Appendix F

Kenwood Village Project

Noise Study and Peer Review

Sound Level Assessment
Kenwood Village
APN 077-130-06, 077-130-19, 077-41-49
7300 Calle Real
Goleta, CA

for
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October 12, 2015

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Sound Level Assessment
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1.0 Description and Criteria

The dimensions, street locations, plans and elevations used in this sound level assessment are taken from a boundary survey, site plan and architectural drawing, sheet A1.10 supplied by Peikert Group Architects, Santa Barbara, dated 1/12/10. All noise sources with a potential impact on the proposed dwelling units are evaluated in this report. The primary potential noise issue is the transportation source of U.S. Highway 101, Calle Real and Union Pacific RR to the south of the site. The Santa Barbara Airport appears to have minimal noise effect on the site in relation to the more significant ground transportation sources. The potentially affected areas and the sound level findings and mitigation recommendations are described in text and figures on the following pages.

With regard to residential land use, potential noise conflict, interior and exterior noise standards and noise mitigation measures, the following criteria are used to evaluate the site:

1. *City of Goleta Interior and Exterior Noise Standards.*

2. *Uniform Building Code requirement for 45 dBA or less in habitable spaces.*

The Noise Element of the General Plan for the City of Goleta recognizes that noise sources for residential land use areas above CNEL = 60 dBA may be permitted only after careful study and inclusion of noise protective measures as needed to satisfy the policies of the Noise Element (Table 9-2 of Noise Element). Mitigation measures may be required to insure that interior spaces shall not exceed CNEL = 45 dBA. Outdoor Activity Areas with sound levels between CNEL = 60 to 65 dBA are designated as “Conditionally Acceptable” in the Noise Element. However, the CNEL is a 24-hour value with a 10 decibel penalty from 10 pm to 7 am.

See Appendix for definitions.

City of Goleta Noise Contours from the Noise Element of the General Plan show the south side of the proposed development to be within the 65 to 69 dB LDN / CNEL contour. See Figure 1. General Plan Noise Level Contours. These are generalized, non-verified contours, which are not based on sound level measurement, but derived from computer modeling by Jones and Stokes (2005), based on Average Daily Traffic Flow.

The present sound level assessment in this report is precisely based on measured existing sound levels, Average Daily Traffic (ADT) flow and computer modeling of sound level contours with proposed residential structures in place. Transportation sound levels may vary

Figure 1. General Plan Noise Level Contours

Plan showing site location, principal transportation noise source, U.S. Highway 101, and Noise Level Contours indicated in the Noise Element of the Goleta General Plan.

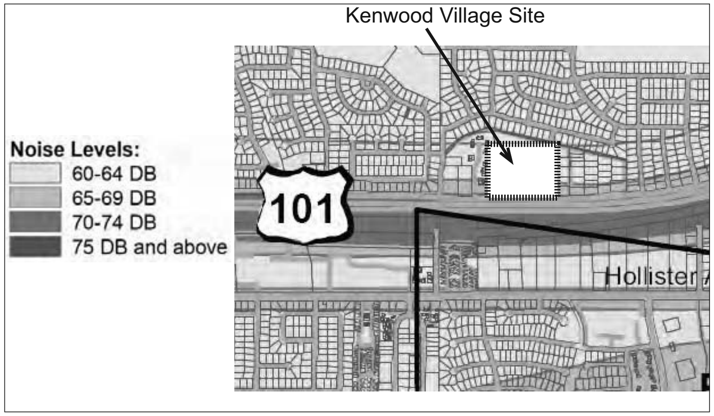

Figure 2. 2009 and 2030 Noise Level Contours

Plan showing site location, principal transportation noise source, U.S. Highway 101, and Noise Level Contours for 2009 and for 2030. These are generalized contours, not based on sound level measurement, but rather computer modeling by Jones and Stokes (2005), based on Average Daily Traffic Flow.

Contours based on measurement of existing sound level in this Assessment are more precise.

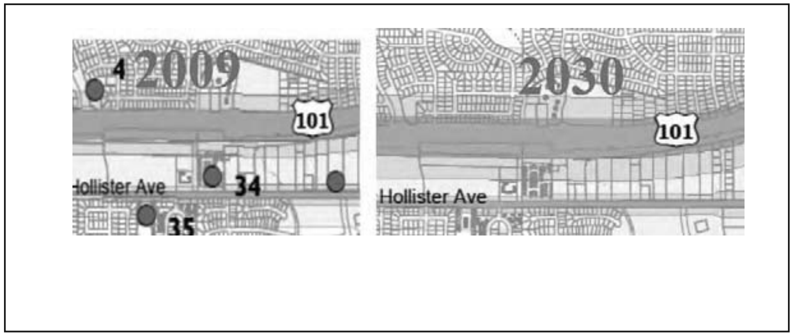

Figure 3. Kenwood Village Site Plan

Plan showing site in relation to principal transportation noise sources: Calle Real, U.S. 101 Northbound and Southbound and Union Pacific RR. Location of 24-hour sound level measurement is indicated near south boundary of site.

Figure 4. 24-hour Existing Sound Level Measurement

Calculated LEQ=1 hour values shown are based on measured values at 10 second intervals. The overall LDN / CNEL value incorporates penalty for sounds from 7pm to 7am. Train pass-by event of 94 dBA at 22:22:15 skews LEQ 1 hour for the 22:00 to 23:00 hour. Details are at http://45db.blogspot.com/2010/02/kenwood-village-goleta-ca.html

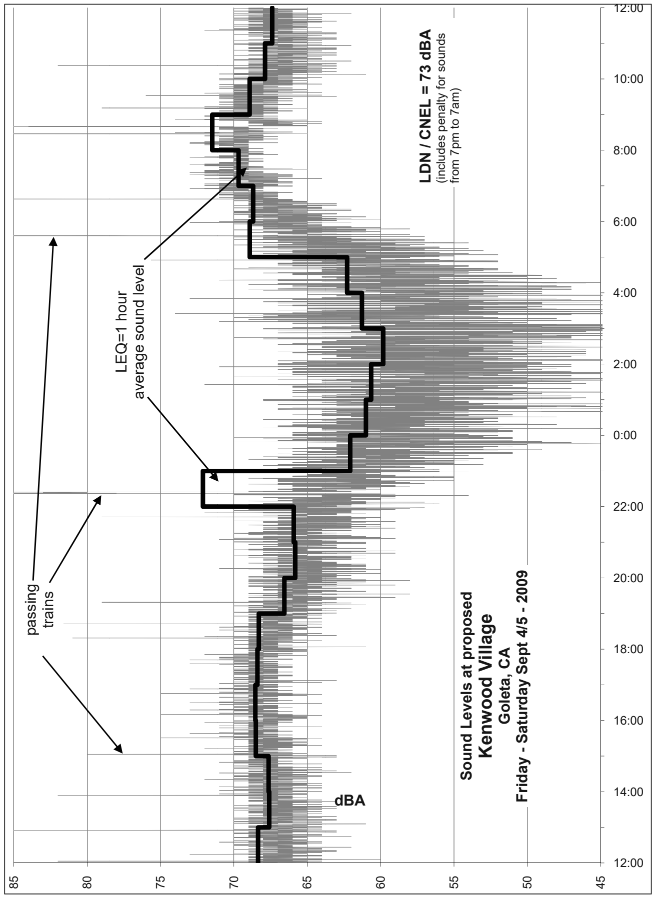

Figure 5. CNEL Calculation, Based on Sound Level Measurements

The phrase “penalty added for evening or night hours” applies to the final LDN and C.N.E.L. values .

