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Project 20020

Acoustical Analysis/Noise Study:	**Requested by:**
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Executive Summary

45dB Acoustics ("**45dB**") has analyzed existing and future transportation noise potentially impacting the proposed apartment building at the above address. Community Noise Equivalent Levels were evaluated for future sound levels as they may affect sound level compliance of outdoor activity areas and sound levels in indoor habitable spaces.

Sound level contours are presented on a 24- hour basis, consistent with the Noise Element of the General Plan.

The County of Santa Barbara General Plan, Noise Element, May 2009, provides regulation and guidelines regarding noise. Using the Noise Element along with the Santa Barbara County Land Use and Development Code, this project has been evaluated through the use of acoustic modeling with SoundPLAN® predictive noise propagation software. It is concluded that this proposed project complies with current and future County of Santa Barbara sound level guidelines, directives and standards.

for 45dB Acoustics, LLC:

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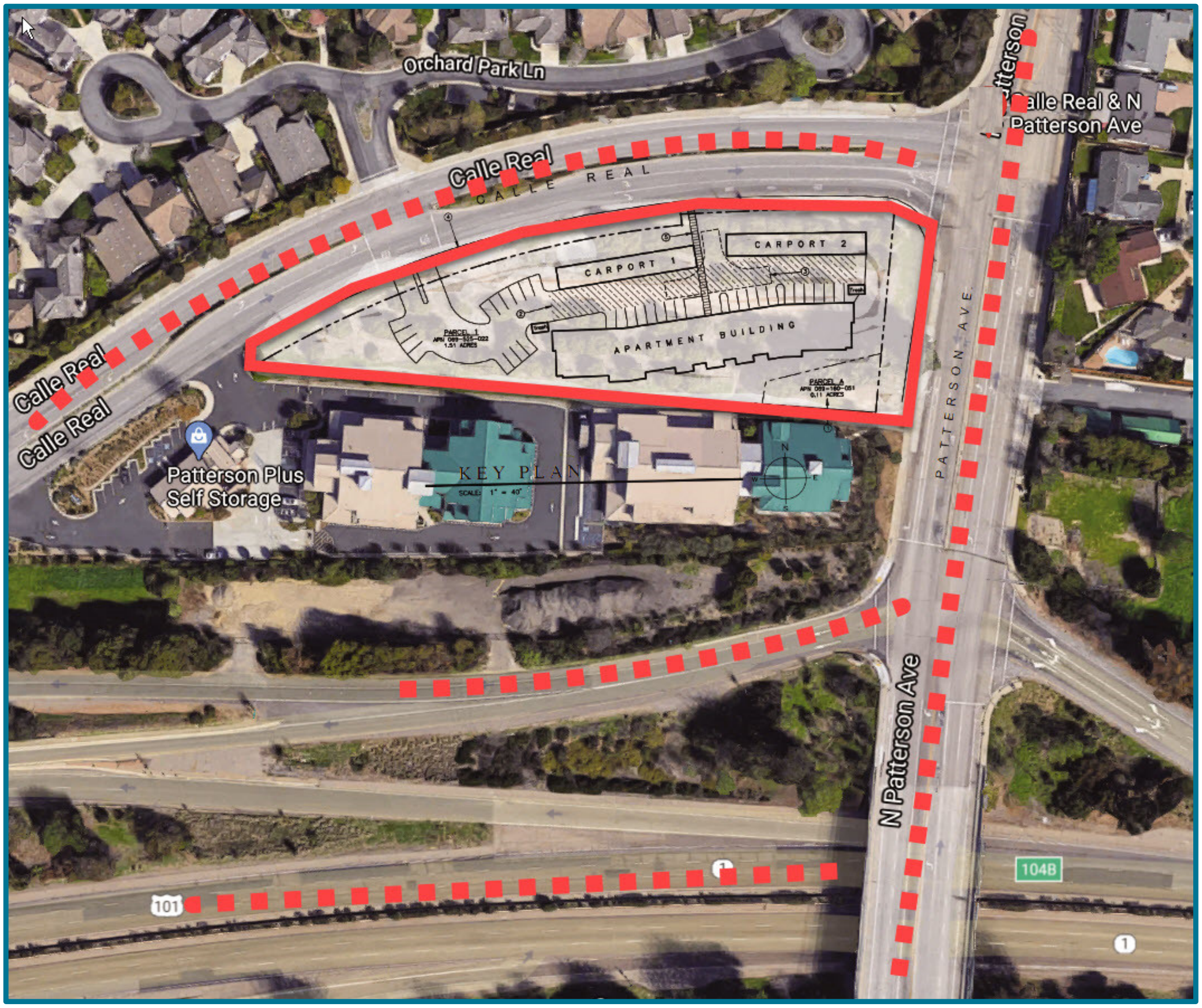
1 Introduction

This project is to be located near the intersection of Calle Real at North Patterson Ave. in Santa Barbara County. The apartment site plan shows that it lies to the north of the adjacent Patterson Plus Self Storage, which partly shields the site from the noise of U.S. Highway 101. The site is shown in Figure 1. This report details sound level and acoustic modeling to predict the potential impact of transportation noise levels on the future development.

Figure 1: Project site vicinity with transportation noise sources



2 Regulatory Setting

Noise regulations are addressed by federal, state, and local government agencies, discussed below. Local policies are generally adaptations of federal and state guidelines, adjusted to prevailing local condition.

2.1 Federal Regulation

The adverse impact of noise was officially recognized by the federal government in the Noise Control Act of 1972, which serves three purposes:

a) Promulgating noise emission standards for interstate commerce.
b) Assisting state and local abatement efforts.
c) Promoting noise education and research.

