Environmental Noise Assessment

Liberty Rock Development

Sacramento County, California

BAC Job # 2021-160

Prepared For:

Liberty Towers Church

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Introduction

The proposed Liberty Rock Development (project) is located at 5132 Elkhorn Boulevard in Sacramento County, California. The project proposes the construction of a mixed-use development that would include multi-family residential (i.e., senior housing and apartments) and day care/school uses. The project area is shown in Figure 1. The project site plans are provided as Figures 2 and 3. The studied site drawings are dated April 29, 2021.

Due to the potential for elevated Elkhorn Boulevard and Hillsdale Boulevard traffic noise at the project site, and due to the proximity of project outdoor play areas to proposed residential uses, the County of Sacramento has requested that a noise assessment be prepared. Specifically, the purposes of this assessment are to quantify noise levels from future traffic on Elkhorn Boulevard and Hillsdale Boulevard, noise from outdoor play area activity at proposed residential uses, and to compare those levels against the applicable Sacramento County General Plan criteria for acceptable exterior and interior noise exposure.

Noise Fundamentals and Terminology

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. If the pressure variations occur frequently enough (at least 20 times per second), they can be heard, and thus are called sound. Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dB. Another useful aspect of the decibel scale is that changes in levels (dB) correspond closely to human perception of relative loudness. Appendix A contains definitions of Acoustical Terminology. Figure 4 shows common noise levels associated with various sources.

The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by weighing the frequency response of a sound level meter by means of the standardized A-weighing network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels in decibels.

Community noise is commonly described in terms of the “ambient” noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent, sound level (L_{eq}) over a given time period (usually one hour). The L_{eq} is the foundation of the Day-Night Average Level noise descriptor, L_{dn} or DNL, and shows very good correlation with community response to noise. The median noise level descriptor, denoted L_{50}, represents the noise level which is exceeded 50% of the hour. In other words, half of the hour ambient conditions are higher than the L_{50} and the other half are lower than the L_{50}.



Legend

- Project Area Boundary (Approximate)
- Traffic Calibration Survey Locations

N

Scale (Feet)

0 125 250

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Sacramento County, California

Project Area

Figure 1

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Legend

- Common Outdoor Area – Senior Housing Use
- Playground / Playing Court Areas – Day Care/School Use

N

Scale (Feet)