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LEQ (hour) calculated from 10-second continuous measurements

	dBA	hour
Calculated DAY LEQ:	70	0700
Calculated DAY LEQ:	71	0800
Calculated DAY LEQ:	69	0900
Calculated DAY LEQ:	68	1000
Calculated DAY LEQ:	67	1100
Calculated DAY LEQ:	68	1200
Calculated DAY LEQ:	68	1300
Calculated DAY LEQ:	68	1400
Calculated DAY LEQ:	69	1500
Calculated DAY LEQ:	69	1600
Calculated DAY LEQ:	68	1700
Calculated DAY LEQ:	68	1800
Calculated DAY/EVE. LEQ:	67	1900
Calculated DAY/EVE. LEQ:	66	2000
Calculated DAY/EVE. LEQ:	66	2100
Calculated NIGHT LEQ:	72	2200
Calculated NIGHT LEQ:	62	2300
Calculated NIGHT LEQ:	61	0000
Calculated NIGHT LEQ:	61	0100
Calculated NIGHT LEQ:	60	0200
Calculated NIGHT LEQ:	61	0300
Calculated NIGHT LEQ:	62	0400
Calculated NIGHT LEQ:	69	0500
Calculated NIGHT LEQ:	69	0600

68	LEQ 24 hrs:
68	LEQ Day 15hr:
69	LEQ Day 12hr:
66	LEQ Night 9hr:
66	LEQ Eve 3hr:

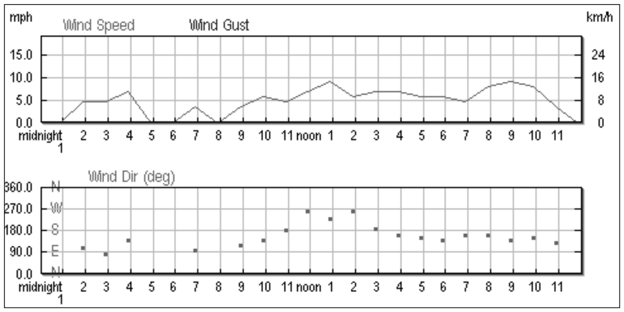
(penalty added for evening or night hours)

LDN: 73 dBA Day / Night Level Calculation

C.N.E.L.: 73 dBA Community Noise Equivalent Level Calculation

Figure 6. Wind Speed during sound level measurement

September 4, 2009



September 5, 2009

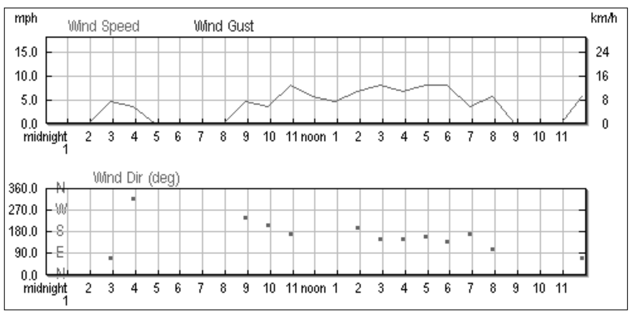


Figure 7. Existing Sound Level Contours, no development

Plan showing existing sound level contours across the site with no site development. Contours are acoustically modeled, based on a 24-hour sound level measurement. Values are LDN = dBA at 6 feet above grade and at 16 feet above grade.

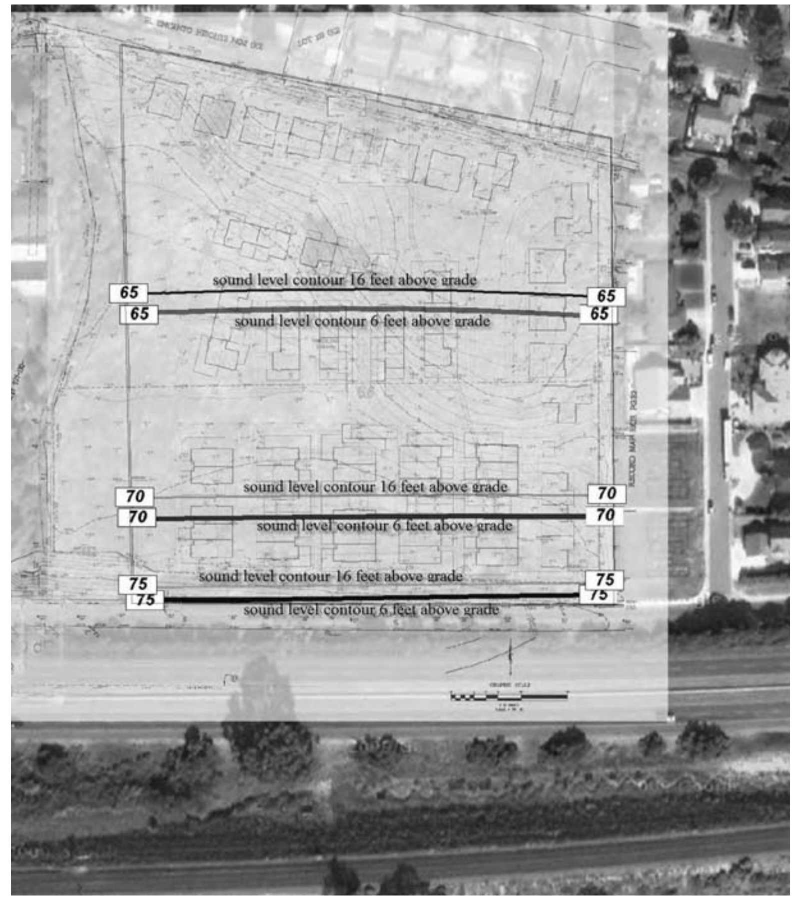


Figure 8. Future Sound Level Contours at 6 feet

Plan showing sound level contours (CNEL = dBA), assuming an 8 ft. noise barrier wall near south boundary (shown in green below--see text and architect's plan). Sound level contours are acoustically modeled, based on a 24-hour sound level measurement of existing sound levels. Contour values are LDN = dBA at 6 feet above grade.

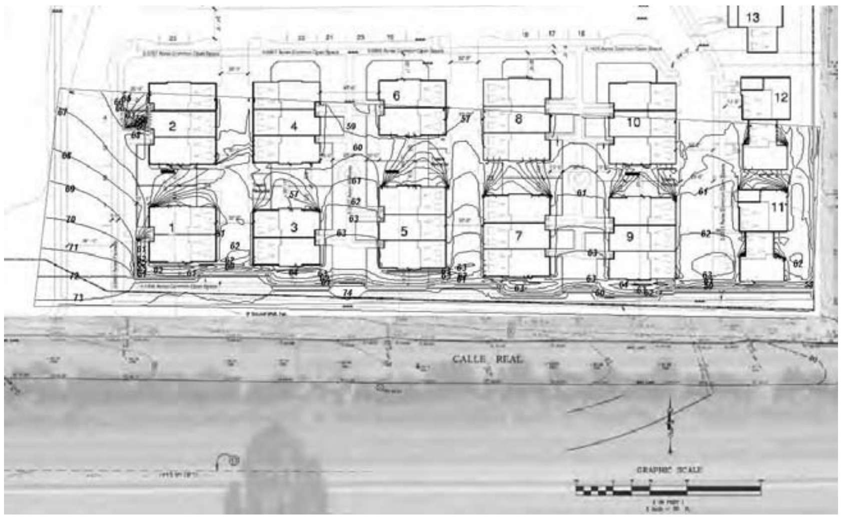


Figure 9. Future Sound Level Contours at 16 feet

Plan showing sound level contours (CNEL = dBA). Sound level contours are acoustically modeled, based on a 24-hour sound level measurement of existing sound levels, adjusted for future traffic ADT. Contour values are LDN = dBA at 16 feet above grade.

