APPENDIX I

Acoustics Assessment for the Froom Ranch Project

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45dB
Acoustics

P.O. Box 1406
San Luis Obispo
California 93406

David Lord, PhD dl@45dB.com
Sarah Taubitz, MSME st@45dB.com

tel. 805.704.8046
www.45dB.com

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Project 1721-1

RE:
Acoustics Assessment
Froom Ranch Project
San Luis Obispo, CA 93401

Client:
John Madonna
P.O. Box 5310
San Luis Obispo, CA 93403

1 Summary

This is a report on the existing and future noise impacts on the proposed Froom Ranch Project located on the southwest side of Los Osos Valley Road (LOVR), between Froom Ranch Road and Calle Joaquin. All noise sources are considered, including occasional air traffic from San Luis Obispo County Regional Airport, and vehicular traffic noise from adjacent Los Osos Valley Road and Calle Joaquin, as well as U.S. Highway 101 to the southeast of the project. The intent of this assessment is to determine noise levels that may potentially impact the proposed residential units at the eastern edge and elsewhere throughout the site.

Several sound level measurement data sets were collected at different locations on site. Existing sound levels were correlated for each of the measurement locations, for use in “calibrating” noise modeling software. The objective is to generate existing sound level contours, which may be compared with generalized sound level contours published by the City of San Luis Obispo in the 1996 Noise Element (Figures 5 and 6).

This report shows the results of an initial sound level survey to establish existing and future sound level contours resulting from transportation noise.

Two sound level ‘portraits’ for the overall site are shown in addition:

1. Existing sound levels with no development on the site, i.e., no project.
2. Potential future sound levels once the proposed project is built.

Contents

2 Location

The project is located west of the intersection of Los Osos Valley Road and Calle Joaquin, near the U.S. Highway 101 interchange. The project site is shown in Figure 1. Vicinity of Site, currently open land separated from Los Osos Valley Road by shrubbery and trees and a barbed wire fence.

The measurement stations on the site were chosen to be near potential future residential building elevations exposed to Los Osos Valley Road, Calle Joaquin, and U.S. Highway 101 in the distance.

During the sound level survey, occasional overflight of small aircraft was observed, departing from San Luis Obispo County Regional Airport and over 1,000 feet above the project area.

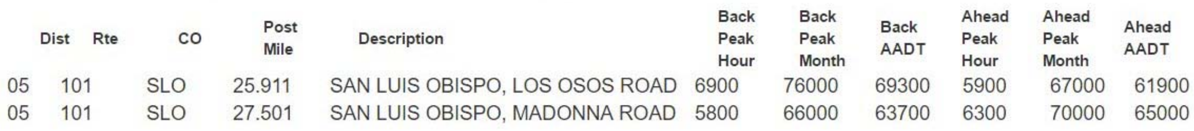
Figure 1. Vicinity of Site,
southwest of Los Osos Valley Road and west of Calle Joaquin.
U.S. Highway 101 is further in the distance toward the southeast of the site.

Figure 2. Sources of traffic noise: Los Osos Valley Road, Calle Joaquin and U.S. Highway 101, two lanes.

Location of the three transportation noise sources is shown in Figure 2.

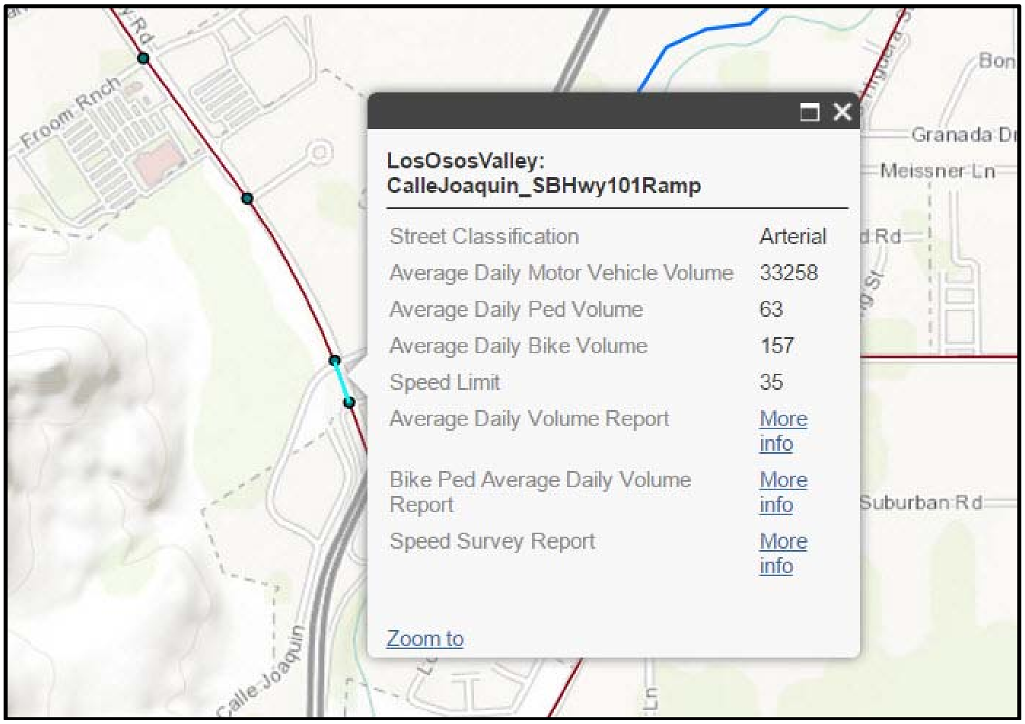
Toward the southeast of the site, U.S. Highway 101 is a significant transportation noise source with an Average Annual Daily Traffic Flow between 62,000 to 69,000.

Figure 3. 2015 Traffic Volumes, U.S. Highway 101, from Caltrans data



Dist	Rte	CO	Post Mile	Description	Back Peak Hour	Back Peak Month	Back AADT	Ahead Peak Hour	Ahead Peak Month	Ahead AADT
05	101	SLO	25.911	SAN LUIS OBISPO, LOS OSOS ROAD	6900	76000	69300	5900	67000	61900
05	101	SLO	27.501	SAN LUIS OBISPO, MADONNA ROAD	5800	66000	63700	6300	70000	65000

Figure 4. Los Osos Valley Road, Calle Joaquin Average Daily Traffic



LosOsosValley: CalleJoaquin_SBHwy101Ramp

Street Classification	Arterial
Average Daily Motor Vehicle Volume	33258
Average Daily Ped Volume	63
Average Daily Bike Volume	157
Speed Limit	35
Average Daily Volume Report	More info
Bike Ped Average Daily Volume Report	More info
Speed Survey Report	More info

2.1 Sound Level Measurements

Six sound level measurement sites are shown in *Figure 6. Plan showing measurement stations and sound levels*, Leq = dBA, at each station. Two measurement sites are stationary; four sites are spot check locations. In addition to the six sites, synchronized duplicate measurements were made at the two stationary sites for a total of eight data sets. The sound level data was compared with nearby data. The fixed measurement stations were then used to calibrate the noise modeling software, in order to generate sound level contours based on precision measurements of existing sound. Future sound level is projected using future growth assumptions for average daily traffic flow.