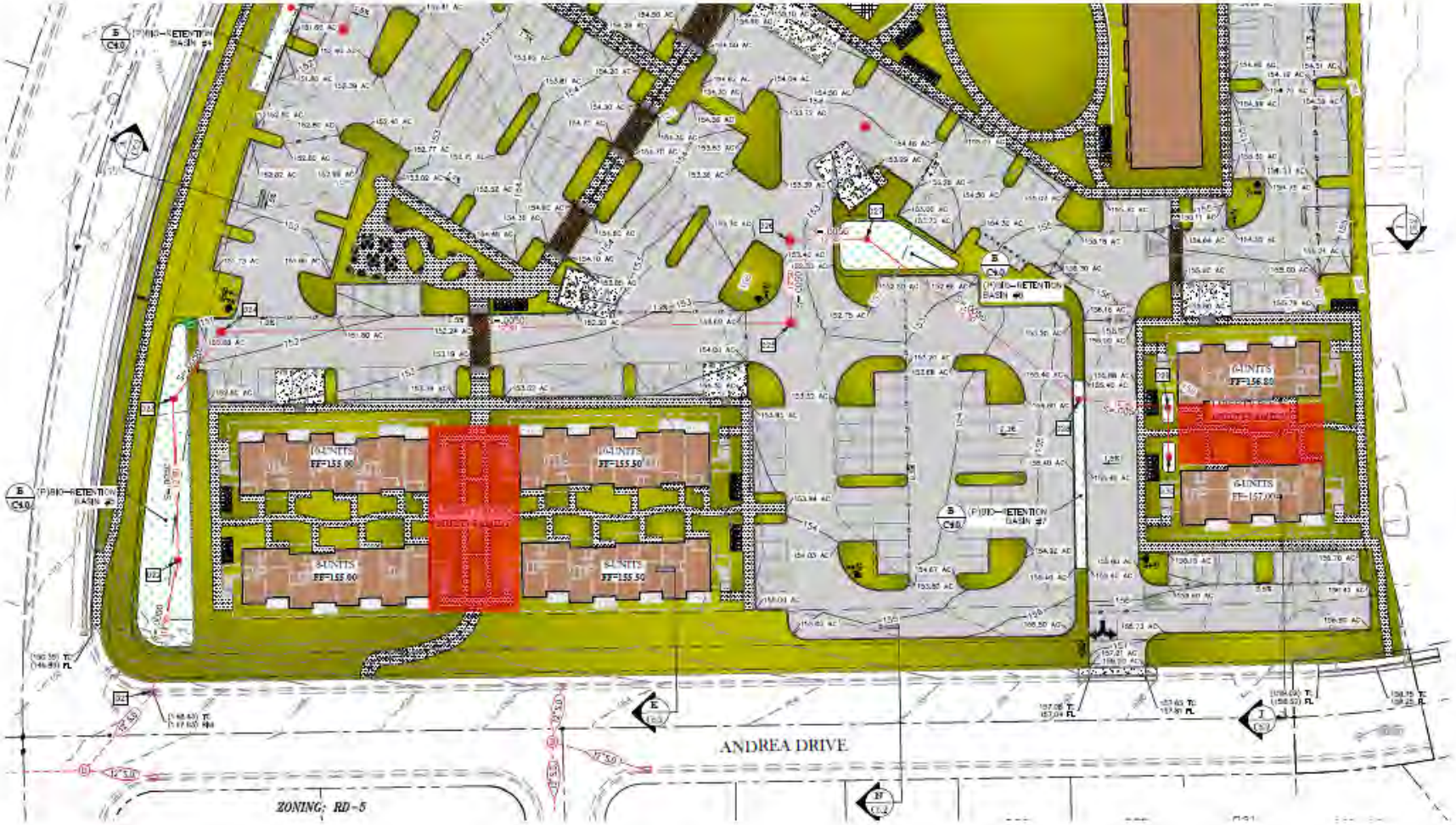
0 50 100

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Project Site Plan – North

Figure 2

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Legend

Common Outdoor Areas – Apartments Uses

N

Scale (Feet)

0 50 100

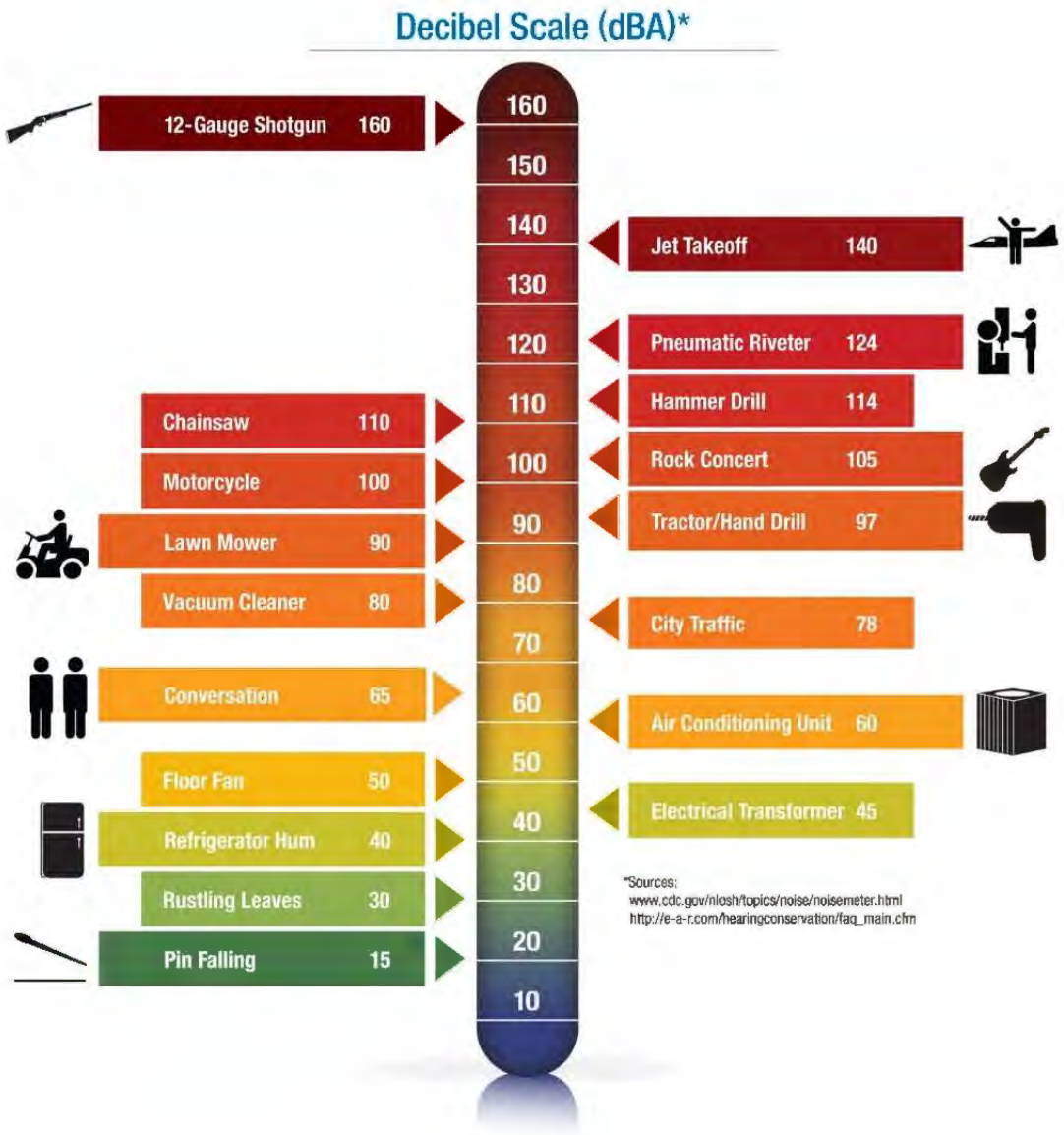
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Project Site Plan – South

Figure 3

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Figure 4
Typical A-Weighted Sound Levels of Common Noise Sources



DNL is based upon the average noise level over a 24-hour day, with a +10-decibel weighting applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because DNL represents a 24-hour average, it tends to disguise short-term variations in the noise environment. DNL-based noise standards are commonly used to assess noise impacts associated with traffic, railroad, and aircraft noise sources.

Criteria for Acceptable Noise Exposure

Sacramento County General Plan

The Noise Element of the Sacramento County General Plan contains policies to ensure that county residents are not subjected to noise beyond acceptable levels. The General Plan policies which would be most applicable to this project are reproduced below.