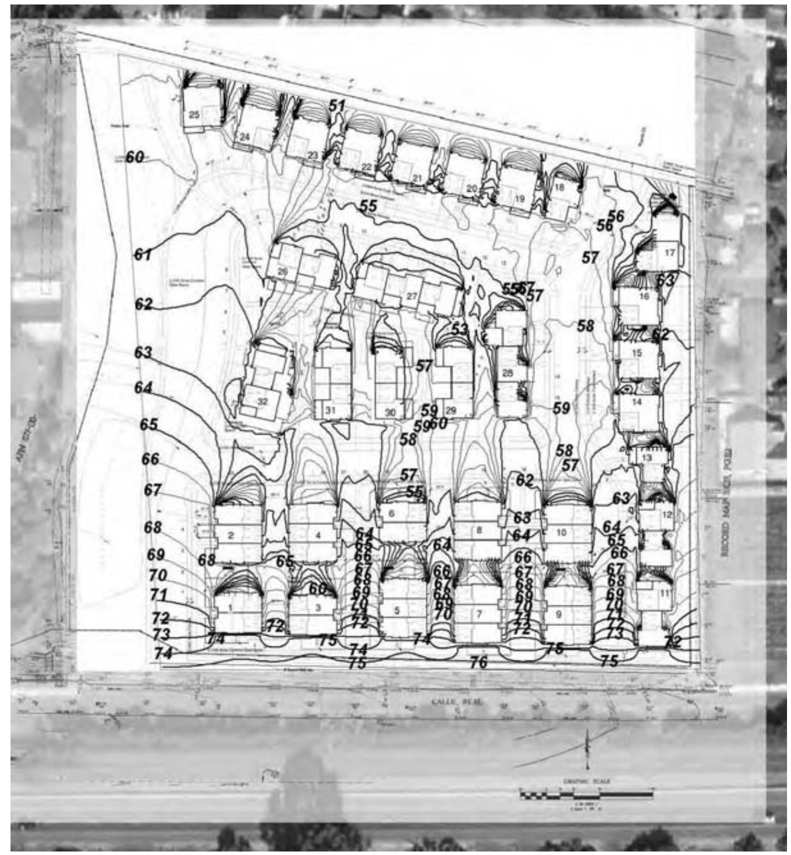
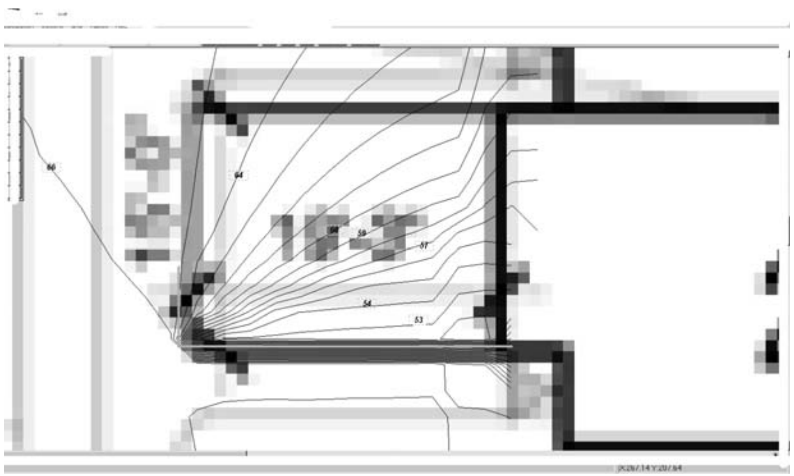


Figure 10. Noise Barrier Wall for unit 2

Plan showing sound level contours, LDN = dBA, at six feet above grade resulting with noise barrier wall for outdoor activity area at Building 2. Wall is eight feet tall in relation to finish floor elevation of nearby dwelling and approximately 16 feet in length.



due to the topographic relationship of U.S. Highway 101 to the site and the presence of intermediate buildings separating U.S. Higway 101 from proposed residences to the north. All of these variables are accommodated in the computer- modeled sound level contours shown in the following pages. The site plan in relation to noise sources and location of 24-hour sound level measurement are shown in Figure 2. Kenwood Village Site Plan.

2.0 Existing and Future Sound Levels

On-site sound level measurements were made Friday through Saturday, September 4-5, 2009. Sound level measurements were taken continuously every 10 seconds for 24 hours, beginning Friday at noon, September 4, 2009. Diurnal peak noise hours are associated with work-related commuter traffic during weekdays." Friday is a weekday. The work-related commuter traffic on Friday afternoon (a peak hour) is a legitimate time to measure sound levels.

Continuous sound level measurements were made at the sound level meter location shown in Figure 2. Kenwood Village Site Plan. From sound level values, the LDN / CNEL was determined. (See Appendix for definitions). A Larson Davis model 820, Type I, integrating, recording sound level meter, accurate to 1 dBA was used for all measurements. The sound level meter was calibrated before and after all measurement sessions. Wind speed data during this study was taken from the nearby Santa Barbara Airport weather station, located about 2 miles southeast of the site. Throughout the measurement period, wind speed was less than 10 m.p.h. A 3.5 inch foam windscreen was used to guard against microphone wind noise at all times. Wind speeds are reported in Figure 4. Wind Speed during sound level measurement.

Based on the sound level measurements, CNEL noise contours for the site were generated by a computer acoustical model (CADNA/A), which incorporates the known sound level propagation patterns in relation to distance attenuation, absorptivity and reflection of terrain, buildings, noise barriers, and sources of sound.

The future noise environment, based on project future trip generation of 397 vehicles ADT, and Average Daily Traffic (ADT) for U.S. Highway 101, may cause an increase in sound level of less than one dBA by the year 2030. The ADT count of 35,000 vehicles on U.S. Highway 101 has remained relatively constant since before year 2000 to 2015 (Caltrans data).

Proposed residential building volumes/masses, topographic contours, proposed pad elevations and height and reflectivity of noise barriers are simulated in the acoustical model to increase the accuracy of the simulation for noise propagation across the site. When the proposed project is built, the southern-most dwellings will act as a partial noise barrier for areas located further north in the site. The results of the sound level contours projected across the site are shown in "Figure 8. Future Sound Level Contours at 6 feet" on page 11. All sound level contours are shown at six feet above grade on the undeveloped site. Sound level contours shown for final configuration of dwellings and noise barrier are assumed to be three feet above grade. Sound levels will increase with height above grade. Exterior outdoor activity areas located to the north of the proposed noise barrier wall mitigation are generally at or below CNEL = 65 dBA with the exception of units 1 and 2.

3.0 Interior Noise Levels

Interior noise levels are controlled by the noise reduction characteristics of the building shell. The interior noise level is a function of the sound transmission loss qualities of the construction material and surface area of each element (wall, window, door, etc.). Typical wood frame construction provides from 20 dBA or greater noise reduction. The reference for typical sound transmission is found in U.S. Department of Housing and Urban Development, Noise Notebook, Chapter 4 Supplement, Sound Transmission Class Guidance. Also, U.S. Department of Housing and Urban Development, A Guide to Airborne, Impact, and Structure Borne Noise Control in Multifamily Dwellings.

In general, doors and windows and construction penetrations for venting, plumbing and electrical equipment are the acoustical weak links in building construction. Therefore, careful consideration must be given to their design and placement. By limiting the number and size of openings on the sides of the building exposed to noise, interior noise levels will be minimized. Further reductions can be achieved by selecting windows and doors with higher noise insulating characteristics.

