FOX PROPERTY PLANNED DEVELOPMENT REZONING
DRAFT ENVIRONMENTAL NOISE AND GROUND-BORNE VIBRATION ASSESSMENT
SAN JOSE, CALIFORNIA

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Prepared for:

DAVID J. POWERS & ASSOCIATES, INC
Will Burns, AICP
1871 The Alameda, Suite 200
San Jose, CA 95126
Phone: (408) 248-3500
Email: wburns@davidjpowers.com

Prepared by:

CHARLES M. SALTER ASSOCIATES, INC.
Joshua M. Roper, LEED AP
Philip N. Sanders, LEED AP
2033 Gateway Place, Suite 600
San Jose, CA 95110
Phone: (408) 295-4944
Email: josh.roper@cmsalter.com
Email: philip.sanders@cmsalter.com

CSA Project No. 10-0053

INTRODUCTION

This report summarizes our environmental noise and ground-borne vibration assessment for the proposed rezoning of a 27-acre property located southeast of the intersection of Brokaw Road and Oakland Road in San Jose, California. The purpose of this study is to quantify the noise environment, and ground-borne vibration due to rail, and compare these with applicable standards for residential and commercial 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 in dwelling units and commercial spaces 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 and ground-borne vibration from trains are potentially significant issues. Access roads, landscaped areas, and non-sensitive uses should be used as buffers between the rail line and residential uses. Additional noise reduction measures may include barrier walls and/or berms, and sound rated walls windows and doors.
3. Since residential windows will need to be closed to achieve the interior noise criterion, the CBC requires a "ventilation or air-conditioning system to provide a habitable interior environment."
4. Outdoor noise levels in the Open Space/Park will exceed the City's goal of DNL 60 dBA. Physical berms or barriers can be used to reduce noise levels. However, achieving DNL 60 dBA may not be feasible. Common open space should be located in shielded areas interior to the site for noise levels to be close to the DNL 60 dBA goal. Outdoor noise levels in other, shielded, portions of the site should be evaluated in greater detail when the site plan is developed.
5. Noise from mechanical equipment must meet the City's Zoning Ordinance requirements and General Plan goals. This should be evaluated in detail when equipment types, locations, and sizes are selected.
6. Traffic increases associated with the project are not expected to significantly affect environmental noise levels.
7. Construction noise should be addressed by following the City of San Jose guidelines, as described below.

DESCRIPTION

The 29.9-acre project site is currently designated Neighborhood/Community Commercial and High Density Residential. The project proposes a land use designation change to Mixed-Use with No Underlying Land Use Designation, with planned development as follows:

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- Commercial uses on 13.7-acres in the northern portion of the site with a maximum building height of 50 feet and up to three stories. Minimum planned setbacks are 10 feet (assumed from all property lines and the planned residential).
- Residential uses on 12.7-acres in the southern portion of the site, consisting of between 254 and 650 residential units. Buildings will be between 50 and 75 feet tall with a minimum of three stories and maximum of five stories over parking. Minimum planned setbacks are 10 feet from the commercial space and railroad right-of-way, and 15 feet from the Oakland Road property line.
- A 1-acre park, most likely located mid-site along Oakland Road.
- 2.5-acres of Open Space/Riparian Area in the southern-most portion of the site adjacent to Coyote Creek.

The site is bordered by Brokaw Road on the north, a Union Pacific Railroad (UPRR) right-of-way on the west, Oakland Road on the east, and Shallenberger Road across Coyote Creek to the south. An actively used railroad track is located in the UPRR right-of-way. Interstate 880 is located approximately ¼-mile to the west, and US-101 is located over 1-mile to the south. Mineta San Jose International Airport is over 1 ½-miles west of the site, which is well outside the CNEL 65 dB airport noise contour. Surrounding land uses include office, commercial, industrial, residential, and a golf course.

APPLICABLE CRITERIA

The City of San Jose General Plan, the City of San Jose Municipal Code, the California Building Code, and the Federal Transit Administration provide applicable noise and vibration guidelines for the project.

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 and commercial land uses.

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

DNL Value in Decibels		Compatibility Level
Residential, Parks & Playgrounds	Commercial	
60 dB or less		Satisfactory
60 to 70 dB	60 to 76 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	Greater than 76 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.

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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." Policy 11 states, "When located adjacent to existing or planned noise sensitive residential and public/quasi-public land uses, non-residential land uses should mitigate noise generation to meet the 55 DNL guideline at the property line."