NO-1 The noise level standards for noise-sensitive areas of new uses affected by traffic or railroad noise sources in Sacramento County are shown by Table 1. Where the noise level standards of Table 1 are predicted to be exceeded at new uses proposed within Sacramento County which are affected by traffic or railroad noise, appropriate noise mitigation measures shall be included in the project design to reduce projected noise levels to a state of compliance with the Table 1 standards.

Table 1
Noise Standards for New Uses Affected by Traffic and Railroad Noise

Receiving Land Use	Outdoor Areas[a] dBA, DNL/CNEL	Interior Areas[b] dBA, DNL/CNEL	Notes
Residential	65	45	5
Transient lodging	65	45	3, 5
Hospitals, nursing homes	65	45	3, 4, 5
Theaters & auditoriums	--	35	3
Churches, schools, libraries	65	40	3
Office buildings	65	45	3
Commercial buildings	--	50	3
Playgrounds, parks	70	--	
Industry	65	50	3

[1] Sensitive areas are defined in acoustic terminology section.
[2] Interior noise level standards are applied within noise-sensitive areas of the various land uses, with windows and doors in the closed positions.
[3] Where there are no sensitive exterior spaces proposed for these uses, only the interior noise level standard shall apply.
[4] Hospitals are often noise-generating uses. The exterior noise level standards for hospitals are applicable only at clearly identified areas designated for outdoor relaxation by either hospital staff or patients.
[5] If this use is affected by railroad noise, a maximum (L_{max}) noise level standard of 70 dB shall be applied to all sleeping rooms to reduce the potential for sleep disturbance during nighttime train passages.

Source: Sacramento County General Plan, Noise Element, Table 1 (2011)

NO-5 The interior and exterior noise level standards for noise-sensitive areas of new uses affected by existing non-transportation noise sources in Sacramento County area shown in Table 2. Where the noise level standards of Table 2 are predicted to be exceeded at a proposed noise-sensitive area due to existing non-transportation noise sources, appropriate noise mitigation measures shall be included in the project design to reduce projected noise levels to a state of compliance with the Table 2 standards within sensitive areas.

Table 2
Non-Transportation Noise Standards – Median (L_{50}) / Maximum (L_{max})[1]

Receiving Land Use	Outdoor Areas[2]		Interior Areas[3]	Notes
	Daytime	Nighttime	Day & Night	
Residential	55 / 75	50 / 70	35 / 55	
Transient lodging	55 / 75	--	35 / 55	4
Hospitals, nursing homes	55 / 75	--	35 / 55	5, 6
Theaters & auditoriums	--	--	30 / 50	6
Churches, schools, libraries	55 / 75	--	35 / 60	6
Office buildings	60 / 75	--	45 / 65	6
Commercial buildings	--	--	45 / 65	6
Playgrounds, parks	65 / 75	--	--	6
Industry	60 / 80	--	50 / 70	6

[1] The Table 2 standards shall be reduced by 5 dB for sounds consisting primarily of speech or music, and for recurring impulsive sounds. If the existing ambient noise level exceeds the standards of Table 2, then the noise level standards shall be increased at 5 dB increments to encompass the ambient.
[2] Sensitive areas are defined in the acoustic terminology section.
[3] Interior noise level standards are applied within the noise-sensitive areas of the various land uses, with windows and doors in the closed positions.
[4] Outdoor activity areas of transient lodging facilities area not commonly used during nighttime hours.
[5] Hospitals are often noise-generating uses. The exterior noise level standards for hospitals are applicable only at clearly identified areas designated for outdoor relaxation by either hospital staff or patients.
[6] The outdoor activity areas of these uses (if any) are not typically utilized during nighttime hours.
[7] Where median (L50) noise level data is not available for a particular noise source, average (Leq) values may be substituted for the standards of this table provided the noise source in question operates for at least 30 minutes of an hour. If the source in question operates less than 30 minutes per hour, then the maximum noise level standards shown would apply.

Source: Sacramento County General Plan, Noise Element, Table 2 (2011)

Noise Standards Applied in this Assessment

General Plan Transportation Noise Sources

The General Plan's exterior and interior noise level limits applicable to transportation noise sources are provided in Table 1. The exterior noise level standards of Table 1 are to be applied at the sensitive outdoor areas of a receiving land use. For the purposes of this analysis, the General Plan's exterior noise level standard for residential uses was applied at the common outdoor areas of the proposed multi-family residential uses (i.e., senior housing and apartments). In addition, the General Plan's exterior noise level standard for school uses was applied at the proposed playground and playing court areas. The locations of the proposed outdoor spaces are shown on Figures 2 and 3. Finally, the interior noise level limits of Table 1 would be applicable within the interior areas of the proposed residential and day care/school buildings.

General Plan Non-Transportation Noise Sources

The General Plan's exterior and interior noise level limits applicable to non-transportation noise sources are provided in Table 2. The exterior noise level limits of Table 2 were applied to project playground and playing court activities and assessed at the common outdoor areas of the proposed multi-family residential uses of the development (i.e., senior housing and apartments). In addition, the interior noise level limits of Table 2 would be applicable within the interior areas of the proposed residential buildings.

It is reasonable to assume that playground and playing court activities associated with the proposed day care/school uses would occur during daytime hours only (i.e., within the hours of 7:00 a.m. to 10:00 p.m.). Based on this assumption, the analysis of outdoor play area noise at proposed residential uses focuses on compliance with the General Plan's daytime exterior and interior noise level limits only.