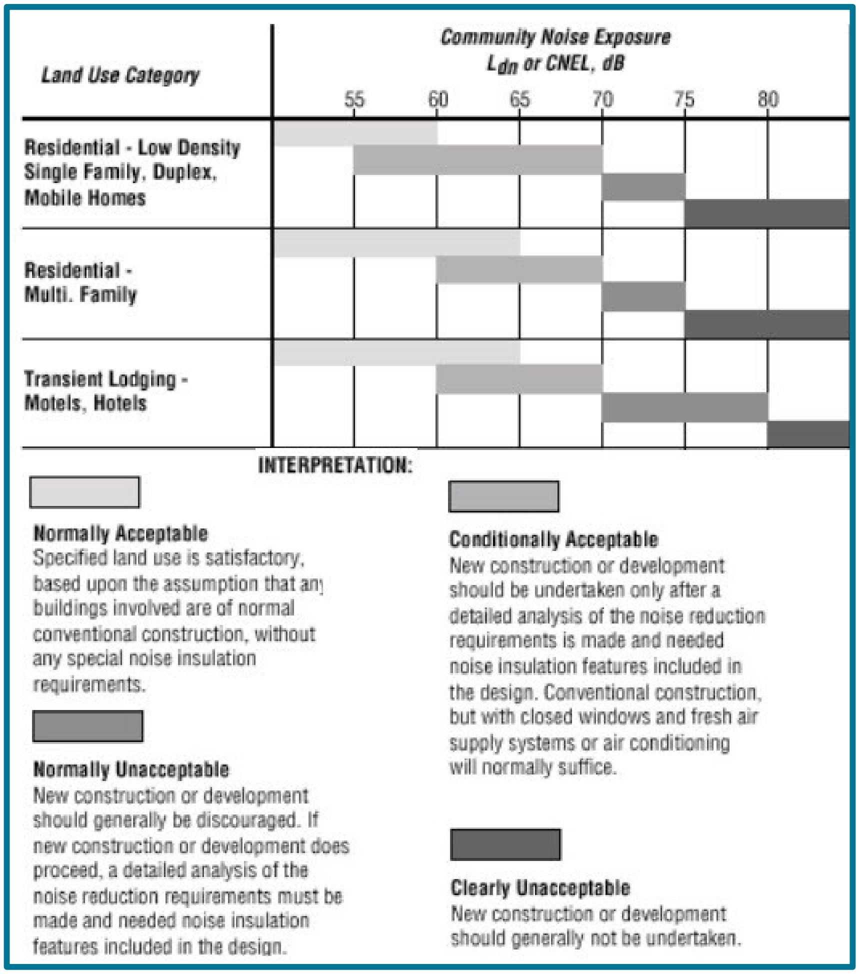
The Department of Transportation (DOT) assumed a significant role in noise control. The Federal Aviation Administration (FAA) regulates noise of aircraft and airports. Surface transportation system noise is regulated by the Federal Transit Administration (FTA). Freeways that are part of the interstate highway system are regulated by the Federal Highway Administration (FHWA).

The Santa Barbara Airport is approximately 1.5 miles to the southeast of this project and is not a noise factor here. The UPRR railroad line is approximately 700 feet to the south, hidden behind the raised road bed for U.S. Highway 101, and therefore not of concern.

2.2 Local Regulation

The County of Santa Barbara General Plan, Noise Element, May 2009, provides regulation and guidelines regarding noise. Along with the Santa Barbara County Land Use and Development Code, The Noise Element provides the conclusions, recommendations, and strategies necessary to ensure an appropriately quiet and pleasurable interior environment for the residents of the proposed project. Since the regulation of transportation noise sources such as roadway and aircraft primarily fall under either state or federal jurisdiction, the local jurisdiction generally uses land use and planning decisions to limit locations or volumes of such transportation noise sources, to avoid development within noise impact zones, or to shield impacted receivers or sensitive receptors. An outdoor CNEL/L_{DN} level of 60 dBA is acceptable here for residential housing (Table 1). For a residential multi-family development, sound levels less than 65 dBA are normally acceptable, with 60-70 dBA being conditionally acceptable. Sound levels above 70 dBA are normally unacceptable, requiring a detailed analysis of the noise reduction and noise insulation features included in the design.