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. Noise from air-conditioning or other mechanical equipment is limited to a maximum of 55 dB at residential property lines, and 60 dB at commercial property lines.

California Building Code (CBC)

The California Building Code (CBC) includes acoustical requirements for interior sound levels in habitable rooms of multi-family housing[1]. In summary, the CBC limits interior noise levels to DNL 45 dB or lower due to exterior sources. Projects exposed to an exterior DNL greater than 60 dB require an acoustical analysis during the design phase showing that the proposed design will limit exterior noise to the prescribed allowable interior level. Additionally, if windows must be closed to meet the interior standard, "the design for the structure must also specify a ventilation or air-conditioning system to provide a habitable interior environment."

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. 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. Following is a summary of the guidelines.

- Frequent Events (more than 70 per day) – 72 VdB[2]
- Occasional Events (30 to 70 per day) – 75 VdB

[1] 2007 California Building Code, California Code of Regulations, Title 24, Part 2, Volume 1 of 2, Section 1207: Sound Transmission
[2] RMS Vibration Velocity Level in VdB relative to 10^{-6} inches/second.

DRAFT

- Infrequent Events (fewer than 30 per day) – 80 VdB

The document also states: "One of the problems in developing suitable criteria for ground-borne vibration is that there has been relatively little research into human response to vibration, in particular, human response to vibration in buildings." For reference, the document identifies the threshold of perception for humans to be around 65 VdB. This analysis assumes that commercial uses will not include vibration-sensitive equipment.

Single-Event Noise Levels.

Neither the City of San Jose nor the State of California specifically regulates maximum instantaneous interior noise levels from singe-events outdoors, such as trains or traffic. However, because of its potential effects on sleep, and because of the site's proximity to an active railroad right-of-way, this report discusses the potential impact of noise from individual train horns.

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.

NOISE ENVIRONMENT

The major sources of environmental noise at the site include vehicle traffic on Oakland Road to the east, Brokaw Road to the north, I-880 to the west, and freight trains on the adjacent tracks. To quantify the existing noise environment, short (15-minute) and long-term (multi-day) measurements were conducted between the 19th and 20th of January 2006, and between the 16th and 22nd of February 2010. The short-term measurements were compared with corresponding time periods of the long-term monitors to determine how noise levels vary across the site.

Day/Night Average Sound Levels (DNL)

Table 2 below summarizes existing noise levels, in terms of DNL, at the site. Environmental noise levels vary significantly in the western portion of the site, depending on the number of trains passing the site, and the location and duration that train horns are used. Approximate measurement locations are indicated in Figure 1, attached.

DRAFT

Table 2: Existing Noise Environment in DNL

Site	Location	Time / Date	DNL
M1	Brokaw Road Monitor Approximately 100' south of roadway centerline, 40' east of UPRR track	19th to 20th January 2006	72 dBA
	Brokaw Road Monitor Approximately 145' south of roadway centerline, 30' east of UPRR track	16th to 22nd February 2010	69 to 73 dBA
M2	Oakland Road Monitor Approximately 75' west of roadway centerline	16th to 18th February 2010	72 dBA
M3	Oakland Road Monitor Approximately 50' west of roadway centerline	19th to 20th January 2006	74 dBA
M4	Northwestern Monitor Approximately 450' south of Brokaw Road centerline, 160' east of UPRR track	17th to 22nd February 2010	59 to 65 dBA
S1	Corner of Brokaw Road and Oakland Road Spot Approximately 100' south of Brokaw Road centerline, 150' east of Oakland Road centerline	10:00 – 10:15 19 January 2006	70 dBA
S2	Oakland Road Spot Approximately 100' west of roadway centerline	10:30 – 10:45 19 January 2006	69 dBA
S3	Northern Mid-Site Spot Approximately 600' west of Oakland Road centerline, 650' south of Brokaw Road centerline	10:45 – 11:00 20 January 2006	58 to 60 dBA
S4	Southern Mid-Site Spot Approximately 300' east of UPRR track	11:15 – 11:30 19 January 2006	59 to 62 dBA
S5	Western Property Line Spot Approximately 60' east of UPRR track	11:15 – 11:30 19 January 2006	60 to 66 dBA

The San Jose Department of Transportation forecasts that traffic volumes on Brokaw Road and Oakland Road will increase by approximately 12 and 122-percent, respectively, by the year 2020.[3] This corresponds with approximately a 1 to 4-decibel increase in environmental noise from these local roadways. This assessment assumes that train activity on the adjacent UPRR track will not change significantly in the future.

