Appendix H

Acoustical Analysis

45dB Acoustics
CONSULTANTS IN SOUND AND VIBRATION

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

California | Colorado
www.45dB.com

February 10, 2021
Project# 19034
Revision 5

Acoustical Analysis:	**Client:**
Mixed-Use Residential 600 Tank Farm Road San Luis Obispo, CA	Covelop, Inc. ATTN: Damien Mavis, dmavis@covelop.net 1135 Santa Rosa St. Suite 210 San Luis Obispo, CA 93401

1 Executive Summary

The proposed mixed-use project is a 22-building development with 2 commercial buildings fronting Tank Farm Road and 19 residential buildings to the north. A new feeder road for the development has been added to this Revision. A residential mobile home park is currently located immediately to the east, and commercial uses are located further to the east and to the immediate south, across Tank Farm Road. Traffic noise from Tank Farm Road and Broad Street are the prominent noise sources at this location. Runway 11-29 of the San Luis Obispo regional airport (SBP) is located approximately 1,500 feet to the southwest. Airport traffic noise was also considered in this analysis. The site is in the Airport Area Specific Plan area of the City of San Luis Obispo, and also in the Planning Area of the Airport Land Use Plan for the San Luis Obispo County Regional Airport. Each of these jurisdictions will review the acoustical analysis.

24-hour CNEL measurements for the area were performed and agree well with our predictive modeling based upon published traffic counts.

Our study concludes that the proposed mixed-use project will result in Community Noise Equivalent Levels of up to approximately 68 dBA at the Commercial buildings facing Tank Farm Road, and up to 54 dBA CNEL at the residential building elevations toward Tank Farm Road. Levels further north for the residential buildings are as low as 42 dBA. With a maximum exterior noise level of 54 dBA for the residential buildings of the project, normal/typical construction practices and designs will be sufficient to maintain interior noise levels of habitable spaces in all the residential buildings of the project. Additionally, even if residential units are placed in the Commercial buildings facing Tank Farm Road, normal/typical construction practices and designs will be acoustically sufficient to meet City noise standards for interior habitable spaces. The courtyard outdoor activity area of Building 3, with its northern location and sound attenuation from intervening buildings, is well below the Noise Element's outdoor noise level limit of 60 dBA. In conclusion, this analysis determines that the project can fully comply with applicable noise standards.

for ***45dB Acoustics, LLC***
A California Limited Liability Company

Sarah Taubitz, MSME

David Lord, Ph.D.

Contents

1 Executive Summary i

Contents ii

List of Figures ii

2 Description 3

3 Acoustical Criteria 5

3.1 State Regulations 5

4 Existing Noise Environment 6

4.1 Measured Existing Noise Levels 6

4.2 Existing Modeled Noise Levels 12

5 Future Modeled Noise Levels 16

6 Conclusions 16

7 References 16

9 Appendix 18

9.1 Characteristics of Sound 18

9.2 Terminology/Glossary 19

9.3 Traffic Noise Model 21

9.4 SoundPLAN® Acoustics Software 22

List of Figures

Figure 1: Preliminary proposed site plan 4
Figure 3: Airport CNEL Contours (RS&H) 6
Figure 4: Project measurement locations 7
Figure 5: Serra Meadows subdivision measurement locations 8
Figure 6: 1-min Laeq for 24 hours at 4 locations 9
Figure 7: Hourly LAeq and max-LAmax for 24 hours at 4 locations (with CNEL noted) 10
Figure 8: Example 1-second data of flyover at four locations 11
Figure 9: San Luis Obispo traffic counts for Tank Farm Road (l.) and Broad Street (r.) 13
Figure 10: CNEL sound level contours for road traffic only, in plan view 14
Figure 11: Vertical north-south cross-section through Tank Farm Road, commercial building, and neraby residential building 15

List of Tables

Table 1: Measured Sound Level Results (in dBA) 12
Table 2: Sound Level Change Relative Loudness/Acoustic Energy Loss 18

2 Description

The project is located north of Tank Farm Road and west of Broad Street. The project will consist of two (2) commercial buildings at the south end of the project along Tank Farm Road, and nineteen (19) multifamily residential buildings to the north (Figure 1). A community building will be located near the middle of the development.

The nearby roads—Tank Farm Road and Broad Street, and the San Luis Obispo Regional Airport—are the principal transportation noise sources. Ambient noise levels due to traffic are moderately high here.

The purpose of this study is to quantify the existing noise environment around the project, calculate the future CNEL noise contours resulting from the future project, and evaluate potentially significant noise impacts with respect to Airport Land Use Plan ("ALUP") and City Ordinance noise standards. Commercial and residential properties exist around the project. The airport sits approximately 1,500 feet to the south of the project, directly across Tank Farm Road.

Figure 1: Preliminary proposed site plan

3 Acoustical Criteria

3.1 State Regulations

The California Airport Noise Regulations defines airport noise compatibility as follows:

"The level of noise acceptable to a reasonable person residing in the vicinity of an airport is established as a community noise equivalent level (CNEL) value of 65 dBA for purposes of these regulations. This criterion level has been chosen for reasonable persons residing in urban residential areas where houses are of typical California construction and may have windows partially open. It has been selected with reference to speech, sleep and community reaction."

