APPENDIX H

Noise Study for Interior Noise Levels

Veneklasen Associates
Consultants in Acoustics | Noise | Vibration | AV | IT

April 3, 2018

The Richman Group of California
7817 Herschel Avenue, Suite 102
La Jolla, California 9237

Attention: Mike Arduino | Development Associate

Subject: **Station Square Multi-Family Development**
Monrovia, California
Exterior Façade Acoustical Design
VA Project No. 6691-004

Dear Mike:

Veneklasen Associates (VA) has completed our review of the Station Square project located in Monrovia, California. This report presents our computer modeling predicting the exterior noise levels as a function of location on the exterior of the proposed development. The model is based on exterior noise from traffic, planes and trains, where applicable. Using the computer model, VA predicts the interior noise level using the acoustical performance of the façade elements to show compliance with Building Code requirements. The acoustical performance of the façade element is included. This report represents the results of our findings.

1.0 INTRODUCTION

This study was conducted to determine the impact of the exterior noise sources on the Station Square project in Monrovia, California. VA's scope of work included calculating the exterior noise levels impacting the site and determining the method, if any, required to reduce the interior and exterior sound levels to meet the applicable code requirements of the State of California and the City of Monrovia.

The project consists of 5 story buildings with a total of 296-dwelling unit, ground-level retail occupancy, the projects also includes residential amenities, a parking lot and a pool court on ground-level. The proposed site is bounded by South Magnolia Avenue to the west, a recycling center to the east, Metro Gold line to the north, and West Duarte Road to the south.

2.0 NOISE CRITERIA

CNEL (Community Noise Equivalent Level) is the 24-hour equivalent (average) sound pressure level in which the evening (7 pm–10 pm) and nighttime (10 pm – 7 am) noise is weighted by adding 5 and 10 dB, respectively, to the hourly level. Since this is a 24-hour metric, short-duration noise events (truck pass-by's, buses, trains, etc.) are not as prominent in the analysis.

Leq (equivalent continuous sound level) is defined as the steady sound pressure level which, over a given period of time, has the same total energy as the actual fluctuating noise.

2.1 Exterior Noise Levels – Residential

Program No. 3 of the City of Monrovia Noise Element of the General Plan states that the city may implement a noise zoning code defining compatible land usage requirements. However, there is no explicit criteria for maximum allowable noise levels at residential outdoor use areas in either the Municipal Code or General Plan. This criterion would typically apply to useable outdoor activity areas excluding porches and balconies.

The Noise Element does reference the California Building Code (Title 24, Part 2, Appendix Chapter 12, California Code of Regulations), which defines noise levels at playgrounds and neighborhood parks up to 70 CNEL as "Normally Acceptable". This is understood to include smaller, residential outdoor use areas.

2.2 Interior Noise Levels - Residential

The State of California Building Code (Section 1207, "Sound Transmission") and the City of Monrovia Noise Element state that interior CNEL values for residential land uses are not to exceed 45 CNEL in any habitable room.

If the windows must be closed to meet an interior level of 45 CNEL, then a mechanical ventilating system or other means of natural ventilation shall be provided.

2.3 Vibration Limits and Guidelines

Section 12.08.560 of the Los Angeles County Noise Control Ordinance limits vibration levels from a source to other properties to 0.01 inches per second.

The "Transit Noise and Vibration Impact Assessment" report from the Federal Transit Administration, U.S. Department of Transportation, dated May 2006 ("FTA Report"). The criterion presented in Table 8-1 of that report for "Frequent Events" (defined as more than 70 events per day of the same source) in residences is that the vibration levels not exceed 72VdB. FTA guidelines are not enforced by the state or city code and compliance is not required.

2.4 CALGreen – Non-residential

Section 5.507.4.2 of the 2016 California Green Building Code stipulates that for buildings exposed to a noise level of 65 dB or more when measured as a 1-hour Equivalent Sound Level (Leq), the building façade, including walls, windows, and roofs, shall provide enough sound insulation so that the interior sound level from exterior sources does not exceed 50 dBA during any hour of operation. This applies to non-residential spaces such as retail space, leasing, and amenities.