Estimated future noise levels around the perimeter of the site are shown in Figure 2, attached, and are the basis of the noise mitigation recommendations in the Analysis and Recommendations section of this report. Future noise levels interior to the site will depend on the size, location, orientation, and the amount of acoustical shielding provided by future buildings on-site, and should be determined when a site plan is developed.

Single-Event Noise Levels

The loudest instantaneous noise levels measured at the site were generated by train horns. These noise levels vary significantly, depending on the location of the train when the horn is blown, as well as the receiver location with respect to the track. Long-term noise monitors recorded audio-samples when maximum levels exceeded preset thresholds. Following is a summary of measured single-event noise levels from train horns, based on the measurement data and audio samples:

[3] Fax Transmittal from the City of San Jose Department of Transportation, 5 February 2010.

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- Two to three trains passed the site each weekday, between 8:00 AM and 2:00 PM
- Maximum noise levels from train horns were as loud as 108 dBA approximately 30 feet east of the UPRR track, and 103 dBA at a distance of approximately 160 feet
- Calculations suggest that train horn noise could be 115 dBA, or louder, along the western property line if trains blow their horns while passing the site.

GROUND-BORNE VIBRATION DUE TO RAIL

On 24 January 2006, ground-borne vibration measurements were conducted at the site, at the existing site grade, at distances of approximately 50, 100 and 200 feet from the track. During these measurements, one train passed the site in the southbound direction at approximately 11:15 AM. The train consisted of two engines and eleven freight cars, traveling at an estimated speed of 15 miles per hour. Table 3 below summarizes measured vibration levels.

Table 3: Measured and Estimated Future Ground-Borne Vibration Levels

24 January 2006 Southbound Freight Train	Maximum Measured Ground-Borne Vibration – Trains Traveling Approximately 15 MPH (VdB re: 1 micro-inch/second)	Estimated Maximum Ground-Borne Vibration for Trains Traveling Approximately 30 MPH
50 feet east of UPRR track	77 VdB	83 VdB
100 feet east of UPRR track	75 VdB	81 VdB
200 feet east of UPRR track	71 VdB	77 VdB

During the time of measurements, it was observed that some maintenance work was being performed on the tracks in the project vicinity. If trains typically pass the site at a faster speed, corresponding vibration levels are expected to increase accordingly. Based on the FTA Guidelines, increasing train speed from 15 to 30 miles per hour might increase ground-borne vibration by approximately 6 VdB.

ANALYSIS AND RECOMMENDATIONS

Environmental Noise

Estimated future environmental noise levels at the site, at the approximate setbacks shown in the Description section above, range from DNL 76 dBA in the northeastern corner adjacent to Brokaw Road and Oakland Road to DNL 64 dBA or lower in the southern portion of the site nearest to Coyote Creek. Noise levels in the western portion of the site will vary, depending on the location and frequency when trains blow their horns. The owner and design team should consider the proximity of sensitive land uses, including residences, to the UPRR right-of-way and local roadways when developing the site plan.

1. Future noise levels interior to the site will depend on the amount of acoustical shielding provided by new buildings. Estimated future noise levels should be evaluated in detail when the site plan is developed. These future noise level estimates should then be used as the basis for selecting windows and doors, designing noise barriers, etc.

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2. Use sound-rated windows, doors and exterior wall assemblies in commercial buildings to reduce interior noise to the General Plan goal of DNL 45 dBA or lower. Building shell assemblies will need to provide noise reduction of up to 31-decibels. Specific ratings must be determined during the design phase based on building locations and orientations, room sizes, and window sizes.

3. It may not be feasible to reduce noise levels in the Open Space/Park to the City's goal of DNL 60 dBA or lower along Oakland Road. Noise levels could be reduced by installing a natural berm, solid barrier, or a combination of both along Oakland Road. For reference, an 8-foot high barrier could reduce noise levels by as much as 10 dBA for a seated person in the eastern portion of the space. The resulting calculated noise level is between 60 and 65 dBA, which exceeds the 60 dBA goal in the General Plan.

   If lower noise levels are desired, the space should be moved to the interior of the site where it can be shielded from adjacent roadways.

4. Use sound-rated windows, doors, and exterior wall assemblies to reduce interior noise from outdoor sources to the DNL 45 dBA criterion in residences.

   a. Assuming a typical room size of 12 feet by 14 feet, with two 3-foot by 5-foot windows, preliminary calculations suggest that sound insulation ratings in the range of STC 35 to 37 may be needed at units along Oakland Road. Windows with sound insulation ratings in this range are available from common manufacturers, such as Milgard.

   b. In the interior shielded portions of the site, typical dual-pane construction-grade windows will likely suffice, without specific higher STC ratings.

   c. Specific ratings and assemblies must be determined during the design phase.

