Attachment 12

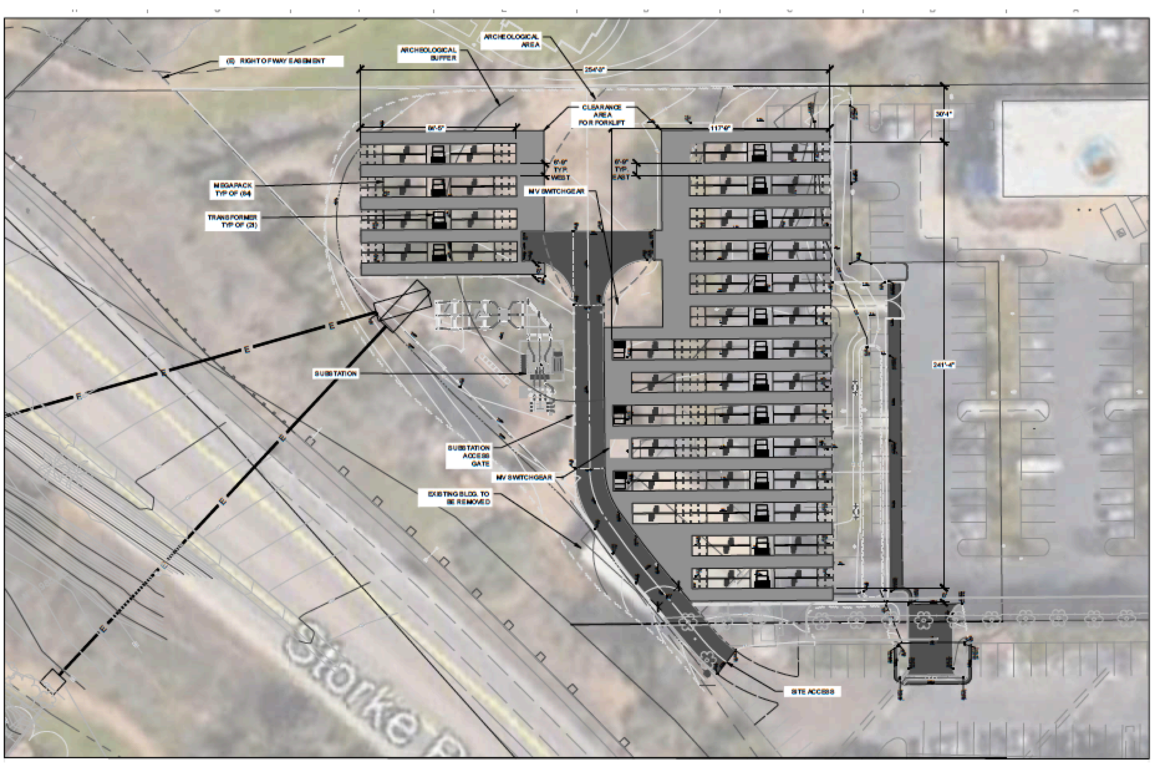
BRUCE WALKER, PH.D., INCE BD. CERT.
ACOUSTICAL ENGINEERING AND RESEARCH
676 WEST HIGHLAND DRIVE
CAMARILLO, CA 93010
805-484-8000
NOISEYBW@AOL.COM

July 16, 2020

Acoustical Analysis Peer Review DRAFT

For

Cortona Drive Battery Energy Storage System



Prepared for
Department of Planning and Environmental Review
City of Goleta
130 Cremona Drive, Suite B
Goleta, CA 93117

INTRODUCTION

Cortona Drive Battery Energy Storage System is a proposed array of 84 self-contained battery energy storage units and associated transformers, inverters and distribution equipment, on a parcel adjacent to approved multi-family residential development in the City of Goleta. The character of sound emitted by the project's mechanical and electrical equipment is expected to differ from the existing ambient transportation noise from nearby Storke Road, Highway 101 and the Union Pacific Railroad. The goal of the analysis is to determine potential acoustical disturbances introduced by the project, to assess significance of the disturbances relative to State, City and generally accepted subjective exposure criteria, and, if necessary, specify abatement measures.

Rincon Engineering has done a comprehensive analysis of the situation relative to State and City noise standards, within uncertainty limits imposed by the nature of the proposed noise sources. In this review, comments will be presented relative to editorial and technical issues in Rincon's Draft Report. Following these, a discussion of difficulties modeling arrays of noise sources with tonal components will be presented. The Reviewer's primary concern is that the Report does not address Goleta Municipal Code 9.09.020 and 9.09.040 relative to the potential subjective effect of introducing a large array of mechanical noise sources in an environment that is currently dominated by sporadic transportation noises.

Note that many results and predictions are presented with 0.1 dB precision. This is for purposes of illustration and comparison only. Human perception acuity, measurement equipment reliability and prediction model validity are generally limited to 1-3 dB tolerance.

COMMENTARY

Noise Overview – This is a good discussion for general reading. It doesn't necessarily comply with ANSI Standards for Terminology, but the information is well conveyed. Using the non-standard (albeit ubiquitous) "dBA" in discussions of propagation rates or changes in level is not advised.

Existing Noise Setting – The graphs in Figures 3 and 4 of the Report are helpful for evaluation of ambient conditions. A statistical analysis would also be helpful, and in fact was provided in an earlier Draft. Note that the level is below 55 dB most of the time in mid-morning, with average (L_{eq}) 57 dB at both locations. On Table 2 of the Report, note that from 9-12 p.m. the L_{eq} is 54-56 dB, while the L_{eq} from 10-11 a.m. is 56 dB, suggesting that the nighttime environment is not radically different than that measured in mid-morning. To help illustrate the ambient conditions, representative segments of the long-term measurement data (from earlier Report Draft) have been graphed and statistically analyzed. Figure 1 below shows plotted results of the long-term measurement in the 10-11 p.m. hour. Figure 2 show the 11 p.m. to midnight hour and Figure 3 shows midnight to 1 a.m. Note that an "off-scale" noise event appears to be occurring right at midnight. Figure 4 shows a 10-minute segment of the measurement data centered on this 18-second event. Finally, Figure 5 shows the time history of noise in the final "nighttime" hour, 6 – 7 a.m. This hour's noise is penalized by +10 dB for purposes of computing CNEL.

It is important to assess the ambient environment in more detail than a single CNEL because of the disparity in character between existing traffic and railroad noise and the proposed array of mechanical and electrical devices. Presence of spectral peaks (tones) and different variability patterns are two potential annoyance factors.

Table 1 summarizes the statistics of noise from the four plotted time periods and the two short-term mid-morning measurements. Late at night and during mid-morning, the median (L_{50}) ambient level is in the range 50-55 dB and the background (L_{90}) level is just below 50 dB. The Sound Exposure Level (SEL) is equal to L_{eq} plus 10 log_{10}(Duration in seconds).

