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May 25, 2012

Mr. Tom Ruby
Morrison & Foerster
755 Page Mill Road
Palo Alto, CA 94304-1018

Subject: **Noise Study per CCR Title 24**
2090 South Delaware Place Apartments, San Mateo, California

Dear Mr. Ruby:

The enclosed report presents the results of our ambient noise survey, predicted future conditions for the project, and our acoustical design recommendations for the 111-unit, apartment development proposed for 2090 South Delaware, in San Mateo, California. The purpose of our noise study was to assess the project's exterior noise environment, which will be dominated by vehicle traffic, along with contributions from CalTrain operations, and to provide recommendations on the control of exterior-to-interior noise transmission. Recommendations are in the form of design details that will be necessary for the project's interior spaces to comply with the requirements of the California Code of Regulations (CCR) Title 24.

Very truly yours,

WILSON, IHRIG & ASSOCIATES, INC.

Pablo A. Daroux
Principal

Arun K. Mahapatra
Assistant

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NOISE STUDY

2090 SOUTH DELAWARE APARTMENTS

SAN MATEO, CALIFORNIA

1 June 2012

Submitted To:

Mr. Tom Ruby
Morrison & Foerster
755 Page Mill Road
Palo Alto, CA 94304-1018

By:

Pablo A. Daroux
Principal

Arun K. Mahapatra
Assistant

1. Introduction

Newport Equities, LLC is proposing a 111-unit, apartment development at the intersection of Pacific Boulevard and South Delaware streets in San Mateo, California. The proposed residential development includes three floors of residential units, a one level semi-subterranean parking garage, and three private courtyards over the garage.

The purpose of this noise study is to assess the exterior noise environment of the subject property and to provide recommendations on the control of exterior-to-interior noise with respect to the requirements of the California Code of Regulations (CCR), Title 24 (included in the California Building Code in Divisions IIA, Appendix Chapter 12, Section 1207 - Sound Transmission).

This report provides a description of the environmental noise survey methodology, a discussion of applicable noise standards, results of the noise survey, future noise level projections, and exterior-to-interior noise mitigation recommendations for the proposed residential development. Noise mitigation recommendations for glazing, exterior assemblies, and exterior doors are presented, along with important installation guidance.

Inter-unit noise mitigation provisions, also required by CCR Title 24, include acoustical design and installation details for party walls, corridor walls, floor-ceiling assemblies, and other components. Criteria for these sound-insulating features are presented, although specific recommendations relating to these interior items will be provided under separate cover as the project's design details are developed.

The project site's existing noise environment is dominated by CalTrain and street traffic sources, most notably traffic on South Delaware Street to the East. Traffic on the elevated Highway 92 also contributes to the background ambient noise levels but it is not a primary contributor. Pacific Boulevard had light vehicular traffic flow, hence traffic noise exposure on the west and south sides of the proposed complex are lower.

Caltrain operations and traffic on South Delaware Street are the primary sources of high instantaneous noise as measured during our 2005 site survey, with trains passing as frequently as every fifteen minutes. Measured maximum levels from passing trains ranged from 80 – 87 dBA at the proposed building façade location closest to the Caltrain line. South Delaware is a busy 4-lane street serving as a major thoroughfare for local traffic. Maximum noise levels from vehicular traffic reached 88 dBA at the proposed building façade closest to South Delaware Street.

Increases in both rail service and traffic are predicted in the San Mateo Circulation Element, citing a projected traffic volume increase from 2005 to 2030 of 15% in most local streets and a

projected traffic volume increase of 12% on local Freeways, including Highway 92. Proposed upgrades to Caltrain stations and rail service, as well as heavier commuter traffic are likely to result in an increase in rail service in the next ten years. Caltrain has plans to significantly increase the number of express trains. This study predicts a net increase in future noise levels along South Delaware Street of approximately 1-2 dB L_{dn}. throughout the site. Conditions along Pacific Boulevard (65 - 71 L_{dn} existing levels) will not change significantly, because noise levels will continue to be influenced by Caltrain as well as distant, background sources. The proposed project façade closest to South Delaware Street will experience predicted noise levels of 70 L_{dn} by 2030.

