August 28, 2018

Stack Wall Manufacturing 888.622.9255
149 South San Antonio Avenue
Pomona, CA 91766

SUBJECT: **Sound Test**

6 ft High Yard Wall Noise Reduction Study Report

Dear Nicole:

At your request, Advanced Engineering Acoustics (AEA) has conducted existing site ambient noise monitoring and yard wall noise reduction testing at the subject residential site that had previously installed a 6-foot high Stack Wall back yard masonry wall. The alley sound source was a 1,000 watt dodecahedron 12 speaker spherical system placed 5 feet above local grade and 18 feet east of the subject easterly property line. The selected alley monitoring site was five feet above the local grade and was located 15 feet east of the subject easterly property line. The subject property receiver sound monitoring systems were located 23 feet and 33 feet west of the sound source. The subject 6-foot high masonry yard wall centerline was 17.5 feet west of the sound source (see Figure 1).

Overall area ambient noise included light local and distant aircraft overflights. This letter report gives the noise measurement methods AEA used to calibrate a sound wall noise model and our findings.

DETERMINING THE YARD WALL NOISE REDUCTION

The noise reduction provided by any obstacle, provided it has sufficient mass, is determined by how much that the obstacle (in this case a 6-foot high masonry yard wall with sufficient mass) increases the path length difference the sound must travel from the source to the receiver (see Figure 2).

FUNDAMENTALS OF SOUND

Physically, sound pressure magnitude is measured and quantified in terms of the decibel (dB), which is associated with a logarithmic scale based on the ratio of a measured sound pressure to the reference sound pressure of 20 micropascal ($20\ \mu Pa = 20 \times 10^{-6}\ N/m^2$). However, the decibel system can be very confusing (see Fig. 1). For example, doubling or halving the number of sources of equal noise (a 2-fold change in acoustic *energy*) changes the receptor noise by only 3 dB, which is a barely perceptible sound change for humans. While doubling or halving the sound *loudness* at the receiver results from a 10 dB change and also represents a 10-fold change in the acoustic *energy* (see Table 1).

In addition, the human hearing system is not equally sensitive to sound at all acoustic frequencies. Because of this variability, a frequency-dependent adjustment called “A-weighting” has been devised so that sound may be measured in a manner similar to the way the human hearing system responds. The A-weighted sound level is abbreviated "dBA". Figure 3 gives typical A-weighted sound levels for various noise sources and the typical responses of people to these levels. All sound levels referred to in this report are A-weighted.