2.2 Sound Level Contours

A Sound Level Contour is a line on a map that represents equal levels of noise exposure. SoundPlan is an acoustics modeling software program used to calculate noise contours, based on topographic relationships of noise sources and noise receivers. The standard calculation software for modeling traffic noise is the Federal Highway Administration program, Transportation Noise Model, TNM. SoundPlan, used for this report, implements TNM in its calculation.

On-site measured sound level values are used to calibrate and to validate the SoundPlan - generated sound level contours. The graphic sound level contours depict sound level on the site from a composite of three transportation noise sources: Los Osos Valley Road, Calle Joaquin and U.S. Highway 101.

Figure 5. Site Plan, proposed project

Figure 6. Plan showing measurement stations and sound levels, Leq = dBA, at each station. There were two stationary measurement stations, one next to LOVR and the other next to Calle Joaquin. There were four 'spot-check' stations near future potential building elevations.

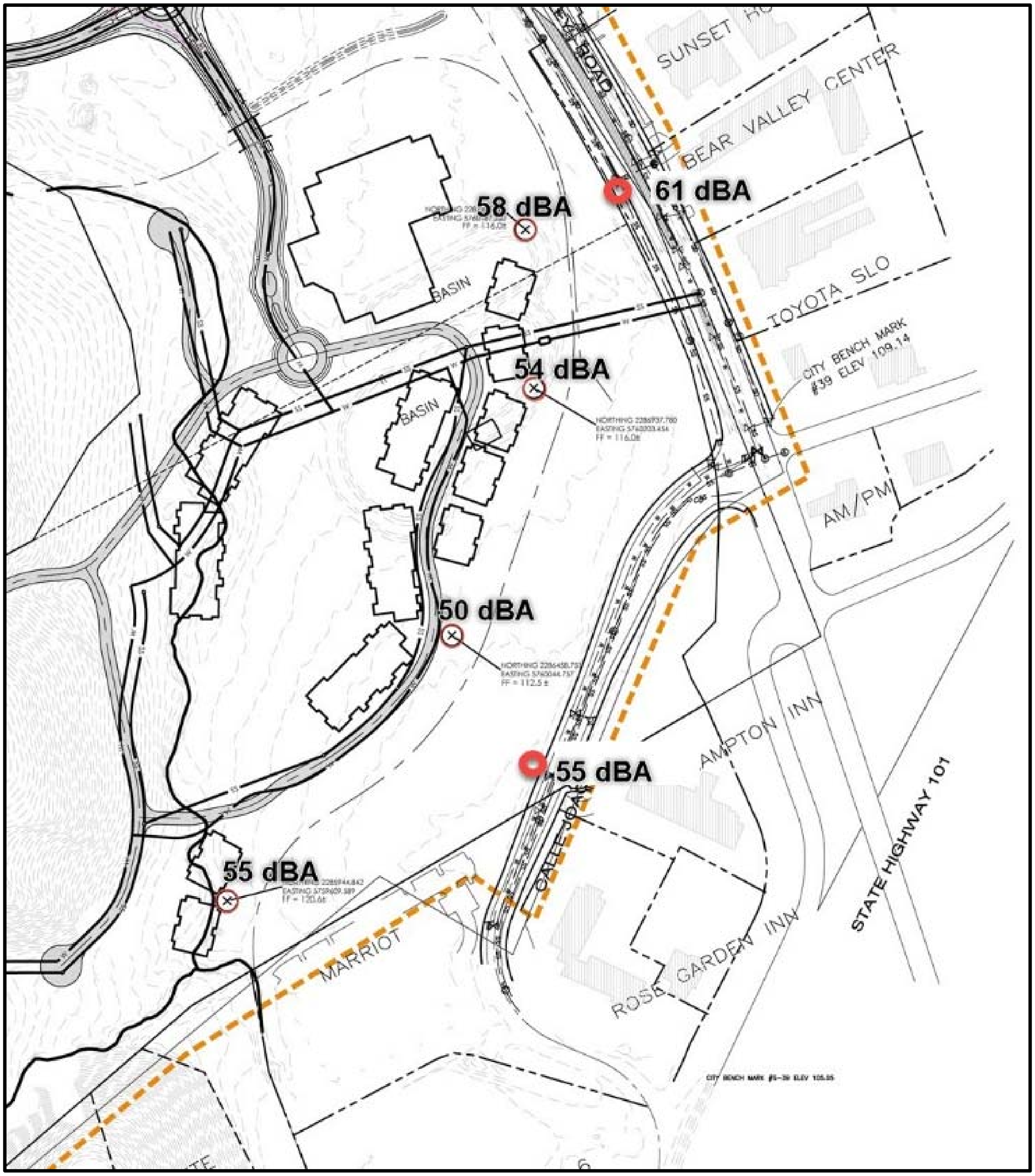
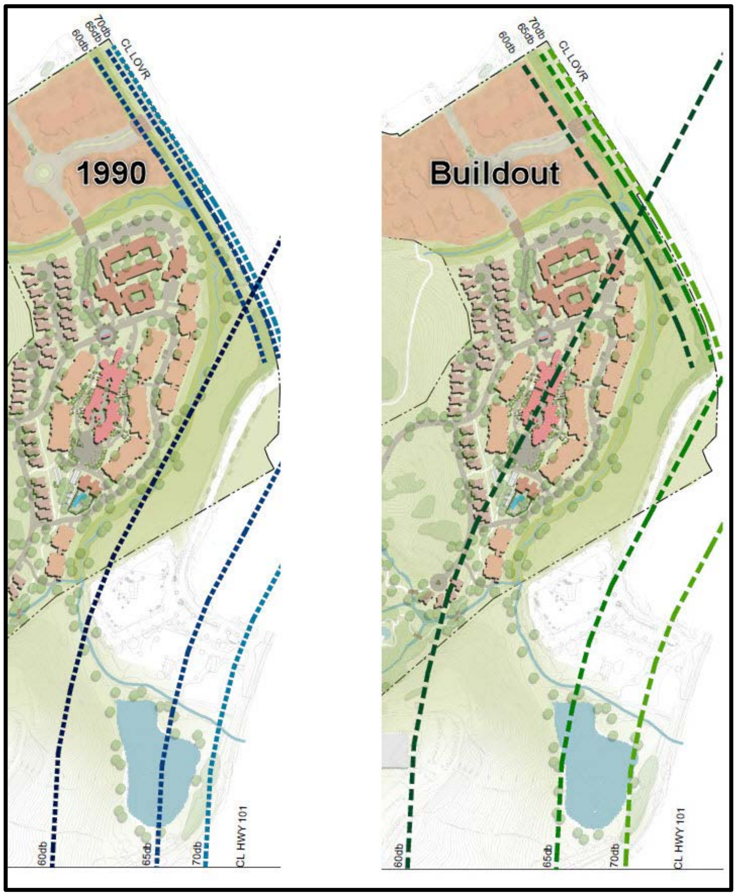


Figure 7. City of San Luis Obispo Sound Level Contours, based on a study by Brown Buntin, 1991. Results appear in City of San Luis Obispo Noise Element, last revised 1996.