This noise study was performed according to information shown in the May 15 2012 Planning Department Resubmittal drawings for 2090 South Delaware Apartments, as prepared by Christiani Johnson Architects; traffic counts and predictions from the 2012 traffic study by Hexagon Transportation Consultants; the City of San Mateo General Plan Noise Element; the requirements of CCR Title 24; our own observations and data collected during our visits to the project site in 2005; and information obtained from the CalTrain website.

2. Applicable Noise Standards – Noise Study Criteria

All new Multi-Family housing must comply with California Code of Regulations (CCR) Title 24 – included in the California Building Code (CBC). Section 1207, "Sound Transmission" – which specifies the maximum level of interior noise due to exterior sources allowable for new residential developments. Requirements for sound transmission control between project spaces are presented in these sections. Division II of the CBC, Appendix 12 presents acoustical requirements in general terms, with more specific language provided in Division IIA of Appendix 12. CCR Title 24 also defers to local requirements if applicable. The Noise Element of the City of San Mateo General Plan specifies a maximum allowable interior noise level of 45 L_{dn} for multi-family projects which is consistent with the above policies for interior noise and also extends this requirement to new single family dwellings. The San Mateo Noise Element also states that 67 L_{dn} or less is the exterior noise goal for outdoor common areas, defined as areas intended for the use and enjoyment of residents. Note that this exterior noise goal is exceeded at the East and West ends of the project site but not at the outdoor common areas.

Noise Level Descriptors

The noise exposure at a site, measured using the Day-Night Level (L_{dn}) metric, represents the A-weighted equivalent continuous noise exposure level for a 24-hour period and includes a 10 decibel (dB) adjustment added to sound levels during nighttime hours (10:00 pm to 7:00 am). The CNEL is identical to the L_{dn} with the exception that in addition to the 10 dB penalty applied to nighttime hours, a 5 dB penalty is added to sound levels between 7 pm to 10 pm. The term "Equivalent Continuous Sound Exposure Level" (L_{eq}) refers to a decibel

level that equals the level of a steady noise containing the same total sound energy as the fluctuating community noise level for a given period of time.

The 10 dB penalty added to sound levels during the nighttime hours – and 5 dB penalty for evening hours in the case of the CNEL – is meant to account for higher sensitivity of people to noise during nighttime and evening hours, relative to the daytime. Under most conditions, the L_{dn} and CNEL are within 1 dB of each other, and either may be used for consistency with the local community noise element. However, L_{dn} is the preferred metric for implementing the acoustical standards of CCR Title 24.

The A-weighted scale, used for community noise measurements, causes the measuring instrumentation to respond to noise in a manner closely correlated with the auditory response of the average person. A-weighting is implicit in noise levels reported in terms of L_{dn} and CNEL.

More complete definitions for these and other acoustical terms can be found in the "Description of Acoustical Terms Relevant to Title 24 Projects" at the end of this report.

Interior Noise due to Exterior Sources

The CBC states that interior noise levels attributable to exterior sources should not exceed an annual L_{dn} of 45 in any habitable room. Furthermore, CCR Title 24 requires that the building be oriented, shielded, and designed to have such sound insulation that, with all exterior doors and windows in the closed position, the interior noise level attributable to exterior sources shall not exceed an annual L_{dn} of 45 in any habitable room.

CCR Title 24 requires an acoustical analysis for any new residential building located in an area where the annual L_{dn} exceeds 60. The report resulting from this analysis is required to show the topographical relationship of noise sources and dwelling sites, and state the predicted noise exposure levels at the exterior of the proposed dwelling structures, considering present and future conditions as the basis for the predictions. The report is to identify noise attenuation measures to be applied and provide an analysis demonstrating that proposed buildings could be designed to limit intruding noise to a maximum interior noise exposure of 45 L_{dn}.