3.0 EXTERIOR NOISE AND VIBRATION MEASUREMENTS

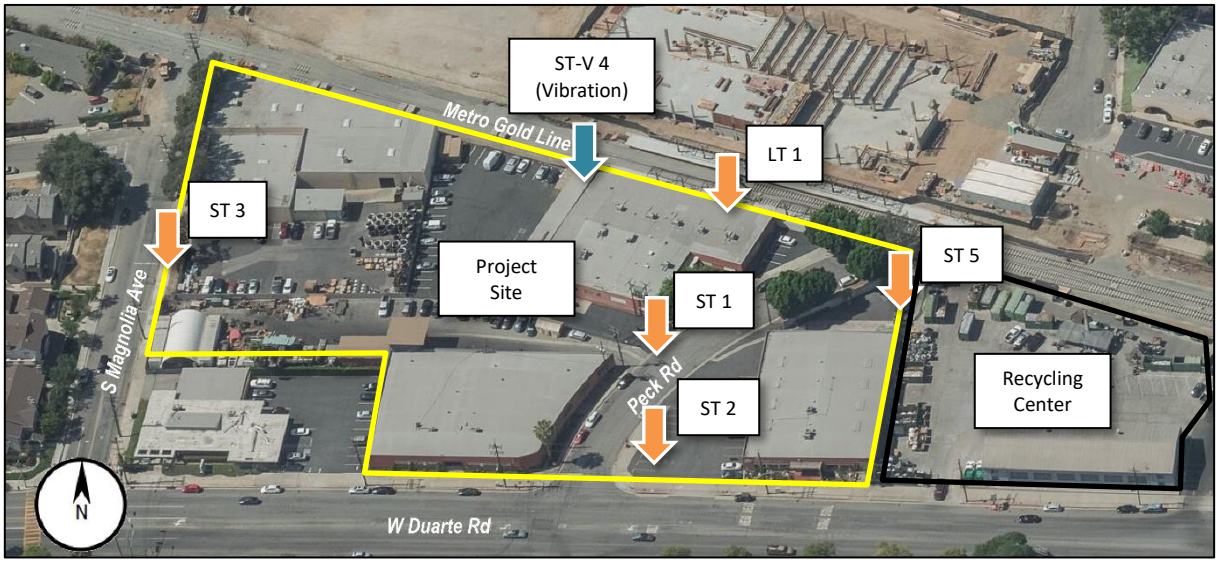
VA visited the site on January 17th, 18th and 19th, 2018 to place sound monitoring systems at different locations within the project site to capture the hourly sound levels on the site for a 24-hour period. VA also made short-term noise measurements. In addition, ground vibration levels were measured using an accelerometer mounted to a stake driven into the ground to capture the train activity at the site. Measurements were made at 20 ft. (approx.) from the rail tracks which is the nearest residence location. Another set of measurements was performed on March 26, 2018 to further quantify noise exposure from an adjacent recycling center.

Metro Gold Line and vehicular movement on Duarte Road, South Magnolia Avenue, and Peck Road are the primary sources of noise affecting the site. It was also noted the contribution of noise along the eastern boundary where the recycling center is located. Heavy truck activity and transportation of big trash-containers were observed. Although the noise was not constant over long periods of time, some events such as trash-containers slamming on the ground can be clearly heard. Table 1 and Figure 1 show the location and summary of the noise measurements.