2.3 Contour Disparities

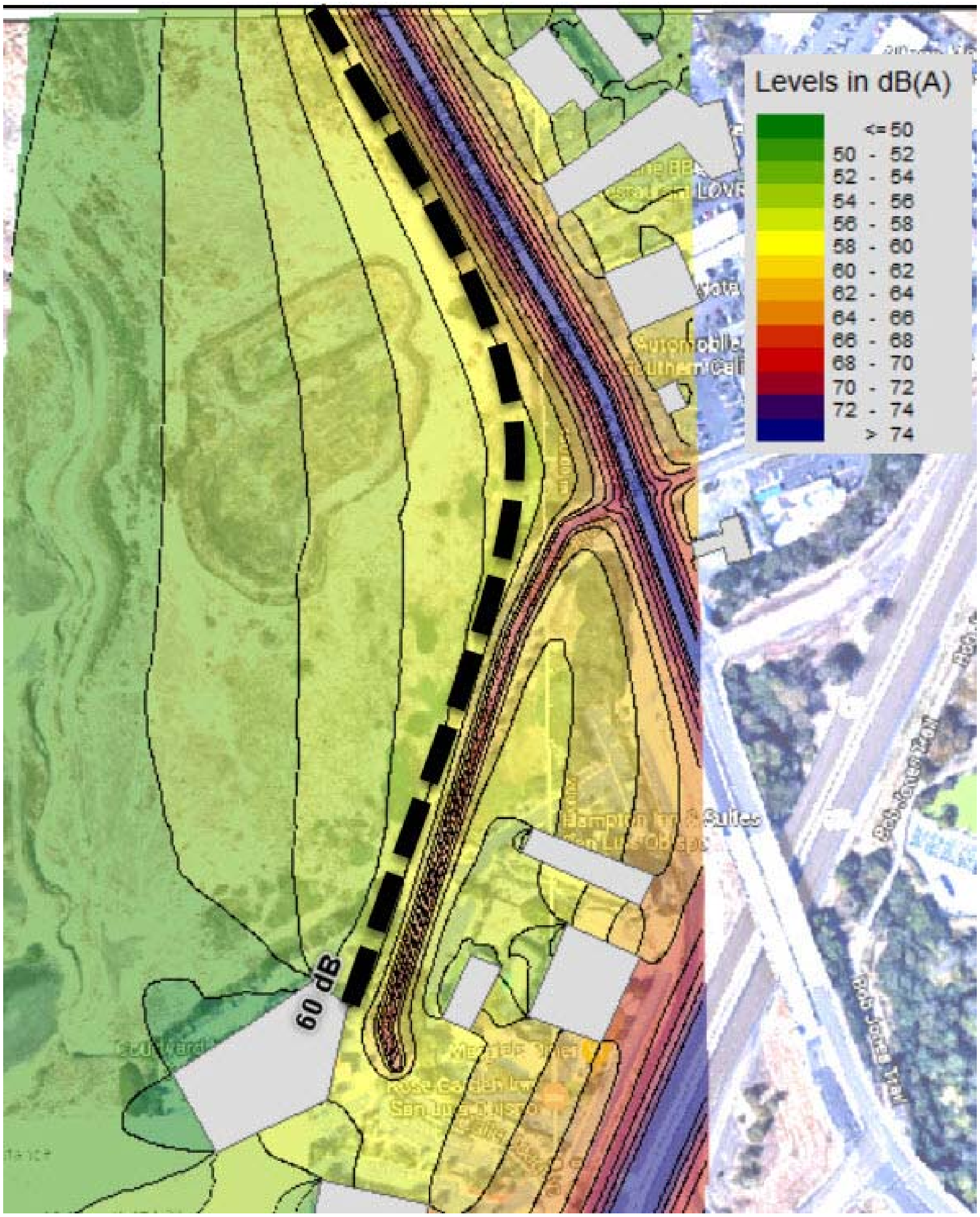
The difference between the sound level contours shown by the City in its 1996 Noise Element exhibit and the measured and modeled contemporaneous sound level contours presented in this report can be attributed to the difference in technology utilized in the 1990s and that used today.

In 1990, when the City's commissioned noise study was completed by Brown-Buntin Associates, the method for drawing sound level contours was based on a mathematical calculation of sound level at fixed and specific distances from the centerline of the roadway. The calculations ignored the effects of topography, shielding by buildings, ground surface variations, absorption and reflection. In 1990, sound level contours were drawn at a constant distance along major roads in the city and ended at the city limits. The calculations accommodated three vehicle types, autos, heavy trucks and medium trucks at constant speeds. Described at the time, "the noise contour information prepared by the consultants and staff generally reflects conservative (worst case) assumptions, so significant noise exposure concerns are not likely to be omitted or understated." (See Reference 9.)

Today, using contemporary sound level mapping, there are noticeable effects and multiple variations due to terrain, ground absorption, reflection and blocking of sound by the built environment. Noise contours change as urban density and traffic patterns change. Today's sound level contours are a more realistic representation of actual conditions.

2.4 Graphic Results

Figure 8. This is the *measured, existing* 60 dBA Sound Level Contour, based on measured values from the six stations shown previously.



2.5 Future Sound Level

The calculated future Ldn/CNEL (year 2037) along the east and south side of the site will depend on growth of traffic, generally accepted to be about one percent per year growth rate.

Figure 9. Future, calculated, 60 dBA Sound Level Contour at Buildout or year 2037