Evaluation of Future Traffic Noise at the Project Site

Traffic Noise Prediction Methodology

The Federal Highway Administration Highway Traffic Noise Prediction Model (FHWA-RD-77-108) was used to predict traffic noise levels at the project site. The FHWA Model is based upon the CALVENO noise emission factors for automobiles, medium trucks, and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receiver, and the acoustical characteristics of the site. The FHWA Model was developed to predict hourly L_{eq} values for free-flowing traffic conditions and is considered to be accurate within 1.5 dB in most situations.

Traffic Noise Prediction Model Calibration

The FHWA Model provides reasonably accurate traffic noise predictions under "ideal" roadway conditions. Ideal conditions are generally considered to be long straight roadway segments with uniform vehicle speeds, a flat roadway surface, good pavement conditions, a statistically large volume of traffic, and an unimpeded view of the roadway from the receiver location. Such conditions did not appear to be in effect at this project site primarily due to varied traffic speeds caused by interrupted flow traffic. As a result, BAC conducted a calibration of the FHWA Model through site-specific traffic noise level measurements and concurrent traffic counts.

The calibration process was performed at two (2) locations on the project site on November 16th, 2021, identified as sites TC-1 and TC-2 on Figure 1. The measurements were conducted to quantify Elkhorn Boulevard (site TC-1) and Hillsdale Boulevard (site TC-2) traffic noise levels at the project site. Photographs of the traffic noise level measurement locations are provided in Appendix B. Detailed results of this procedure are provided in Appendix C.

As indicated in Appendix C, the FHWA Model was found to underpredict Elkhorn Boulevard and Hillsdale Boulevard traffic noise levels at the project site by approximately 4 dB and 3 dB, respectively. These underpredictions are believed to be due to the presence of the nearby traffic lights. To provide traffic noise level predictions more representative of local conditions,

calibration offsets of +4 dB and +3 dB were applied to the FHWA Model for the prediction of future Elkhorn Boulevard and Hillsdale Boulevard traffic noise levels at the project site, respectively.

Predicted Future Exterior Traffic Noise Levels

The calibrated FHWA Model was used with future traffic data to predict future Elkhorn Boulevard and Hillsdale Boulevard exterior traffic noise levels at the project site. The future Average Daily Traffic (ADT) for the roadways were conservatively estimated by increasing the existing ADT volumes by a factor of 50% to account for regional growth in the next twenty years. The existing (2019) ADT volumes for the roadways were obtained from data published by the County of Sacramento Municipal Services Department of Transportation. The FHWA Model inputs and predicted future exterior traffic noise levels at the project site are shown in Appendix D and are summarized in Table 3.

Table 3
Predicted Future Exterior Traffic Noise Levels at the Project Site

Roadway	Proposed Use	Location	Future Exterior DNL (dB)[1]
Elkhorn Boulevard	Senior Housing	Common outdoor space	63
		First-floor building facade	77
		Upper-floor building facades	79
	Day Care/School	Playground	56
		Playing court	62
		Building facade	63
	Apartments	Nearest common outdoor space	60
		Nearest first-floor building facade	61
		Nearest upper-floor building facade	63
Hillsdale Boulevard	Senior Housing	Common outdoor space	62
		First-floor building facade	70
		Upper-floor building facades	72
	Day Care/School	Playground	56
		Playing court	60
		Building facade	66
	Apartments	Nearest common outdoor space	63
		Nearest first-floor building facade	69
		Nearest upper-floor building facade	71

[1] Negative offsets were applied at some locations to account for shielding that would be provided by existing and/or proposed intervening structures, where applicable. Complete listings of FHWA Model inputs are provided in Appendix D.

Source: Bollard Acoustical Consultants, Inc. (2021)

Evaluation of Exterior Noise Compliance

As indicated in Table 3, future exterior Elkhorn Boulevard and Hillsdale Boulevard traffic noise level exposure is predicted to satisfy the applicable Sacramento County General Plan 65 dB DNL exterior noise level standard at the common outdoor areas of the multi-family residential

uses proposed nearest to the roadways (i.e., senior housing and apartments). The Table 3 data also indicate that future exterior traffic noise level exposure is predicted to satisfy the applicable General Plan 65 dB DNL exterior noise level standard at the outdoor play areas of the proposed day care/school uses (i.e., playground and playing court). As a result, no further consideration of exterior traffic noise reduction measures would be warranted for this aspect of the project.

Evaluation of Interior Traffic Noise Compliance

Standard building construction (stucco siding, STC-27 windows, door weather-stripping, exterior wall insulation, composition plywood roof), *typically* results in an exterior to interior noise reduction of approximately 25 dB with windows closed and approximately 15 dB with windows open. Therefore, provided future Elkhorn Boulevard or Hillsdale Boulevard traffic noise levels do not exceed 70 dB DNL at exterior building facades of proposed senior housing or apartment uses, standard construction would normally be adequate to ensure compliance with the Sacramento County General Plan 45 dB DNL interior noise level standard for residential uses. In addition, provided future traffic noise levels do not exceed 65 dB DNL at exterior building facades of proposed day care/school uses, standard construction should be adequate to ensure compliance with the General Plan's 40 dB DNL interior noise level standard applicable to school uses.

Based on the results presented in Table 3, window and door assembly upgrades would be warranted for portions of the development. To achieve compliance with the applicable General Plan interior noise level criteria *including* a factor of safety, it is recommended that all windows and doors (where applicable) of building facades illustrated on Figures 5 and 6 be upgraded to the minimum STC rating indicated. In addition, mechanical ventilation (air conditioning) should be provided for all buildings within this development to allow the occupants to close doors and windows as desired for additional acoustical isolation.