5. While not a City or State requirement, the owner should consider maximum noise levels from trains and train horns when developing the site plan. Designing exterior shells to reduce interior noise levels to the DNL 45 dBA criterion could result in train whistle levels exceeding 90 dBA inside dwelling units facing the railroad tracks. Achieving maximum noise levels of 50 dBA in sleeping rooms and 55 dBA in other living spaces may not be feasible using standard construction methods. Following are some initial suggestions for reducing train noise intrusion. Specific achievable and measurable noise goals and noise reduction measures should be developed during the design phase:

   a. Locate commercial buildings as buffers between residences and the UPRR track. By increasing the distance between railroad tracks and residential buildings, this would also help reduce vibration levels in residences.

   b. Avoid locating sleeping rooms with a line-of-sight to the UPRR track.

   c. Depending on the location and exposure to the UPRR track, shell assemblies of residential buildings may need to include double-stud exterior walls with added layers of gypsum board, and windows with sound insulation ratings in the range of STC 44 to 50 or higher. While some residential dual-sash operable windows are available with sound insulation ratings in the range of STC 44 to 46, windows with higher sound insulation ratings (e.g., STC 50) are not common.

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d. Noise barriers may be effective at reducing noise levels for ground-floor receivers, however would have little or no effect for second-floor units and above in podium buildings.

e. Prospective residents should be advised of the presence of high noise levels and possible perceptible vibration from trains.

6. The entire site is exposed to exterior DNL greater than 60 dB. Therefore, multi-family residential projects on the site will require an acoustical analysis to show how the proposed design will limit exterior noise to DNL 45 dBA or lower indoors. In addition, attached residences will require a "ventilation or an air-conditioning system to provide a habitable interior environment." The system must not compromise noise insulation of exterior wall assemblies.

Project Generated Traffic Noise

Traffic volume data provided by Hexagon Traffic Consultants, received 24 February 2010, indicates the proposed project would generate an additional 258 to 369 peak-hour vehicle trips in and out of the site. Based on the existing and forecast traffic volumes along Brokaw Road and Oakland Road, this would increase environmental noise by less than 1-decibel, which is a less-than-significant increase.

Mechanical Equipment (associated with the project)

Mechanical equipment associated with the project is expected to include rooftop heating, ventilation, and air-conditioning units on the commercial buildings, and residential air-conditioning units. The project may also incorporate a mechanical treatment device for storm water drainage.

Select and locate equipment to meet the noise levels limits outlined in the Zoning Ordinance and General Plan (summarized in the Applicable Criteria section above). If needed, mitigation measures may include equipment enclosures, acoustical louvers, and/or equipment noise attenuators. Details must be determined during the design phase when equipment is selected and located.

Ground-Borne Vibration due to Rail

As described above, two to three trains passed the site each weekday during the noise measurement period. Vibration measurements were conducted at a time when it was some maintenance work was observed on the tracks in the project vicinity. If trains travel faster when work is not being preformed, vibration levels could increase by 6 VdB or more.

The minimum setback currently envisioned is ten feet from the UPRR right-of-way, or approximately 40 feet from the UPRR track. The estimated vibration level at this distance is 78 VdB if trains travel 15 MPH, or 84 VdB if trains travel 30 miles per hour. Vibration from trains traveling at the faster speed would be expected to exceed the 80 VdB FTA guideline for infrequent events. At the slower speed, vibration would not exceed the guideline, but would be perceptible in the nearest residences. Consider the following:

DRAFT

1. Increase the setback of residences from the UPRR right-of-way, by locating parking, common space, commercial buildings, etc., in this portion of the site. A setback of approximately 120 feet from the UPRR track, or 90 feet from the UPRR right-of-way, would reduce interpolated levels from a train traveling at 30 miles per hour to the FTA guideline at the nearest residences.

2. Use reasonable measures to stiffen the residential structures. For example, use deeper and stiffer joists than would otherwise be used, space the joists more closely than normal, and limit the span of unsupported floor joists to a maximum of 15-feet. These measures would reduce the potential for amplification of vibration by increasing the natural frequency of floors. A structural engineer should be consulted regarding the feasibility of these measures.

3. Conduct additional ground-borne vibration measurements at the site, to quantify ground-borne vibration levels when track work does not appear to be in progress in the project vicinity. This could be used to help determine whether additional mitigation measures are necessary.