Table 1. Measured Sound Level Statistics Examples

	Short 1	Short 2	2200-2300	2300-2400	0000-0100	0600-0700
L_{05}	59.2	61.3	58.4	57.7	56.8	66.9
L_{10}	56.7	56.1	57.1	56.8	55.7	64.9
L_{50}	52.8	51.8	53.3	53.1	51.4	62.0
L_{90}	49.3	49.1	50.1	49.8	48.0	59.2
L_{95}	48.4	48.0	49.5	49.0	47.2	58.6
Lmax	74.8	72.7	64.9	80.6	83.9	77.7
Time	15 min	15 Min	60 min	60 min	60 min	60 min
SEL	86.6	86.7	90.0	92.0	93.9	99.3
Leq	57.2	57.3	54.4	56.4	58.4	63.7

For purposes of assessing the potential subjective impact of introducing noise sources adjacent to noise-sensitive uses, it would be appropriate to examine the effect on more than the hourly average (L_{eq}) and weighted 24-hour average (L_{dn} or CNEL) sound levels, particularly when the ambient conditions are significantly time-variant and/or dominated by occasional short-duration, high level events. Changes to the median, or even background noise for extended time periods could be considered.

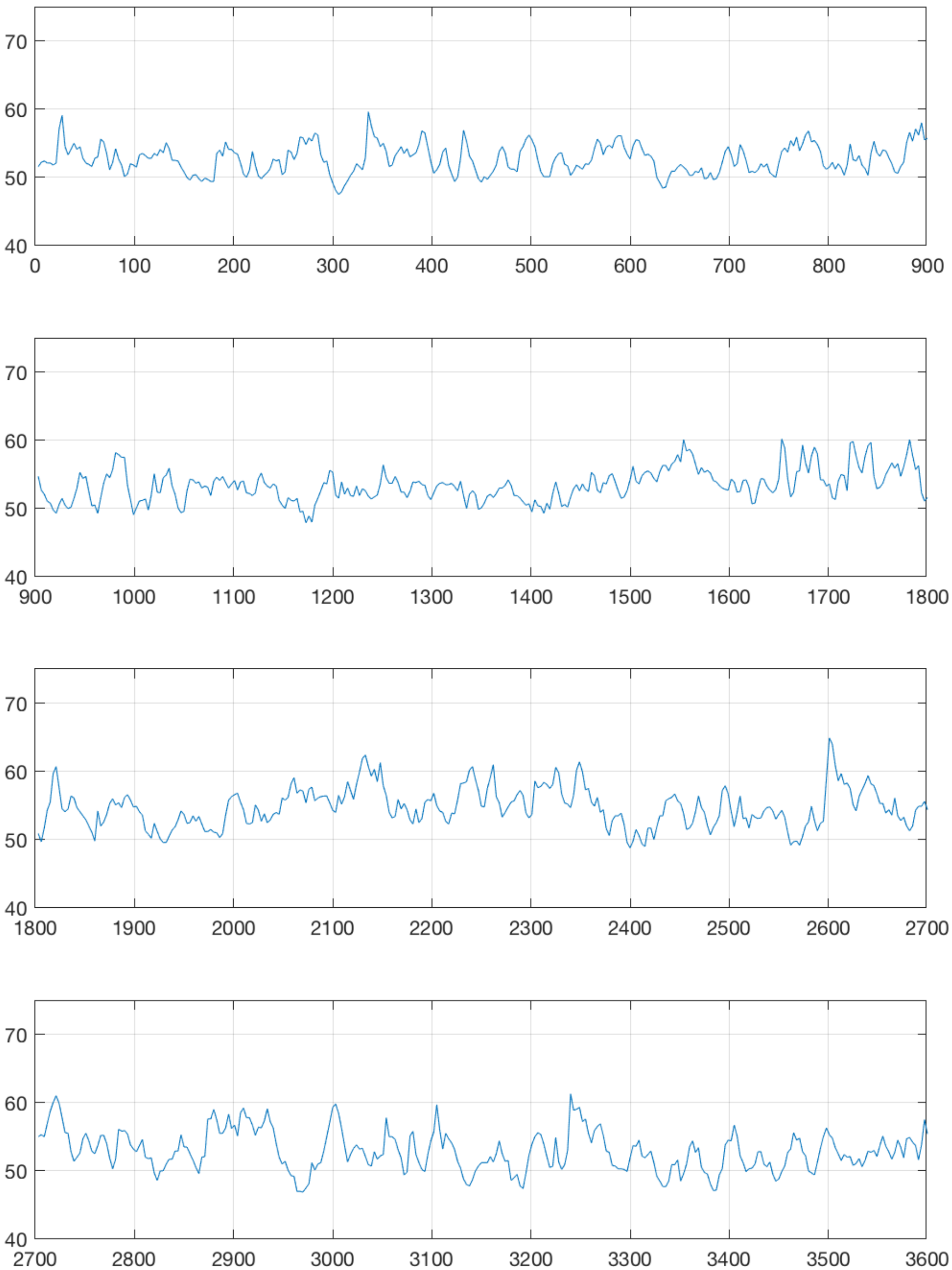


Figure 1. Long Term Measurement Data 2200-2300

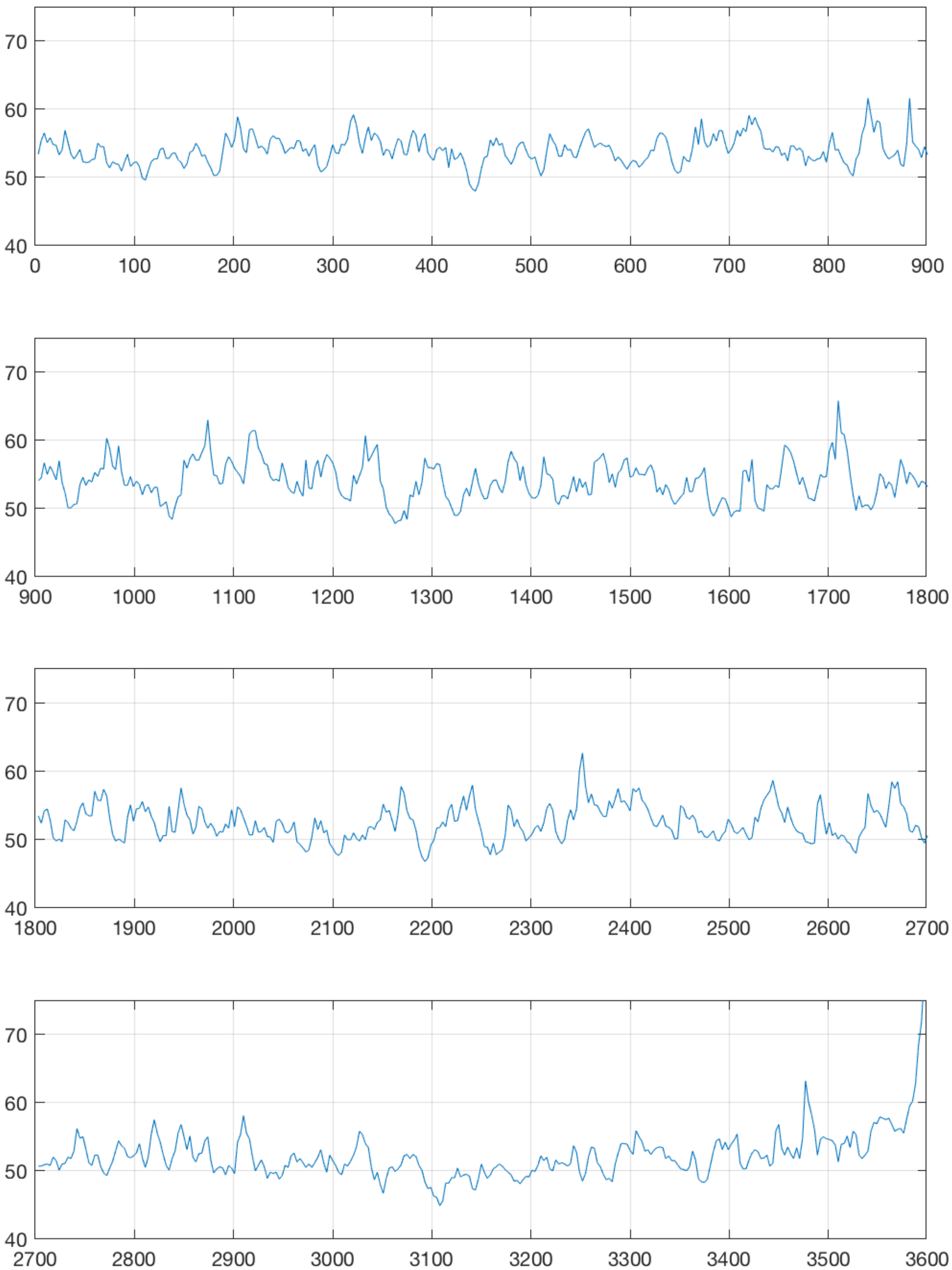


Figure 2. Long Term Measurement Data 2300-2400

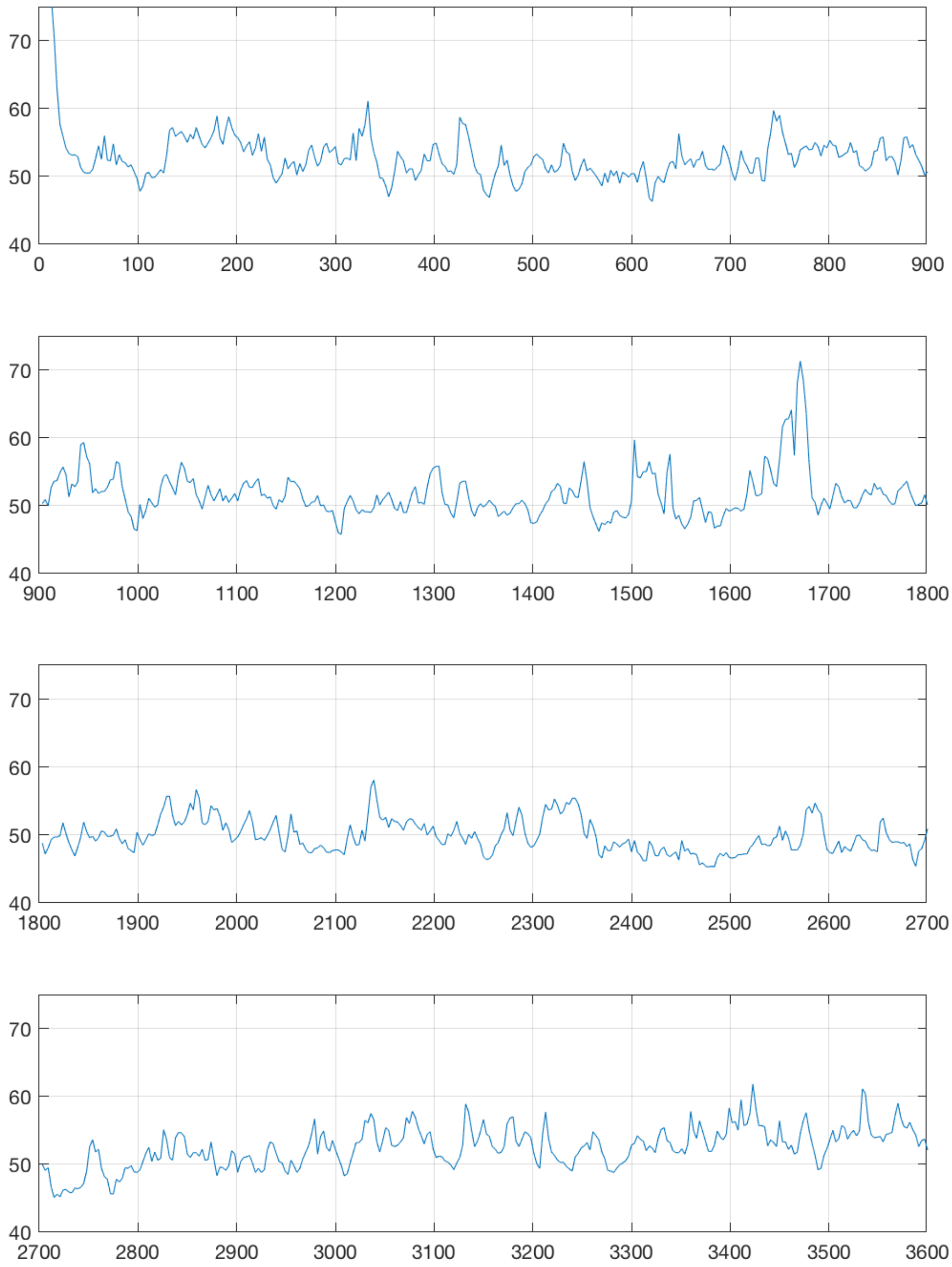


Figure 3. Long Term Measurement Data 0000-0100

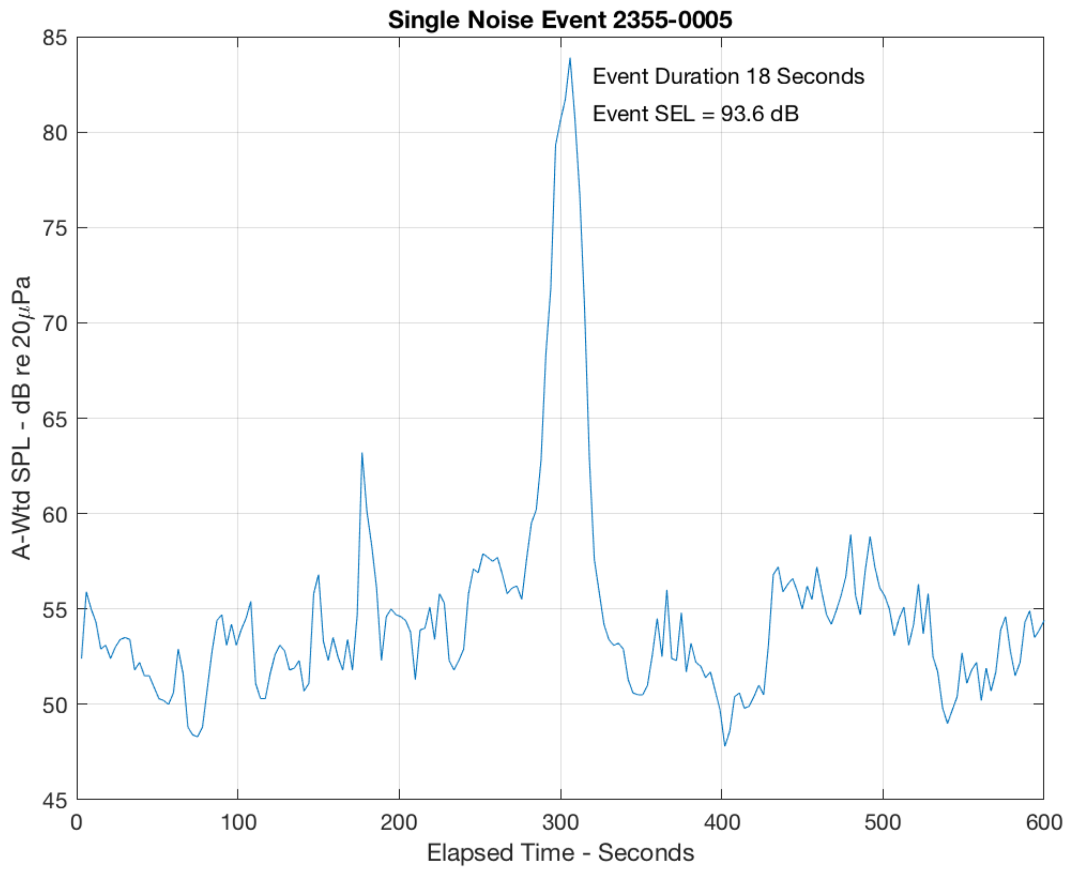


Figure 4. Detail of Midnight Noise Event from Long Term Measurement Data

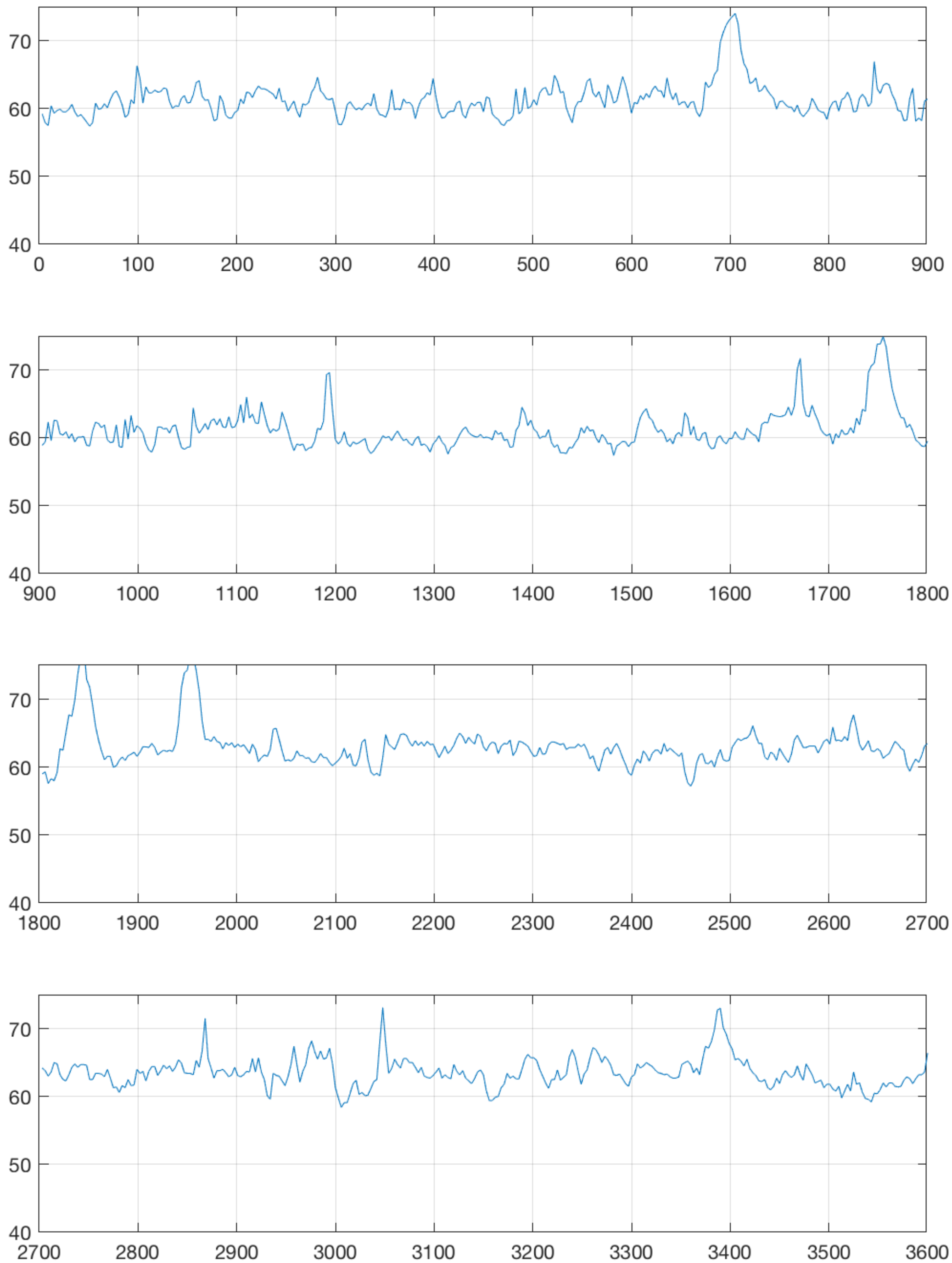


Figure 5. Long Term Measurement Data 0600-0700 (per Report, may be influenced by local noise sources)

City of Goleta General Plan Noise Element – Report Table 3 shows that the Normally Acceptable compatibility criterion for Multi-Family Residential uses is 50-60 dB CNEL.

City of Goleta Municipal Code – The Report refers to Zoning Code 17.39.070 and states that if proposed newly introduced sources emit sounds with dominant tonal components, the Normally Unacceptable range may be reduced 5 dB, i.e. to 60-70 dB CNEL. The tonal properties of project noise sources and assessing introduced noises relative to existing noises will be discussed in later sections. The Report does not refer to Public Peace and Welfare Code 9.09.020, which limits nighttime and weekend noise levels to 60 dB at the property line or to 9.09.040 (reproduced below), which discusses noise nuisance effects in some detail. For example 9.09.040.B.4 flags for consideration "Whether the nature of the noise, music, or related sound is unusual for the area in which it occurs."