Legend

- Window/Door Assembly Upgrades: STC-37 (1st Floors) | STC-39 (Upper-Floors)
- Window/Door Assembly Upgrades: STC-33 (1st Floors) | STC-35 (Upper-Floors)
- Window/Door Assembly Upgrades: STC-32

N

Scale (Feet)

0 50 100

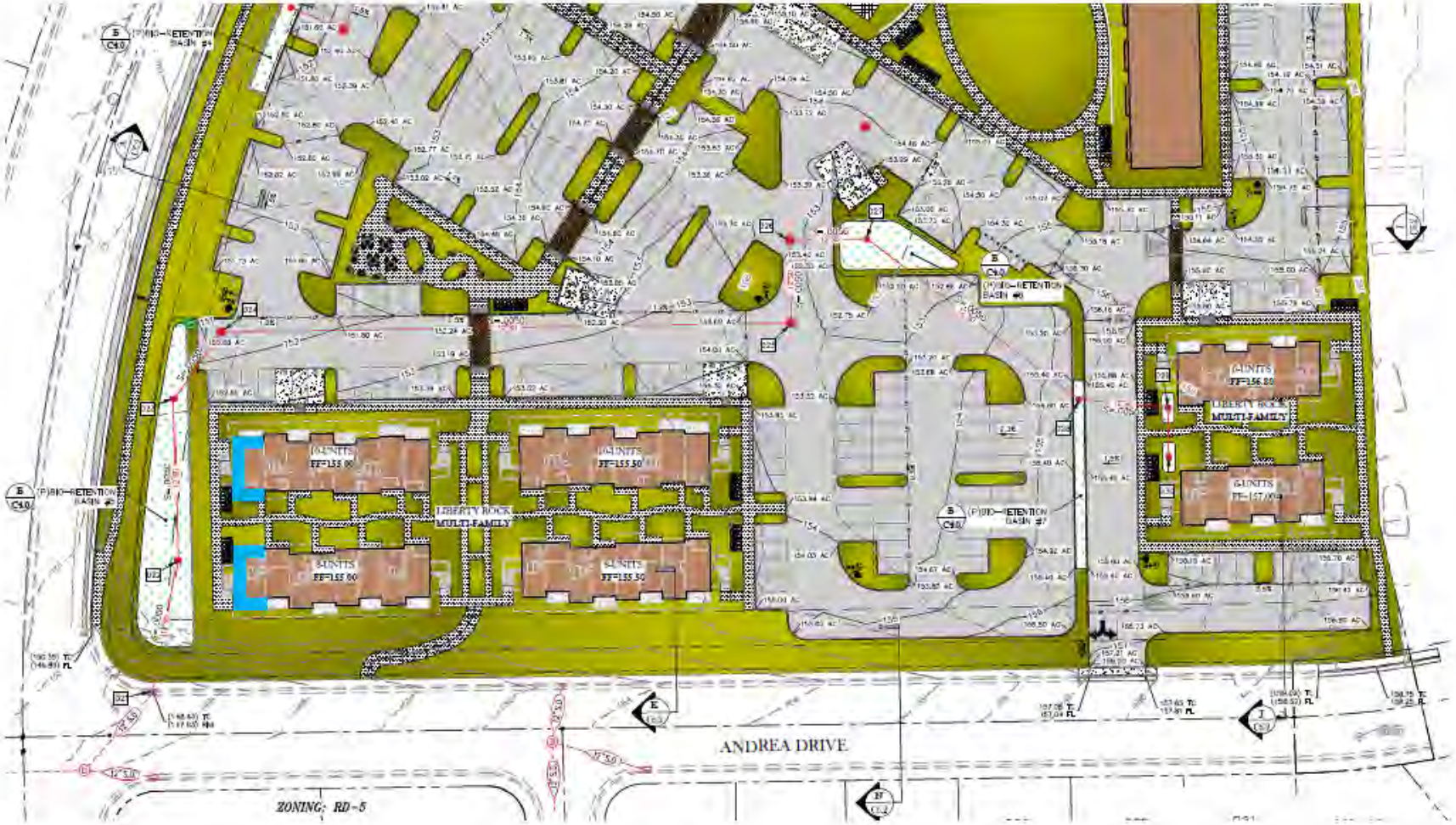
Liberty Rock Development

Sacramento County, California

Project Site Plan (North)
& Interior Noise Compliance Mitigation

Figure 5

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Legend

Window/Door Assembly Upgrades: STC-32 (All Floors)

N

Scale (Feet)

0 50 100

Liberty Rock Development
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Recommended Interior Traffic Noise Mitigation
Window/Door Assembly Upgrades

Figure 6

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Evaluation of Outdoor Play Area Noise at Proposed Residential Uses

The site plans indicate that a playground and playing court will be located adjacent to the day care/school use. The locations of the outdoor play areas are shown on Figure 2. The primary noise source associated with play area use is shouting children. For the assessment of playground and playing court noise impacts at the proposed residential uses of the development, noise level data collected by BAC staff at various outdoor play areas in recent years was utilized. BAC file data indicate that median (L_{50}) and maximum (L_{max}) noise levels of similar sized playgrounds and playing courts are approximately 55 dB L_{50} and 75 dB L_{max} at a distance of 50 feet from the focal point of the play area. For the purposes of this analysis, it was conservatively assumed that activity could occur within both outdoor play areas simultaneously (i.e., worst-case noise exposure).