Figure 1. Project Aerial View with Sound Source and Noise Monitoring Sites

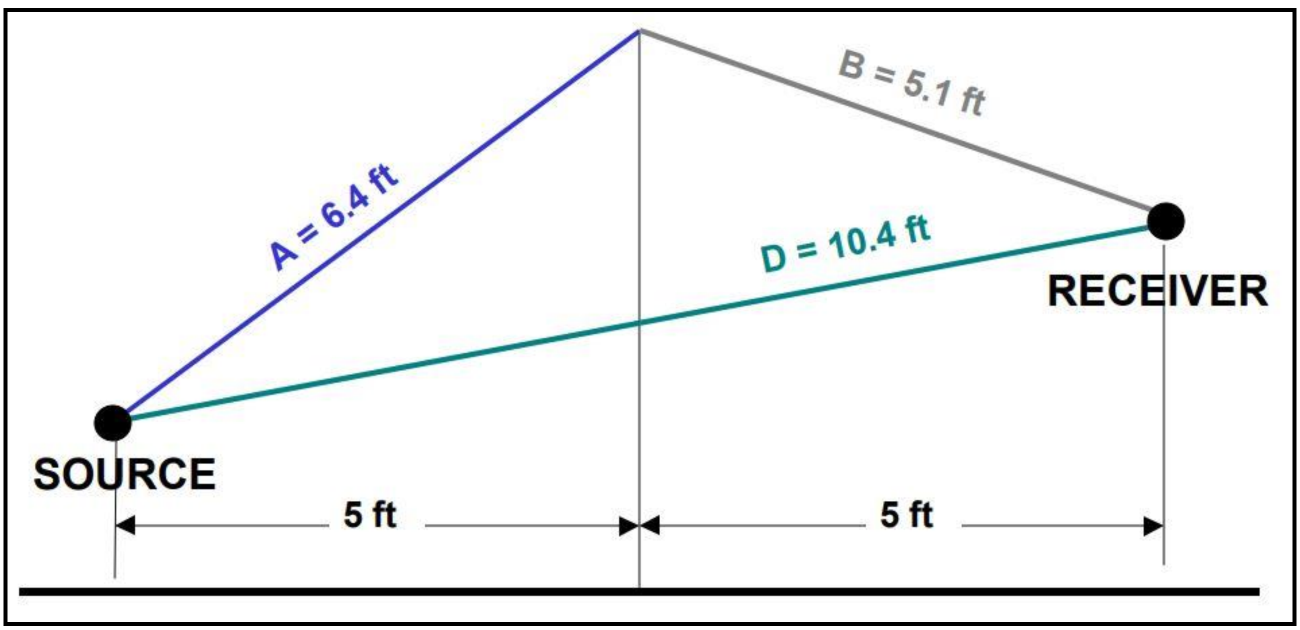

Figure 2. Sound Wall Path Length Difference (Example PLD = A+B-D = 1.1 feet)

Table 1. Human Perception of Changes in Noise Level

Change in Sound Level (Δ dB)	Change in Loudness
1 to 3 dB	"Just perceptible"
5 dB	"Noticeable" change
10 dB	"Twice" (or ½) as loud
15 dB	"Large" change
20 dB	"Four times" (or ¼) as loud

WALL NOISE REDUCTION (NR) MONITORING RESULTS

The test source noise and yard wall noise reduction were monitored for a period of time in the mid-morning of Tuesday, February 27, 2018. The noise monitors were three (3) NTi Model XL2 Type 1 Real Time Analyzer (RTA)/Sound Level Meters (SLM) with audio recording capability activated, which were calibrated according to the manufacturer's instructions prior to conducting the noise measurements. Noise calibration also was checked following the noise measurement period.

After instrument calibration, the A-weighted sound level and 1/3rd Octave Band sound pressure levels were monitored continuously and logged by the minute. The noise measurements also included the energy average sound level (L_{eq}), the minimum sound level (L_{min}) and the maximum sound level (L_{max}). Tables 2 and 3 summarize the results of the 6-foot yard wall noise reduction (NR) study. The computer program calculated results, based on the noise measurement calibrations by AEA, are in the Appendix.

By comparing the noise reductions (NR) for 1-foot high (e.g. tires and tail pipe exhaust noises) and 5-foot high noise sources (e.g., people talking), one sees that the noise sources closer to the ground result in greater Path Length Distances (PLD) tyhan do those higher in elevation. Noise source that are the same height as the yard wall (grazing incidence) would be expected to have a noise reduction of about 5 dB. Noise sources higher than the yard wall would not be expected to be reduced by the wall except for locations quite close to the receiver side of the wall. Higher yard walls that provide a greater PLD would also provide greater noise reduction. Other factors also affect the performance of yard wall noise reduction. For example, this study dealt with hard ground surfaces on both sides of the yard wall. Different results would be expected for cases where a hard surface (pavement) is on one side of the wall and a soft surface (lawn grass) is on the other side of the wall. And different results would also occur for soft ground surfaces on both sides of the yard wall.

