LESTER SITE
DRAFT ENVIRONMENTAL NOISE AND GROUND-BORNE VIBRATION ASSESSMENT
SAN JOSE, CALIFORNIA

4 August 2010

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CSA Project No. 10-0056

INTRODUCTION

This report summarizes our environmental noise and ground-borne vibration assessment for the proposed residential project located between Blossom Hill Road and Highway 85, west of Shadowcrest Way, in San Jose, California. The purpose of this study is to quantify the noise environment, and ground-borne vibration due to VTA[1] Light Rail trains, and compare these with applicable standards for residential projects to determine the degree of mitigation that may be necessary. For readers not familiar with the fundamental concepts of environmental noise, please refer to Appendix A.

Following is a summary of our findings:

1. Average indoor noise levels can be reduced to DNL 45 dBA or lower by incorporating sound-rated windows, doors, and exterior wall assemblies into the building design.
2. Single event noise from vehicles and emergency sirens have the potential to disrupt conversational speech and cause sleep disturbance indoors. The developer should consider maximum noise levels indoors when determining sound rated windows, doors, and walls nearest to Highway 85 and Blossom Hill Road.
3. Incorporating noise barriers at yards along Blossom Hill Road can reduce outdoor noise levels in residential yards to between DNL 60 and 68 dBA across the site. It would not be feasible to meet the City's goal of DNL 60 dBA without substantially increasing the height of the noise barrier along Highway 85.
4. Noise from mechanical equipment, such as air-conditioning units, must meet the Zoning Ordinance requirements. This should be evaluated in detail when equipment types, locations, and sizes are selected.
5. Measured ground-borne vibration levels from VTA Light Rail trains are within the FTA guidelines for residences.
6. A VTA transformer station is located adjacent to the northwestern corner of the site. Future homeowners should be informed that they may hear noise from the transformer when traffic noise is low.
7. Construction noise should be addressed by following the City of San Jose guidelines, as described below.

DESCRIPTION

The project consists of up to 90 single-family two or three-story detached homes to be built on a vacant 9.8-acre site between Highway 85 and Blossom Hill Road (see Figure 1, attached). Outdoor use space will consist of private fenced yards. Housing setbacks will be approximately 70 feet and farther from the centerline of Blossom Hill Road, and 140' and farther from the centerline of Highway 85, and the site grade will not change significantly in the future.

[1] Santa Clara Valley Transportation Authority (VTA).

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Two active VTA Light Rail tracks are located in the center of Highway 85, currently carrying 64 to 69 northbound and 66 to 71 southbound trains daily.[2] A noise barrier separates the site from the adjacent highway and train tracks. An existing VTA transformer station is located adjacent to the northwestern corner of the site. One and two-story single-family detached homes border the site on the east and west and commercial businesses, including a gas station, wireless telephone store and restaurant, are located across Blossom Hill Road to the south.

ACOUSTICAL CRITERIA

City of San Jose General Plan

The Noise Element of the San Jose General Plan 2020 contains land use compatibility guidelines for environmental noise in the community. Table 1, below, summarizes these guidelines for residential land uses.

Table 1 – Summary of Figure 16: Land Use Compatibility Guidelines for Community Noise

DNL Value in Decibels	Residential Compatibility
60 dB or less	Satisfactory
60 to 70 dB	When new development requires a full EIR, an acoustical analysis should be made indicating amount of attenuation necessary to maintain an indoor level of DNL <=45. Onsite outdoor activity limited to acoustically protected areas. Existing uses should receive remedial treatment.
Greater than 70 dB	New development permitted only if uses are entirely indoors and building design limits interior levels to <=45 DNL. Onsite activity areas should be permitted if site planning and noise barriers can achieve levels of 60 DNL or less. Existing uses have top priority for remedial treatment.

- The Noise Element defines short and long-range noise quality level goals for outdoor use areas as DNL 60 and 55 dB, respectively. However, the City acknowledges that it may not be possible to attain these levels in “special noise impact areas”, such as areas adjacent to major roadways, without eliminating the beneficial attributes of the exterior space.