Additional Airborne Sound Insulation Requirements

Section 1207 – Sound Transmission – of the CBC includes requirements related to both exterior and interior project assemblies, penetrations therein, and entry doors:

> *All walls and floor-ceiling assemblies separating dwelling units or guest rooms from each other and from public space such as interior corridors and service areas shall provide an airborne sound insulation equal to that required to meet*

STC 50 (45 if field tested). Such floor-ceilings are further required to provide impact insulation of at least IIC 50 (45 if field tested). Floor coverings used to provide the required IIC rating must be retained as a permanent part of the floor-ceiling assemblies. They may then only be replaced by another covering providing equal or greater impact insulation.

Penetrations or openings in construction assemblies for piping; electrical devises; recessed cabinets; bathtubs; soffits; or heating, ventilation or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings.

Entrance doors from interior corridors together with their perimeter seals shall have a laboratory-tested STC rating of not less than 26, and such perimeter seals shall be maintained in good operating conditions. Acoustical requirements for exterior doors must be assessed separately, based on the composite sound transmission performance of the assembly in which they are included.

Ventilation Requirements

Item 1207.12 of the CBC includes the following regarding ventilation of dwellings:

If interior allowable noise levels are met by requiring that windows be unopenable or closed, the design for the structure must also specify a ventilation or air-conditioning system to provide a habitable interior environment. The ventilation system must not compromise the dwelling unit or guest room noise reduction.

3. Environmental Noise & Vibration Survey Methodology

The Environmental Noise Survey consisted of both short-term noise recordings and long-term noise measurements at several locations in the project vicinity. Table 1 summarizes the noise measurement locations, with distances to adjacent sources and the types of measurements performed at each. Figure 1 shows the relative position of measurement locations for this noise study on a plan, which includes the proposed project footprint, the Caltrain rail line as well as South Delaware Street and Pacific Boulevard.

Long-Term Measurements

Long-term, statistical noise levels were measured at the site by means of four precision, calibrated, Type I logging sound level meters left unattended at the site to monitor complete days between Thursday, November 17, and Tues, November 22, 2005. These long-term meters were placed at the locations indicated in Table I and Figure 1, where they were secured to light poles.

Microphone heights were approximately 15 ft above grade in this mounting arrangement. The sound meters monitored noise levels continuously during the survey period, providing hourly-averaged and statistical noise levels over four complete days at the four locations. The hourly equivalent noise data (L_{eq}) were then used to calculate the daily and typical Day-Night Levels (L_{dn}), as required by CCR Title 24.

Short-term and "Delta" Measurements

At Short-Term locations #1A and #1B, calibrated, digital audio tape (DAT) recordings were made simultaneously at microphone heights of 15ft above grade to determine what, if any, additional reduction of the noise exposure will be received by the project's closest units compared to the exposure at the property line. At least six CalTrains (Northbound and Southbound passenger trains) were recorded at each location. "Delta" refers to the difference in noise levels, if any, between two microphone locations. Delta measurement data were also used to determine relative noise level differences between two locations on the site and to predict the reduction of noise with increasing distance from the rail line.

One additional recording was made at Short-Term #2 adjacent to South Delaware Street at a 5 ft microphone height, approximately 10 minutes in duration, to record typical daytime noise levels from traffic on South Delaware Street.

Vibration Measurements

Simultaneous short term vibration from passing rail cars was recorded at locations #1B and #1C using digital audio tape (DAT). These ground vibration recordings were made using accelerometers at grade. These samples were analyzed to determine maximum ground vibration levels where the proposed apartments will be located as well as the approximate energy reduction of vibration with increasing distance away from the rail line. At least six CalTrains (Northbound and Southbound passenger trains) were recorded at each location.