Table 1 – Measured Sound Levels

Street/Source	Location	CNEL
Metro Gold Line	LT 1	67
Peck Road	ST 1	61
West Duarte Road	ST 2	68
South Magnolia Avenue	ST 4	65
Peck Road	ST 5	65

Figure 1 – Aerial View of Project Site Showing Measurement Locations

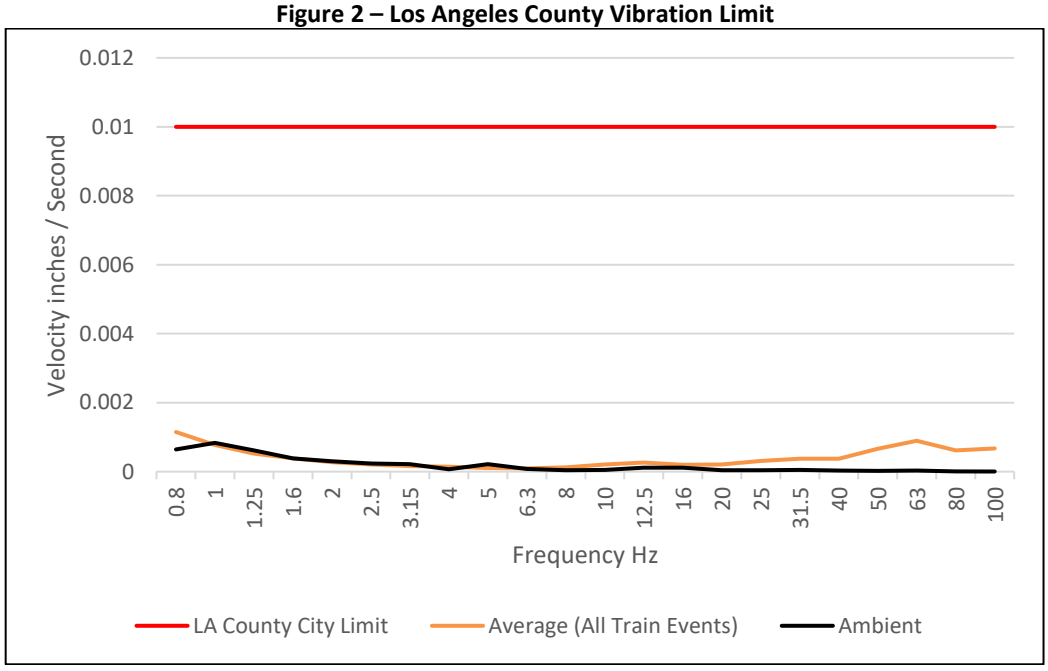


4.0 VIBRATION IMPACT

Vibration measurements were made along the north boundary of the site to determine the environmental impact of the Metro Gold Line due to train activity. Measurements were made at 20 feet (approx.) from the nearest rail track. This corresponds to the approximate position of the nearest residence to the tracks.

Los Angeles County Vibration Limit:
Several train events were captured and used to analyze the impact of vibration at the proposed site. To simplify the analysis, all the train events were averaged in one set of data. Figure 2 presents the measured train events in comparison with the City of Los Angeles County vibration limit.

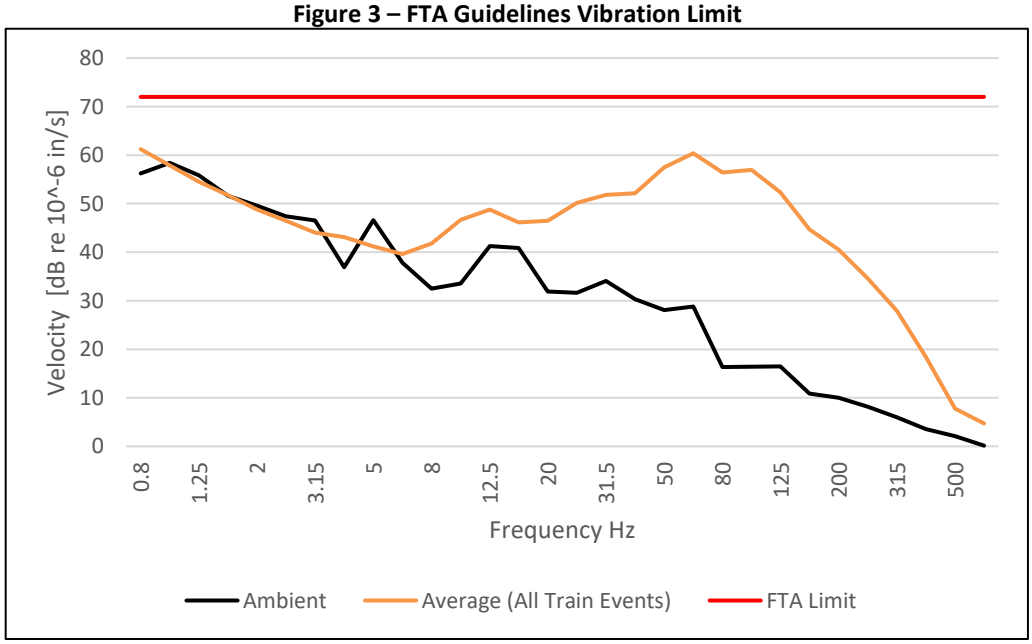
Figure 2 – Los Angeles County Vibration Limit