Using the reference noise level data cited above, and assuming standard spherical spreading loss (-6 dB per doubling of distance), data were projected from the outdoor play areas to the common outdoor spaces and building facades of the nearest proposed residential uses of the development. The results of those projections are presented below in Table 4.

Table 4
Predicted Exterior Outdoor Play Area Noise Levels at Proposed Residential Uses

Proposed Use	Location[1]	Predicted Exterior Noise Levels (dB)					
		Playground		Playing Court		Combined[2]	
		L_{50}	L_{max}	L_{50}	L_{max}	L_{50}	L_{max}
Senior Housing	Common outdoor space	37	57	40	60	42	62
	Nearest building facade	32	52	40	60	40	60
Apartments	Nearest common outdoor space	33	53	31	51	35	55
	Nearest building facade	39	59	33	53	40	60

[1] Common outdoor spaces and residential buildings are shown on Figures 2 and 3.
[2] Combined noise levels include consideration of concurrent activity occurring within the proposed playground and playing court.
Source: Bollard Acoustical Consultants, Inc. (2021)

Evaluation of Exterior Play Area Noise Compliance

Pursuant to footnote 2 of Table 2, the Sacramento County General Plan's non-transportation noise standards shall be reduced by 5 dB for sounds consisting primarily of speech or music (i.e., shouting children within play areas). After application of this downward adjustment, the daytime exterior noise level limits applicable to project outdoor play area noise at proposed residential uses would be 50 dB L_{50} and 70 dB L_{max}.

As indicated in Table 4, the combined noise exposure from project outdoor play area activities is predicted to comply with the applicable General Plan daytime exterior noise level limits of 50 dB L_{50} and 70 dB L_{max} at the common outdoor areas of the nearest proposed residential uses. As a result, no further consideration of outdoor play area noise reduction measures would be warranted for the project relative to the General Plan's daytime exterior noise level limits.

Evaluation of Interior Play Area Noise Compliance

As mentioned above, the General Plan's non-transportation noise standards shall be reduced by 5 dB for sounds consisting primarily of speech or music (i.e., shouting children within play areas). After application of this downward adjustment, the (anytime) interior noise level limits applicable to project outdoor play area noise at proposed residential uses would be 30 dB L_{50} and 50 dB L_{max}.

As shown in Table 4, combined noise levels from project outdoor play area activities are predicted to be 40 dB L_{50} and 60 dB L_{max} at the building facades of the nearest proposed residential uses. Given predicted exterior noise levels of 40 dB L_{50} and 60 dB L_{max} at the nearest building facades, and after consideration of the aforementioned exterior to interior noise level reduction achieved from standard building construction (approximately 25 dB with windows closed), combined noise levels from project outdoor play area activity are calculated to be 15 dB L_{50} and 35 dB L_{max} within the interior areas of the nearest residences. The calculated outdoor play area noise levels of 15 dB L_{50} and 35 dB L_{max} within the nearest proposed residential interior areas would satisfy the applicable General Plan interior noise level limits of 30 dB L_{50} and 50 dB L_{max} by a wide margin. As a result, no further consideration of outdoor play area noise reduction measures would be warranted for the project relative to the General Plan's interior noise level limits.

Conclusions and Recommendations

The Liberty Rock Development is predicted to be exposed to future Elkhorn Boulevard and Hillsdale Boulevard traffic noise exposure in compliance with the applicable Sacramento County General Plan exterior noise level criteria for transportation noise sources. However, portions of the development are predicted to be exposed to future traffic noise exposure in excess of applicable General Plan interior noise level criteria. Finally, future noise levels from project outdoor play areas are predicted to comply with the applicable General Plan non-transportation exterior and interior noise level limits at proposed residential uses of the development.

Based on the analysis and results presented in this report, the following specific noise mitigation measures are recommended for the project:

1. To achieve compliance with the applicable General Plan interior noise level criteria *including* a factor of safety, it is recommended that all windows and doors (where applicable) of building facades illustrated on Figures 5 and 6 be upgraded to the minimum STC rating indicated.

2. Mechanical ventilation (air conditioning) should be provided for all residences in this development to allow the occupants to close doors and windows as desired to achieve compliance with applicable General Plan interior noise level criteria.

These conclusions are based on the project site plans presented in this report, the traffic data cited in Appendices C and D, BAC file data, and on noise reduction data for standard dwellings and for typical STC rated window data. Deviations from the data cited herein or the project site

plans presented in this report could cause future traffic or outdoor play area noise levels to differ from those predicted in this assessment. Bollard Acoustical Consultants, Inc. is not responsible for degradation in acoustic performance due to poor building construction practices, failure to comply with applicable building code requirements, or for failure to adhere to the minimum building practices cited in this report.

This concludes BAC's noise assessment for the Liberty Rock Development in Sacramento County, California. Please contact BAC at (530) 537-2328 or dariog@bacnoise.com with any questions regarding this assessment.

Appendix A
Acoustical Terminology

Acoustics The science of sound.

Ambient Noise The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.

Attenuation The reduction of an acoustic signal.

A-Weighting A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.

Decibel or dB Fundamental unit of sound. A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.

CNEL Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging.

Frequency The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.

IIC Impact Insulation Class (IIC): A single-number representation of a floor/ceiling partition's impact generated noise insulation performance. The field-measured version of this number is the FIIC.