9.09.040 Disturbing the Peace.

A. Disturbing the Peace—Excessive or Unreasonable Noise. It is unlawful for any person to make, cause or suffer or permit to be made or caused, upon any premises owned, occupied or controlled by him or her in the City, any unnecessary noises or sounds which are physically annoying to persons of ordinary sensitiveness or which are so harsh or so prolonged or unnatural or unusual in their use, time or place as to occasion physical discomfort to the inhabitants of the City, or any number thereof.

B. Factors Used in Determining Whether a Violation Has Occurred. The factors which shall be considered by the City in determining whether to issue a citation for a violation and whether a violation of this section has occurred shall include, but not be limited to, the following:

1. The volume of the noise, music, or related sound;

2. The intensity of the noise, music, or related sound;

3. The continuousness or repetitive nature of the noise, music, or related sound;

4. Whether the nature of the noise, music, or related sound is unusual for the area in which it occurs;

5. Whether the origin of the noise, music, or related sound is natural or unnatural to the area in which it occurs;

6. The volume and intensity of the background noise or sound, if any;

7. The proximity of the noise, music, or related sound to residential sleeping facilities or to overnight accommodations, such as hotels and motels;

8. The proximity to offices, places of business or other areas where work is known to be carried on, of the noise, music, or related sound;

9. The nature and zoning of the area within which the noise, music, or related sound emanates;

10. The time of day or night the noise, music, or related sound occurs and the relationship of this time to the normal activities of the area in which it occurs and in relation to the other factors listed in this subsection;

11. The duration of the noise, music, or related sound;

12. Whether the noise, music, or related sound is recurrent, intermittent, or constant;

13. Whether the noise, music, or related sound is produced by a commercial or a noncommercial activity;

14. Whether the person or business responsible for the noise, music, or related sound has been previously recently warned that complaints have been received about the noise, music, or related sound and such person or business has failed to reduce it to an appropriate level. (Ord. 12-17 § 2)

Impact Analysis

Methodology – The use of ISO 9613-2 in SoundPlan is the current standard method for propagation calculations. As stated in the Report, it is conservative in that it assumes receivers are all downwind of sources, so that shadow zones associated with atmospheric lapse or upwind propagation will not occur. However, SoundPlan does account for atmospheric and ground plane absorption and it is up to the user to provide correct parameters for these variables. The Report indicates 10°C 70% RH, which are conservative values re atmospheric absorption. The Reviewer could not find ground absorption settings.

Receivers – The three floors of Building 6 of Cortona Apartments have been added to the receivers, at elevations 5, 16 and 27 ft respectively. This is a valuable addition, as the levels nearer the ground are substantially reduced by the geometry of the source locations atop the 8 ft tall Megapacks.

Noise Sources – No table is provided showing the locations of all noise sources, although they are identified on the Site Plan in Attachment 1. Spectral data is not provided for transformers and sub-station. Considerable detail regarding the cooling fans has been provided, but the application of this data is unclear. The Report appears to discard the data for two fans operating at the 40% setting on the basis of potential cancellation between the two fans. The tone level of two fans operating at the same speed but at different phases would be subject to uncertainty, but the overall level would be reasonably reliable. To avoid this uncertainty, the Report computes a 40% single fan level from the 95% single fan level, but appears to have only used the "Top" sound power level in the data (78.7 dB re 1pW). The actual sound power is the sum of the five measured components (LWA = 87.7 dB re 1pW). The total LWA for the various test settings are shown in Figure 6 and the third-octave spectra for single fan at 95% and two fans at 40% are shown in Figure 7. The Report subtracts 4 dB from the 78.7 dB to obtain a single fan sound power level 74.7 dB. It would be more appropriate to subtract 3 dB from the true LWA of 76.7 dB to obtain 73.7 dB. Serendipitously, this is only 1 dB lower than the value modeled in the Report. However, note in Figure 7 that the computed octave band SLA spectrum (from Report Attachment 6) does not track the 40% LWA spectrum, particularly in the range around 200 Hz where the blade passage tone occurs at 40%.