Table 1: Land Use Compatibility, edited

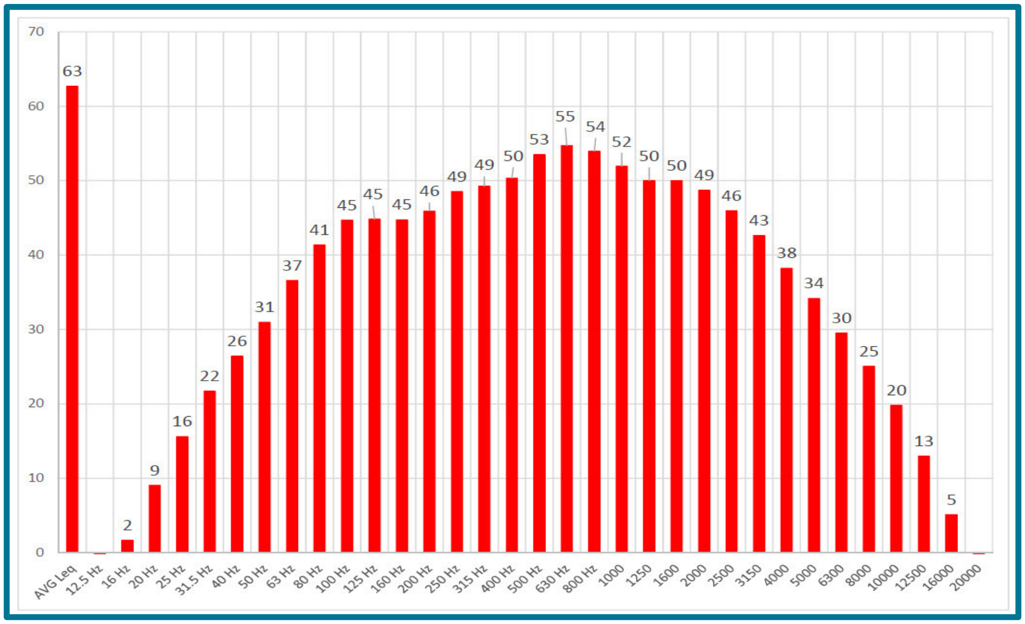


Adapted from California Noise Element Guidelines, Land Use Compatibility

3 Modeled Exterior Noise Levels

Previous studies along U.S. Highway 101 by 45dB Acoustics confirms relative noise propagation characteristics of highway traffic. Spectral content adjacent to Highway 101 reveals a distribution of sound levels across third-octave band frequencies from 16 to 20,000 Hz, as shown in Figure 2. Sound level varies predictably with distance from Highway 101 and Average Annual Daily Traffic (AADT) flow, but the relative levels, i.e., the shape of the curve, are expected to be consistently similar to this “hill shape” for Highway 101.

Figure 2: Spectral content of Highway 101 sound (typical)



To accurately model and predict noise levels, the noise propagation software SoundPLAN® utilizes traffic counts from the 2017 Caltrans database, which are shown in Figure 3, adjusted upward by approximately 1% per year to the year 2020. 132,000 AADT was used as a conservatively high traffic count near the location between Turnpike Road and Junction Route 217 South.

Figure 3: California Department of Transportation traffic volume 2017

Dist	Rte	CO	Post Mile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
05	101	SB	20.062	TURNPIKE ROAD	11400	137000	125000	10900	131000	119000
05	101	SB	21.414	JCT. RTE. 217 SOUTH	10900	131000	119000	7600	91000	82900
05	101	SB	22.533	FAIRVIEW AVENUE	7600	91000	82900	6700	81000	73500

Peak Month AADT

The peak month AADT is the average daily traffic for the month of heaviest traffic flow. This data is obtained because on many routes, high traffic volumes which occur during a certain season of the year are more representative of traffic conditions than the annual AADT.

Back and Ahead

Back AADT, Peak Month, and Peak Hour usually represent traffic South or West of the count location. Ahead AADT, Peak Month, and Peak Hour usually represents traffic North or East of the count location.

Resulting CNEL noise contours in plan view with project are shown in Figure 4, at finish grade level plus 5 feet. Receiver points placed around the apartment building will show the difference in ground (G), second floor (F2) and third floor (F3) levels at all elevations of the proposed apartment building (Table 2). Outdoor activity areas such as the 2nd floor balcony facing north and the communal activity area to the south of the apartment building are consistently at or below 60 dBA CNEL. Sound levels at the north and west elevations remain generally at or below 60 dBA CNEL, which is still within the Normally Acceptable range, requiring no mitigation.

However, sound levels are predicted to reach 70 dBA CNEL for the east elevation facing North Patterson Road, which is elevated above the site. This indicates that further analysis is necessary for this elevation.

Future noise levels, assuming a 1-percent increase per year in traffic counts, will not increase by more than 1dB, and as such, our recommendations apply to a 20-year buildout, year 2040.

Figure 4: Sound level contours at finished grade level plus 5 ft. [CNEL = dBA]