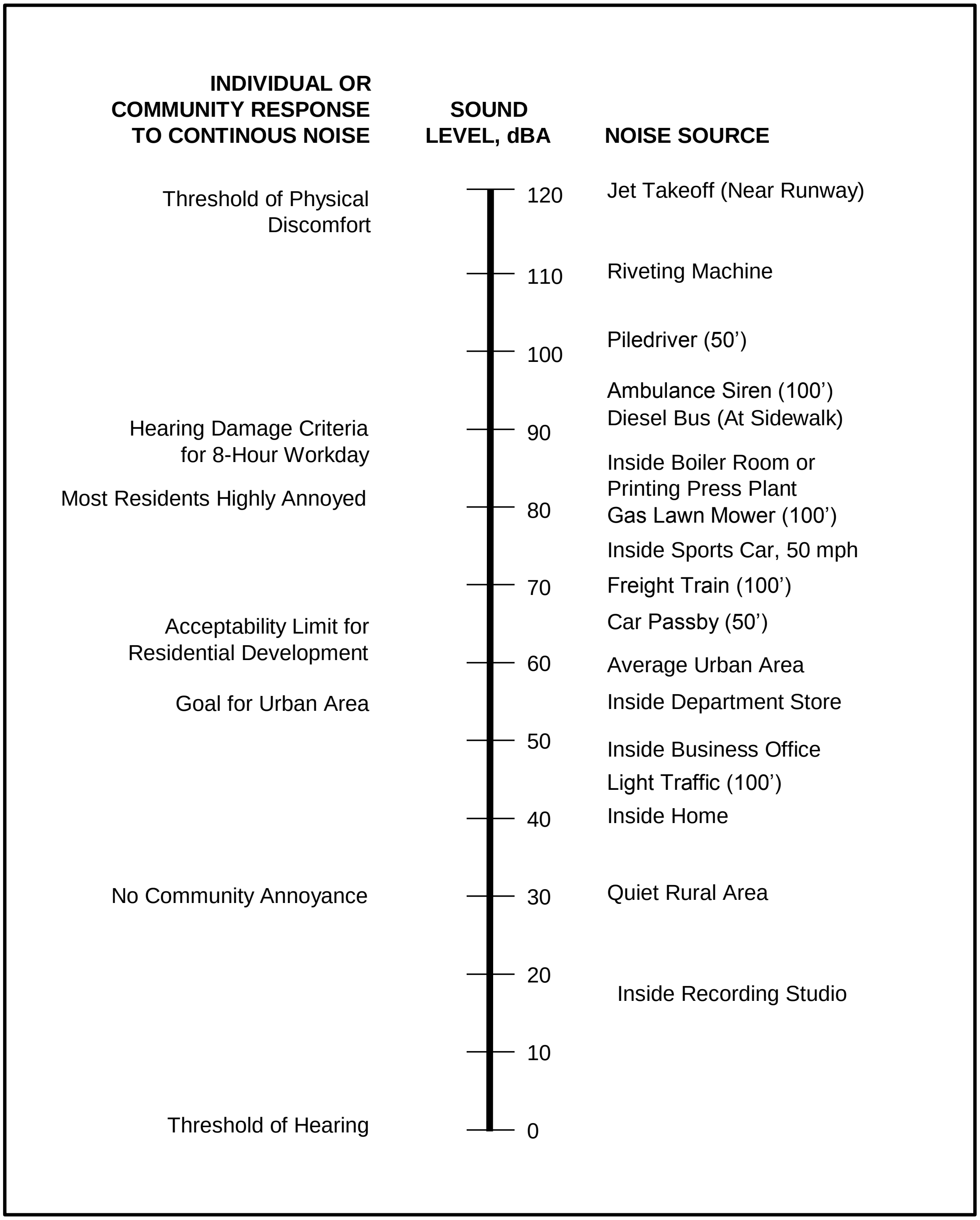

Figure 4. Typical Sounds from Indoor and Outdoor Noise Sources and their Effect on People

Table 2. 1-ft Alley Source Noise Reduction (Hard Ground Surfaces on Both Sides of Wall)

Source to Receiver Horizontal	ALLEY NOISE SOURCE 1-FT HIGH Extended NR Results Based on AEA Tests for Hard Alley and Hard Yard Ground Results Without and With 6-Foot High Yard Wall Noise Source 1-ft above Grade		
	w/o Wall	w/ Wall *	NR
5	85.6	85.6	0.0
10	81.0	81.5	-0.5
15	77.8	79.3	-1.5
20	75.4	63.4	12.0
25	73.5	61.9	11.6
30	71.9	60.2	11.7
35	70.6	58.7	11.9
40	69.4	57.4	12.0
45	68.4	56.3	12.1
50	67.4	55.3	12.1
55	66.6	54.4	12.2
60	65.8	53.6	12.2

* Wall is 17.5 feet from noise source.

Table 3. 5-ft Alley Source Noise Reduction (Hard Ground Surfaces on Both Sides of Wall)

Source to Receiver Horizontal	ALLEY NOISE SOURCE 5-FT HIGH Extended NR Results Based on AEA Tests for Hard Alley and Hard Yard Ground Results Without and With 6-Foot High Yard Wall Noise Source 5-ft above Grade		
	w/o Wall	w/ Wall *	NR
5	93.4	93.4	0.0
10	87.3	87.7	-0.4
15	83.7	85.1	-1.4
20	81.2	71.5	9.7
25	79.2	71.4	7.8
30	77.6	70.4	7.2
35	76.2	69.3	6.9
40	75.1	68.3	6.8
45	74	67.4	6.6
50	73.1	66.6	6.5
55	72.2	65.8	6.4
60	71.4	65.1	6.3

* Wall is 17.5 feet from noise source.

CONCLUSIONS

This concludes our report on the subject 6-foot high yard wall noise reduction. If you have any questions regarding this report, please contact us at (909) 397-5350