- In addition, Policy 1 of the Noise Element defines DNL 45 dB as the interior noise quality level goal, and DNL 76 dB as the maximum exterior noise levels to “avoid significant adverse health effects.”

City of San Jose Municipal Code

The Zoning Ordinance of the San Jose Municipal Code contains performance standards for the generation of noise at adjacent properties. In summary, noise levels from air-conditioning units and other mechanical equipment is limited to a maximum of 55 dB at residential property lines.

[2] VTA Light Rail. http://www.vta.org/schedules/SC_901, accessed 10 March 2010.

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Federal Transit Administration (FTA)

A document entitled "Transit Noise and Vibration Impact Assessment", published by the Federal Transit Administration (FTA) of the United States Department of Transportation in May of 2006, provides guidelines for levels of ground-borne vibration due to rail lines adjacent to various land uses. In summary, the guidelines identify 72 VdB as the upper limit for ground-borne vibration from frequent events (more than 70 per day) at residences.

While the guidelines are generally intended to help assess the potential impact of new rail projects adjacent to existing land uses, they are frequently used to help assess the compatibility of new projects adjacent to existing rail lines. For reference, the document identifies the threshold of perception for humans to be around 65 VdB.

Single-Event Noise Levels.

The City of San Jose does not specifically regulate maximum instantaneous interior noise levels from singe-events outdoors, such as vehicles and emergency sirens. However, because of its potential effects on sleep, and because of the site's proximity to Blossom Hill Road and Highway 85, this report discusses the potential impact of noise from individual vehicles.

Some cities do have guidelines for addressing maximum interior noise levels due to individual outdoor events such as train horns. The most common present a goal of 50 dBA or lower in bedrooms, and 55 dBA or lower in other rooms.

ENVIRONMENTAL NOISE AND GROUND-BORNE VIBRATION ENVIRONMENT

Existing Noise Environment

Vehicles on adjacent roadways dominate environmental noise levels at the site. To quantify the existing noise environment, two long-term monitors continuously measured noise levels at the site between the 9th and 15th of February 2010. In addition, short-term "spot" measurements were conducted and compared with corresponding time periods of the long-term monitors to determine how noise levels vary across the site and at different elevations. Table 2 summarizes existing noise levels at the site. Approximate measurement locations are shown in Figure 1, attached.

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Table 2: Existing Noise Environment

Site	Location	Date / Time	DNL
LT-1	Highway 85 Monitor Approximately 235' south of roadway centerline, 8' above ground	9 to 15 February 2010	65 dBA
LT-2	Blossom Hill Road Monitor Approximately 55 feet north of roadway centerline		72 dBA
ST-1	Northern Portion of Site Spot Measurement Approximately 240' south of Highway 85 centerline, 20' to 40' above ground	12:30 – 13:30 15 Feb 10	68 to 74 dBA
ST-2	Northern Portion of Site Western Spot Measurement Approximately _170' south of Highway 85 centerline, 18' above ground	9:50 – 10:05 30 July 10	69 dBA
ST-3	Northern Portion of Site Eastern Spot Measurement Approximately _170' south of Highway 85 centerline, 18' above ground	9:50 – 10:05 30 July 10	68 dBA
ST-4	Mid-Site Spot Measurement Approximately 750' south of Highway 85 centerline	14:45 – 15:15 15 Feb 10	61 dBA
ST-5	Blossom Hill Road Spot Measurement Approximately 65' north of roadway centerline	15:50 – 16:05 15 Feb 10	70 dBA

Reoccurring maximum noise levels at the long-term monitor along Blossom Hill Road were as high as 101 dBA, due to vehicles and sirens. For reference, estimated typical maximum sound levels at the setback of homes nearest the roadway is 92 dBA.[3] In the northern portion of the site, maximum noise levels at the long-term monitor were in the range of 80 to 82 dBA due to vehicles and aircraft. Due to decreased shielding from the highway noise barrier, maximum noise levels at the second and third-story levels are estimated to be at least 4 and 6-decibels higher, respectively, from vehicles on Highway 85.

As described above, a VTA transformer station is located adjacent to the northwestern portion of the site. While transformer noise was not measurable above transportation sources during on-site measurements, noise may be audible at the nearest residences when traffic noise is low.