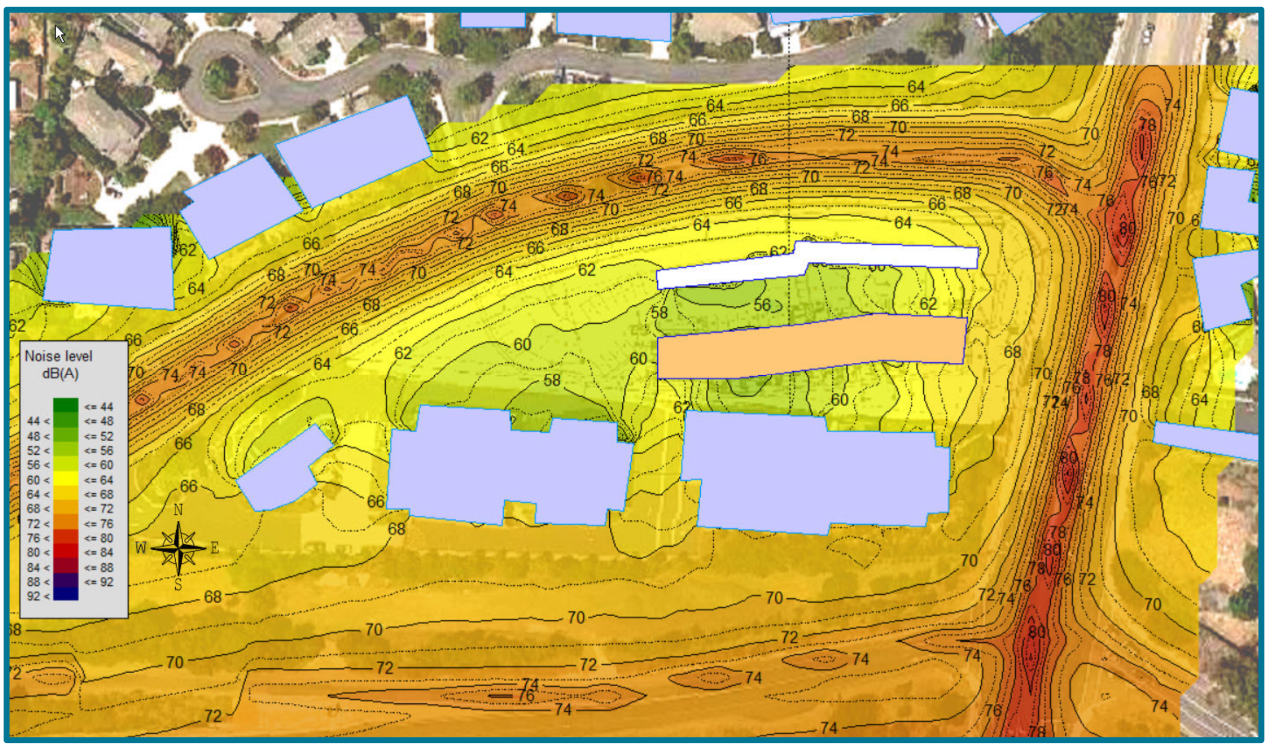


Figure 5: Vertical cross section sound level contours

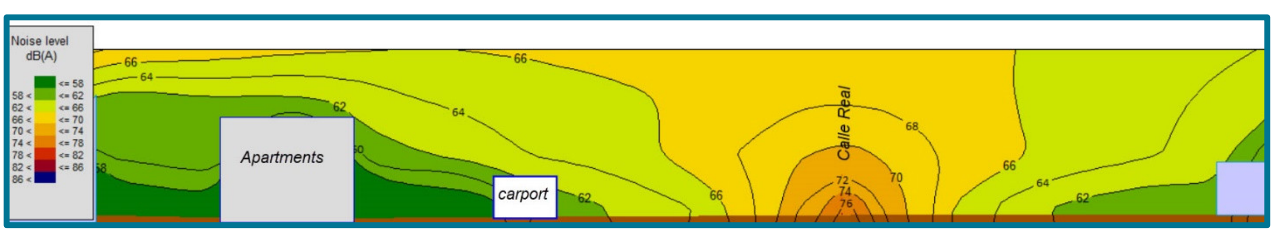


Figure 6: 3D view of project acoustic model, vertical sound level contours

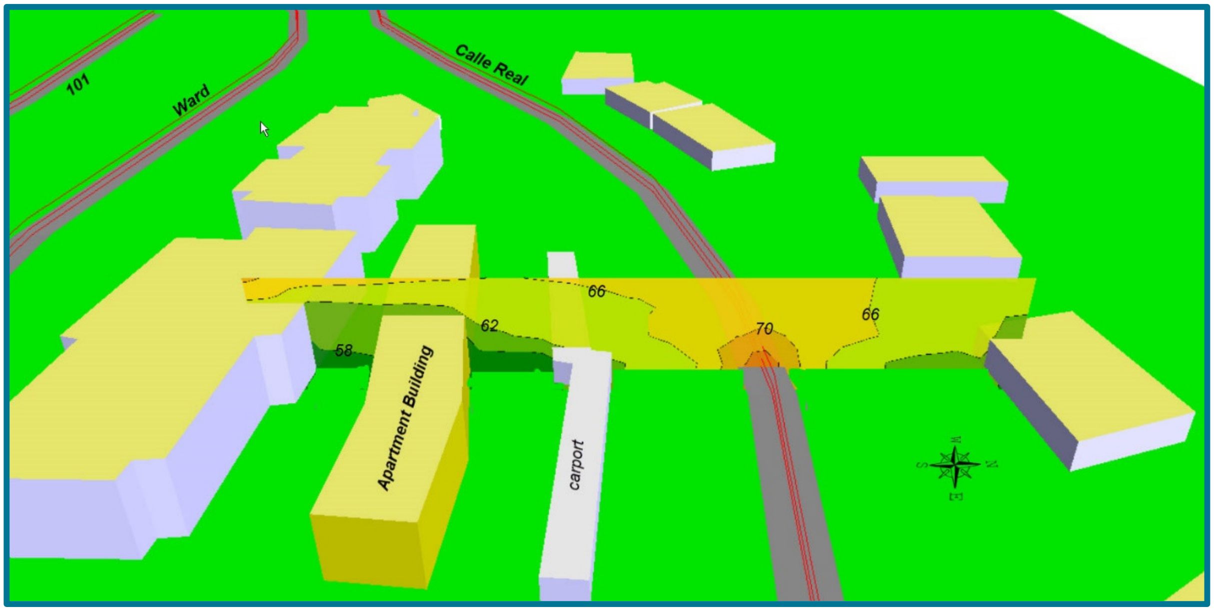


Table 2: Sound Level at: Ground ("G"), 2nd-floor ("F2"), 3rd-floor ("F3")

Receiver	Usage	Fl	Ldn dB(A)	Leq,d dB(A)	Leq,e dB(A)	Leq,n dB(A)
EastSide1	SCR	G	68.0	67.3	61.8	59.1
EastSide1	SCR	F2	69.3	68.6	63.0	60.4
EastSide1	SCR	F3	70.2	69.4	64.0	61.4
NorthSide1	SCR	G	45.4	44.2	39.0	36.9
NorthSide1	SCR	F2	47.3	45.8	40.9	39.0
NorthSide1	SCR	F3	51.2	49.4	44.8	43.1
NorthSide2	SCR	G	62.4	61.9	56.2	53.3
NorthSide2	SCR	F2	63.0	62.7	56.8	53.8
NorthSide2	SCR	F3	64.2	64.0	58.0	54.9
SouthSide1	SCR	G	61.4	60.2	55.2	52.9
SouthSide1	SCR	F2	64.5	63.3	58.3	56.1
SouthSide1	SCR	F3	65.7	64.4	59.5	57.3
SouthSide2	SCR	G	59.0	58.4	52.7	50.0
SouthSide2	SCR	F2	61.9	61.2	55.7	53.1
SouthSide2	SCR	F3	62.8	61.9	56.5	54.0
SouthSide3	SCR	G	64.3	63.5	58.1	55.6
SouthSide3	SCR	F2	66.0	65.1	59.7	57.2
SouthSide3	SCR	F3	67.1	66.1	60.8	58.4
WestEnd1	SCR	G	61.8	60.9	55.6	53.0
WestEnd1	SCR	F2	64.4	63.3	58.1	55.7
WestEnd1	SCR	F3	64.7	63.7	58.4	56.0