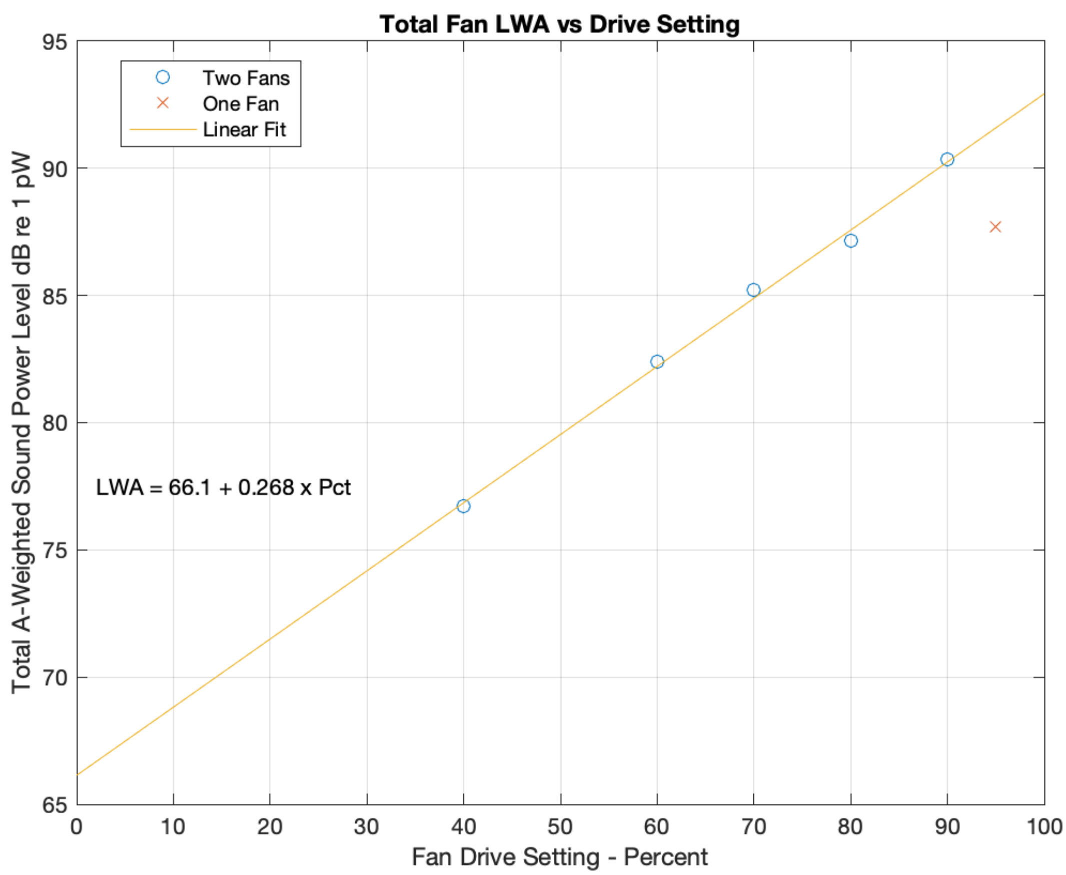


Figure 6. Tesla Cooling Fans Total Sound Power Level vs Drive Setting

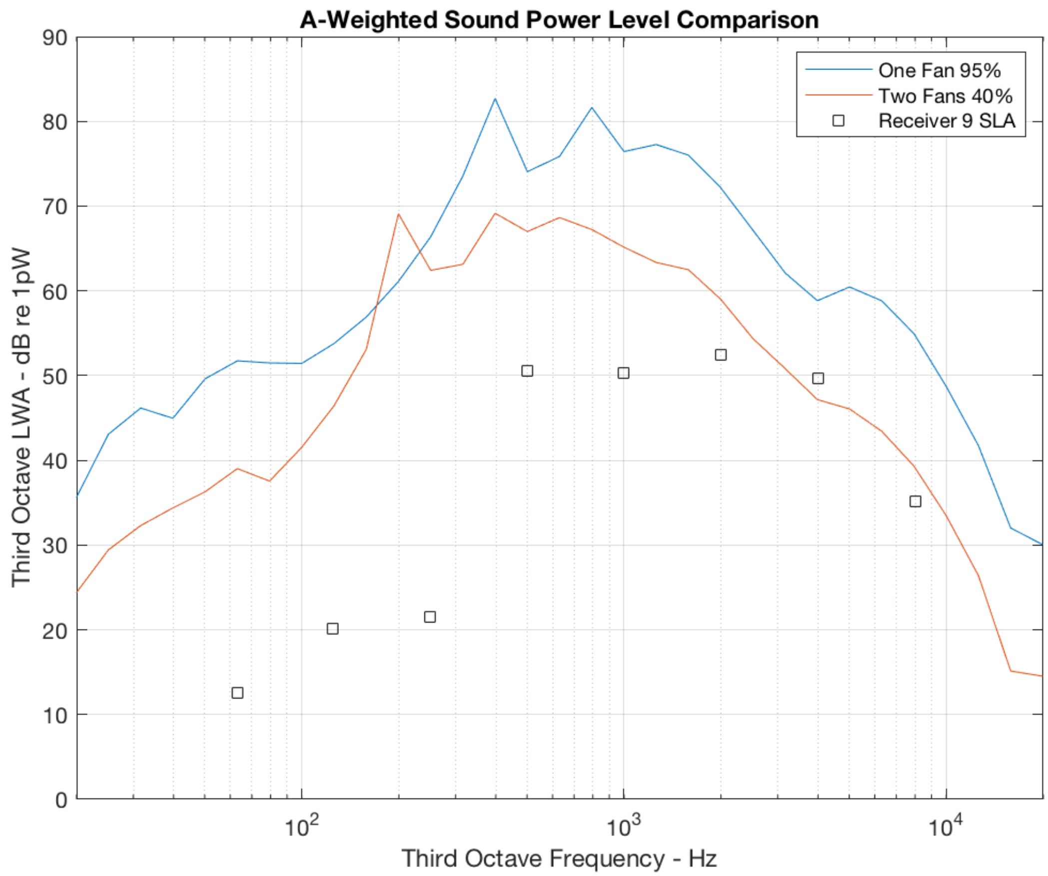


Figure 7. Third-Octave A-Weighed Sound Power Level Spectra (Receiver 9-3 is Octave Band SLA in dB re 20 μPa)

The 1/3-Octave spectra in Figure 7 show clear indication of peaks at Blade Passage Frequency (BPF), 2BPF and 3BPF, both at 40% and 95%. The BPF Tone Prominence, defined as the SPL in the BPF third octave minus the average of the SPL's in the two neighboring third octaves, was computed for each set of data from Tesla, as shown in Figure 8. Typically, Tone Prominence triggers a penalty if it exceeds 8 dB for frequencies up to 400 Hz, and 5 dB above 400 Hz. The 40% Tone Prominence is 11 dB at 200 Hz, so whatever tonality penalty is suggested in the Municipal Code sections would be applicable.