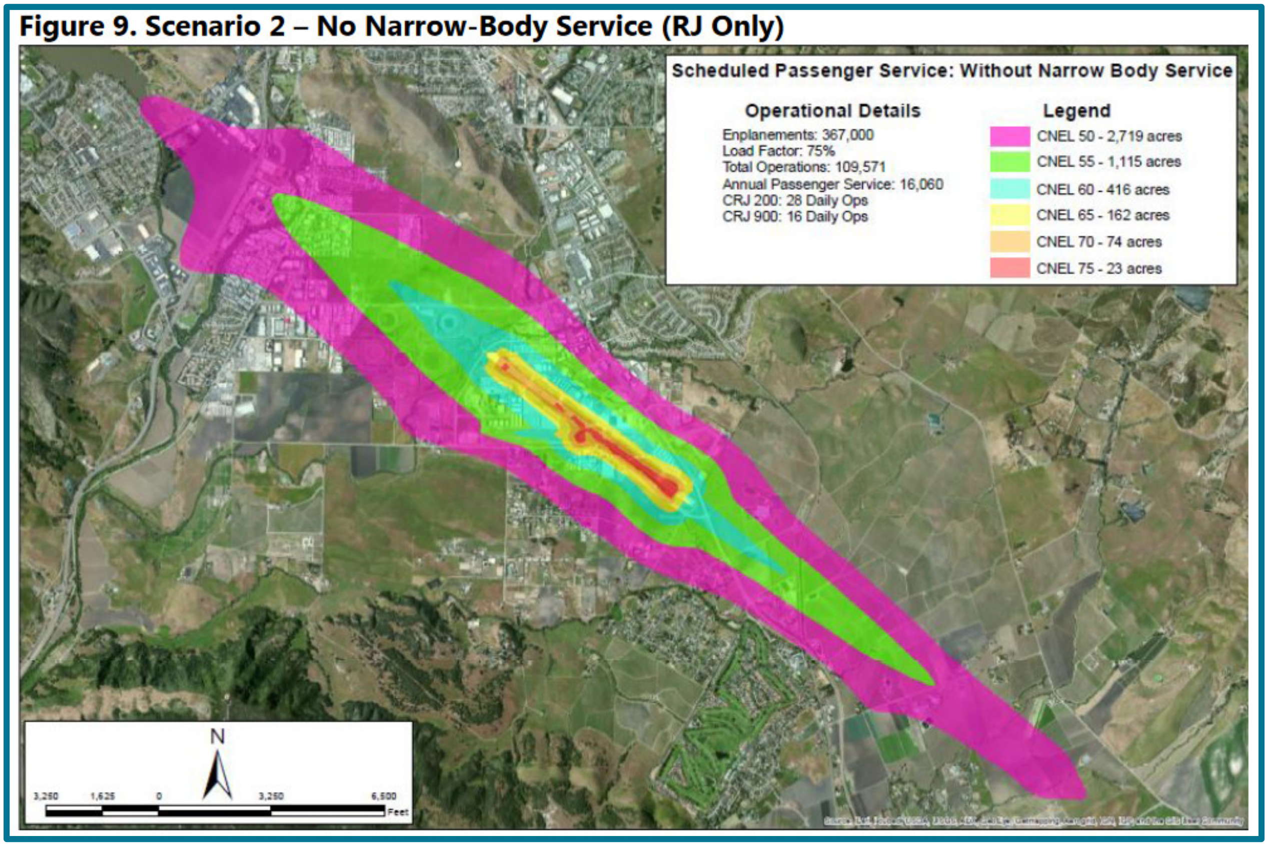
It is important to understand, however, that the compatibility criterion (i.e., 65 dBA CNEL) identified in the Airport Noise regulations is only mandated for a few airports (less than a dozen) that have been formally declared to have a "noise problem", the regulations do not establish a mandatory criterion for evaluating the compatibility of proposed land use development around other airports.

24-hour metric CNEL is also used to describe noise around airports. The U.S. Environmental Protection Agency identified CNEL as the most appropriate measure of evaluating airport noise based on the following considerations:

1. It is applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods of time.
2. It correlates well with known effects of noise on individuals and the public.
3. It is simple, practical, and accurate. In principal, it is useful for planning as well as for enforcement or monitoring purposes.
4. The required measurement equipment, with standard characteristics, is commercially available.
5. It is closely related to existing methods currently in use.

The CNEL levels (for aircraft-related noise only) published in the ALUP are shown in **Error! Reference source not found.**. The site lies within the 55-61 dBA CNEL range. However, more recent contours as reported by RS&H (Reference 3) are approximately 5 dB lower and agree better with our results, shown in the next section.

Figure 2: Airport CNEL Contours (RS&H)



4 Existing Noise Environment

4.1 Measured Existing Noise Levels

Sound levels (Leq, Lmax, Lmin, etc.) were measured by **45dB** from 5pm on September 10 through 5pm September 11, 2019 at two locations on the project site (Figure 3) and two locations in the "Serra Meadows" residential neighborhood northwest of the site (Figure 4). These two neighborhood locations were chosen because they still lie almost directly under the flight path of aircraft departing to the NW from the SBP airport.