4 Interior Sound Level Check

The State Building Code requires that residential habitable spaces, where the exterior CNEL is 60 dBA or higher, shall be designed so that interior noise level attributable to exterior sources does not exceed 45 dBA CNEL when doors and windows are closed. Referring to Table 2Table 2, sound levels at the east end of the apartment building exceed 65 dBA. One apartment, no. 27, receives exterior noise level of 70 dBA from Patterson Avenue. See plan view of apartment 27 in Figure 7 below.

Therefore, we have calculated the interior sound level in the habitable spaces at the east end of the apartment building. We used INSUL to check interior sound level. INSUL software is an engineering application that is widely used in architectural acoustics and room acoustics. We assumed that achievable wall construction is STC 52 and window STC 30 for apartment 27. See Figure 8. The resulting composite STC / OITC for the exterior wall is 38 / 30. See Figure 9.

Figure 7: Third Floor Plan, Apartment 27

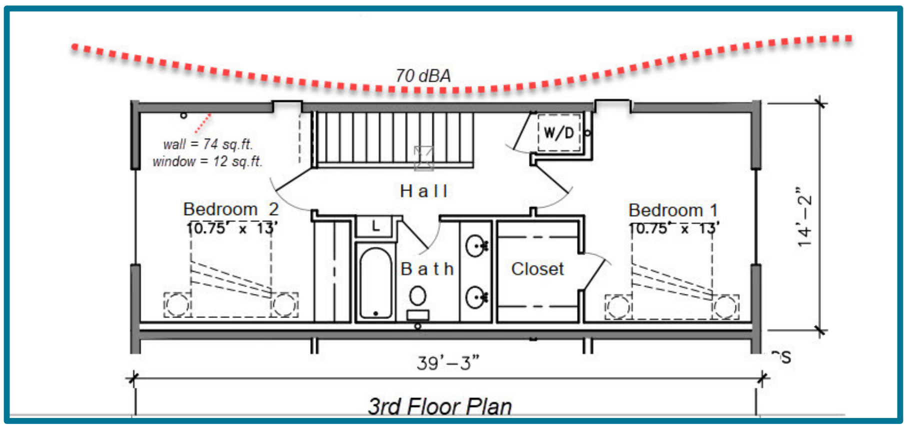
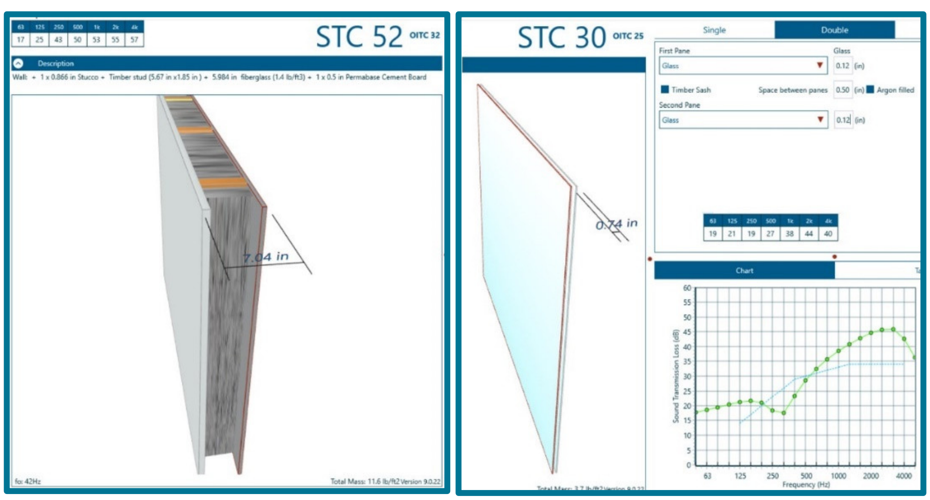
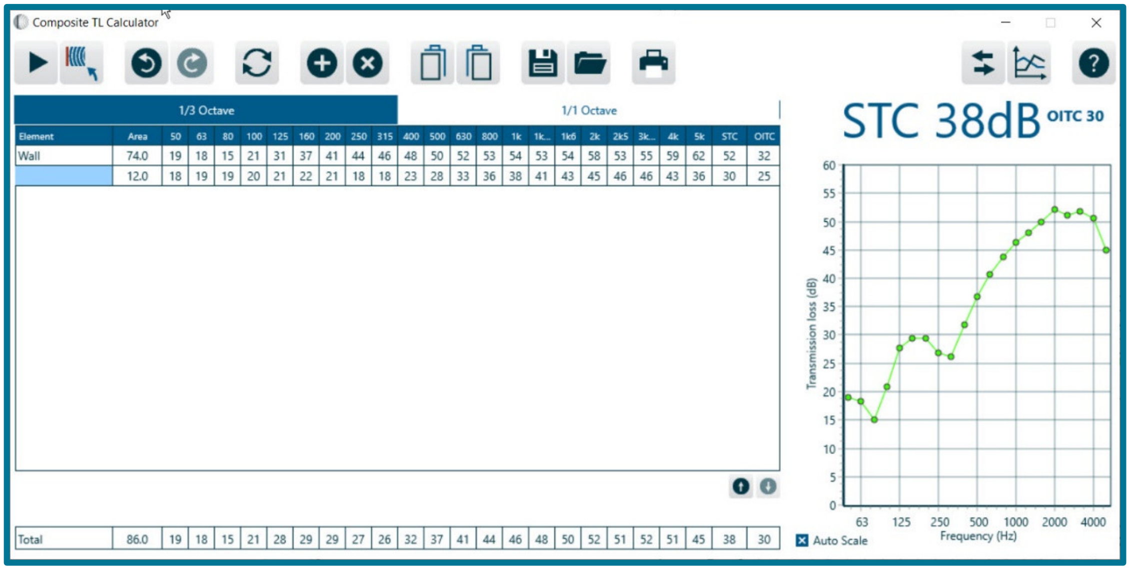