FTA Guidelines:

For train sources, guidelines are provided in the "Transit Noise and Vibration Impact Assessment" report from the Federal Transit Administration, U.S. Department of Transportation, dated May 2006 ("FTA Report"). The criterion presented in Table 8-1 of that report for "Frequent Events" (defined as more than 70 vibration events of the source per day) in residences is that the vibration levels not exceed 72VdB. Metro Gold Line's schedule show more than 70 train events a day. Figure 3 presents the measured train events in comparison with the FTA guidelines vibration limit.

Figure 3 – FTA Guidelines Vibration Limit



As is shown in both figures above, the City of Los Angeles County and the FTA guideline will be

satisfied and no mitigation is required.

Note that the FTA guideline is more stringent than the County of Los Angeles and complying with such guideline isn't a state or city requirement. However, even when satisfying the FTA guideline, it does not imply that vibration from train activity will not be perceptible. The proximity to the train tracks and the possibility of perceiving vibration from train pass-by's should be disclosed to potential residents.

Vibration in lightweight structures often increases on the upper floors due to structural resonances, so that occupants of higher floors may experience increased vibration levels. The predictions show that the vibration levels will remain below the FTA guideline.

5.0 EXTERIOR NOISE ENVIRONMENT

5.1 Recycling Center

During the site visit, VA personnel observed high-impact noise including big containers being loaded/unloaded and heavy truck activity at the recycling center located on the east boundary. As the data reflects, some of the events witnessed while installing the monitoring equipment were not detected during the initial measurement. VA subsequently performed additional measurements in order to accurately ascertain the noise exposure due to recycling activity. Additionally, VA utilized data of the same nature from a similar recycling center to predict both the average and maximum noise levels at the property line between the project site and the recycling center. The average noise exposure at the outdoor use area adjacent the recycling center was calculated to be 65 CNEL. This is within the "Normally Acceptable" limits as defined in the California Building Code.

5.2 Metro Gold Line Noise Levels

As is shown in

Figure 1, the Metro Gold Line train runs along the north boundary of the site. The schedule indicates that the trains run every 7-10 minutes from approximately 3am-2am which is almost 24 hours. The most common noise events registered were train pass-by and speaker PA announcements. The maximum average noise event at LT1 was approximately 85 dBA. VA utilized 85 dBA as the maximum noise level at the north façade of the site.

5.3 Computer Modeling

VA has utilized the Traffic Noise Model computer software program developed by the FHWA (Federal Highway Administration TNM 2.5) in order to predict vehicular noise levels at various locations. The primary purpose of the computer model was to determine how the noise environment will change due to traffic and site changes.

Table 2 – Traffic Counts

Street	ADT (2010)	8 Year Prediction*
Duarte Rd.	20461	22156
Magnolia Ave.	3409	3691

**Based on 1% increment per year.*

Traffic counts for local streets were obtained from the City of Monrovia General Plan.