Figure 3: Project measurement locations

Figure 4: Serra Meadows subdivision measurement locations

Figure 5 shows 1-minute averaged A-weighted Leq for all four sites.

Figure 6 shows the corresponding hourly equivalent Leq for all four sites in solid lines, along with the maximum 1-second Lmax that occurred during each hour, to show how instantaneous levels can be 10 to 25dB higher than the hourly Leq, depending upon the noise sources in the area. The CNEL is notated for each location on this graph, and listed in Table 1 as well.

Figure 5: 1-min Laeq for 24 hours at 4 locations

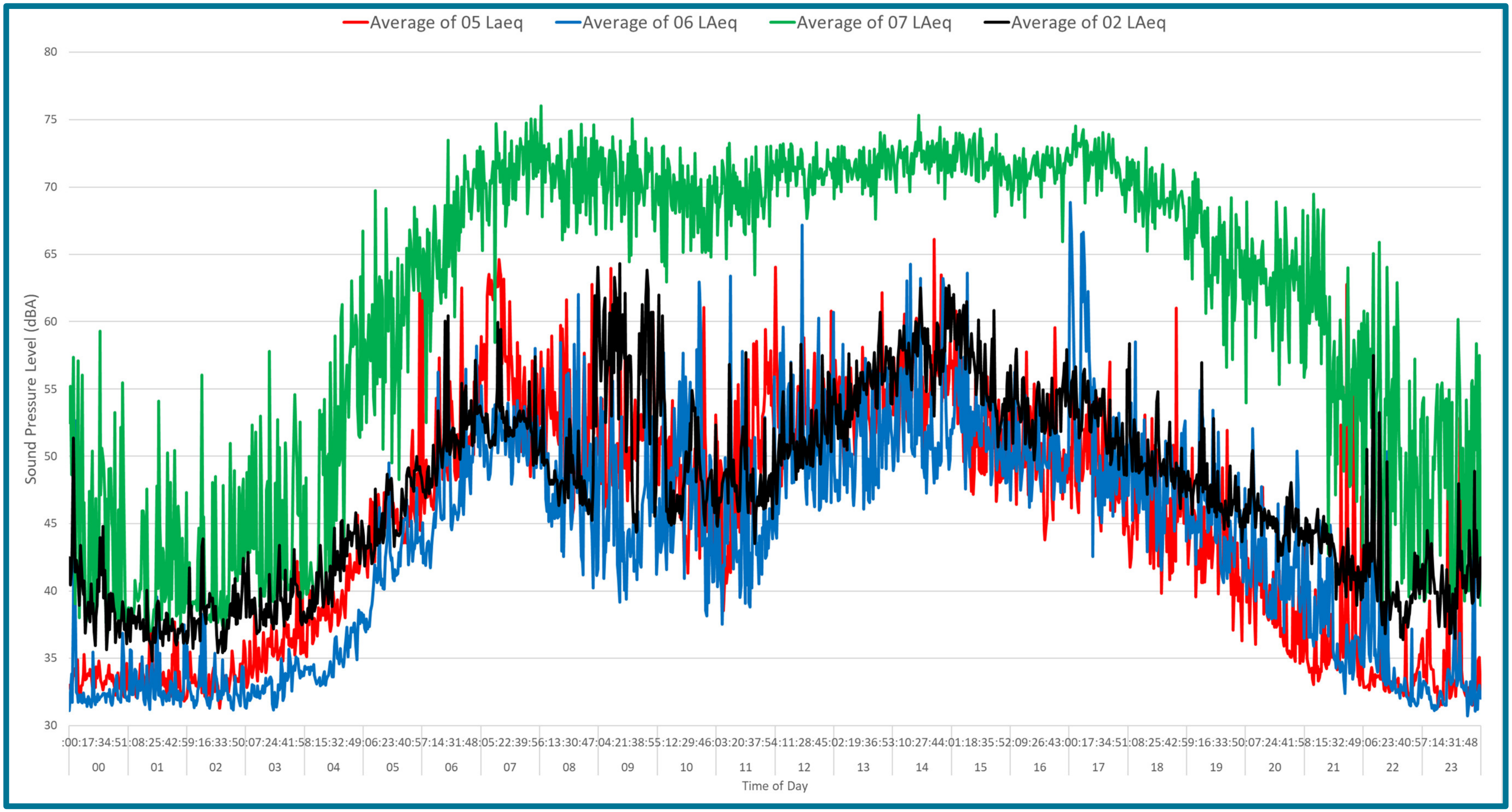
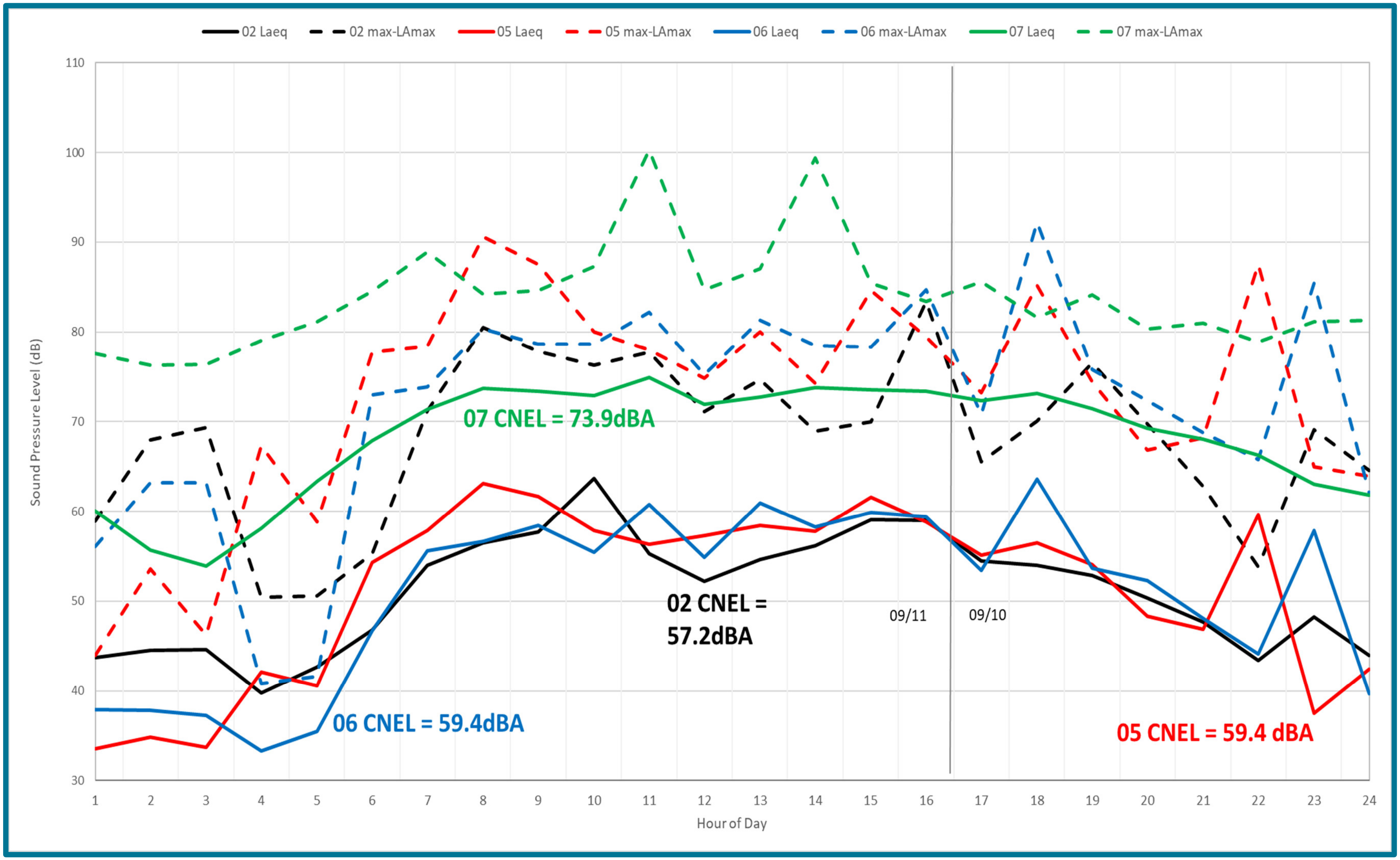