L_{dn} Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.

L_{eq} Equivalent or energy-averaged sound level.

L_{max} The highest root-mean-square (RMS) sound level measured over a given period of time.

Loudness A subjective term for the sensation of the magnitude of sound.

Masking The amount (or the process) by which the threshold of audibility is for one sound is raised by the presence of another (masking) sound.

Noise Unwanted sound.

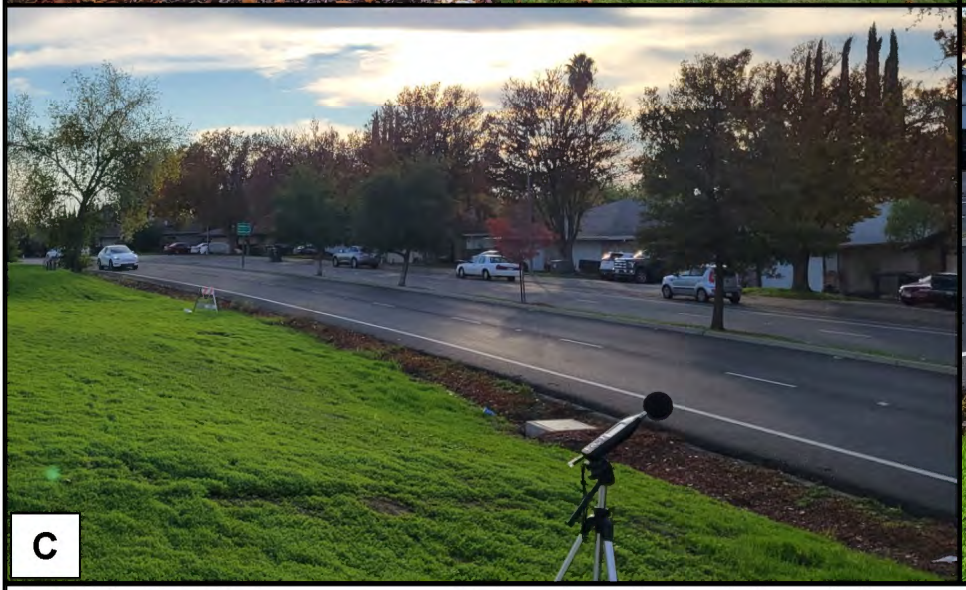
Peak Noise The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the "Maximum" level, which is the highest RMS level.

RT_{60} The time it takes reverberant sound to decay by 60 dB once the source has been removed.

STC Sound Transmission Class (STC): A single-number representation of a partition's noise insulation performance. This number is based on laboratory-measured, 16-band (1/3-octave) transmission loss (TL) data of the subject partition. The field-measured version of this number is the FSTC.









Legend

A: TC-1: Facing northwest along Elkhorn Blvd. towards Hillsdale Blvd. intersection
B: TC-1: Facing southeast along Elkhorn Blvd. towards intersection Andrea Blvd. intersection
C: TC-2: Facing southwest from project site along Hillsdale Blvd.
D: TC-2: Facing north from project site along Hillsdale Blvd.

Liberty Rock Development
Sacramento County, California

Traffic Calibration Survey Photographs

Appendix B

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Appendix C-1
FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Calibration Worksheet

Project Information:	Job Number:	2021-160
	Project Name:	Liberty Rock Development
	Roadway Tested:	Elkhorn Boulevard
	Test Location:	Site TC-1
	Test Date:	November 16, 2021
Weather Conditions:	Temperature (Fahrenheit):	59
	Relative Humidity:	79%
	Wind Speed and Direction:	NNW 5 MPH
	Cloud Cover:	Partly Cloudy
Sound Level Meter:	Sound Level Meter:	LDL Model 831 (BAC #5)
	Calibrator:	LDL Model CAL200
	Meter Calibrated:	Immediately before
	Meter Settings:	A-weighted, slow response
Microphone:	Microphone Location:	On project site
	Distance to Centerline (feet):	80
	Microphone Height:	5 feet above ground
	Intervening Ground (Hard or Soft):	**Soft**
	Elevation Relative to Road (feet):	8
Roadway Condition:	Pavement Type	Asphalt
	Pavement Condition:	Good
	Number of Lanes:	6
	Posted Maximum Speed (mph):	45
Test Parameters:	Test Time:	2:35 PM
	Test Duration (minutes):	15
	Observed Number Automobiles:	812
	Observed Number Medium Trucks:	6
	Observed Number Heavy Trucks:	2
	Observed Average Speed (mph):	45
Model Calibration:	Measured Average Level (L_{eq}):	72.9
	Level Predicted by FHWA Model:	68.7
	Difference (dB):	**-4.2**

Conclusions: The FHWA Model was found to under-predict existing Elkhorn Blvd. traffic noise levels at the project site by approximately 4 dB. This under-prediction is believed to be due to the prescence of nearby traffic lights at Hillsdale Blvd. and Andrea Blvd. As a result, a +4 dB offset was applied to the FHWA Model for the prediction of future Elkhorn Blvd. traffic noise levels at the project site.