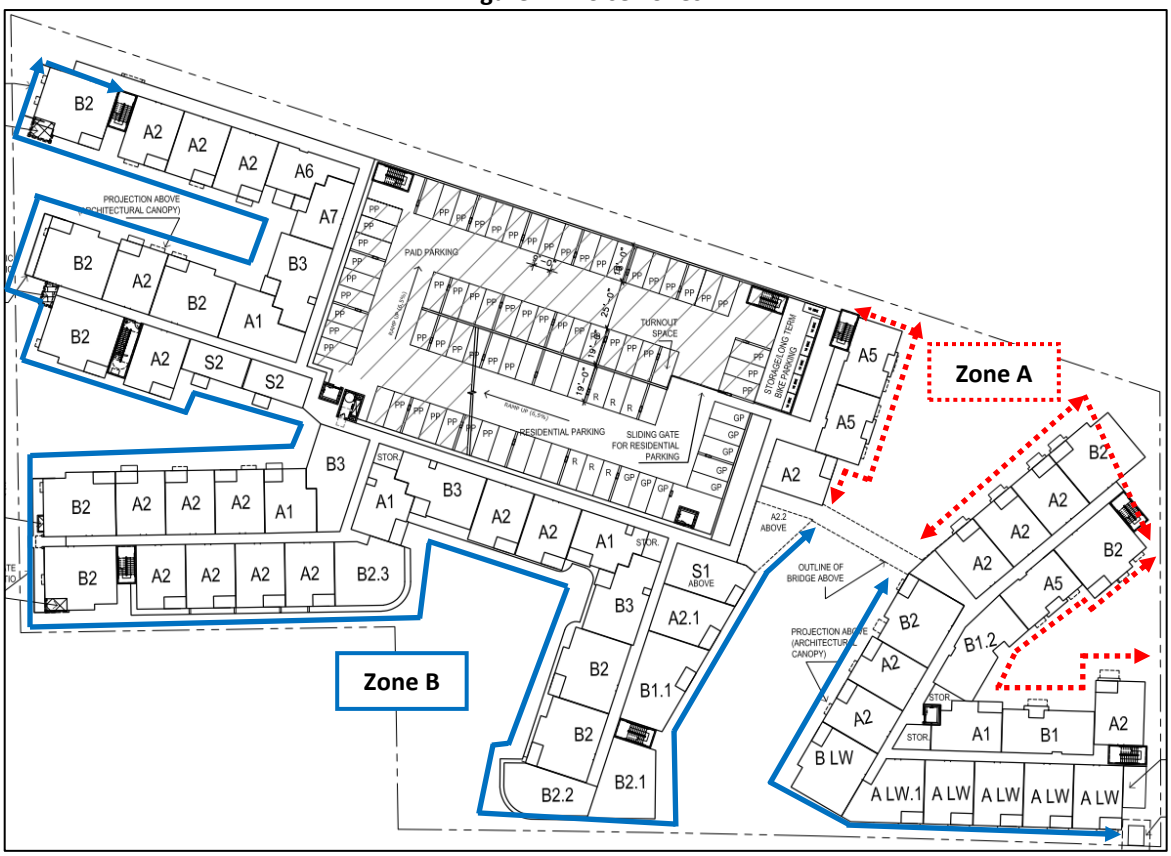
5.4 Overall Exterior Exposure

Based on the computer model and measurements, VA calculated the noise level at different locations across the project site. To simplify the presentation of the exterior noise levels, VA has separated the site into locations based on the sound exposure and required mitigation. The predicted sound levels at each zone, shown in Figure 4, are listed in Table 3 below.

Table 3 – Exterior Noise Levels

Location	Exterior Noise Level, CNEL
Zone A	65-68
Zone B	62-67

Figure 4– Noise Zones



6.0 EXTERIOR NOISE LEVELS AT OUTDOOR USE AREAS

The plans show that the project contains courtyard areas along the west and east property lines, a pool area along the south property line, and publicly accessible walk space along Peck Road. The calculated noise level at all exterior use areas is between 62-68 CNEL. This is less than 70 CNEL and is acceptable for outdoor use areas, as described in Section 2.1.