Approximately 7 dBA of interior noise reduction can be achieved for typical homes within California simply by closing the windows. Most modern dual-paned windows have a Sound Transmission Class (STC) rating in the high 20s to low 30s. Relatively higher noise insulation can be achieved by using a larger spacing between the separate panes in a dualpane unit, avoiding solid (aluminum) spacers between the panes, increasing the thickness of panes and using panes that have different thicknesses. With these techniques it is possible to specify or select window with STC ratings into the high 30s.

The configuration of the building shell and noise walls in this contemporary best-practice design provides good noise shielding for most of the buildings. Special noise mitigation is required only for the southernmost residences facing the noise source, which will be exposed to exterior noise levels in excess of 65 dBA above the eight foot level, and at the 16 foot level with a future exterior CNEL of about 73 dBA.

4.0 Potential Construction Noise

During the construction phase, potentially noisy construction work at the project site shall be restricted to times on Monday through Friday from 7:00 am - 4:30 pm. No construction shall occur on State Holidays (e.g., Thanksgiving, Labor Day). Activities occurring outside these typical work hours would comply with City standards for noise levels. Potentially noisy construction refers to any on-site construction noise that would be likely to exceed the City's limits for daytime noise levels, a maximum noise level of LDN = 65 dBA at the project's property line. Any on site security/ surveillance activities, however, are not limited to these hours. Prior to construction or ground disturbing activities, the Applicant shall employ and clearly specify in its contractors' specifications the following noise suppression techniques to minimize the impact of temporary noise associated with construction and decommissioning activities:

(a) Trucks and other engine-powered equipment shall include noise reduction features such as mufflers and engine shrouds that are no less effective than those originally installed by the manufacturer.

(b) Trucks and other engine-powered equipment shall be operated in accordance with posted speed limits and limited engine idling requirements.

(c) Truck engine exhaust ('jake') brake use shall be limited to emergencies.

(d) Back-up beepers for all construction equipment and vehicles shall be adjusted to the lowest sound levels feasible, consistent with safety, provided that OSHA and Cal/OSHA's safety requirements are not violated. These settings shall be retained for the life of the project.

(e) Vehicle horns shall be used only when absolutely necessary, as required in the contractors' specifications.

(f) Radios and other "personal equipment" shall not exceed 65 dBA sound level at boundary of site.

5.0 Potential Construction Vibration

There are several different methods that are used to quantify vibration. The peak particle velocity (PPV) is frequently used to describe vibration impacts to buildings and is usually measured in inches per second. The PPV is defined as the maximum instantaneous peak of the vibration signal. The root mean square (RMS) amplitude is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (Vdb) is commonly used to measure RMS. The approximate human threshold of perception to vibration is 70 VdB (Vibration Velocity Level, dB). Buses, trucks and heavy traffic at 50 feet distance is equal to 70 VdB or less, and therefore will have less than adverse impact at distances greater than 50 feet.

Potential construction vibration from the project would be a localized event and is typically only perceptible to a receptor that is in close proximity to the vibration source. As an example, the potential vibration from worst-case construction equipment, a small bulldozer: is: PPV at 100 feet = 0.0004 inches / second. This vibration level is far below the Federal Transit Administration Significant Impact guideline maximum of 0.2 inches / second.

6.0 Potential Project Impact on Surrounding Uses

The proposed project impact on the surrounding land uses can be related to future traffic levels: Future traffic levels attributable to the project in year 2030 are expected to be less than one percent of overall transportation traffic from all sources in the vicinity of the project compared to the undeveloped site in 2009. There are 397 Average Daily Trips generated by the project, which is a small percentage of the total transportation in the vicinity of this project. The resulting additional noise impact directly attributable to the project is calculated at less than one decibel, which is below the human threshold of perception and is therefore a less-than-significant impact.

7.0 Discussion and Conclusion

The existing, above-grade sound levels at the south boundary of the proposed residential units are typical for a suburban area located next to a significant source of vehicular noise, such as U.S. Highway 101. The northbound and southbound travel lanes are visible from some of the proposed residential units. Sound levels increase with elevation above grade, and sound levels will be higher on potential second floors of the proposed south elevations. Noise mitigation for enclosing habitable spaces on the south side of the southernmost row of dwellings, numbers 1, 3, 7, 9 and 11, and a noise barrier wall, are required in order to meet both State Building Code and General Plan requirements. In addition, the west-facing elevations of dwellings 1 and 2 require noise mitigation, described below.

7.1 Mitigation of Sound Levels in Outdoor Activity Areas

Outdoor activity areas are typically used during daytime hours (from7 am to 7 pm) and evening hours (7 pm to 10 pm). The noise contours in Figure 7 represent calculated CNEL average sound level values over a 24 hour period. In the CNEL rating system there is a 5 dB added penalty for each hour from 7 pm to 10 pm and a 10 dB added penalty from 10 pm to 7 am. Therefore, the measured hourly sound level is actually lower than that shown in the noise contours. Figure 4, CNEL Calculation Based on Sound Level Measurements, shows the hour-by-hour measured sound levels, the overall calculated CNEL and the average sound levels during daytime, evening, and nighttime. The average daytime (12 hour) measured value is 69 dBA. The average evening measured value is 66 dBA at the boundary line. However, the weighted CNEL value over a 24-hour period is 73 dBA at the boundary line.

Based on this fact, hourly measured sound levels shown on the critical south side are actually (73 - 69 = 4 dB) lower than CNEL in the daytime and (73 - 66 = 7 dB) lower than CNEL in the evening hours. Therefore, the practical impact of noise in daytime and evening hours is less than it appears using the standard 24-hour CNEL measurement.

8.0 Required Noise Barrier Wall

As indicated on the architect’s Site Plan, along the line of the Proposed Eight Foot Noise Barrier Wall, a solid masonry noise barrier wall is required to mitigate noise from the several transportation sources to the south. The total height of the required solid masonry noise barrier wall shall be eight feet above nearby finish pad elevations of the residences closest to U.S. Highway 101. An additional 8 foot high noise barrier is required at the west side of the center unit in Building 2, as shown in Figure 9. With the required noise barrier walls in place, areas of residential outdoor activity for the proposed residences are at or below CNEL = 65 dBA. However, as noted above, the actual noise level experienced by a resident during the daytime and evening hours is less than the CNEL value. Actual daytime noise levels would be 61 dBA or less and actual evening noise levels would be 58 dBA or less.

9.0 Required Building Construction

9.1 Performance Target.

There are many construction methods for the south elevation construction assembly that can be used in order to achieve the required interior sound level of CNEL = 45 dBA or less in habitable spaces facing the noise source. Ordinary dwelling unit construction is not likely to result in quiet spaces, and therefore enhanced construction methods and materials are detailed below.

9.2 South-facing Wall Assemblies

The following construction specification will result in an acoustical performance which gives less than CNEL = 45 dBA interior noise level for enclosed habitable spaces located along the south elevations of residences facing transportation noise sources, as required by the State Building Code. Noise mitigation may fail to perform if each and every following recommendation is not followed. A small crack or air leak in the construction may completely compromise all other sound-proofing.

9.3 Vents and roof penetrations

Soffit vents, eave vents, dormer vents and other wall and roof penetrations shall be located on the walls and roofs facing away from the noise source (located on the north, west and east elevation) wherever possible. If kitchens or bathrooms are located on the south side, remote venting to other elevations is required. If vents are required to be located facing the noise source, a 90 degree bend shall be incorporated in the design of the ductwork or vent opening to attenuate noise. Use of patented foam insulation solutions, such as Icynene spray foam insulation or equivalent, in walls, floors, and ceiling cavity / roof construction will allow elimination of soffit vents and gable end vents, thereby eliminating a significant path for noise penetration.