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Appendix C-2
FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Calibration Worksheet

Project Information:	Job Number:	2021-160
	Project Name:	Liberty Rock Development
	Roadway Tested:	Hillsdale Boulevard
	Test Location:	Site TC-2
	Test Date:	November 16, 2021
Weather Conditions:	Temperature (Fahrenheit):	59
	Relative Humidity:	79%
	Wind Speed and Direction:	NNW 5 MPH
	Cloud Cover:	Partly Cloudy
Sound Level Meter:	Sound Level Meter:	LDL Model 831 (BAC #5)
	Calibrator:	LDL Model CAL200
	Meter Calibrated:	Immediately before
	Meter Settings:	A-weighted, slow response
Microphone:	Microphone Location:	On project site
	Distance to Centerline (feet):	60
	Microphone Height:	5 feet above ground
	Intervening Ground (Hard or Soft):	**Soft**
	Elevation Relative to Road (feet):	8
Roadway Condition:	Pavement Type	Asphalt
	Pavement Condition:	Good
	Number of Lanes:	6
	Posted Maximum Speed (mph):	35
Test Parameters:	Test Time:	3:04 PM
	Test Duration (minutes):	15
	Observed Number Automobiles:	88
	Observed Number Medium Trucks:	2
	Observed Number Heavy Trucks:	0
	Observed Average Speed (mph):	35
Model Calibration:	Measured Average Level (L_{eq}):	61.1
	Level Predicted by FHWA Model:	58.2
	Difference (dB):	**-2.9**

Conclusions: The FHWA Model was found to under-predict existing Hillsdale Blvd. traffic noise levels at the project site by approximately 3 dB. This under-prediction is believed to be due to the prescence of nearby traffic lights at Elkhorn Blvd. and Andrea Blvd. As a result, a +3 dB offset was applied to the FHWA Model for the prediction of future Hillsdale Blvd. traffic noise levels at the project site.



Appendix D-1
FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Prediction Worksheet

Project Information:

Job Number: 2021-160
Project Name: Liberty Rock Development
Roadway Name: Elkhorn Boulevard

Traffic Data:

Year: Future
Average Daily Traffic Volume: 82,680
Percent Daytime Traffic: 75
Percent Nighttime Traffic: 25
Percent Medium Trucks (2 axle): 1
Percent Heavy Trucks (3+ axle): 1
Assumed Vehicle Speed (mph): 45
Intervening Ground Type (hard/soft): **Soft**

Traffic Noise Levels:

				DNL (dB)			
Location	**Description**	**Distance**	**Offset (dB)**	**Autos**	**Medium Trucks**	**Heavy Trucks**	**Total**
Senior Housing	Common outdoor space	175	-6	62	51	55	63
	First-floor building facade	95	4	76	65	69	77
	Upper-floor building facades	95	6	78	67	71	79
Day Care/School	Playground	535	-6	55	44	48	56
	Playing court	440	-1	61	50	54	62
	Building facade	420	-1	62	50	55	63
Apartments	Nearest common outdoor space	600	-1	59	48	52	60
	Nearest first-floor building facade	530	-1	60	49	53	61
	Nearest upper-floor building facade	530	1	62	51	55	63

Traffic Noise Contours (No Calibration Offset):

DNL Contour (dB)	Distance from Centerline (ft)
75	75
70	161
65	347
60	748

Notes: Future ADT was conservatively estimated by increasing the existing ADT volume of Elkhorn Blvd. adjacent to the project site by 50% to account for regional growth in the next 20 years. Existing (2019) ADT obtained from published Sacramento County traffic count data (55,120 ADT). A +4 dB offset was applied at all locations based on the results from the BAC traffic calibration. Offsets ranging from -5 dB to -10 dB were applied at locations where existing and/or propsed intervening structures would provide shielding of the roadway. A +2 dB offset was applied at upper-floor facades of the senior housing building to account for reduced abosorption of sound at elevated positions.



Appendix D-2
FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Prediction Worksheet

Project Information:

Job Number: 2021-160
Project Name: Liberty Rock Development
Roadway Name: Hillsdale Boulevard

Traffic Data:

Year: Future
Average Daily Traffic Volume: 28,983
Percent Daytime Traffic: 75
Percent Nighttime Traffic: 25
Percent Medium Trucks (2 axle): 1
Percent Heavy Trucks (3+ axle): 1
Assumed Vehicle Speed (mph): 35
Intervening Ground Type (hard/soft): **Soft**

Traffic Noise Levels:

				DNL (dB)			
Location	**Description**	**Distance**	**Offset (dB)**	**Autos**	**Medium Trucks**	**Heavy Trucks**	**Total**
Senior Housing	Common outdoor space	190	0	60	50	55	62
	First-floor building facade	85	3	68	58	63	70
	Upper-floor building facades	85	5	70	60	65	72
Day Care/School	Playground	320	-2	55	45	50	56
	Playing court	235	0	59	49	54	60
	Building facade	155	3	65	54	60	66
Apartments	Nearest common outdoor space	165	0	61	51	56	63
	Nearest first-floor building facade	100	3	67	57	62	69
	Nearest upper-floor building facade	100	5	69	59	64	71

Traffic Noise Contours (No Calibration Offset):

DNL Contour (dB)	Distance from Centerline (ft)
75	25
70	53
65	115
60	247

Notes: Future ADT was conservatively estimated by increasing the existing ADT volume of Hillsdale Blvd. adjacent to the project site by 50% to account for regional growth in the next 20 years. Existing (2019) ADT obtained from published Sacramento County traffic count data (19,322 ADT). A +3 dB offset was applied at all locations based on the results from the BAC traffic calibration. Offsets ranging from -2 dB to -5 dB were applied at locations where existing and/or propsed intervening structures would provide shielding of the roadway. A +2 dB offset was applied at upper-floor facades of the senior housing building to account for reduced abosorption of sound at elevated positions.