7.0 INTERIOR NOISE CALCULATION

7.1 Exterior Facade Construction

The plans provided for the client did not show any partition details. VA understands that the exterior wall construction will consist of 3 coat stucco over sheathing on wood studs with a single layer of gypsum board on the interior and batt insulation in the cavity. This type of construction is typically used for exterior façade conditions.

Our calculations include the roof path, but the sound contribution from this path was small.

VA utilized the glazing ratings (glass, frame and seals) shown in Appendix I.

7.2 Interior Average Noise Level (CNEL) – Residential

VA calculated the interior level within the residential units given the measured noise environment and the exterior facade construction described above. Calculations were based on the plans dated on January 15, 2018. Table 4 shows the predicted interior CNEL noise levels based on the windows and doors with STC ratings as shown and glazing construction as described in Appendix I.

Table 4 – Calculated Interior CNEL Noise Levels

Location	Exterior Noise Level, CNEL	Window/ Door Rating	Interior Noise Level, CNEL
Zone A	65-68	STC 31	40-43
Zone B	62-67	STC 30	37-41
Remaining units	<60	No requirement STC 30 suggested	-

7.3 Mechanical Ventilation - Residential

Because the windows and doors must be kept closed to meet the noise requirements, mechanical or other means of ventilation may be required for all units in Zone A and Zone B. The ventilation system shall not compromise the sound insulation capability of the exterior facade assembly.

7.4 CALGreen – Non-Residential

In a similar manner, VA calculated the noise level within Retail, Leasing and other non-residential spaces. CALGreen is based on the loudest hourly Leq. VA utilized a statistical methodology to determine this level from the measurements[1]. The results are shown in Table below and a sample of the calculations is included in the appendices.

Table 5 – Calculated Interior Average Noise Levels at Non-Residential Areas

Location	Exterior Leq, dBA Loudest hour	Minimum Glazing	Interior Leq
Zone B Non-residential	60-65	STC 31	< 50

[1] LoVerde, John; Dong, Wayland; Rawlings, Samantha. “Noise Prediction of Traffic on Freeways and Arterials from Measured Data.” Noise-Con 2014. Fort Lauderdale, Florida.

8.0 SUMMARY

The following summarizes the acoustical items required to satisfy the noise criteria as described in this report.

Residential

- The average exterior noise level at outdoor use areas will be less than 70 CNEL. This is within acceptable noise criteria, and no mitigation is required.
- Exterior wall assembly is acceptable as described in Section 7.1.
- Windows and glass doors with minimum STC ratings as shown in Table 4 with STC and Transmission Loss data specified in Appendix I are required.

Residential mechanical ventilation, or other means of natural ventilation, may be required for all units in Zone A and Zone B.

Non-Residential

- At retail, amenity, and other non-residential spaces, windows and glass doors as shown in Table 5 are required to meet the CALGreen interior noise criterion. These windows and door STC rating and Transmission Loss are specified in Appendix I.

Various noise mitigation methods may be utilized to satisfy the noise criteria described in this report. Alteration of mitigation methods that deviate from requirements should be reviewed by the acoustical consultant.

If you have any questions or comments regarding this report, please do not hesitate to contact us.

Sincerely,
Veneklasen Associates, Inc.