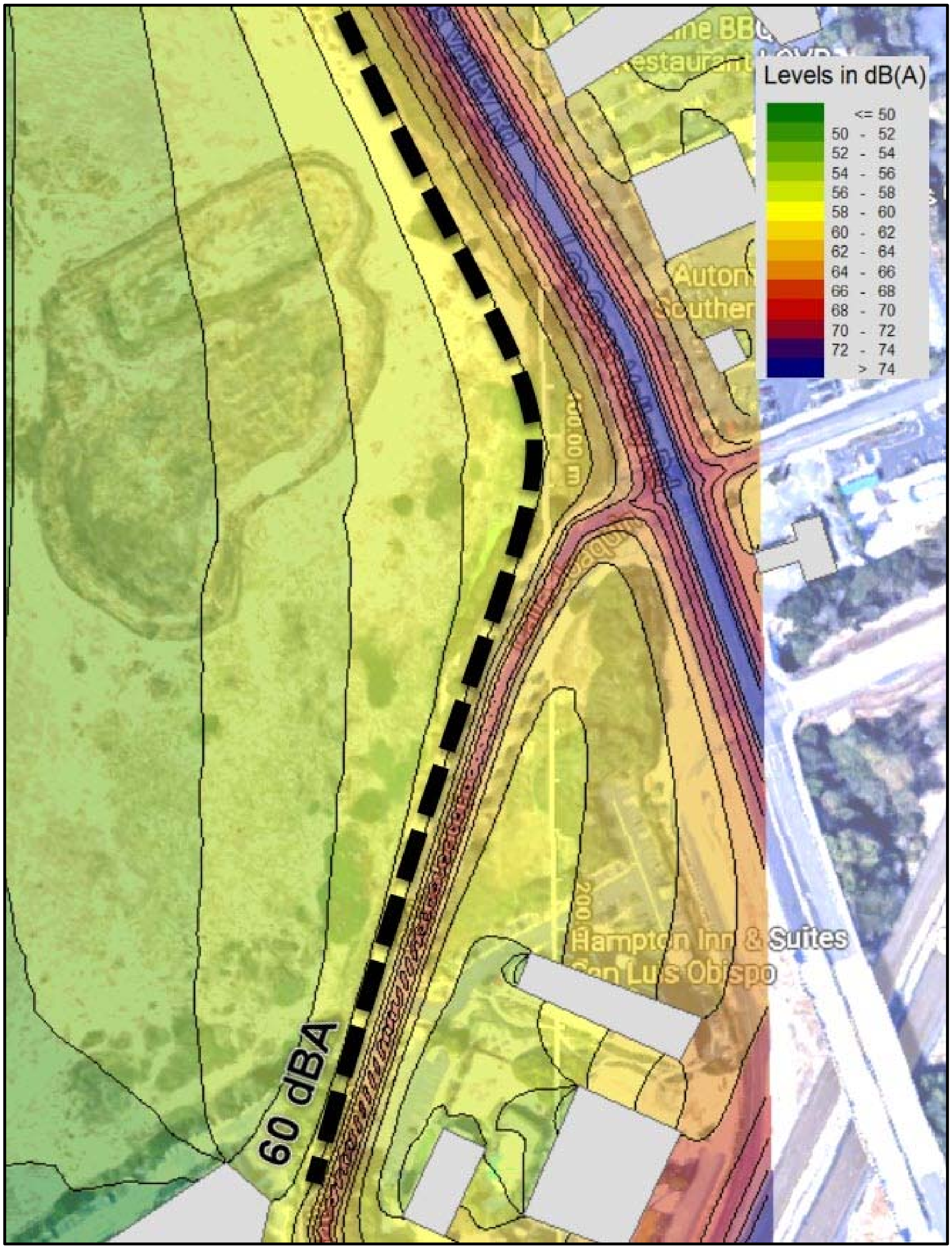


Figure 10. No Project, Sound Level Contours Across the Site

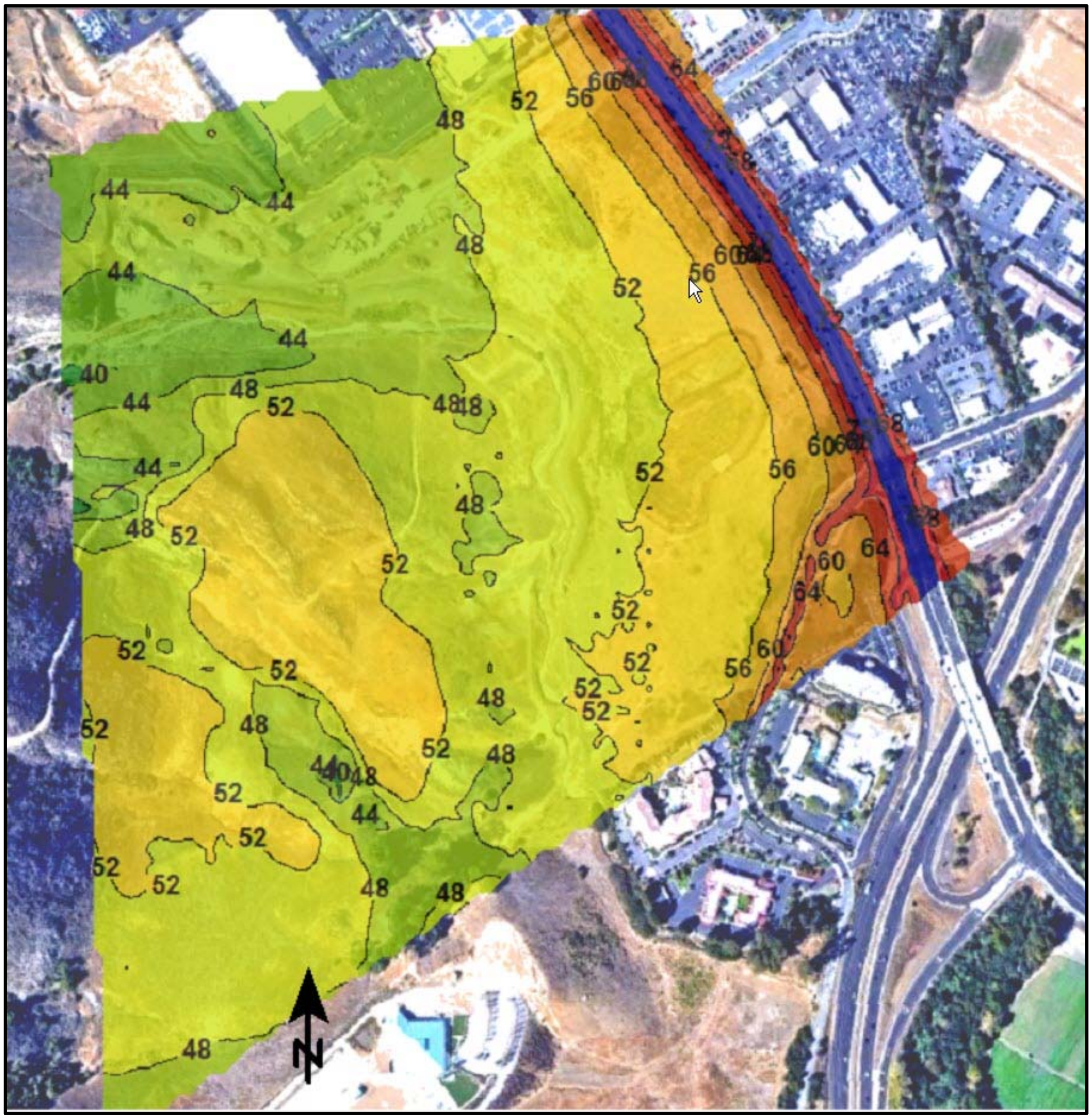
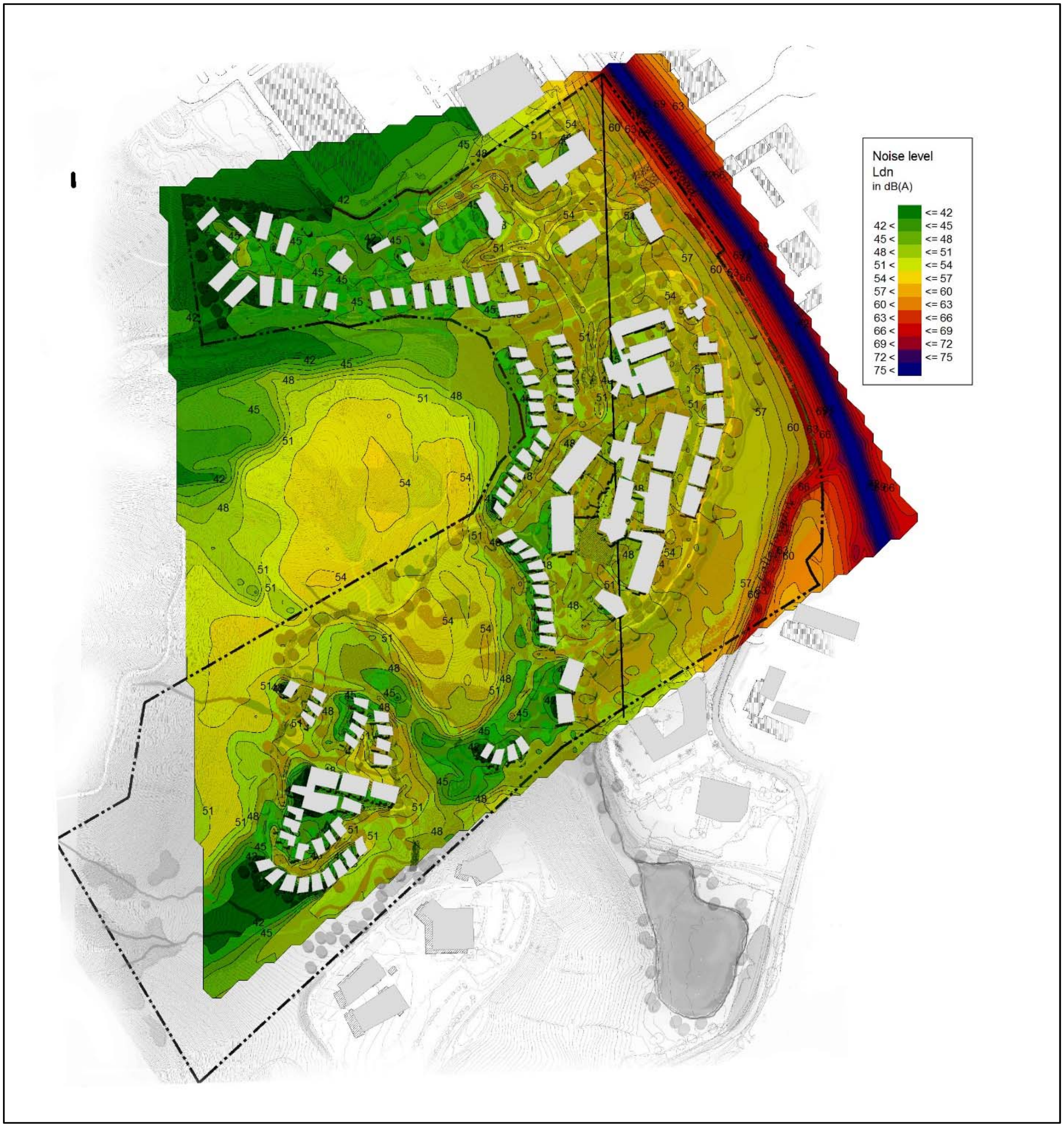


