is about 100 dB.

Sound level meters are usually equipped with electronic filters or weighting circuits, for the purpose of simulating the frequency response characteristics of the human ear. The A-weighting filter included with essentially all sound level meters is most commonly employed for this purpose because the measured sound level data correlate well with subjective response to sounds. Sound levels measured using the A-weighting filter are designated by dBA.

The frequency of a sound is analogous to its tonal quality or pitch. The unit for frequency is hertz, abbreviated Hz (formerly cycles per second or cps). Thus, if a sound wave oscillates 500 times per second, its frequency is 500 Hz. The normal frequency range of human hearing extends from a low frequency of about 20 to 50 Hz (a rumbling sound) up to a high frequency of about 10,000 to 15,000 Hz (a hissing sound) or even higher for some people. People have different hearing sensitivity to different frequencies and generally hear best in the mid-frequency region that is common to human speech, about 500 to 4000 Hz.

An increase or decrease of the sound level by 1 or 2 dB is generally not noticeable. Whereas a change of the ambient sound level by 5 or 6 dB is generally noticeable and a change in the sound level by 10 dB is generally considered to represent a doubling or halving of the perceived sound.

C3. VIBRATION IN LAY TERMS

Vibration in buildings is often reported in terms of Vibration Velocity, where velocity represents the rate that vibration waves change. The level of vibration velocity is typically reported in micro-inches per second (µin/s) or inches per second (in/s). Unlike sound levels reported using the dB scale, vibration reported in terms of linear units (µin/s or in/s) is simpler to understand when levels change. A doubling of vibration velocity level corresponds to an actual doubling of the vibration.

As with sound, the frequency of a vibration is analogous to its tonal quality or pitch. Thus, if a vibration wave oscillates 10 times per second, its frequency is 10 Hz. People have different sensitivity to vibration, though a level of .004 inches per second, root-mean-squared (RMS) is considered a conservative threshold of perception.

In some situations, where you may be concerned about damage, vibration is calculated from the peak of the actual vibration waveform, this is known as Peak Particle Velocity (PPV). PPV is typically the metric used during large construction or mining activities that may include blasting, or where vibration may be strong enough to cause structural damage to a building or other object (such as artwork). The relationship between root-mean-squared (RMS) vibration velocity and peak particle velocity is difficult to define for various reasons, but peak particle velocity is always at least 1.4x higher than RMS vibration velocity.