All fireplaces shall be provided with closable dampers.

9.4 Walls

Only the south-facing exterior walls closest to the transportation noise sources require mitigation. Any wall assembly that encloses habitable spaces nearest the noise source shall be constructed with an S.T.C. (Sound Transmission Class) rating of 50 or greater. For instance, stucco exterior or fiber-cement panel siding, with 15 pound felt on 5/8” sheathing, on 2” x 4” stud walls with R-21 fiber glass batt insulation and a layer of 5/8” Type X Gypsum Board will provide an S.T.C. rating of 50 or greater. Metal studs are preferable to wood studs for noise resistance.

Construction of the south-facing walls must include the liberal use of non-hardening acoustical sealant at all construction joints, including the header and footer construction and the edges and corners of gypsum board intersecting ceiling, walls and floor, especially behind papered joints. Apply resilient acoustical sealant (Johns Manville or equivalent) to gaps at intersecting walls, ceiling and floor before taping and spackling gypsum board in conventional manner. All peripheries, apertures and joints around windows shall be sealed with acoustical sealant.

9.5 Acoustic Leaks:

Common acoustic leaks, such as electrical outlets, pipes, vents, ducts, flues and other breaks in the integrity of the wall, ceiling or roof insulation and construction on the south sides of the dwelling units nearest transportation noise source shall receive special attention during construction. All construction openings and joints through the gypsum board on south-facing walls shall be insulated and sealed with putty pads, and a resilient, non-hardening acoustical sealant, as appropriate. All such openings and joints shall be airtight to maintain sound isolation.

9.6 Windows

To meet the interior CNEL = 45 dBA requirements, windows for habitable spaces on all levels of the affected South Elevations facing the noise source shall be of double-glazed construction and installed in accordance with the recommendations of the manufacturer. The entire window assemblies shall be fully gasketed, with an S.T.C. rating of 38 or better, as determined in testing by an accredited acoustical laboratory. An example that meets this requirement is Milgard Quiet Line windows. Other window solutions with laminated glass may meet this requirement. Potential cracks, openings or air gaps in peripheral window frames shall be sealed with acoustical sealant.

9.7 Doors

Location of doors on the south elevation facing the noise source shall be avoided if possible. More than 90% of all exterior noise comes in through windows and doors. To meet the interior CNEL = 45 dBA requirement, doors directly facing the noise source shall be solid core with sound dampening and fully gasketed, sealed jambs and grouted frames, with an overall S.T.C. rating of 36 or better, as determined in testing by an accredited acoustical laboratory. Potential cracks, openings or air gaps in peripheral door frames shall be sealed with acoustical sealant.

Doors meeting the following “Double Door Construction” criteria shall be considered to meet the S.T.C. 36 rating:

9.8 Interior and Exterior “Double Door Construction” Alternate

(g) Double door construction shall have a minimum required space of not less than three inches between the interior and exterior double doors.

(h) For side-hinged doors, at least one of the doors shall be a solid-core wood, or insulated hollow metal door, that is not less than one and three-quarters (1 3/4) inch thick at its thinnest point. The second, exterior door may be a glazed storm door. Both doors

shall meet all requirements of this section.

(i) Glazing installed in a solid-core wood door, that has a total area of more than two (2) square feet, shall be not less than three-sixteenths (3/16) inch thick.

(j) All glass and glazing used in doors shall be sealed in an airtight manner with a nonhardening acoustical sealant or in a soft elastomer gasket or glazing tape.

(k) Exterior sliding glass doors shall be weather-stripped with an efficient airtight gasket system. For sliding glass doors, the interior sliding glass door assembly shall be double-glazed with a separation between glass panels of not less than one-half (1/2) inch. The glazing used in the double-glazed glass panels shall be of unequal thickness to avoid harmonic resonance. The second, exterior sliding glass door may be a storm door, separated by three inches from the interior door.

Required Mechanical Ventilation: If interior allowable noise levels are met by requiring that windows and doors be unopenable or closed, then the design for the structure must also specify the means that will be employed to provide ventilation, and cooling if necessary, to provide a habitable interior environment.

10.0 REFERENCES

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11.0 APPENDIX I: Notes, Definitions

TERM	DEFINITION
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise or sound at a given location. The ambient level is typically defined by the LEQ level.
Background Noise 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.
Sound Level, dB	Sound Level. Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of 20 micropascals, SLOW time response, in accordance with ANSI S1.4-1971 (R1976) Unit: decibels(dB).
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.
Equivalent Sound 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, both a 15 minute and an hourly period is used.
Community Noise Equivalent Sound Level CNEL	CNEL is the average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels occurring during the evening from 7 p.m. to 10 p.m. and addition of ten decibels to sound levels occurring during the night from 10 p.m. to 7 a.m. The 5 and 10 decibel penalties are applied to account for increased noise sensitivity during the evening and nighttime hours. The CNEL represents the daily energy noise exposure averaged on an annual basis. It is not measured, but computed..
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., L90)
Subjective Loudness Changes.	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.
Time weighting	Different, internationally recognized, meter damping characteristics are available on sound level measuring instruments: Slow (S), Fast (F) and Impulse (I). In this community sound level measurement, the Fast (F) response time is used.

12.0 APPENDIX II: Measurements and Calculation Methods

12.1 Wind Measurement

Sound level measurements become less reliable when average wind speed is greater than 11 m.p.h. at the measurement site. Therefore, wind speed and direction were measured periodically at the measurement sites and the results are correlated with wind data from a nearby established weather station. A Larson Davis WS 001 windscreen is used as wind protection for all microphones and is left in place at all times.

Wind speed and direction were noted throughout the measurement period and compared with data from the Santa Barbara airport NOAA weather station located approximately one mile southeast of the project site. A magnetic compass was used to estimate wind direction. A Davis Turbo Wind meter was used to measure wind speed at the measurement site. The Turbo Wind meter is a high performance wind speed indicator with exceptional accuracy.

12.2 Precision of Sound Level Meters.

The American National Standards Institute (ANSI) specifies several types of sound level meters according to their precision. Types 1,2, and 3 are referred to as "precision," "general-purpose," and "survey" meters, respectively. Most measurements carefully taken with a type 1 sound level meter will have an error not exceeding 1 dB. The corresponding error for a type 2 sound level meter is about 2 dB. The sound level meters used for measurements shown in this report are Larson-Davis Laboratories Model 812 and Model 820. These meters meet all requirements of ANSI s1.4, IEC 651 for Type 1 accuracy and include the following features: 110 dB dynamic range for error free measurements. Measures FAST, SLOW, Unweighted PEAK, Weighted PEAK, Impulse, Leq, LDOD, LOSHA, Dose, Time Weighted Average, SEL, Lmax, Lmin, LDN. Time history sampling periods from 32 samples per second up to one sample every 255 seconds.

Field calibration of the meter is accomplished before and after all field measurements with an external calibrator. Laboratory calibration of the all instruments is performed at least biannually and accuracy can be traced to the U.S. National Institute of Science and Technology standard.

A Type 1 Sound Level Meter was used for this study: The sound level meter is factory calibrated as three separate components; the body of the meter itself plus the preamplifier and the microphone, each of which has a Certificate of Calibration and Conformance. When calibrated, the instrument is certified as meeting factory specifications; Normal elapsed time between factory calibrations should not exceed two years. The recording sound level meter was a Larson Davis model 812 Sound Level Meter, Serial Number 0292. The calibrator used in this study was a Larson Davis CA250 Acoustic Calibrator, Serial Number 1931. The instrument meets factory specifications per Procedure D0001.8192. The instrument was found to be in calibration as received. Full calibration report available on request. The above instruments meet factory specifications per ANSI S1.4 1983.