Future Noise Environment

- The San Jose Department of Transportation forecasts that peak-hour traffic volumes on Blossom Hill Road will increase from 1,900 to 2,700, or by approximately 42-percent, by the year 2020.[4] This corresponds with approximately a 1 to 2-decibel increase in environmental noise. The City does not provide forecast traffic volumes for Highway 85. In the absence of published data, this assessment assumes a similar increase in environmental noise across the site.

[3] Greene, Rob, "Max Level Intrusive Noise Limit", 1982 National Conference on Environmental and Occupational Noise. Typical maximum is the L_{max30}, obtained by logarithmically averaging the loudest 30-percent of maximum sound levels for 1-hour intervals. The estimated level includes a distance adjustment, assuming the source is in the center of the near lanes of traffic.
[4] Fax Transmittal from the City of San Jose Department of Transportation, 5 February 2010.

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- The VTA is in the process of developing a long-range (more than five years out) plan for Light Rail train schedules in the project vicinity. While long-range plans are not known at this time, they do not expect train volumes to change significantly in the next five years.[5] In the absence of additional forecasts, this assessment assumes that train volumes will not increase significantly in the foreseeable future.

- Estimated future noise levels, in terms of DNL, are summarized in Figure 1, attached.

Ground-Borne Vibration due to Rail

On 15 February 2010, ground-borne vibration was measured at the existing site grade, at distances of approximately 130 feet and farther from the VTA Light Rail tracks in the center of Highway 85. Measurements consisted of two northbound and four southbound trains. Measured vibration levels were all below the 72 VdB guideline for frequent train events at residences. Therefore, while train vibration may be perceptible at the nearest residences, no mitigation is required to comply with the FTA Guidelines. The developer should include highway noise and VTA Light Rail noise and vibration in its disclosures to buyers.

ANALYSIS AND RECOMMENDATIONS

Environmental Noise

As shown in Figure 1 attached, estimated future environmental noise at the site will range from approximately DNL 76 dBA or higher at the third-story of residences in the northern portion of the site nearest to Highway 85, to DNL 60 dBA in the center portion of the site, to DNL 72 dBA at residences along Blossom Hill Road. Residences must be designed to reduce environmental noise to DNL 45 dBA or lower indoors. Outdoor use space should be located in "acoustically protected areas". Consider the following:

1. Use sound-rated windows, doors, and exterior wall assemblies to reduce interior noise from outdoor sources to the DNL 45 dBA criterion.
   a. Assuming a typical room size of 12 feet by 14 feet, with approximately 33-percent window on one or two exterior façades, and exterior walls consisting of 3-coat stucco over wood sheeting, insulation in stud cavities, and at least 2-layers of gypsum board on the interior, preliminary calculations suggest that sound insulation ratings in the range of STC 39 to 42 or higher may be needed at residences in the northern portion of the site nearest to Highway 85, and sound insulation ratings in the range of STC 32 to 35 may be needed in residences along Blossom Hill Road.
   b. Sound insulation ratings will decrease towards the middle of the site, where typical dual-pane construction-grade windows will likely suffice, without specific higher STC ratings. For reference, typical dual-pane construction grade windows and sliding glass doors have sound insulation ratings in the range of STC 26 to 28.
   c. Window and door sound insulation ratings must be for the complete assemblies, including frames and operable sashes. Sound insulation ratings should be from

[5] Telephone correspondence with Eric Rosenberg of the Valley Transportation Authority, 5 March 2010.

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tests conducted by an NVLAP accredited laboratory. For reference, sound insulation ratings of up to STC 36 can typically be achieved using high quality insulated windows with glazing selected to meet the required ratings. Sound insulation ratings between STC 36 and 39 can be achieved by some specialty window manufacturers by using 1-inch or 1-½ inch glazing sections. Ratings above STC 39 typically require dual sash or "four track" windows with frames that are 5 to 6 inches deep.

d. Specific details and sound insulation ratings must be determined during the design phase, when the site, grading and floor plans, and exterior elevations have been developed. The height of the Highway noise barrier should be determined, and an acoustical consultant should review this and drawings during the design phase to determine appropriate noise mitigation measures.

e. Dual pane windows and doors with equal glass thicknesses can have resonances that result in audible tones indoors. Acoustical test reports of all sound rated windows and doors should be reviewed by an acoustical consultant, and compared with traffic noise spectrums, prior to approval.