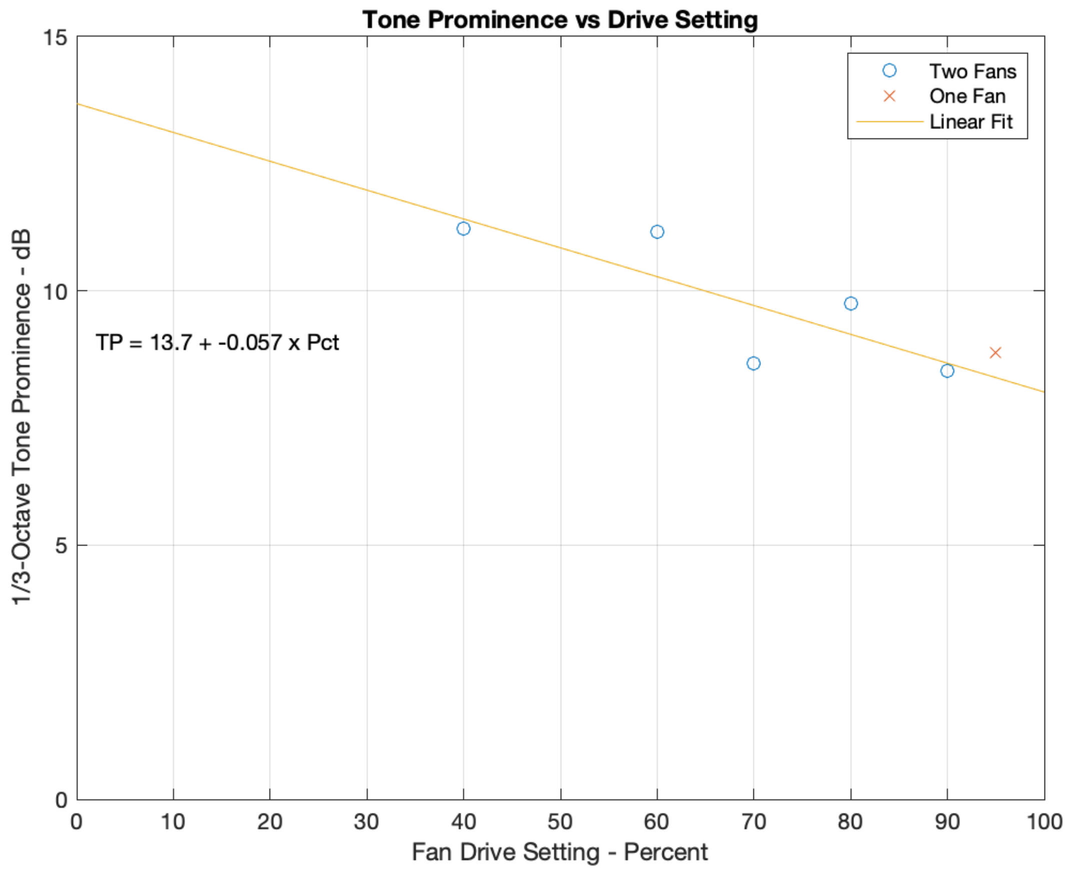


Figure 8. Tesla Cooling Fans Blade Passage Tone Prominence vs Drive Setting

A further problem with tonal sources is that ISO 9613-2 treats individual sources as statistically independent, so that adding two sources results in +3 dB compared to each, i.e. the powers add. In actuality, the pressures add and the total depends on the correlation between the two sources. If the sources are tones, the correlation R_{12} is the cosine of the phase between the two sources and varies between +1 and -1. Power is proportional to pressure-squared, so adding two pressure signals $p_{1+2}^2 = p_1^2 + p_2^2 + 2\ p_1 p_2 \cos(\text{Phase}_{12})$. The third (coherence) term casus the pressure sum to vary between +3 dB and -∞ dB compared to simply adding the energies. With a large number (N) of sources, the possible underprediction is 10 $\log_{10}(N)$, although the probability of encountering the maximum is very low. As shown in Figure 9, with two sources, there is an equal chance of over or underpredicting the sound level by ignoring coherence effects. With three or greater numbers of sources, there is approximately 40% probability of underprediction and 60% probability of overprediction, with a very small (3%) probability of underprediction by more than 5 dB. [Note that these calculations were done for one million random combinations of source phases. Even with this large number of trials, the theoretical maximum of +10 dB for ten sources was not observed.]

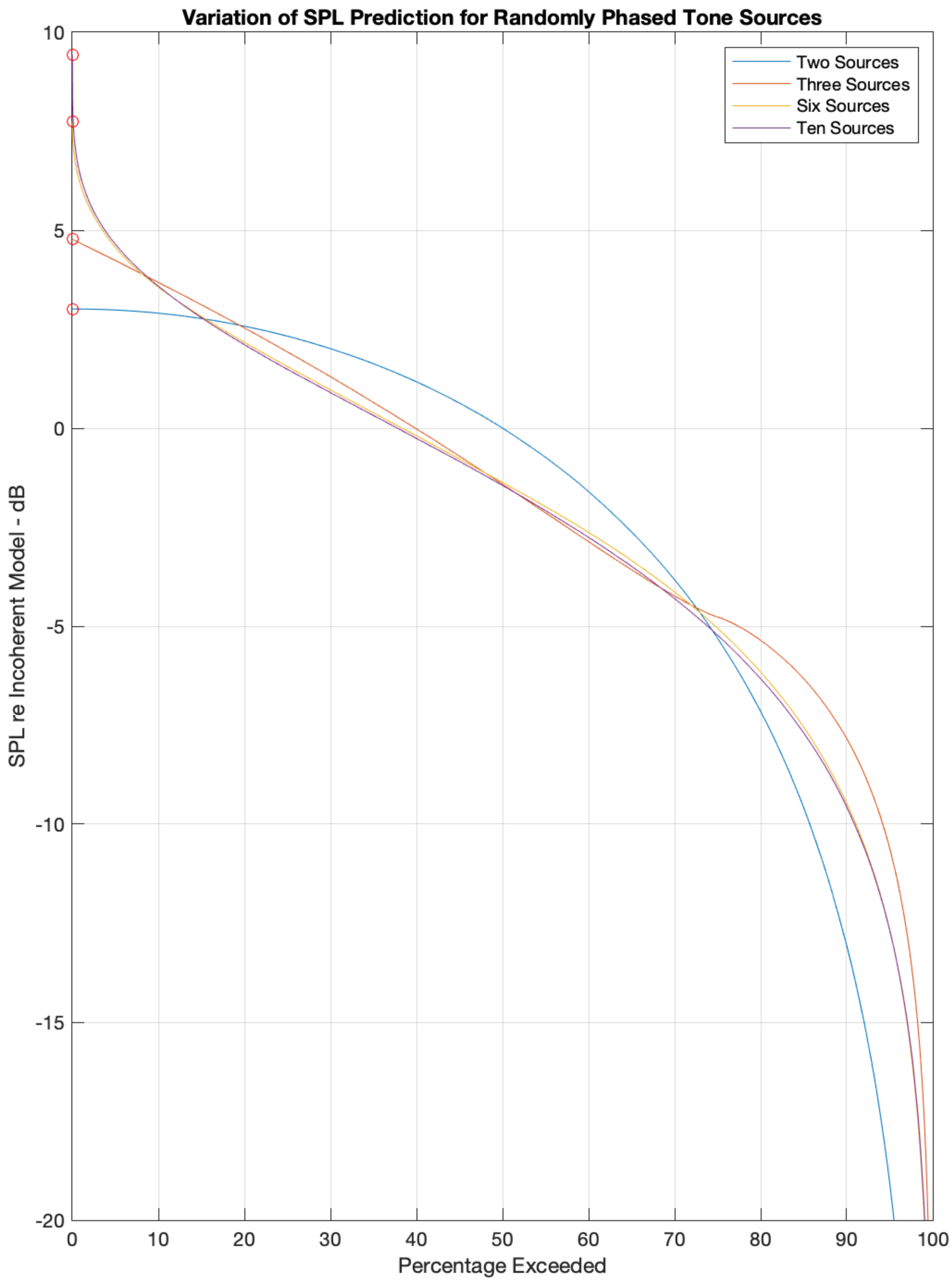


Figure 9. Summing Two, Three, Six or Ten Equal Tonal Sources with Random Phases

Transformers and the Sub-Station have been included in the Report noise modeling and appear to have a dominant effect in some directions. The fan noise alone, with all fans running at 40%, has been computed at 16 ft elevation with result as shown in Figure 10. It results in approximately 59 dB at the location of Building 6, which would be taken as 64 dB with a 5 dB tonality penalty applied. If the fans never actually run simultaneously, the off-site sound level could be estimated as 59 dB – 10 $\log_{10}$(fraction of fans running). The considerable difference in shape between Figure 10 and Report Figure 7 likely results from contributions by the sub-station and transformers, although the difference in shape of the 65 dB contours near the corners of the Megapack arrays is puzzling, and ,also be related to the number of fans assumed operating in the time period for which L_{eq} was being computed. It is very likely that noise emitted by the sub-station and transformers is tonal in character, but no data has been presented to allow investigation.