Pablo H. Cantero
Associate

John LoVerde
Principal

APPENDIX I – GLAZING REQUIREMENTS

In order to meet the predicted interior noise levels described in Section 6.0, the glazing shall meet the following requirements:

Table 6– Acoustical Glazing Requirements: Minimum Octave Band Transmission Loss and STC Rating

Nominal Thickness	Minimum Transmission Loss Octave Band Center Frequency (Hz)						Min. STC Rating
	125	250	500	1000	2000	4000	
1" dual	21	18	27	35	36	33	**30**
1" dual	21	19	28	35	37	33	**31**

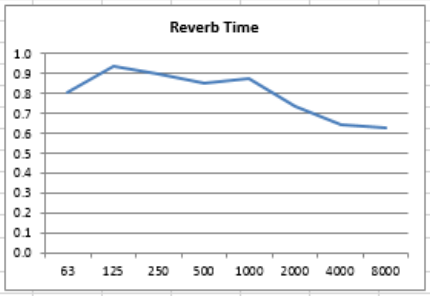
However, it should be noted that an assembly's frame and seals may limit the performance of the overall system. The assemblies given above are provided as a basis of design, but regardless of construction, the octave band transmission loss of the particular system selected must meet the minimum values in Table above. Similarly, it is permissible to use an alternate assembly construction if it meets the transmission loss requirements. Note that the systems shall not be selected on the basis of STC rating alone.

Independent laboratory acoustical test reports should be provided for review by the design team to ensure compliance with glazing acoustical performance requirements. Lab shall be a member of the NVLAP program for accreditation and shall be pre-qualified by the acoustical consultant. Lab reports shall be in compliance with ASTM standard E90 and be no more than 10 years old (from date of submission on specific project). The tests shall be performed on the entire assembly, including frame and seals. If test reports are not available for the assembly, VA would require that the assembly be tested at a third party independent lab accredited through NVLAP for the ASTM E90.

APPENDIX II – SAMPLE CALCULATIONS

Figure 5 – Calculation Sample

Project Name:	**Station Square South**													
Plan:	Retail													
Floor:	First													
Room:	B2.1													
Receiving Room Absorption														
Length	34		**Location**	**Material**	**Code**	**Area**								
Width	34		Ceiling	1" Gypboard	22	1156								
Height	15		Floor	Carpet	15	1156								
			Walls	1" Gypboard	22	1530								
Volume	17340		Furnishings	Absorption	100	350								
F/C area	1156		Glazing	1/8" Glass	47	510.0								
Wall area	2040			Enter Code & Area										
				Enter Code & Area										
				Enter Code & Area										
				Enter Code & Area										
				Total Surface Area(ft^2) =		4702								
Total Interior Level:		**42**												
					63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**	
				Room Constant	1188	997	1044	1116	1076	1304	1499	1499		
Exterior Noise Level														
		Level	Source type		**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**	
		67		Duarte Rd.	71.4	66.4	63.4	63.7	64.3	57.4	47.0	38.1	**67.0**	
				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
CNEL, LDN, or average:				**Total**	71.4	66.4	63.4	63.7	64.3	57.4	47.0	38.1	**67.0**	
		Level	Source type		**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**	
	Maximum:	0		<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
Exterior Assemblies					**Average Interior Levels**									
	Area			Assembly Type	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**	
wall				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
glazing	510.0			WEAL STC 30-31 no lam average	53.8	48.4	47.2	38.3	33.0	22.3	15.3	3.4	**41.8**	
door				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
				<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	
				Total	**53.8**	**48.4**	**47.2**	**38.3**	**33.0**	**22.3**	**15.3**	**3.4**	**41.8**	
				A-weighted	27.8	32.4	38.2	35.3	33.0	23.3	16.3	2.4		



APPENDIX III – GLOSSARY OF ACOUSTICAL TERMS

Term	Definition
Absorption	A property of material referring to how much sound it absorbs (as opposed to reflecting). In the context of this report, absorption refers to the total quantity of absorption within the receiving space. Absorption is measure in sabins.
A-weighting (dBA)	The sound pressure level in decibels as measured in an A-weighting filter network. The A-weighting de-emphasizes the low frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Decibel (dB)	A unit describing the amplitude of sound equivalent to 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound to the reference pressure of 20 μPa. Used to quantify sound pressure levels.
Equivalent Sound Level (Leq)	The time-weighted average noise level during the stated measurement period.
Sabin	A unit used to describe absorption within a space. One sabin is equal to the absorption of a one-square-foot open window.
Sound Pressure Level (SPL)	The amplitude of sound when compared to the reference sound pressure level of 20 μPa. SPL is measured in dB.
Sound Transmission Class (STC)	A single-number metric used to describe the transmission loss performance of a material or assembly across the frequency spectrum. It is intended for use primarily when speech is the noise source.
Transmission Loss (TL)	A measure of the reduction in sound level as a sound wave passes through a material. The higher the transmission loss, the better the material's sound insulating properties.