Figure 6: Hourly LAeq and max-LAmax for 24 hours at 4 locations (with CNEL noted)



One-second sampled acoustic data allow for energy- or logarithmic-averaging to find hourly levels, as well as determination of SENEL of an example flyover event from a jet aircraft departure from the SBP airport (Figure 7). The SENEL results at each location are included in the rightmost column of Table 1.

This jet aircraft fly-over example is positively identified firstly by using audio recording from location 02, near the airport where background noise from traffic is low, and then inspecting 1-second data for all four locations. It is further confirmed by the commercial aircraft flight schedule for SBP. The approximate 30-second flyover event occurs at all four locations when positively identified, and there is an approximate 27-second delay from locations 02 and 07 (near the airport runway's end) until the aircraft noise is picked up at locations 05 and 06, which are approximately 4,700 ft/ 0.9 miles away. An aircraft traveling at 120MPH would reach location 06 approximately 27 seconds after reaching location 07.

Figure 7: Example 1-second data of flyover at four locations

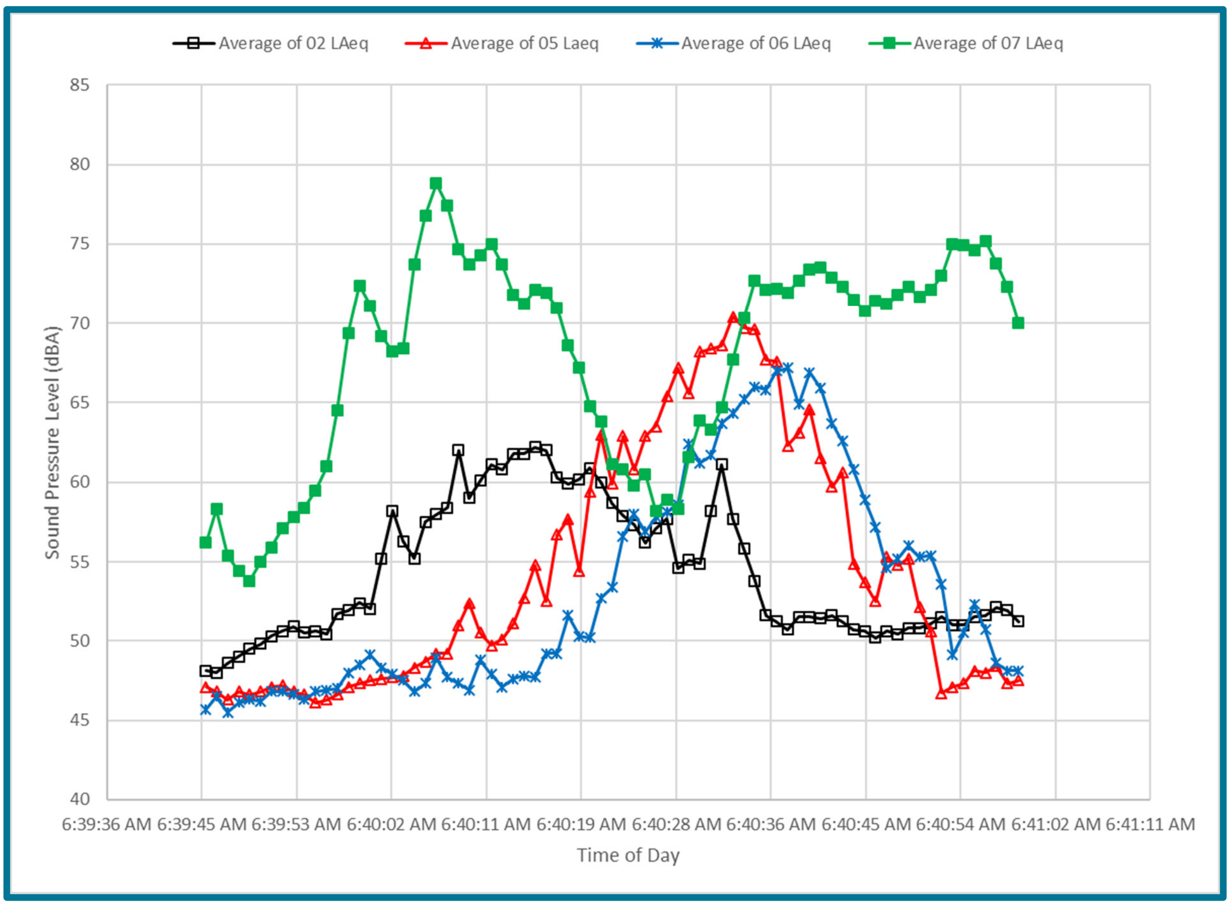


Table 1 also shows the range of hourly Leq levels for each of the four measurement locations. Locations 05 and 06, in the neighborhood just south of South Hills Open Space, have quiet nighttime levels of 33-34 dBA. Location 02 is slightly louder at nighttime, but this was primarily due to wind causing vegetation rustling noise during nighttime hours on this date.

The representative SENEL levels at the four sites (Table 1) show that the north end of Tank Farm Rd (location 02) experiences aircraft flyover noise levels very similar to those of the neighborhoods to the northwest near South Hills Open Space (locations 05 and 06). The south end of the 600 Tank Farm Road project—where commercial space is planned—will experience higher aircraft noise levels, than at project locations north, where the residential buildings are planned.

Location 02 daytime levels are slightly elevated due to ongoing industrial operations, e.g., back-up beeping from forklifts which dominated some of the daytime noise levels at location 02. Even so, hourly Leq and CNEL levels at location 02 are similar to those of the residential neighborhood near South Hills Open Space. When this industrial operation is replaced by the 600 Tank Farm Road residential project, we expect that the planned residential buildings of the 600 Tank Farm Road project site will be very similar in acoustic environment to the residential neighborhood near South Hills Open Space, including during aircraft flyover events.

Table 1: Measured Sound Level Results (in dBA)

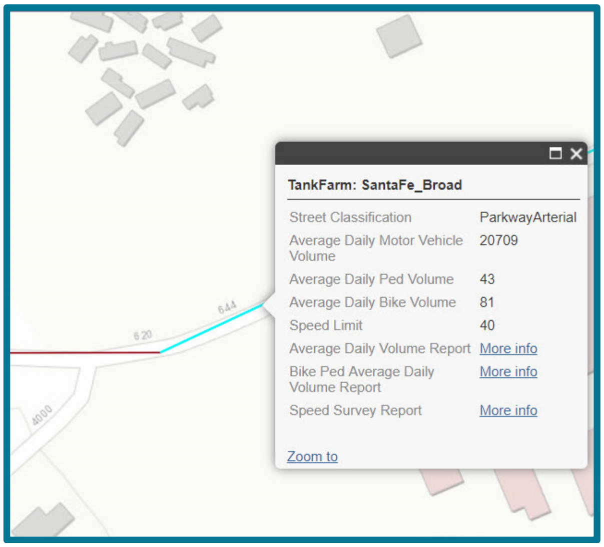
Location	Hourly LAeq Range	CNEL	Highest 1-second LAmax due to 06:40am aircraft pass-by	1-minute LAeq at 06:40am	1-hour LAeq for 6:00-7:00am
02: North end of 600 Tank Farm Rd.	40 to 64	57	62	70	54
07: South end of 600 Tank Farm Rd.	54 to 75	74	79	55	71
05: Calle Malva & Lupita	34 to 62	59	70	56	58
06: Serra Meadows Rd. & Junipero	33 to 61	59	67	55	56