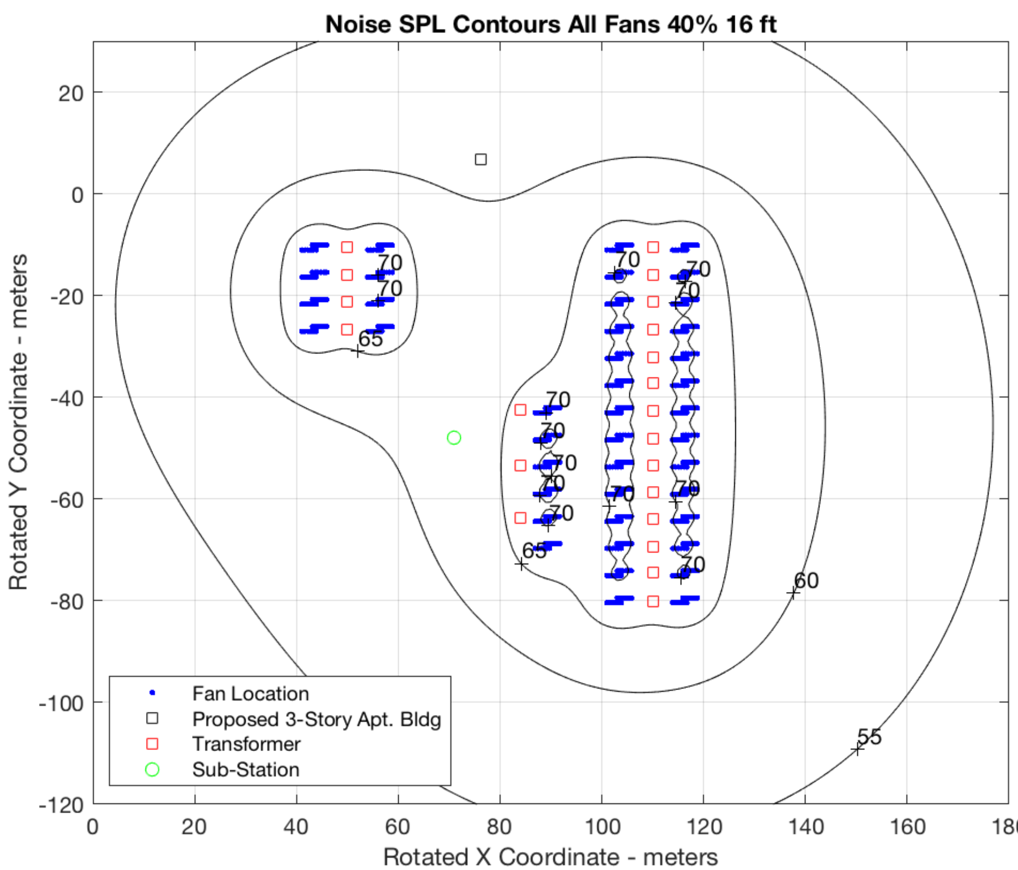


Figure 10. Fans Only Noise Sound Level Contours at 16 ft Elevation with All Fans Running at 40%

On Page 12, and extensive discussion is presented regarding fan scheduling. A statement is made that not all fans would operate at the same time, yet later in the paragraph it is shown that sometimes all fans would operate from 9 to 12 at night. On the basis of CNEL, this would not be an issue since overall computed levels appear to be below ambient levels. Relative to

Municipal Code Section 9, tonal noises from a large number of fans and transformers late at night could be expected to annoy residents in nearby units of Cortona Apartments.
In the Noise Sources discussions and in Attachment 3, the term "Duty Cycle" appears to be used to describe both the portion of time the sources are active and the fan operating point. It is possible that the fans are driven by a variable pulse-width electrical signal, so that "Duty Cycle" is appropriate, but it would be clearer to use separate terminology for these two issues.

As a check on the effect of the transformers and sub-station, Figure 11 shows the approximate effect of adding them to the fan noise. At the nearest apartment, the total is raised about 1 dB, to just below 60. The contour shapes indicated in the Report could not be duplicated, possibly due to the Reviewers simpler model not including the shielding and reflecting effects of buildings or the Megapacks.

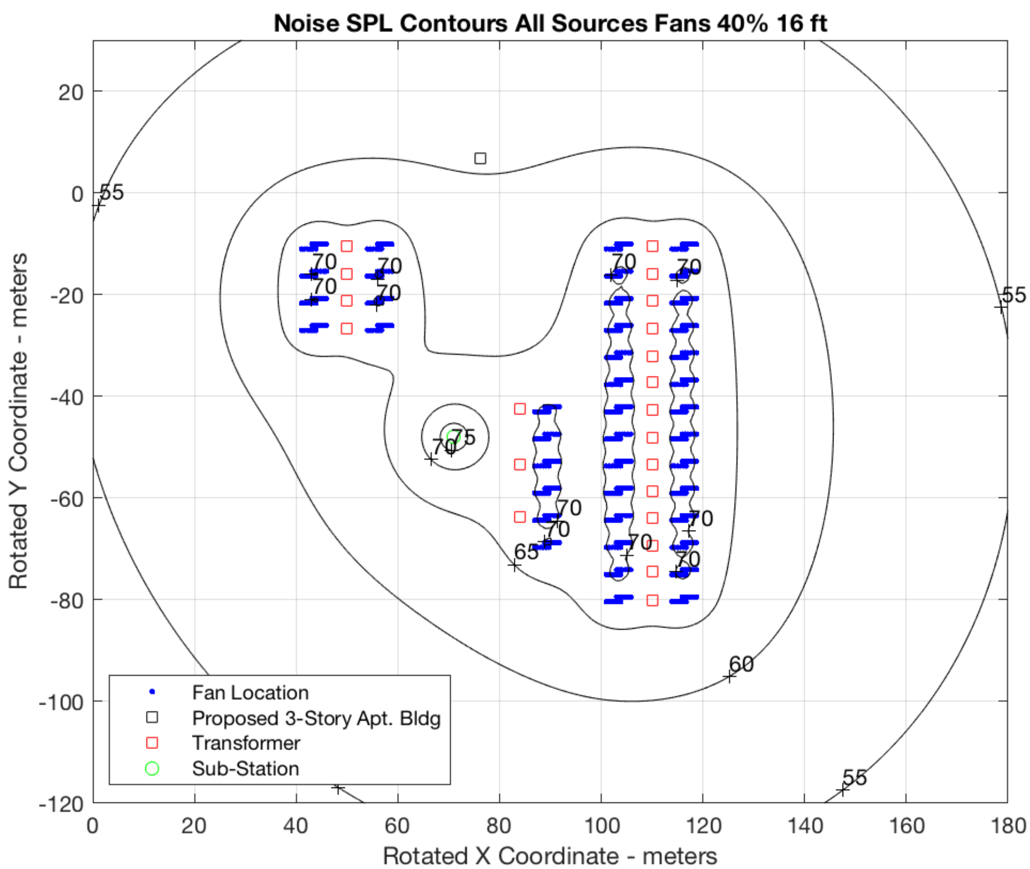


Figure 11. Approximate (unshielded) Noise Contours for All Fans, Transformers and Sub-Station

CONCLUSIONS AND RECOMMENDATIONS

1. The project has been shown to comply with CEQA guidelines and City of Goleta Code and Noise Element requirements for overall noise exposure at adjacent noise-sensitive uses.

2. The spectral and temporal characters of the project noise are expected to differ significantly from those of the existing ambient noise and may be expected to ellicit complaints from nearby residents.

3. It is not possible to provide a totally reliable prediction of off-site noise from a large array of tonal sound sources. The tonality of off-site noise would also be inconsistent and randomly variable, possibly making investigation of complaints difficult.

4. The project should include a contingency for installing sound-attenuating treatments above the cooling fans on some of the Megapacks nearest the property line with Cortona Apartments. Sound barriers around the northerly side of some of the transformers and the noisy components of the substation may also be advisable.

Respectfully,

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