Figure 11. Future Sound Level Contours with Proposed Project (year 2037)



3 Regulatory Setting

Noise is regulated at the federal, state and local levels through regulations, policies and/or local ordinances. Local policies are generally adaptations of federal and state guidelines, adjusted to prevailing local condition.

3.1 State Regulation

The State of California's *Guidelines for the Preparation and Content of Noise Element of the General Plan (1987)* make reference to land use compatibility standards for community noise environments as developed by the California Department of Health Services, Office of Noise Control. Sound levels up to 65 Ldn or CNEL are determined to be normally acceptable for multi-family residential land uses. Sound levels up to 70 CNEL are normally acceptable for buildings containing professional offices or defined as business commercial.

All new Multi-Family housing must comply with California Code of Regulations (CCR) Title 24. This is included in the California Building Code (CBC), Section 1207, "Sound Transmission" – which specifies the maximum level of interior noise due to exterior sources allowable for new residential developments.

3.2 Local Regulation

CCR Title 24 also defers to local requirements if applicable. The Noise Element of the City of San Luis Obispo General Plan specifies a maximum allowable interior noise level of 45 dBA Ldn for multi-family projects which is consistent with the above policies for interior noise and also extends this requirement to new single-family dwellings. The City of San Luis Obispo Noise Element also states that 60 dBA Ldn or less is the exterior noise goal for outdoor common areas, defined as areas intended for the use and enjoyment of residents.

Guidelines for transportation noise exposure are contained in City of San Luis Obispo, General Plan Noise Element and Noise Guidebook (1996). The maximum noise exposure standards for noise-sensitive land uses are shown in Figure 12. The maximum noise exposure standards for noise-sensitive land uses due to traffic are shown in Figure 13.

Figure 12. Community Noise Exposure Ldn / CNEL

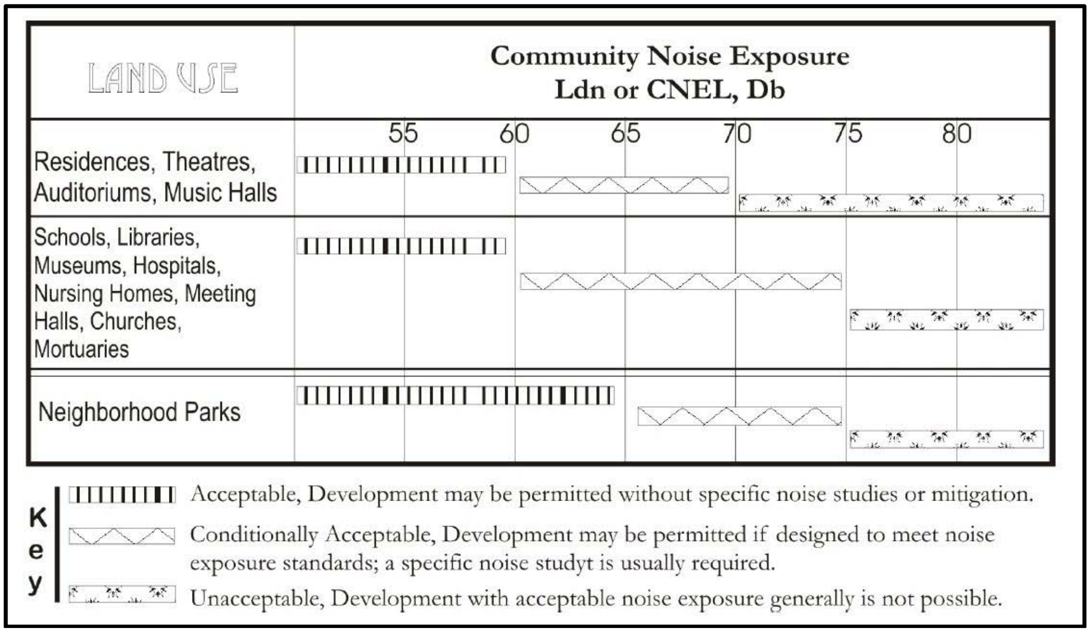
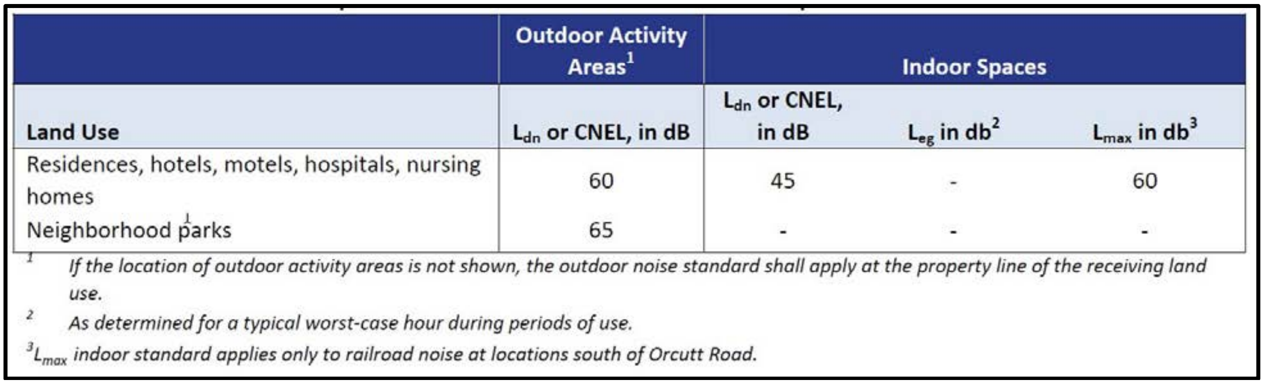