2. The City does not currently limit maximum noise levels from instantaneous sources such as emergency sirens and vehicles. Designing the building shell to achieve the interior DNL goal described above would result in calculated maximum noise levels in the range of 55 to 67 dBA, or higher, in residences nearest to Highway 85 and Blossom Hill Road.

   a. Achieving the maximum noise level criteria adopted by some cities (L_{max} 50 dB in bedrooms and 55 dBA in other rooms) may require double-stud exterior walls with added layers of gypsum board, and windows with sound insulation ratings in the range of STC 40 to 52. For reference, windows with STC ratings of 50 are not common. If feasible, avoid locating bedrooms with a direct line-of-sight to Blossom Hill Road, as this would decrease necessary STC ratings.

   b. Consider undertaking an exercise during the design phase to clearly define achievable and measurable goals for maximum instantaneous noise levels inside residences.

3. Similar to what would be required by the California Building Code for multi-family housing, consider providing a "ventilation or air conditioning system to provide a habitable interior environment", since windows will need to be closed to meet the indoor noise criterion.

4. Outdoor noise levels will vary, depending on the location and orientation of homes.

   a. In the middle and northern portions of the site, the existing highway noise barrier reduces estimated future noise levels in private yards to between approximately DNL 60 and 68 dBA. Further reducing these levels would require increasing the height of the noise barrier.

   b. Along Blossom Hill Road, preliminary calculations suggest that noise barriers in the range of 10 to 12 feet tall will be needed to reduce vehicle noise to DNL 60 dBA or lower in private yards. For reference, noise barriers in the range of 7 or 8 feet tall would reduce calculated levels to DNL 65 dBA or lower.

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c. In the southern portion of the site not directly along Blossom Hill Road, shielding from the future houses will reduce estimated future noise levels to between DNL 60 and 65 dBA in private yards.

d. Noise barrier heights and details should be determined during the design phase, when the site and grading plans have been developed. Effective barriers must be solid from bottom to top with no cracks or gaps, and a minimum surface density of approximately three pounds per square foot.

5. The residences in the northwestern portion of the site will be located adjacent to the existing VTA transformer station. Future residents should be aware that they may occasionally hear tonal noise from the transformer station, particularly at the quietest times of the day or night.

Project Generated Traffic Noise

Traffic volume data provided by Hexagon Traffic Consultants, received 11 March 2010, indicates the proposed project would generate an additional 795 daily vehicle trips in and out of the site. Vehicles are expected to access the site via Cahalan Avenue, Southcrest Way, and Chesbro Avenue. Calculations suggest that the additional traffic will increase DNL along Cahalan and Chesbro Avenues by approximately 1-decibel or less, which is a less-than-significant increase. Existing and forecast traffic volumes are not available for Southcrest Way. However, since environmental noise is dominated by distant traffic, DNL is not expected to increase significantly along this roadway.

Stationary Noise Sources

Stationary noise sources associated with the project are expected to consist of mechanical equipment such as air-conditioning units. Units should be selected and located to meet the City's Zoning Ordinance limit of 55 dBA at residential property lines. If needed, additional mitigation measures may consist of equipment barriers and/or enclosures. Details should be determined during the design phase.

Construction Noise

Noise levels from construction activities will vary significantly, depending on the type of equipment being used, the process, and the location. In general, the potential impact of a particular construction activity is also dependent on the fraction of time the equipment is operated over the construction period. Construction activity noise is generally stationary, such as generators or compressors, or mobile, such as trucks, excavators, cutting and welding tools, pneumatic tools, etc.

Construction activities that are expected to generate the highest noise levels include grading, concrete work and framing, where heavy equipment may be used. The site is currently vacant; therefore demolition and/or concrete crushing will not be needed. Construction will not include the use of pile driving. The nearest sensitive receivers are the adjacent one and two-story residences to the east and west of the site. While most residences appear to be farther than 50 feet from the site, the nearest appear to be approximately 20 to 40 feet from the western edge, and within approximately 10 feet of the northeast corner, of the site.