12.3 Sound Level Measurement Method

The protocol for conducting sound level measurements is prescribed in detail by the American Society for Testing and Materials (ASTM) in their E 1014 publication and the Cal Trans Traffic Noise Analysis Protocol. The procedures and standards in those documents are met or exceeded for sound level measurements shown in this report. The standards of ASTM E 1014 are exceeded by using Type 1 sound level meters for all measurements in this report instead of the less accurate Type 2 meters. Therefore, the precision of the measurements in this report is likely to be better than +/- 2 dB as stated in ASTM E1014. The ASTM standard height above grade for sound level measurements is five feet six inches, the height of the average human ear. For outdoor activity areas, decks and patios, it is a reasonable assumption that much of the time during periods of socializing and conversation the average individual will be seated. Therefore the height above grade assumed for sound level contours in this study is three feet, ear height for the seated individual.

12.4 Caltrans Noise Measurement Guidelines

Caltrans makes available general guidelines for taking into account environmental elements in noise measurements. The following is an excerpt from their guidelines. The Traffic Noise Analysis Protocol (hereafter referred to as the Protocol) contains Caltrans noise policies, which fulfill the highway noise analysis and abatement/mitigation requirements stemming from the following State and Federal environmental statutes:

- California Environmental Quality Act (CEQA)
- National Environmental Policy Act (NEPA)
- Title 23 United States Code of Federal Regulations, Part 772 "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 CFR 772)
- Section 216 et seq. of the California Streets and Highways Code

12.5 Meteorological conditions, discussion

Wind speed and direction, temperature profiles, relative humidity, and sky conditions can cause changes in noise measurement results at normal receiver distances from the transportation noise source. Information concerning these effects is made part of the documentation accompanying the noise measurement data. Without it, there is no baseline against which subsequent measurements can be compared. The prevailing wind direction is expressed in degrees clockwise from the north direction, or it can be expressed as a direction on a 16-point compass, where north is 0 degrees, east is 90 degrees, south is 180 degrees and west is 270 degrees. Wind, air temperature, and humidity observations are ideally made at the average height above the ground that noise is traveling between the source and the receiver. The minimum height should is at least 1.5 meter, or 5 feet, above the ground. In addition to the wind, temperature and humidity observations, sky conditions are also documented.

Meteorological conditions can affect noise measurements in two ways: they can affect the measurement instruments directly, or they can affect the actual noise levels. Wind speeds of 5 meters per second, or 11 miles per hour, create a wind noise of about 45 dBA on a typical ½" microphone with windscreen. This means that measurements of noise below 55 dBA will be contaminated under these conditions. Extreme hot or cold temperatures and humidity can also affect the operation of noise measurement instruments. High humidity or rapid changes in temperature can cause droplets of moisture to form on the microphone diaphragm, creating a popping noise. This can contaminate the noise measurement. Rain, or wet pavement will change tire-pavement noise characteristics, altering traffic noise both in level and frequency. Changes in wind speed and direction relative to the location of the noise source and receiver can cause changes in the magnitude and direction of wind shear. This can result in refraction effects that can redirect sound energy away from or toward a receiver and change overall noise levels.

For normal roadway traffic noise measurements, meteorological conditions are restricted as follows: If wind speeds, regardless of direction, are greater than 5 meters per second, or 11 miles per hour, those measurements are not included in the noise analysis. For research or special studies this criterion is often lower, depending on the objectives of the study. Temperatures and humidity are within the operational ranges specified for the equipment used. [reference: Caltrans Traffic Noise Analysis Protocol For New Highway Construction and Highway Reconstruction Projects, October, 1998]

13.0 Computer Noise Modeling

CADNA/A is an acoustical modeling program which is in conformance with the algorithms of the Federal Highway Administration Highway Traffic Noise Model (TNM 2.5). The TNM 2.5 model is the analytical method currently favored for traffic noise prediction by most state and local agencies. It is applied to federal and state roadway projects by the California Department of Transportation (Caltrans). The TNM 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 project site. In addition, sound level measurements were performed over 24-hour periods at two locations to describe ambient sound levels in the project area, and to derive suitable LDN day/night traffic noise distribution factors for traffic noise modeling.

This computer modeling tool, made by Datakustik GmbH, is an internationally accepted acoustical modeling software program, used by many acoustics and noise control professional offices in the U.S. and abroad. The software has been validated by comparison with actual values in many different settings, with the results published in peer-reviewd professional journals. The program has a high level of reliability and follows methods specified by the International Standards Organization in their ISO 9613-2 standard, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation." The 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."

The computer modeling software takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain variations. The CADNA/A software uses a grid of receivers covering the project site.

Acoustical modeling of the entire site without structures incorporates the assumption that sound levels are measured at approximately five feet five inches above grade, the approximate height of the human ear while standing. Acoustical modeling of the site with dwellings and sound barrier wall in place was modified with the assumption that a good number of outdoor activities take place at approximately three feet above grade. Therefore, sound level contours for outdoor activity areas are modeled for three feet above grade.

14.0 Qualifications of Preparer

David Lord, Ph.D., Principal Consultant

For more than 30 years, David Lord has worked with architects, engineers, building contractors and public agencies to assess and solve problems in acoustics, noise and vibration. Dr. Lord is recognized as an acoustical consultant by several municipal and county planning departments and has provided acoustical consulting services for projects located in the following counties in California: San Luis Obispo, Santa Barbara, Orange, San Bernardino, Ventura and Los Angeles. David Lord is approved by the Department of Defense as an acoustical consultant at Vandenberg Air Force Base and at the Naval Facilities Engineering Command, Port Hueneme.

Community Noise Assessment

Projects have ranged in scale and complexity from residential to commercial and institutional developments. All noise assessments rigorously follow Caltrans and ASTM standard procedures, while adhering to local planning standards and noise ordinances and the Uniform Building Code. Recent projects include: Environmental Impact Report noise chapter for a Metrolink station in Orange County; noise assessment for an automobile service center, a retail food market, a community theater, a water treatment plant, various wineries, a boutique hotel, a remote, 600 acre religious retreat site, an annual rodeo and tractor pull event, a metal salvage yard, etc. Residential neighbor-noise assessments range from animal noise to motorcycle noise, to stationary mechanical noise issues.

Room Acoustics

Consulting projects undertaken in room acoustics range in scale from 50- to 400-seat spaces, such as church sanctuaries and restaurants. Consultation begins preferably with the architect early in design and continues through construction and occupancy. Music sources are evaluated and matched to the shape, the volume and the absorptivity of the space, using energy/time/frequency analysis tools. Recent projects include the Katsuya Restaurant at Hollywood and Vine; the Vina Robles Winery Refectory, and the United Methodist Church, San Luis Obispo.

Instrumentation

Sound and vibration measurements are made with multiple, state-of-the-art, data-logging, integrating, Type I instruments and a real time analyzer. Long-term total sound monitoring is conducted with high-resolution digital sound recorders. Sound transmission and reverberation studies are made with a real-time analyzer following ASTM procedures. Each instrument is factory calibrated annually to meet U.S. National Institute of Standards and Technology requirements and has a current Certificate of Calibration and Conformance.

Recent Projects in California. Partial list; References provided on request.

1. Bradley Square, Santa Maria, California; Housing Development 120 units. Transportation noise assessment, mitigation recommendations, noise-resistant construction design.