Figure 13. Maximum Exposure for Noise Sensitive Uses due to Traffic



	Outdoor Activity Areas[1]	Indoor Spaces		
Land Use	L_{dn} or CNEL, in dB	L_{dn} or CNEL, in dB	L_{eg} in db[2]	L_{max} in db[3]
Residences, hotels, motels, hospitals, nursing homes	60	45	-	60
Neighborhood parks	65	-	-	-

[1] *If the location of outdoor activity areas is not shown, the outdoor noise standard shall apply at the property line of the receiving land use.*

[2] *As determined for a typical worst-case hour during periods of use.*

[3] *L_{max} indoor standard applies only to railroad noise at locations south of Orcutt Road.*

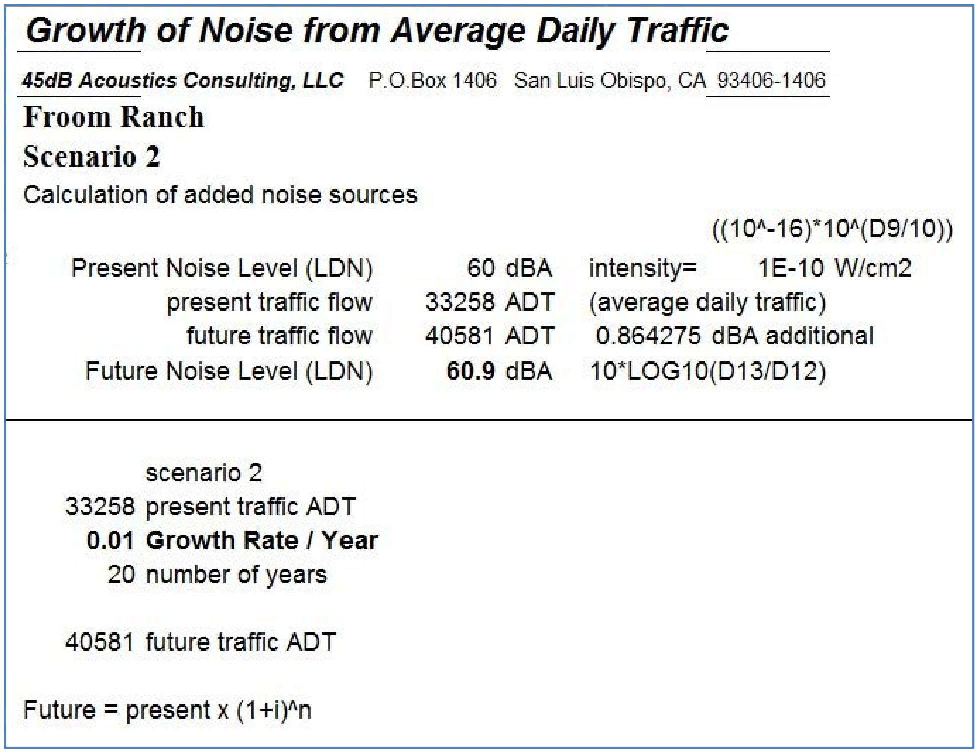
4 Traffic Characteristics

This section examines the effects of traffic growth over time on the sound level contours of the site, and the relationship of traffic flow to sound levels on site.

4.1 Traffic Growth

Federally funded projects and environmental reviews typically require the projection of traffic volumes 10–30 years in the future, typically assuming a 1–2% annual growth in vehicle volume. In this report, we have assumed a 20-year period of growth to year 2037, at an annual growth rate of 1 percent (0.01). The calculation in Figure 14 shows the result for Los Osos Valley Road.

Figure 14. Growth of Noise from Average Daily Traffic



Growth of Noise from Average Daily Traffic

45dB Acoustics Consulting, LLC P.O.Box 1406 San Luis Obispo, CA 93406-1406

Froom Ranch

Scenario 2

Calculation of added noise sources

		((10^-16)*10^(D9/10))
Present Noise Level (LDN)	60 dBA	intensity= 1E-10 W/cm2
present traffic flow	33258 ADT	(average daily traffic)
future traffic flow	40581 ADT	0.864275 dBA additional
Future Noise Level (LDN)	**60.9** dBA	10*LOG10(D13/D12)

	scenario 2
33258	present traffic ADT
0.01	**Growth Rate / Year**
20	number of years
40581	future traffic ADT

Future = present x (1+i)^n

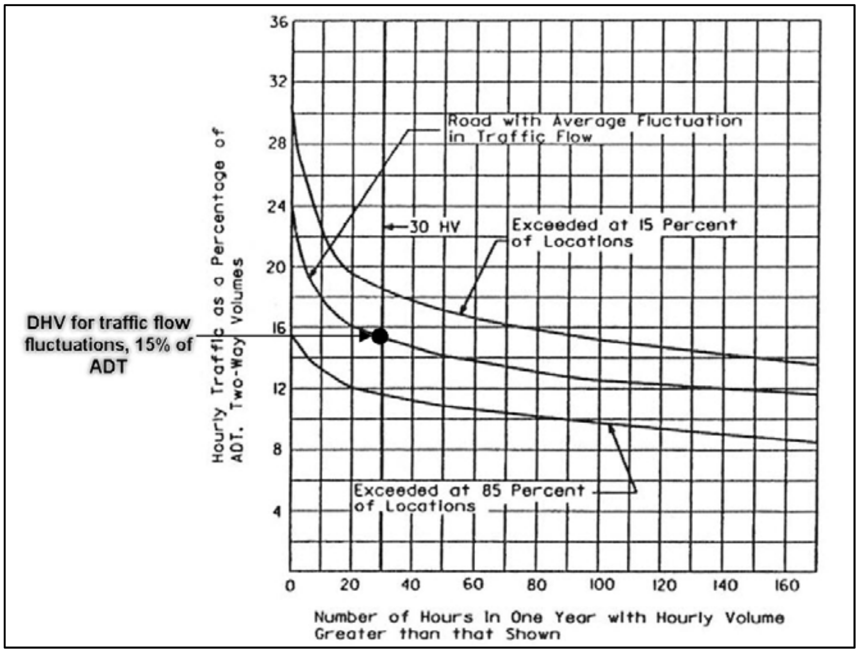
4.2 Traffic Flow and Sound Level

Consulting the Highway Traffic Manual (reference 15) helps to understand the issues in measuring sound level resulting from traffic flow. There are several descriptors of traffic flow from Average Daily Traffic (ADT) to Design Hourly Volume (DHV) of traffic on a road or highway. DHV is sometimes used as a benchmark for sound level measurements. However, the DHV is defined as the 30th highest hourly volume in the "design" year, whereas the Peak Hour Volume (PHV) is defined as the highest hourly volume during an average day.

Depending on the type of roadway, the PHV may be from 5 to 45 percent lower than the DHV.