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Table 5 lists typical noise levels for various construction equipment, at a reference distance of 50 feet. For reference, corresponding noise levels at 25 feet would be approximately 6-decibels higher.

Table 3 – Summary of Typical Construction Equipment Noise Levels.

Equipment	Typical Sound Level 50' from source
Air Compressors	81 dBA
Backhoe	80 dBA
Concrete Mixer	85 dBA
Concrete Pump	82 dBA
Dozer	85 dBA
Generator	81 dBA
Grader	85 dBA
Loader	85 dBA
Paver	89 dBA
Pneumatic Tool	85 dBA
Saw	76 dBA
Truck	88 dBA
Table 12 -1: Construction Equipment Noise Emission Levels, Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.	

The project is expected to be built-out over a period of two to three years. Homes will be built in groups, or "pods", with construction times of approximately 6-months or less. Pods should be built to help shield adjacent residences from on-going construction activities. Therefore, the loudest construction activities are expected to occur at adjacent off-site residences for periods of 6-months or less (or up to 12-months if the adjacent residence is located between two pods). Consistent with City of San Jose goals, the following measures are intended to reduce the impact of general construction noise on neighbors.

1. Construction will be limited to the hours of 7:00 a.m. to 7:00 p.m. Monday through Friday for any on-site or off-site work within 500 feet of any residential unit. Construction outside of these hours may be approved through a development permit based on a site-specific construction noise mitigation plan and a finding by the Director of Planning, Building and Code Enforcement that the construction noise mitigation plan is adequate to prevent noise disturbance of affected residential uses.

2. The contractor shall use "new technology" power construction equipment with state-of-the-art noise shielding and muffling devices. All internal combustion engines used on the project site shall be equipped with adequate mufflers and shall be in good mechanical condition to minimize noise created by faulty or poor maintained engines or other components.

3. Locate stationary noise generating equipment as far as possible from sensitive receptors. Staging areas shall be located as close as feasible to the City's goal of at least 200 feet from noise sensitive receptors, such as residential uses.

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4. Prohibit unnecessary idling of internal combustion engines.

5. Designate a "noise disturbance coordinator" who would be responsible for responding to any local complaints about construction noise. The disturbance coordinator would determine the cause of the noise complaints (e.g., beginning work too early, bad muffler, etc.) and institute reasonable measures warranted to correct the problem. A telephone number for the disturbance coordinator would be conspicuously posted at the construction site.