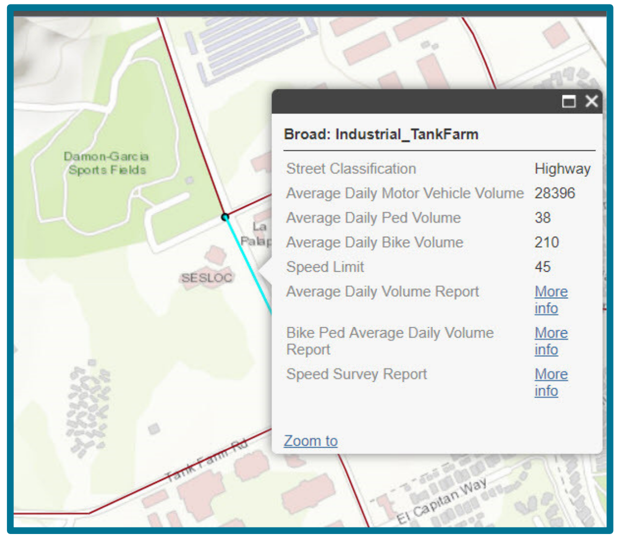
4.2 Existing Modeled Noise Levels

The nearest railroad line, Union Pacific Railroad, lies approximately 3,800ft (1.2km) away from the site, and is not a significant noise source at this location. Noise levels modeled from road traffic alone are presented first. Aircraft noise from San Luis Obispo Regional Airport (SBP) is then added to the road noise analysis.

Road noise levels for the existing environment for this location can be accurately predicted using current Annual Average Daily Traffic (AADT) traffic counts published by the City of San Luis Obispo's website (Figure 8).

Figure 8: San Luis Obispo traffic counts for Tank Farm Road (l.) and Broad Street (r.)





Existing noise level sound contours are shown below in plan view in Figure 9. CNEL Noise levels range from approximately 42 dBA at the north end, to 68 dBA at the south end facing Tank Farm Road.

Airport noise is a minor factor in the overall noise portrait of the site; road noise dominates the levels at the project site.

The noise levels are shown through a vertical cross-section, slicing through Tank Farm Road and the first two rows of buildings in Figure 10. The commercial buildings act as a noise barrier, reducing noise levels for residential buildings located further north.

So, for building locations not along Tank Farm Road—i.e., the ten multifamily residential buildings—noise levels are expected to be significantly quieter than the ALUP's published contours would lead one to expect.