The definition infers that if a highway or street is to adequately serve throughout its life, its physical capacity will only be exceeded for about 30 hours out of the total 8,760 hours in the "design" year. The choice of the 30th highest hourly volume is a long-held concept which stems from research published in *A Policy on Geometric Design of Rural Highways* (Reference 1.)

Figure 15. Relationship Between Peak-Hour and Average Daily Traffic Volumes.



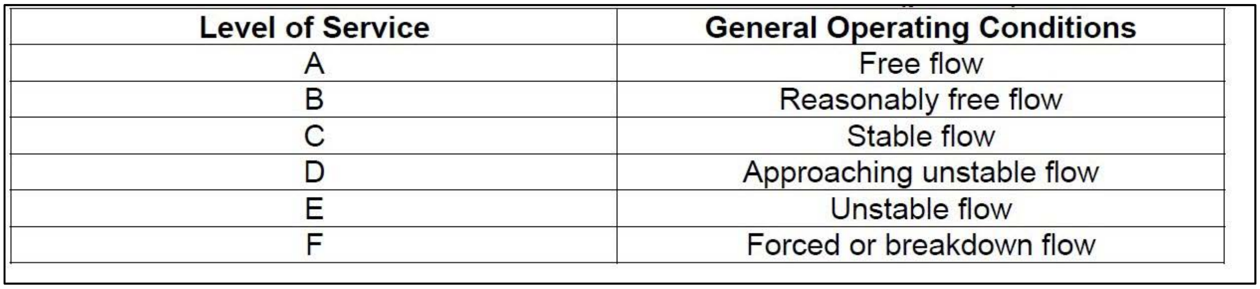
Visually comparing the traffic flow trend lines above indicates that significant traffic flow changes occur at the inflection point of the 30th highest volume hour of the year. The difference in volume of traffic between the 1st highest hourly volume and the 30th increases rapidly. For the remainder of the hours between the 30th and the 170th, there is very little change in the slope of the curves. This indicates that designing for that 30th hour would cover the expected traffic volume at almost any given hour in a given day of a given week in a given month of a given year.

Noise impacts are measured during the one-hour period when the worst-case noise levels are expected to occur. This may or may not be the peak hour of traffic. That is, higher traffic volumes can lead to higher congestion and lower operating speeds. Since higher speeds lead to higher noise emissions from motor vehicles, the worst-case noise levels may occur in hours with lower volumes and higher speeds. In addition, vehicle mix may also change hourly. On many highways, the percentage of heavy trucks is reduced during peak hour. Since heavy trucks have greater sound emissions than passenger cars, vehicle mix is an important component in determining the peak hour of noise impact.

During the sound level measurement for this project, Level of Service (LOS) was observable and gives us confidence that we are measuring during a busy-but-not-congested time period.

The LOS during the measurements was generally Level B to Level C and at one time became Level of Service D.

Figure 16. Level of Service vs General Operating Conditions



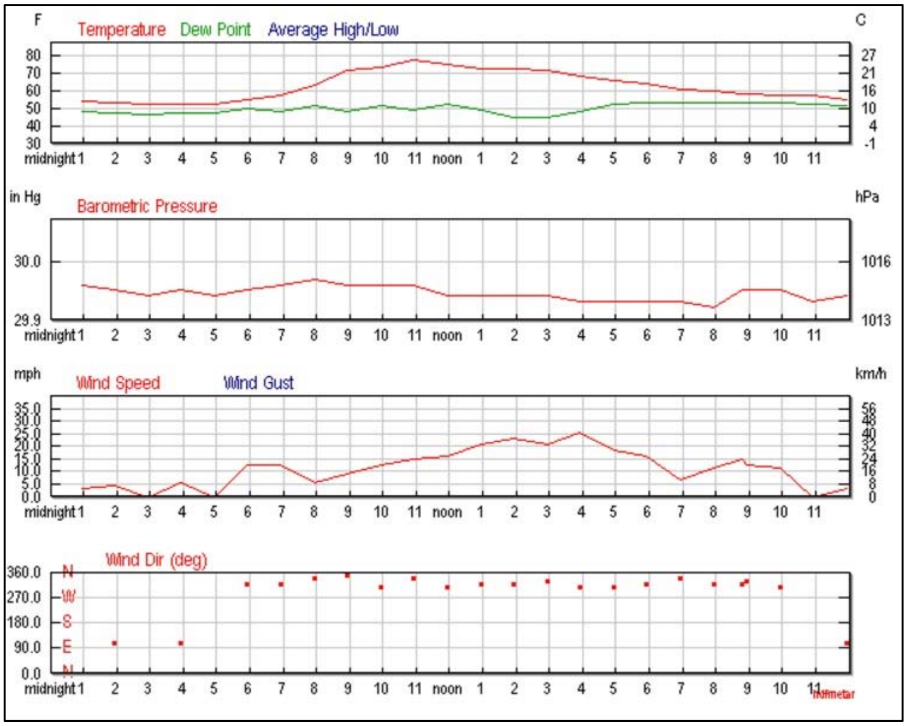
Level of Service	General Operating Conditions
A	Free flow
B	Reasonably free flow
C	Stable flow
D	Approaching unstable flow
E	Unstable flow
F	Forced or breakdown flow

5 Meteorological Conditions

During the measurement period from 10 am to 12 noon on Saturday, April 22, 2017, the sky was essentially clear and the wind speed was less than 10 mph from the west and north. Wind speed and direction data was taken from San Luis Obispo County Regional Airport weather station.

Wind speed above 12 mph has an increasing adverse effect on the accuracy of sound level measurements (reference: Federal Highway Administration, Noise Measurement).

Figure 17. Weather conditions at SBP San Luis Obispo Airport, 3.2 km SE of the project site.



6 Sound Level Data

Figure 18. Location Name, Coordinates and Sound Level, LAeq

Location Name	Coordinates	LAeq (
SC1	35.245107, -120.684473	54.9
SC2	35.244282, -120.686455	54.9
SC3	35.247990, -120.684612	58
SC4	35.247065, -120.684385	53.8
SC5	35.248028, -120.684247	61.6
SC6	35.245840, -120.685085	49.9
LT1	35.245107, -120.684473	54.4
LT2	35.248028, -120.684247	61.1

Figure 19. Spectral quality of sound, Third Octave Bands at LT1, near Calle Joaquin.