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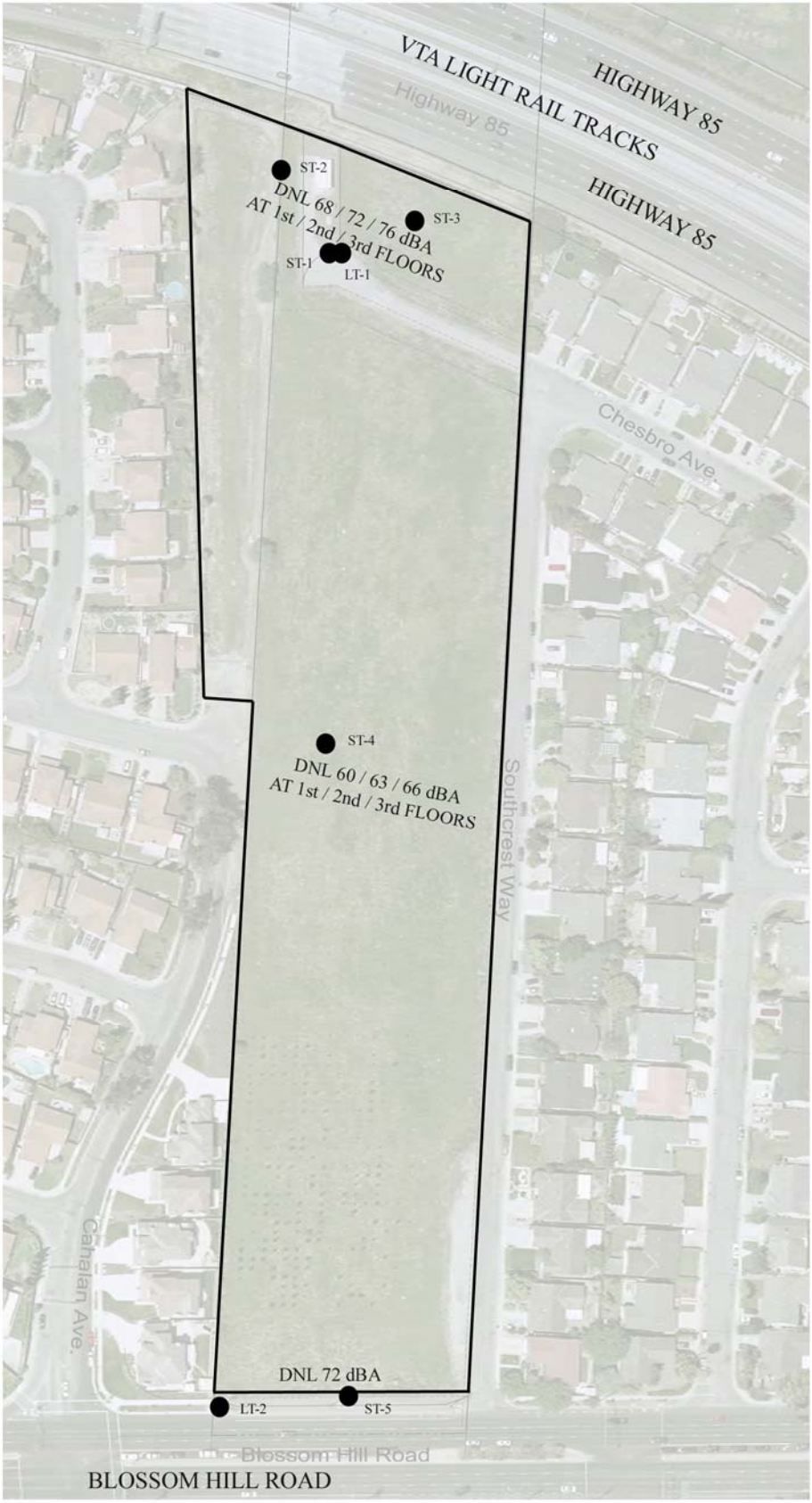

NOTES: ESTIMATED FUTURE NOISE LEVELS AT APPROXIMATELY 8' / 18' / 28' ABOVE GRADE FOR 1st / 2nd / 3rd FLOORS HIGHWAY NOISE BARRIER ELEVATION AND ENVIRONMENTAL NOISE LEVELS TO BE CONFIRMED DURING THE DESIGN PHASE
AERIAL PHOTO PROVIDED BY OTHERS; NOT TO SCALE
● INDICATES APPROXIMATE NOISE MEASUREMENT LOCATION

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LESTER SITE
NOISE MEASUREMENT LOCATIONS AND ESTIMATED FUTURE NOISE LEVELS

FIGURE 1

Project No. 10-0056
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APPENDIX A

FUNDAMENTAL CONCEPTS OF ENVIRONMENTAL NOISE

This section provides background information to aid in understanding the technical aspects of this report.

Three dimensions of environmental noise are important in determining subjective response. These are:

a) The intensity or level of the sound;
b) The frequency spectrum of the sound; and
c) The time-varying character of the sound.

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound levels are usually measured and expressed in decibels (dB), with 0 dB corresponding roughly to the threshold of hearing.

The "frequency" of a sound refers to the number of complete pressure fluctuations per second in the sound. The unit of measurement is the cycle per second (cps) or hertz (Hz). Most of the sounds which we hear in the environment do not consist of a single frequency, but of a broad band of frequencies, differing in level. The name of the frequency and level content of a sound is its sound spectrum. A sound spectrum for engineering purposes is typically described in terms of octave bands, which separate the audible frequency range (for human beings, from about 20 to 20,000 Hz) into ten segments.