Figure 9: CNEL sound level contours for road traffic only, in plan view

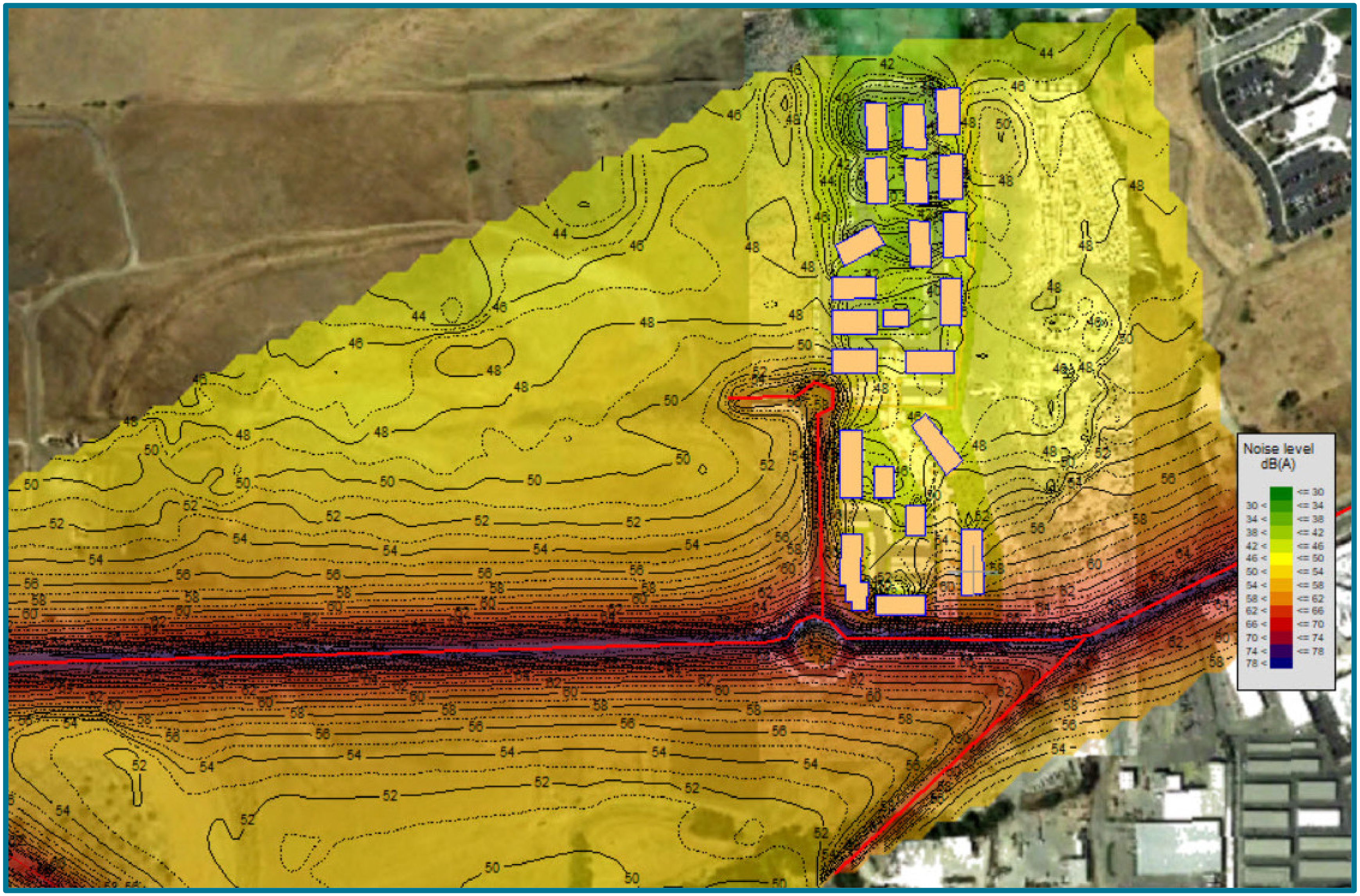
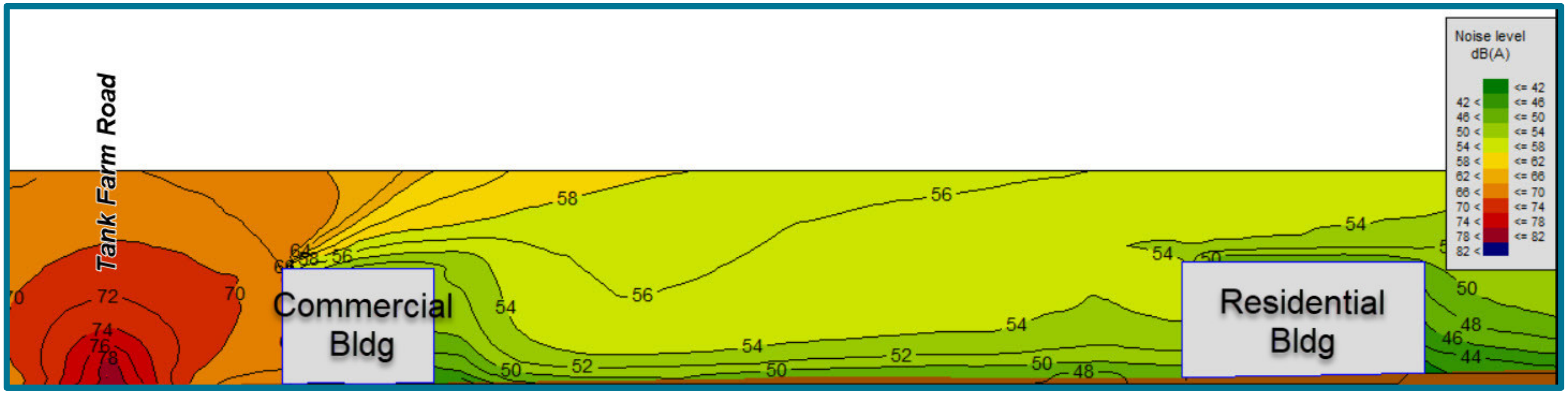


Figure 10: Vertical north-south cross-section through Tank Farm Road, commercial building, and nearby residential building



5 Future Modeled Noise Levels

The calculated future Ldn/CNEL (year 2039) for the site, assuming a traffic growth rate of 1% per year, is expected to increase by approximately 1dB, a less-than-significant amount.

6 Conclusions

With a maximum exterior noise level of 54 dBA for the southernmost residential buildings of the project, normal/typical construction practices and designs will be sufficient in maintaining the interior noise levels of habitable spaces in all the residential buildings of the project. (Typical construction assumes dual-paned glazing, wood- or steel-stud walls with fiberglass insulation of 3" thickness or more, gypsum wall board on the interior, and any exterior finish, including stucco and exterior siding on a suitable base.) Additionally, even if residential units get put into the Commercial buildings facing Tank Farm Road, normal/typical construction practices and designs will be acoustically sufficient there as well to meet City noise standards for interior spaces. The courtyard outdoor activity area of Building 3 is well below the Noise Element's limit of 60 dBA.

Measurements at the north and south ends of the project sight and in the neighborhood south of South Hills Open Space were conducted. Noise levels at the project site away from Tank Farm Road have levels similar to those at the South Hills Open Space neighborhood locations. The project's commercial buildings facing tank farm act as effective noise barrier walls, reducing the noise levels for the residential buildings within the project by approximately 5 dB.

In conclusion, this analysis determine that the project can fully comply with City noise standards.