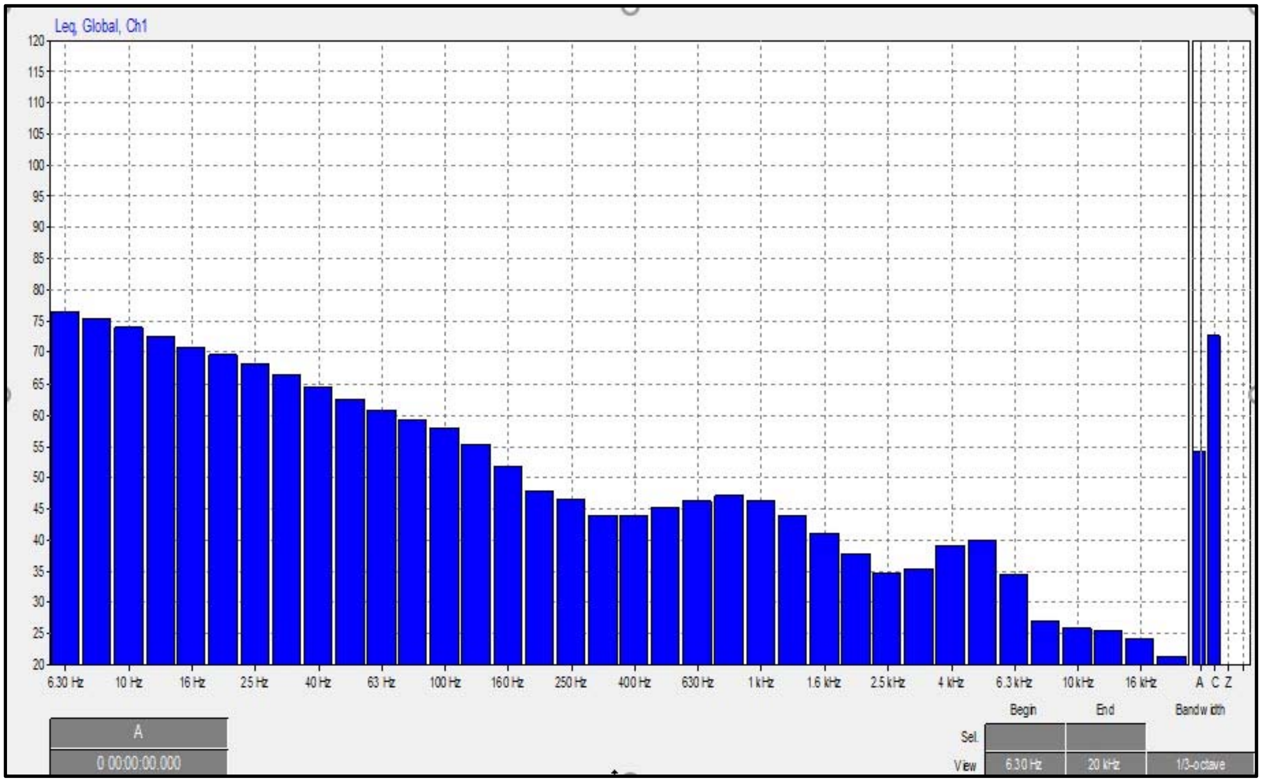
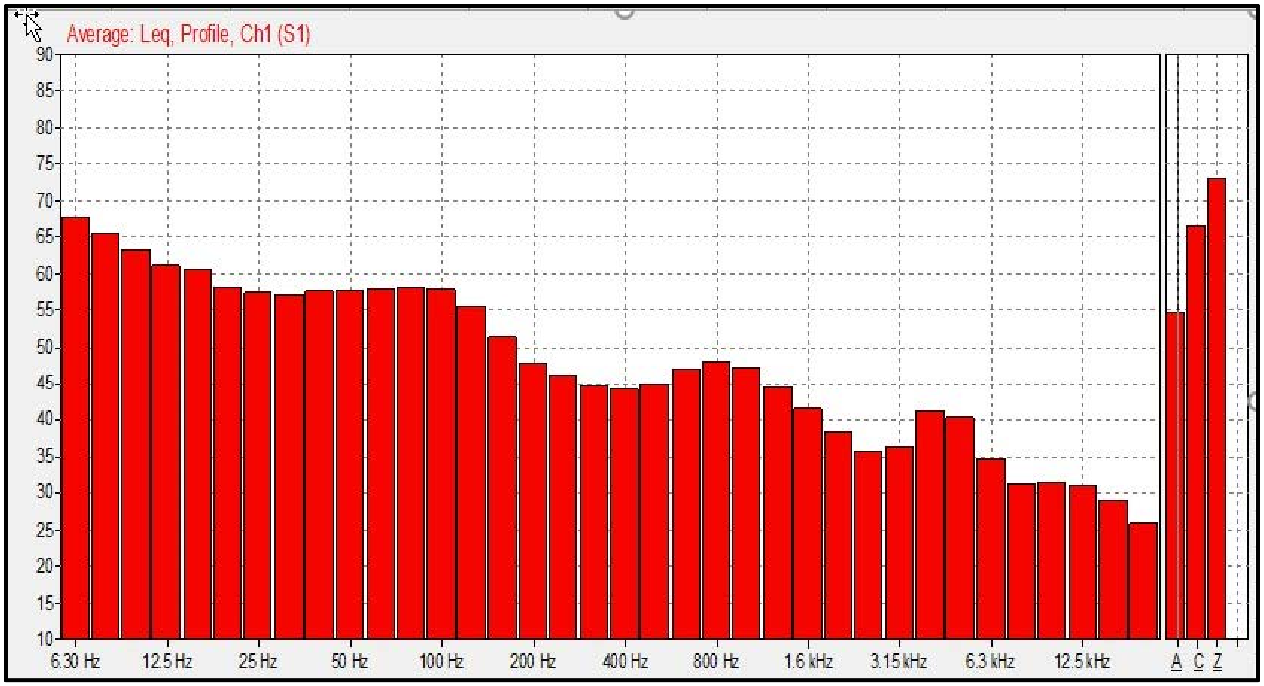


Figure 20. Spectral Quality of Sound, Third Octave Bands at LT2 near Los Osos Valley Road



7 Conclusion

The measured and predicted sound levels impacting the proposed Villaggio project are a mix of transportation noise along Los Osos Valley Road, the Calle Joaquin interchange with Highway 101, and to a lesser extent, Calle Joaquin west of Los Osos Valley Road. Future noise level from transportation sources at buildout are predicted to result in an increase in sound level of about one decibel in 20 years' time.

Perceived sound level studies reveal the subjective interpretation of sound differences. A one dBA increase in sound level is barely noticeable to the most sensitive subjects. Sound level must increase by five (5) dBA before most listeners report a noticeable or significant change in sound level.

David Lord

for 45dB Acoustics, LLC
David Lord

8 Glossary of Acoustical Terms

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 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, but 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 spectra 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.

Single Event Noise Exposure Level (SENEL)
The time-integrated A-weighted sound pressure level of a single aircraft flyover (which exceeds a threshold noise level) which is expressed by the level of an equivalent one-second duration reference signal.

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.

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 as being *twice* (or *half*) as loud.

9 Sound Level Modeling and Measurement

9.1 Sound level modeling

Sound level contours compared to the measured sound level values were generated for assessment using *SoundPlan* noise simulation software. The software calculates sound attenuation of environmental noise around buildings. For this project, the land between the sources (road and airport operations) and receiver project boundary, is generally flat and partially paved. 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.”

9.2 Sound Level Measurement

The protocol used for the sound level measurements is prescribed in detail by the American Society for Testing and Materials (ASTM) in their E 1014 publication. The procedures and standards in that document were met or exceeded for sound level measurements shown in this report. The standards of ASTM E 1014 are exceeded by using Type 1 (Class 1) sound level meters for all measurements in this report instead of less accurate Type 2 meters. Therefore, the precision of the measurements in this report is likely to be better than +/- 1 dB. The sound level meters used for measurements shown in this report are Norsonic Nor140 Sound Analyzers, with synchronized time settings. These sound level meters meet all requirements of ANSI s1.4, IEC 651 for Class 1 accuracy. The sound level meters were calibrated before and after each sound level measurement. The measurement results from both sound level meters running simultaneously were compared and found to be in close agreement.

10 References

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