Table 1: Environmental Survey Measurement Locations

Location Label*	Microphone Height (Above Grade)	Distance From Street	Distance From Caltrain *	Measurement
L1	15 ft	13 ft – from curb (Pacific Boulevard)	75 ft	Long Term Noise Levels
L2	15 ft	13 ft – from curb (South Delaware)	(shielded by existing building)	Long Term Noise Levels
L3	15 ft	13 ft – from curb (Pacific Boulevard)	150 ft	Long Term Noise Levels
L4	15 ft	13 ft – from curb (Pacific Boulevard)	250	Long Term Noise Levels

Location Label*	Microphone Height (Above Grade)	Distance From Street	Distance From Caltrain *	Measurement
1A	15 ft	13 ft – from curb (Pacific Boulevard)	75 ft	Short-Term Noise Levels
1B	15 ft	53 ft – from curb (Pacific Boulevard)	115 ft	Short-Term Noise and Vibration Levels
1C	-	103 ft – from curb (Pacific Boulevard)	165 ft	Short-Term Noise and Vibration Levels
2A	5 ft	20 ft – from curb (South Delaware)	(shielded by existing building)	Short-Term Noise Levels

*Notes: * Distance to closest rail, north bound*

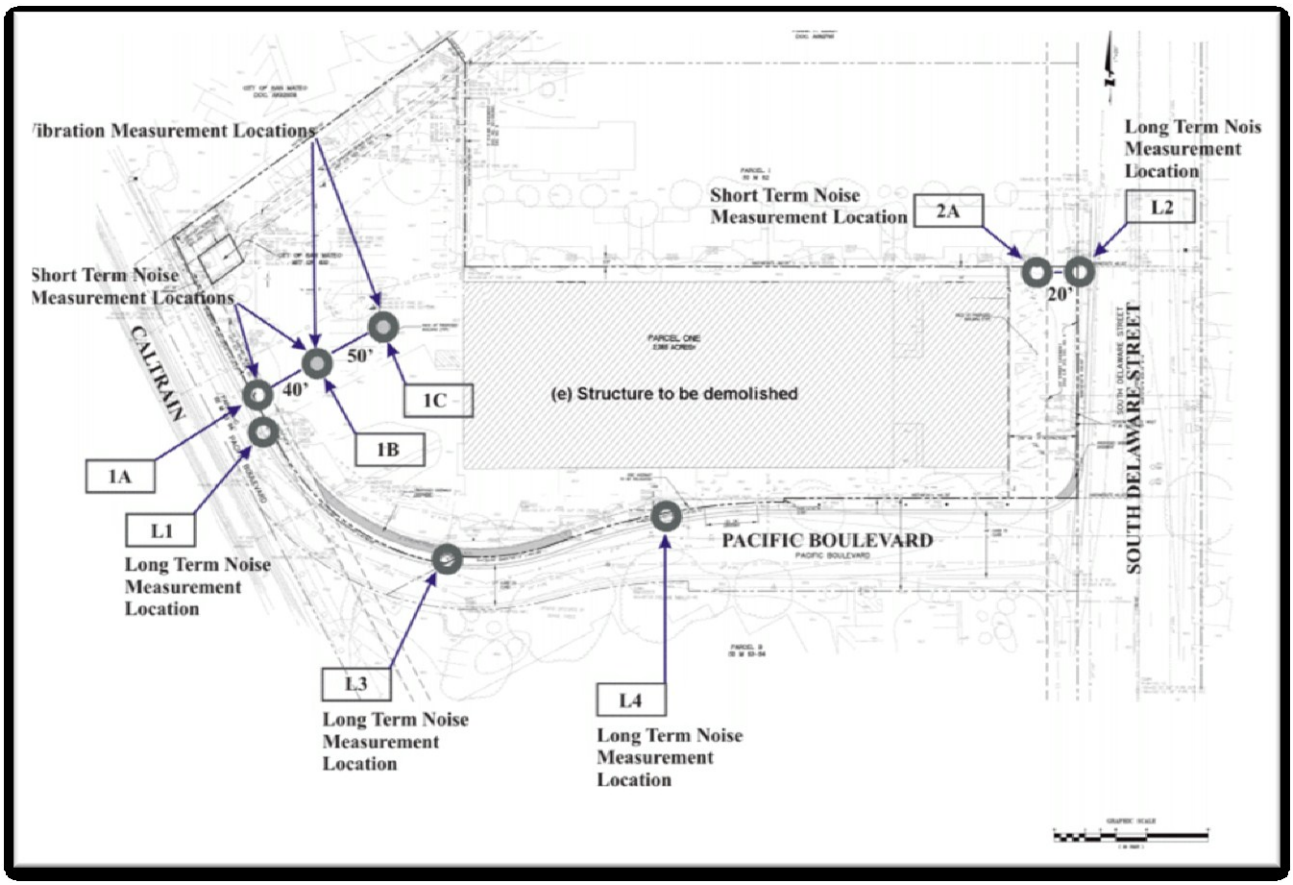


Figure 1 Survey measurement locations for noise and vibration

4. Survey Results

Measured Noise Levels

The results of the environmental noise survey reveal that noise levels across the South Delaware Place Site were consistently above 60 L_{dn}. Figures 7 through 10 present the hourly-averaged L_{eq} sound levels and calculated L_{dn} sound levels from the long-term survey for four complete days at each monitoring location. Long-term results show higher noise levels on weekdays, when CalTrain operations and car and truck traffic in the vicinity are greater. Lower levels are particularly evident on Saturday and Sunday mornings, due to the absence of a defined commute period. Measured and predicted L_{dn} values are summarized in Table 3 for each measurement location.

Short-term recordings were made on 17 November 2005, between 11:00 am and 4:00 pm. Results from short-term noise recordings are shown in Table 2 and spectral data is presented in Figures 11 and 12. Frequency spectra for maximum (L_{max}) and energy-equivalent (L_{eq}) noise levels from the short-term measurements are consistent with those from other noise environments dominated by vehicle traffic, particularly truck traffic and diesel-powered passenger train operations. Maximum levels from the microphones at the façade (setback) location on Pacific Boulevard were 1-2 dB lower than the maximum levels measured at the property line.