Figure 8: STC 52 exterior stucco wall, STC 30 window, typical



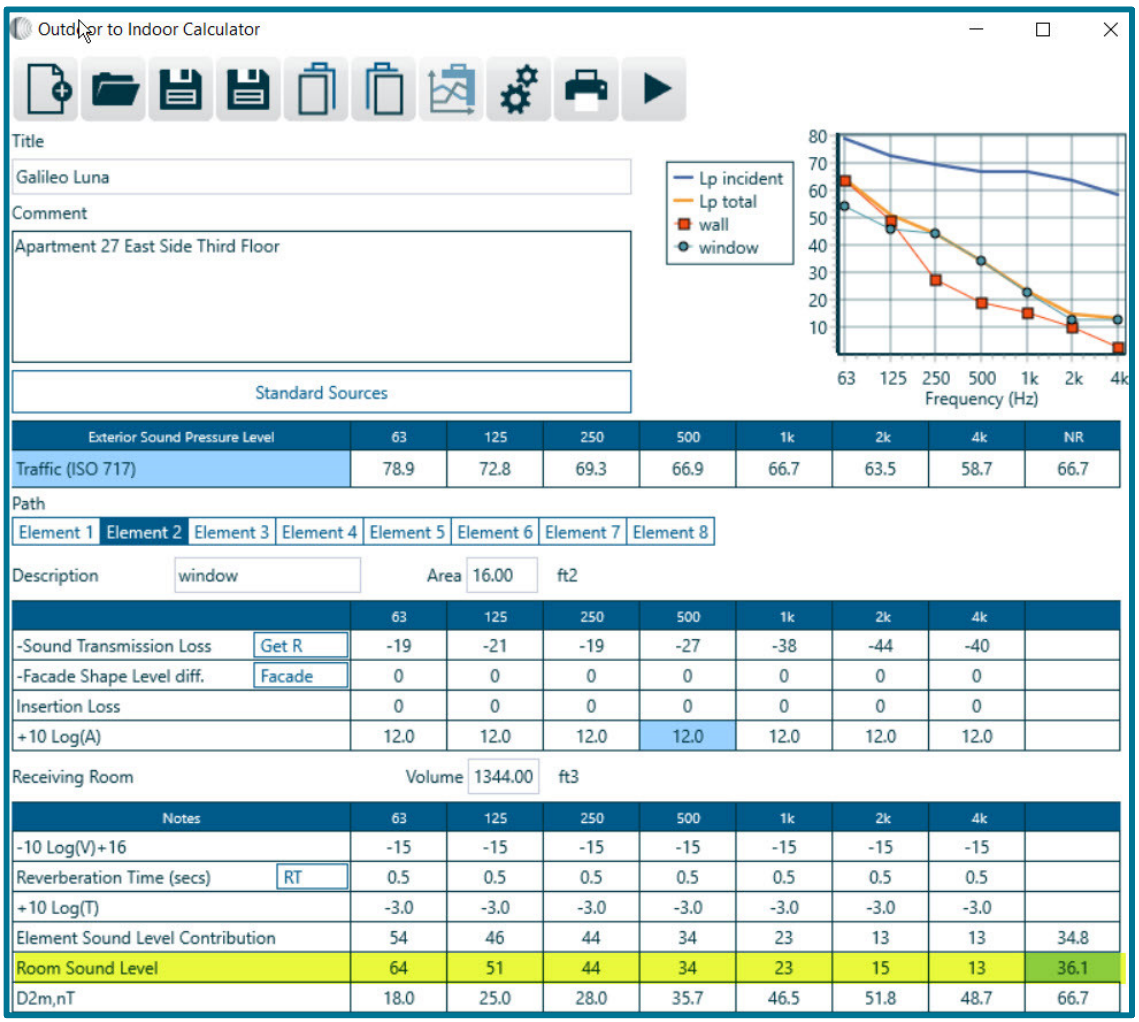
Using these values and making average assumptions for the bedrooms, the predicted interior sound level is found to be 37 dB, which is well within the required annual CNEL 45 dBA required by the California Building Code. See Figure 10 for interior sound level calculation.