APPENDIX IV – ACOUSTICAL CALCULATION METHODS

Decibel Addition

Decibels are based on a logarithmic scale; defined as the logarithmic ratio between a measured sound pressure level and a reference sound pressure level. When decibels are added, they are not combined arithmetically, but logarithmically. Decibels are added according to the following equation.

$$SPL_{tot} = 10log\left(10^{\left(SPL_1/10\right)}\right) + 10log\left(10^{\left(SPL_2/10\right)}\right)$$

Where:
SPL_{tot} = Total Sound Pressure Level (dB or dBA)
SPL_1, SPL_2 = Sound Pressure Level 1, 2 (dB or dBA)

A-Weighting

A-weighting a spectrum is completed by applying standardized weighting factors to a frequency spectrum, either in octave bands or third-octave bands. These resultant A-weighted levels are summed using decibel addition to generate the overall A-weighted level, noted as dBA. In a report, spectral data is typically presented un-weighted, and the overall level is presented with A-weighting.

The octave band A-weighting correction factors are shown in the table below:

	Octave Band Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
A-weighting Correction Factor (dB)	-26	-16	-9	-3	0	+1	+1	-1

Acoustical Shielding

The presence of adjacent buildings or facades, changes in terrain, parapets, and other similar barriers provide acoustical shielding, reducing the sound level incident on the exterior facades. Common locations where acoustical shielding occurs include, but are not limited to, the roof, the back, and sides of the building that are not directly facing the noise source.

Acoustical shielding due to building geometry can be separated into two categories: reduction due to reduced area of exposure (side of a building), and shielding from barriers (such as a parapet or sound wall).

Reduction as a result of reduced area of exposure is calculated according to the following equation:

$$\Delta SPL = 10\log_{10}\left(\frac{\theta_{exp}}{180}\right)$$

Where:
ΔSPL = Change in Sound Pressure Level (dB)
θ_{exp} = Angle of exposure (degrees)

Acoustical Attenuation due to Distance

Sound pressure level reduction due to distance is calculated according to the following equation:

$$SPL_2 = SPL_1 + C_S \log\left(\frac{r_1}{r_2}\right)$$

Where:
SPL_1 = Sound Pressure Level at Location 1 (dB or dBA)
SPL_2 = Sound Pressure Level at Location 2 (dB or dBA)
C_S = Source Coefficient; 20 for point source, 10 for a line source
r_1 = Location 1 distance from source (ft.)
r_2 = Location 2 distance from source (ft.)

In some situations, the C_S value is between 10 and 20; selection of this number is an engineering judgment based on the relationship between the source and receiver as well as the type of source.

Interior Noise Calculation

The interior noise calculation takes into account the exterior noise level, the transmission loss of the glazing (including glass, frame, and seals), wall, and roof/ceiling systems, the finishes within the space, and noise exposure due to building geometry and acoustic shielding. The interior sound level is calculated using the equation:

$$SPL_I = SPL_E + 10\,log_{10}(A) - 10log_{10}(R) - TL + 6$$

Where:
SPL_I = the Interior Sound Pressure Level (dB or dBA)
SPL_E = Exterior Sound Pressure Level (dB or dBA)
A = Surface Area exposed to Exterior Noise (sq.ft.)
R = Room Absorption Coefficient (sabins)
TL = Sound Transmission Loss of Exterior Façade Assembly (dB)

This calculation is performed for each exposed façade individually. The total interior sound level is found by using decibel addition to sum the sound level from all exposed facades.