Construction Noise

Consistent with City of San Jose goals, the following measures are intended to reduce the impact of general construction noise into 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 a minimum of 200 feet from noise sensitive receptors, such as residential uses.
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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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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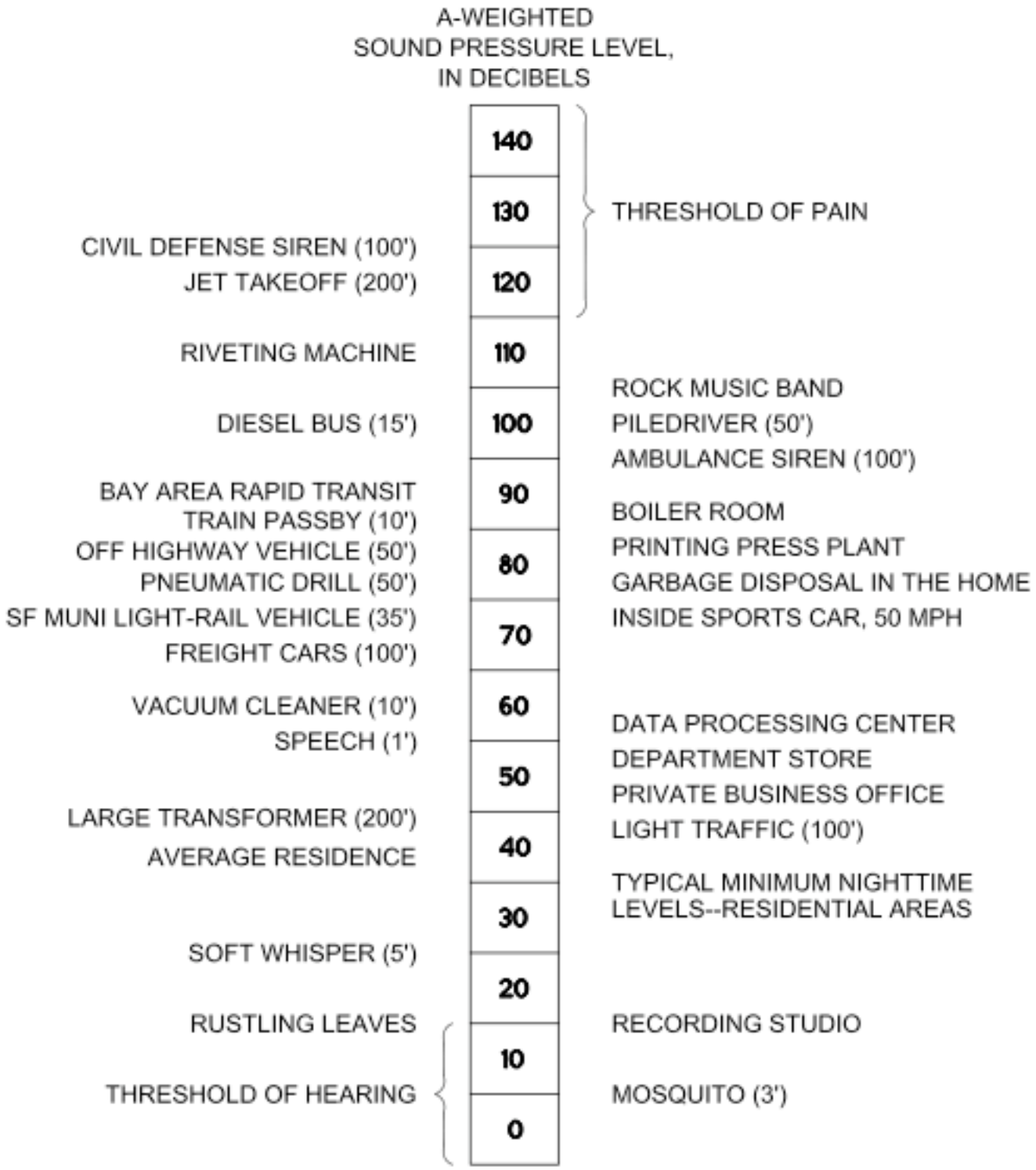

(100') = DISTANCE IN FEET BETWEEN SOURCE AND LISTENER

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TYPICAL SOUND LEVELS MEASURED IN THE ENVIRONMENT AND INDUSTRY

FIGURE 2

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Charles M Salter Associates Inc 130 Sutter Street San Francisco California 94104 Tel 415 397 0442 Fax 415 397 0454