Figure 9: Composite Window / Wall for Apartment 27



Element	Area	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1k...	1k6	2k	2k5	3k...	4k	5k	STC	OITC
Wall	74.0	19	18	15	21	31	37	41	44	46	48	50	52	53	54	53	54	58	53	55	59	62	52	32
	12.0	18	19	19	20	21	22	21	18	18	23	28	33	36	38	41	43	45	46	46	43	36	30	25
Total	86.0	19	18	15	21	28	29	29	27	26	32	37	41	44	46	48	50	52	51	52	51	45	38	30

Figure 10: Apartment 27 interior room sound level calculation



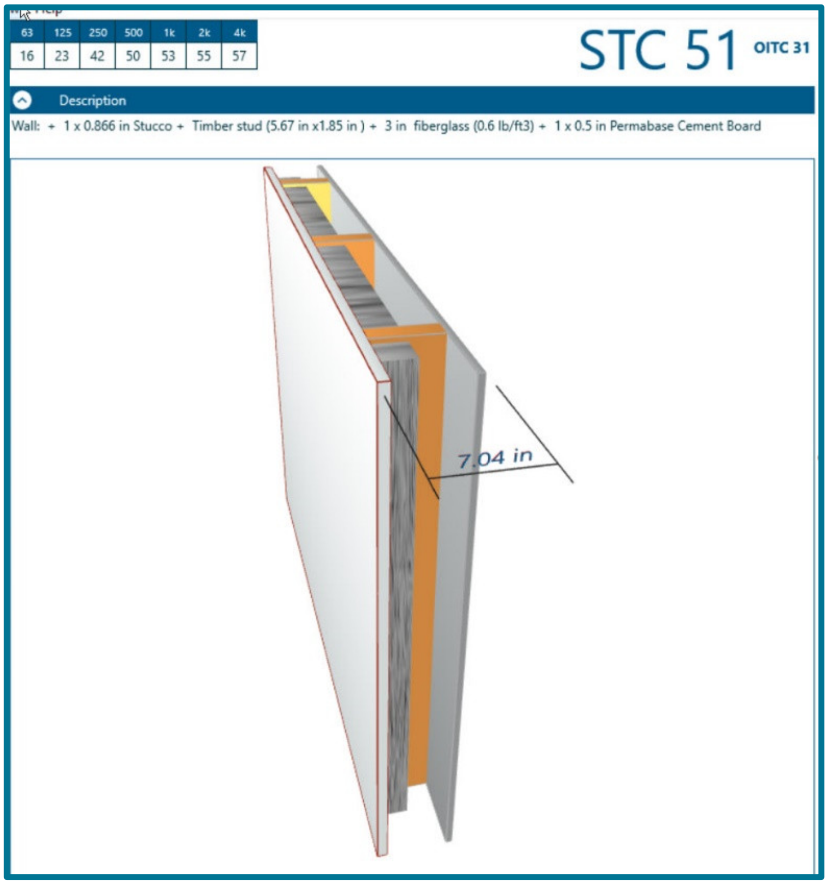
Exterior Sound Pressure Level	63	125	250	500	1k	2k	4k	NR
Traffic (ISO 717)	78.9	72.8	69.3	66.9	66.7	63.5	58.7	66.7

	63	125	250	500	1k	2k	4k	
-Sound Transmission Loss (Get R)	-19	-21	-19	-27	-38	-44	-40	
-Facade Shape Level diff. (Facade)	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	
+10 Log(A)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	

Notes	63	125	250	500	1k	2k	4k	
-10 Log(V)+16	-15	-15	-15	-15	-15	-15	-15	
Reverberation Time (secs) (RT)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
+10 Log(T)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	
Element Sound Level Contribution	54	46	44	34	23	13	13	34.8
Room Sound Level	64	51	44	34	23	15	13	36.1
D2m,nT	18.0	25.0	28.0	35.7	46.5	51.8	48.7	66.7

Other elevations of the apartment building— north, west and south— are appropriate for residential units with exterior walls and windows providing sufficient noise mitigation to maintain the interior sound level of habitable rooms at no greater than 45dBA CNEL. Window and wall assemblies require an OITC of 31 or better in order to remain compliant with applicable State codes and the County of Santa Barbara Noise Element. This may be accomplished with a 2" x 6" stud wall with stucco exterior finish, batt insulation and one layer of 5/8" Type X gypsum interior wall board. Other wall assembly designs must perform equal to or better for compliance.

Figure 11: Typical STC 51 / OITC 31 exterior wall



The exterior ground level activity area on the south side of the apartment is in compliance with noise standards for outdoor activity areas.

5 Appendix

5.1 Terminology/Glossary

A-Weighted Sound Level (dBA)
The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Air-borne Sound
Sound that travels through the air, differentiated from structure-borne sound.

Ambient Sound Level
The prevailing general sound level existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far. The ambient level is typically defined by the Leq level.

Background Sound Level
The underlying, ever-present lower level noise that remains in the absence of intrusive or intermittent sounds. Distant sources, such as Traffic, typically make up the background. The background level is generally defined by the L90 percentile noise level.

Community Noise Equivalent Level (CNEL)
The Leq of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m. CNEL is identical to Lden and similar to Ldn.

Day-Night Sound Level (Ldn)
The Leq of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m. Ldn is similar to CNEL.

Decibel (dB):
The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a reference quantity.

DBA or dB(A)
A-weighted sound level. The ear does not respond equally to all frequencies and is less sensitive at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dBA. The A-weighted sound level is also called the noise level.

Energy Equivalent Level (Leq)
Because sound levels can vary markedly in intensity over a short period of time, some method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, one describes ambient sounds in terms of an average level that has the same acoustical energy as the summation of all the time-varying

events. This energy-equivalent sound/noise descriptor is called Leq. In this report, an hourly period is used.

Field Sound Transmission Class (FSTC)
A single number rating similar to STC, except that the transmission loss values used to derive the FSTC are measured in the field. All sound transmitted from the source room to the receiving room is assumed to be through the separating wall or floor-ceiling assembly.

Outdoor-Indoor Transmission Class (OITC)
A single number classification, specified by the American Society for Testing and Materials (ASTM E 1332 issued 1994), that establishes the A-weighted sound level reduction provided by building facade components (walls, doors, windows, and combinations thereof), based upon a reference sound spectrum that is an average of typical air, road, and rail transportation sources. The OITC is the preferred rating when exterior façade components are exposed to a noise environment dominated by transportation sources.