2. Por La Mar Nursery commercial horticulture development, worker housing, Santa Barbara / Goleta, California. Transportation noise assessment, noise resistant housing design.
3. Fess Parker Wine Center, Lompoc California, with Pults & Associates, Architects. CEQA Environmental Impact Assessment for Noise, City of Lompoc.
4. San Ysidro Ranch, Montecito, with Mechanical Engineering Consultants, Santa Barbara. Total sound level monitoring, recording, assessment and mitigation design.
5. Santa Maria Country Club, Santa Maria, California; room acoustics solutions for conference, dining and meeting rooms.
6. State Street, City of Santa Barbara, consultant to several entertainment establishments for entertainment noise mitigation and conflict resolution.
7. Expert testimony for Allen Hutkin, Attorney at Law, San Luis Obispo, noise nuisance cases.
8. Environmental Impact Report, Noise Impact Assessment for Enos Ranchos and Mahoney Ranch General Plan Amendment/Zone Change/Specific Plan Amendment/Annexation, Santa Maria, CA, with Science Applications International Corporation (SAIC)
9. Environmental Impact Report, Noise Impact Assessment, including rail noise issues, for Westgate Metrolink Station, Placentia, CA, with Crawford, Multari and Clark Associates.
10. Expert testimony for William S. Walter, Attorney, eminent domain compensation case, San Luis Obispo, CA.
11. QAD Inc., Summerland, CA. Chiller installation noise assessment and mitigation design evaluation to meet County of Santa Barbara noise standards.

Academic Qualifications

David Lord is a Professor Emeritus of Architecture at California Polytechnic State University, San Luis Obispo, where he developed the curriculum and taught courses in community noise and acoustical engineering.

David Lord holds the Master of Architecture degree from the University of California, Berkeley, with a specialization in architectural acoustics. David Lord earned the Ph.D. degree from the University of London, Bartlett School of Architecture.

Memberships

David Lord is a member of the American Society of Heating, Refrigerating and Air Conditioning Engineers, the Acoustical Society of America, the American Institute of Physics, and the Institute of Noise Control Engineering.

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Review of Sound Level Assessment

and

Response to Comments from ICF

for

Kenwood Village Development
Goleta, CA

July 2, 2015

Prepared by:

Bruce Walker, Ph.D., INCE Bd. Cert.

Introduction

The following is an independent review of the Sound Level Assessment (January, 2010) and Response to Comments from ICF (March 2015), prepared by 45dB.com for the Kenwood Village development proposed for the northerly side of Calle Real in western Goleta. This review was conducted by Dr. Bruce Walker, INCE Bd. Cert. (the Reviewer). In general, the Assessment covers the primary acoustical issue – control of long-term exposure of potential inhabitants of the project to traffic noise from Highway 101 – quite thoroughly. There are a few residual issues that could benefit from clarification or additional analysis. In particular (to be discussed in more detail below), the assessment of outdoor noise levels at 3 ft above site grade (ASG), ignoring the effects of sound reflection from buildings and barriers, should probably be re-done. There is one issue – exposure of residents to transient noises from the railroad – that should probably be looked at from an effects standpoint in addition to State and City general criteria based on long-term average sound levels.

Commentary on the Assessment

Page 4: In the discussion of CNEL, the 10 dB night penalty is mentioned but not the 5 dB evening penalty. This is stated and used correctly later in the report.

Page 5: It is stated that measurements were taken from Friday Sept 4 through Saturday Sept 5, 2009. From Figure 3 on Page 7, it can be inferred that this means from noon on Friday to noon on Saturday, so that weekday morning traffic noise is not included. The Reviewer's assessment is that for this project, the peak a.m. traffic noise on Friday would not be higher than the peak a.m. traffic noise shown for Saturday. Further, evening and post 10 p.m. noise tends to be higher on Fridays than other weeknights, so it is likely the measurements slightly overstate the average condition.

Page 5: It is stated that a Larson-Davis 820 meter was used for all measurements, while the Appendix states that a Larson-Davis 812 was used. The 820 is a fully Type 1 device, while the 812 is Type 2 in integrating mode.

Page 5: Collecting meteorological date concurrent with the acoustical monitoring is definitely good practice, although one could question the applicability of wind data from two miles away. In view of the relatively high traffic noise at proximity to Highway 101, in this case the remote monitoring of wind is probably adequate.

Page 7: Based on the caption of Figure 3, the graph truncates at least one and possibly several transient noise events. The referenced web site "Details" state that the peak train sound level was measured to be 94 dBA (sic). The Reviewer's assessment of the data shown in the "Details" is that 94 dB is the Leq10sec at 22:22:15, and that the peak sound level could be several dB higher. http://45db.blogspot.com/2010/02/kenwood-village-goleta-ca.html

Page 10: Although the noise contours appear reasonable and to have been correctly calibrated to match the measurement results near the south end of the site, the color legend on the figure ought to be fixed so that it matches the color scale of the contours, or else deleted.

Page 10: The bare site contours are computed at 6 feet above site grade. It is not indicated why this elevation was chosen. The *de facto* outdoor noise measurement height is 5 ft, although ASTM E1014 (section 8.1.7) states between 4 and 5 ft is acceptable. The Assessment Appendix states that the ASTM standard is 5 ft 6 in, but this appears to be incorrect. The Assessment implies that the measurements were taken at 5 ft 6 in, which would have little effect compared to 5 ft for bare site conditions. Similarly, the contour calculation at 6 ft would not be expected to differ significantly from 5 ft.

Page 11: The same confusion as for Page 10 results from a color legend not showing the colors in the graph.

Page 11: The caption, the first paragraph of Page 13 and Page 21 Appendix 9.3 state that the contours were computed at 3 ft above site grade, to represent seated ear height outdoors. In response to IFC comment on this issue, it was stated that it was a typographical error, but the justification presented in Appendix 9.3 contradicts. As is stated in the report, with barriers present, the sound level can be strongly dependent upon height, and showing the 3 ft contour only gives an optimistic picture of noise exposures at building faces and windows. Presenting 3 ft, 6 ft and 12 ft contours on separate graphs would provide a much more complete view.

Page 11: The Reviewer is not directly familiar with CADNA/A, but has extensive experience with SoundPlan, which runs the same ISO 9613-2 calculation model. It appears doubtful that the CADNA/A model used in the Assessment has been set up with appropriate sound reflection characteristics for the modeled buildings. As an example, the two contour plots shown below were computed at 3 ft ASG for a highly simplified model of the southern area of the project using an arbitrary line source centered 5 ft above the westbound side of Hwy 101 and generating 10 mW acoustic power per meter (apparently about 10 dB greater than the sound power modeled in the Assessment). The barrier is 8 ft tall and the buildings are modeled as 18 ft tall. Figure 1 ignores reflections from the buildings and barrier while Figure 2 includes them. Despite the oversimplification, the greater resemblance of the "no reflections" graph to Assessment Figure 7 is evident.

The Reviewer has subsequently learned that, whereas SoundPlan's default condition is to include reflections up to third order, CADNA/A requires the user to activate reflections in the model setup. Sound modeling should be conducted to account for reflected noise. Not accounting for reflected noise would definitely result in an optimistic prediction of outdoor sound levels.