Many rating methods have been devised to permit comparisons of sounds having quite different spectra. Surprisingly, the simplest method correlates with human response practically as well as the more complex methods. This method consists of evaluating all of the frequencies of a sound in accordance with a weighting that progressively de-emphasizes the importance of frequency components below 1000 Hz and above 5000 Hz. This frequency weighting reflects the fact that human hearing is less sensitive at low frequencies and at extreme high frequencies relative to the mid-range.

The weighting system described above is called "A"-weighting, and the level so measured is called the "A-weighted sound level" or "A-weighted noise level." The unit of A-weighted sound level is sometimes abbreviated "dBA." In practice, the sound level is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting characteristic. All U.S. and international standard sound level meters include such a filter.

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Although a single sound level value may adequately describe environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise is a conglomeration of distant noise sources, which results in a relatively steady background noise having no identifiable source. These distant sources may include traffic, wind in trees, industrial activities, etc. and are relatively constant from moment to moment. As natural forces change or as human activity follows its daily cycle, the sound level may vary slowly from hour to hour. Superimposed on this slowly varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities such as single vehicle passbys, aircraft flyovers, etc. which cause the environmental noise level to vary from instant to instant.

To describe the time-varying character of environmental noise, statistical noise descriptors were developed. "L_{10}" is the A-weighted sound level equaled or exceeded during 10 percent of a stated time period. The L_{10} is considered a good measure of the maximum sound levels caused by discrete noise events. "L_{50}" is the A-weighted sound level that is equaled or exceeded 50 percent of a stated time period; it represents the median sound level. The "L_{90}" is the A-weighted sound level equaled or exceeded during 90 percent of a stated time period and is used to describe the background noise.

As it is often cumbersome to quantify the noise environment with a set of statistical descriptors, a single number called the average sound level or "L_{eq}" is now widely used. The term "L_{eq}" originated from the concept of a so-called equivalent sound level which contains the same acoustical energy as a varying sound level during the same time period. In simple but accurate technical language, the L_{eq} is the average A-weighted sound level in a stated time period. The L_{eq} is particularly useful in describing the subjective change in an environment where the source of noise remains the same but there is change in the level of activity. Widening roads and/or increasing traffic are examples of this kind of situation.

In determining the daily measure of environmental noise, it is important to account for the different response of people to daytime and nighttime noise. During the nighttime, exterior background noise levels are generally lower than in the daytime; however, most household noise also decreases at night, thus exterior noise intrusions again become noticeable. Further, most people trying to sleep at night are more sensitive to noise.

To account for human sensitivity to nighttime noise levels, a special descriptor was developed. The descriptor is called the DNL (Day/Night Average Sound Level), which represents the 24-hour average sound level with a penalty for noise occurring at night.

The DNL computation divides the 24-hour day into two periods: daytime (7:00 am to 10:00 pm); and nighttime (10:00 pm to 7:00 am). The nighttime sound levels are assigned a 10 dB penalty prior to averaging with daytime hourly sound levels. For highway noise environments, the average noise level during the peak hour traffic volume is approximately equal to the DNL.

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The effects of noise on people can be listed in three general categories:

a) Subjective effects of annoyance, nuisance, dissatisfaction;
b) Interference with activities such as speech, sleep, and learning; and
c) Physiological effects such as startle, hearing loss.

The sound levels associated with environmental noise usually produce effects only in the first two categories. Unfortunately, there has never been a completely predictable measure for the subjective effects of noise nor of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individual thresholds of annoyance and habituation to noise over time.

Thus, an important factor in assessing a person's subjective reaction is to compare the new noise environment to the existing noise environment. In general, the more a new noise exceeds the existing, the less acceptable the new noise will be judged.

With regard to increases in noise level, knowledge of the following relationships will be helpful in understanding the quantitative sections of this report:

a) Except in carefully controlled laboratory experiments, a change of only 1 dB in sound level cannot be perceived.

b) Outside of the laboratory, a 3 dB change is considered a just-noticeable difference.

c) A change in level of at least 5 dB is required before any noticeable change in community response would be expected.

d) A 10 dB change is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse community response.