Percentile Sound Level, Ln
The noise level exceeded during *n* percent of the measurement period, where *n* is a number between 0 and 100 (e.g., L10 or L90)

Sound Transmission Class (STC)
STC is a single number rating, specified by the American Society for Testing and Materials, which can be used to measure the sound insulation properties for comparing the sound transmission capability, in decibels, of interior building partitions for noise sources such as speech, radio, and television. It is used extensively for rating sound insulation characteristics of building materials and products.

Structure-Borne Sound
Sound propagating through building structure. Rapidly fluctuating elastic waves in gypsum board, joists, studs, etc.

Sound Exposure Level (SEL)
SEL is the sound exposure level, defined as a single number rating indicating the total energy of a discrete noise-generating event (e.g., an aircraft flyover) compressed into a 1-second time duration. This level is handy as a consistent rating method that may be combined with other SEL and Leq readings to provide a complete noise scenario for measurements and predictions. However, care must be taken in the use of these values since they may be misleading because their numeric value is higher than any sound level which existed during the measurement period.

Subjective Loudness Level
In addition to precision measurement of sound level changes, there is a subjective characteristic which describes how most people respond to sound:

- A change in sound level of 3 dBA is *barely perceptible* by most listeners.
- A change in level of 6 dBA is *clearly perceptible*.
- A change of 10 dBA is perceived by most people as being *twice* (or *half*) as loud.

5.2 Traffic Noise Model

The Federal Highway Administration Traffic Noise Model (TNM) used for the sound level analysis in this study, contains the following components:

1. Modeling of five standard vehicle types, including automobiles, medium trucks, heavy trucks, buses, and motorcycles, as well as user-defined vehicles.
2. Modeling both constant- and interrupted-flow traffic using a field-measured data base.
3. Modeling effects of different pavement types, as well as the effects of graded roadways.
4. Sound level computations based on a one-third octave-band data base and algorithms.
5. Graphically-interactive noise barrier design and optimization.
6. Attenuation over/through rows of buildings and dense vegetation.
7. Multiple diffraction analysis.
8. Parallel barrier analysis.
9. Contour analysis, including sound level contours, barrier insertion loss contours, and sound-level difference contours.

These components are supported by a scientifically founded and experimentally calibrated acoustic computation methodology, as well as a flexible data base, made up of over 6000 individual pass-by events measured at forty sites across the country.

5.3 SoundPLAN Acoustics Software

SoundPLAN, the software used for this acoustic analysis, is an acoustic ray-tracing program dedicated to the prediction of noise in the environment. Noise emitted by various sources propagates and disperses over a given terrain in accordance with the laws of physics. Worldwide, governments and engineering associations have created algorithms to calculate acoustical phenomena to standardize the assessment of physical scenarios. Accuracy has been validated in published studies to be + / - 2.7 dBA with an 85% confidence level.

The software calculates sound attenuation of environmental noise, even over complex terrain, uneven ground conditions, and with complex obstacles. The modeling software calculates the sound field in accordance with ISO 9613-2 “Acoustics - Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation.” This standard states that “this part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors, in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.”

5.4 Characteristics of Sound

When an object vibrates, it radiates part of its energy as acoustical pressure in the form of a sound wave. Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). The human hearing system is not equally sensitive to sound at all frequencies. Therefore, to approximate this human, frequency-dependent response, the A-weighted filter system is used to adjust measured sound levels. The normal range of human hearing extends from approximately 0 to 140 dBA. Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale, representing points on a sharply rising curve. Because of the physical characteristics of noise transmission and of noise perception, the relative loudness of sound does not closely match the actual amounts of sound energy.
Table 3 below presents the subjective effect of changes in sound pressure levels.

Table 3: Sound Level Change Relative Loudness/Acoustic Energy Loss

0 dBA	Reference 0%
-3 dBA	Just Perceptible Change 50%
-5 dBA	Readily Perceptible Change 67%
-10 dBA	Half as Loud 90%
-20 dBA	1/4 as Loud 99%
-30 dBA	1/8 as Loud 99.9%

Source: Highway Traffic Noise Analysis and Abatement Policy and Guidance, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch, June 1995.

Sound levels are generated from a source and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. This phenomenon is known as spreading loss. Generally, sound levels from a point source will decrease by 6 dBA for each doubling of distance. Sound levels for a highway line source vary differently with distance because sound pressure waves propagate along the line and overlap at the point of measurement. A closely spaced, continuous line of vehicles along a roadway becomes a line source and produces a 3 dBA decrease in sound level for each doubling of distance. However, experimental evidence has shown that where sound from a highway propagates close to "soft" ground (e.g., plowed farmland, grass, crops, etc.), a more suitable drop-off rate to use is not 3.0 dBA but rather 4.5 dBA per distance doubling (FHWA 2010).

When sound is measured for distinct time intervals, the statistical distribution of the overall sound level during that period can be obtained. The Leq is the most common parameter associated with such measurements. The Leq metric is a single-number noise descriptor that represents the average sound level over a given period of time. For example, the L50 noise level is the level that is exceeded 50 percent of the time. This level is also the level that is exceeded 30 minutes in an hour. Similarly, the L02, L08 and L25 values are the noise levels that are exceeded 2, 8, and 25 percent of the time or 1, 5, and 15 minutes per hour. Other values typically noted during a noise survey are the Lmin and Lmax. These values represent the minimum and maximum root-mean-square noise levels obtained over the measurement period.

Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, State law requires that, for planning purposes, an artificial dB increment be added to quiet-time noise levels in a 24-hour noise descriptor called the CNEL or Ldn. This increment is incorporated in the calculation of CNEL or Ldn, described earlier.

6 References

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