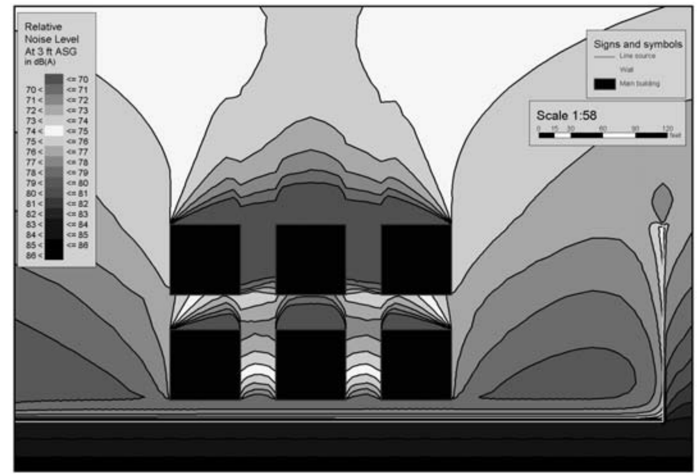

Figure 1. Simplified Model with No Sound Reflections

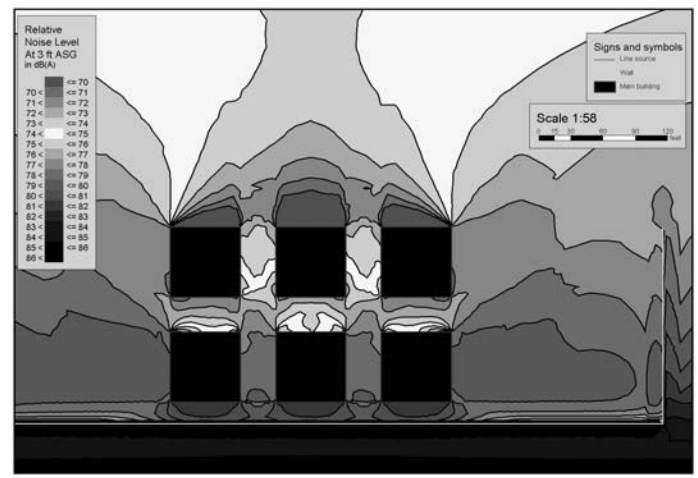

Figure 2. Simplified Model with Sound Reflections Included

Page 12: Figure 8 is very hard to comprehend, apparently showing 62-65 dB range noise contours inside Building 2 and indicating no reflected sound from the west wall of the building or the north patio wall of the middle unit. This issue is probably related to the disregard of reflections discussed above.

Page 13: Paragraph 1 – The determination that outdoor activity areas will be below 65 dB at locations other than Buildings 1 and 2 may change if computations are re-done at both seated and standing height and including the effects of reflections. The determination that sound levels will increase less than 1 dB in the next 20 years appears to be based on a 1.16% or less per year traffic flow increase and no change in vehicle noise emission levels. This degree of vehicle and train traffic increase should be checked against CalTrans and UPRR projections.

Page 13: Paragraph 1 – It is stated, correctly, that sound levels will be increase with increasing height above grade. It would be useful to quantify this increase, either by tabulating sound levels at realistic first and second floor elevations at representative locations near each building or by plotting noise contour maps (with reflections included) at the appropriate heights.

Page 13: Interior Noise Levels – It would be more useful to discuss the acoustical properties of windows and doors in terms more specific to the noise exposure conditions on the project. Sound Transmission Class gives a general figure of acoustical merit to a sound attenuation structure, but, for example, two window configurations with the same STC can have markedly different effects on traffic noise. The engineering approach would be to use the frequency spectrum of the train and traffic noise and the sound transmission loss as a function of frequency for the noise control elements to determine indoor sound levels.

Page 13: Paragraph 4 - It is anticipated that all buildings except 18 – 22 will actually avoid some degree of noise reduction to meet 45 dB indoors, even if the noise reduction is only keeping windows closed.

Pages 13-14: Discussion and Conclusion – Transient railroad noise was shown to be an important factor in the nighttime environment, with crossing horn sound more than 20 dB greater than the CNEL documented. While such infrequent transient noises may not be particularly consequential for outdoor recreational activities, indoors they can be disruptive and cause sleep disturbance. The report should include a discussion of the effects and control of high amplitude transient noises. Regarding section 4.1, it is a truism that average evening sound levels are several dB lower than the CNEL, but the CNEL includes the +5 dB evening weighting based on the presumption that there would be an increased sensitivity to noise during this period.

Page 14: Required Noise Barrier Wall – The actual extent and height of walls needed to maintain CNEL 65 dB or below in outdoor living spaces should be revisited using modeling that accounts for reflected sound transmission paths.

Pages 14-17: Required Building Construction – The Reviewer does not possess building plans and cannot assess the effectiveness of the proposed treatments. The treatments proposed appear to be reasonable in general, but may have more widespread necessity than suggested. Specification of acoustical performance of individual construction elements should be related to the noise source characteristics rather than STC. Locations where windows must be closed to meet the CNEL 45 requirement and the window performance requirement should be tabulated.

Page 19: Definitions – Sound Level (dB, dBA or dB(A)) is A-weighted by default. If other weightings (e.g. C, Z, G) are to be used, they are to be stated explicitly. dBA and dB(A) are convenient constructs to draw attention to the fact that A-weighting was used, but dB does not connote or denote the absence of A-weighting. It is customary to specify the time period for LEQ and ANSI Standard way of writing is $L_{\mathrm{Aeq}T}$ where T is the elapsed time of the measurement. In the report, 10 seconds ($L_{\mathrm{Aeq}10sec}$) and one hour ($L_{\mathrm{Aeq}1hr}$) are used.

Page 22: Section 10.0 – States that 24 hour measurements were taken at two locations. Only one appears to be documented in the report.

Page 23: Paragraph 2 – Note that, as discussed at length above, CADNA/A apparently only computes reflected sound transmission paths if instructed to do so explicitly.

Commentary on Response to Comments from ICF

Minor Issues

1. Although it would be useful to include measurements taken over a longer time period, the measurement program as described and reported has probably produced conservative results.
2. The CADNA/A contour maps do indeed include the roadway at the southwest corner.
3. The ICF point is well-taken. Tabulations of noise levels at first and second floor plus outdoor living space elevations near each residence unit would be an excellent supplement to the contour maps. As discussed above, the legends are for 5 dB increment maps and the maps are 1 dB increments, so they are not very helpful. The numerical notations on the maps are adequate, once one figures them out, but they only apply to the 3 ft ASG elevation.
4. If the Traffic and Circulation Study confirms approximately 1 percent per year traffic growth, it is an adequate reference.
5. When and INCE Certified consultant makes a statement of generally accepted fact, the consultant can be considered to be the reference.

Major Issues

1. The 3 ft and 6 ft issue has been discussed above. It is clearly not a typographical error.
2. This issue again has been discussed above. Additional modeling at applicable elevations would aid in the specification of appropriate noise reducing elements.
3. Mitigations should include the 1 dB increment, although measuring and modeling any environment with variable sources like trains, traffic flow, etc. to 1 dB precision is an administrative exercise. Prudent design will suppress peak railroad noise in bedrooms and therefore automatically comply with CNEL 45.
4. The writing in Section 4.1 just makes observations about the actual outdoor noise levels relative to CNEL, but the objective appears to be to satisfy CNEL 65 at 3 ft above ground.
5. The response to the comment regarding construction noise needs some editing. For example, it speaks of limiting the daytime noise level to LDN 65 dB at the property line. LDN is a 24 hour descriptor. One might consider specifying perimeter units be built first, to provide acoustic shielding for adjacent homes. The City’s 65 dB daytime noise limit may refer to environments for new developments and not to property line noise from on-site sources.
6. The discussion presented in response to the Vibration comment addresses impact on the new residences from the railroad and highway traffic, which is expected to be negligible. However, the comment referred to construction-generated vibration. This might refer to vibratory ground compacting or similar, and should be mentioned in the response.
7. The response to comment regarding project-generated traffic noise increments is not adequately answered, although the conclusion is probably correct. The shielding effect from Highway 101 of the project on residences to the north would very likely offset any noise from project-generated traffic on local roadways, and project-generated traffic noise near the southeast must be miniscule compared to existing noise from Highway 101.