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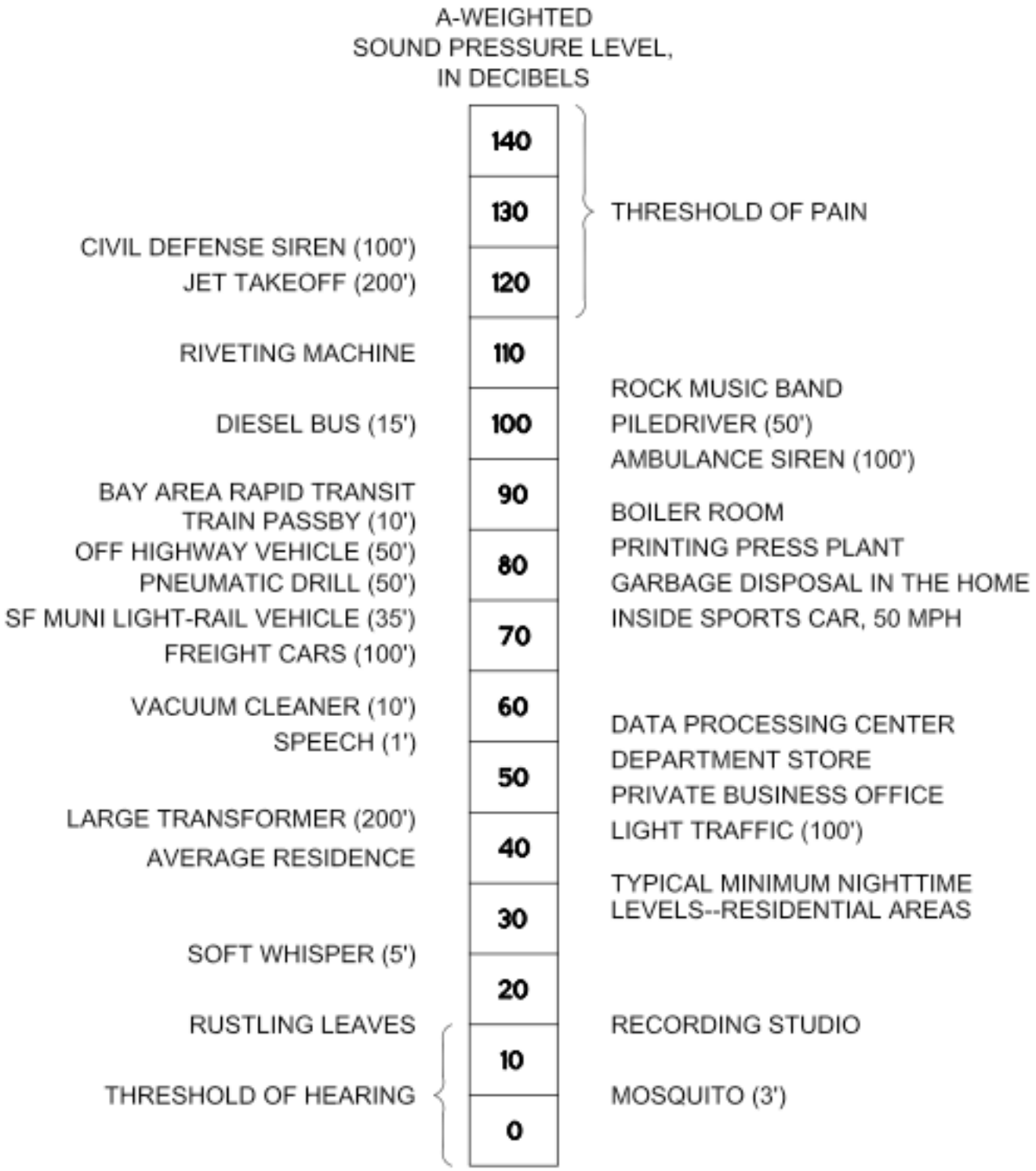

(100') = DISTANCE IN FEET BETWEEN SOURCE AND LISTENER

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TYPICAL SOUND LEVELS MEASURED IN THE ENVIRONMENT AND INDUSTRY

FIGURE 2

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