7 References

1. City of San Luis Obispo Municipal Code: https://sanluisobispo.municipal.codes/Code/9.12.060
2. 2005. Airport Land Use Commission of San Luis Obispo County. *Airport Land Use Plan for the San Luis Obispo County Regional Airport.*
3. RS&H, May 20, 2015. *Attachment 1: CNEL Contours and Technical Report for the San Luis Obispo County Regional Airport.* http://slocounty.granicus.com/MetaViewer.php?view_id=3&clip_id=2085&meta_id=303525
4. American National Standards Institute, Inc. 2004. *ANSI 1994 American National Standard Acoustical Terminology*. ANSI S.1.-1994, (R2004), New York, NY.
5. American Society for Testing and Materials. 2004. ASTM E 1014 - 84 (Reapproved 2000) Standard Guide for Measurement of Outdoor A-Weighted Sound Levels.
6. Bolt, Beranek and Newman. 1973. *Fundamentals and Abatement of Highway Traffic Noise*, Report No. PB-222-703. Prepared for Federal Highway Administration.
7. California Department of Transportation (Caltrans). 1982. *Caltrans Transportation Laboratory Manual.*
8. ______. 1998. Caltrans Traffic Noise Analysis Protocol for New Highway Construction and Highway Reconstruction Projects.

9. Federal Highway Administration. 2006. *FHWA Roadway Construction Noise Model User's Guide Final Report.* FHWA-HEP-05-054 DOT-VNTSC-FHWA-05-01
10. Harris, Cyril M., editor. 1979. *Handbook of Noise Control*.
11. Computer Modeling of STC – Options and Accuracy. Horan, Daniel. 2014. Cavanaugh Tocci Associates, Sudbury, MA. December 2014, p. 8 ff.
12. National Research Council Canada. 1998. Gypsum Board Walls: Transmission Loss Data. NRC-NCRC Internal Report IRC-IR-761.
13. Office of Noise Control, California Department of Health Services. 1981. Catalog of STC and IIC Rating for Wall and Floor/Ceiling Assemblies.

9 Appendix

9.1 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 2 below presents the subjective effect of changes in sound pressure levels.

Table 2: Sound Level Change Relative Loudness/Acoustic Energy Loss

0 dBA	Reference 0%
-3 dBA	Barely 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.

9.2 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. An A-weighted Leq is designated as “LAeq”.

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.

Apparent Sound Transmission Class (ASTC)
A single number rating similar to STC, except that the transmission loss values used to derive the ASTC 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.

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.

Coherent Noise Source
Coherent sources have exactly the same frequency and a definite phase relationship between the two waves, whereas incoherent sources do not. An example of coherent sources is two speakers with the amp set to mono. Another is direct and reflected sound from the same source.

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 Average Sound Level (L_{dn} or DNL)
Day-Night Average Sound Level (Ldn or DNL) – A descriptor established by the U.S. Environmental Protection Agency to represent a 24-hour average noise level with a 10dB penalty applied to noise occurring during the nighttime hours (10 p.m. to 7 a.m.) to account for the increased sensitivity of people during sleeping hours.

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 (L_{eq}) or 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. Therefore, Leq is the equivalent steady-state sound level (in decibels) that, in a stated period of time, would contain the same acoustic energy as the time-varying sound level during the same period of time.

Effective perceived noise in decibels (EPNdB)
A measure of the relative loudness of an individual aircraft pass-by event. Separate ratings are stated for takeoff, overflight and landing phases, and represent the integrated sum of loudness over the period within which the noise from the aircraft is within 10 dB of the maximum noise (usually at the point of closest approach.) It is defined in Annex 16 of the Convention on International Civil Aviation and in Part 36 of the US Federal Aviation Regulations. The scaling is such that the EPNdB rating represents the integrated loudness over a ten-second period; EPNdB of 100 dB means that the event has the same integrated loudness as a 100 dB sound lasting ten seconds. The EPNdB rating of an aircraft is used to estimate how much contribution a given aircraft operation will make to the noise impact of an airport in a community, which is estimated using the https://en.wikipedia.org/wiki/Day-night_average_sound_level metric. Detailed information on measurement of aircraft acoustic signature to meet the requirements of Annex 16 is found in ICAO Document 9501 and IEC 61265. Data acquisition in one-third-octave bands is required, followed by processing to yield a logarithmically-scaled value in decibels relative to a sound pressure of 20 micropascals, approximately the threshold of hearing.

Incoherent Noise Source
Incoherent noise sources do not share the same frequency and phase relationship between the two waves. Broadband noise sources without tones are incoherent.

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. Apparent OITC (AOITC) is the field-measured OITC.

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), or Sound Exposure Noise Equivalent Level (SENEL)
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.

Sound Pressure Level (p or SPL)
The acoustic pressure level, typically in units of decibels relative to 20 micropascals (μPa), at any given receiver location due to all noise sources affecting that location. It is a property of the field at a point in space.

Sound Power Level (P, L_{WA}, or SWL)

The level, typically in units of decibels relative to 1 Watt, at which sound energy is emitted by a source. For a sound source, unlike sound pressure, sound power is neither room-dependent nor distance-dependent. Sound power is a property of a sound source, equal to the total power emitted by that source in all directions.

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.

9.3 Traffic Noise Model

The Federal Highway Administration Traffic Noise Model (TNM) used within SoundPLAN® software 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.

9.4 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 dB 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 many optional standards depending on the noise source type, including the FHWA's TNM described in the previous subsection, and 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."