Measured Vibration Levels

Ground vibration levels from passing trains were measured at the setback location of the proposed building façade closest to the rail line and at a second location 50 feet further back from this façade. The measured vibration levels of six passing trains were all below 65 dB (re 1.0 micro in/sec) at these locations. A slight reduction (1-2 dB) in ground vibration was measured between the two locations. This is a relatively low vibration level. Generally, this level of vibration may be perceptible but it is not likely to be a source of annoyance. Slight amplification due to floor resonances may make this vibration more perceptible but would not result in levels exceeding the FTA vibration impact criterion of 72 VdB for frequent events impacting residences (Transit Noise and Vibration Impact Assessment, April 1995, Chapter 8, Table 8-1).

5. Projected Future Noise Levels

Future conditions for this study were determined from a review of the *City of San Mateo General Plan Section III. Circulation Element* as well as a 2012 traffic study by Hexagon Transportation Consultants of the area surrounding the project site. These documents provide information on trends and transportation changes that could affect the South Delaware Place site noise

environment. The following changes are based on information presented in the Circulation Element.

- According to the San Mateo Circulation Element, traffic flow on SR 92 and US 101 is expected to increase moderately in future years based on an a predicted overall increase in traffic volume of 12% on freeways passing through San Mateo between 2005 and 2030. Local traffic volume is expected to increase 15% between 2005 and 2030.
- According to the 2012 traffic study, South Delaware Street traffic will increase moderately in future years based on a predicted average increase in traffic volume during peak hours of 20% between 2012 and 2030.

We reviewed traffic volumes along S. Delaware Street at Pacific Avenue as measured by Hexagon Transportation Consultants in 2005 and the volumes as measured by them at the same location again in 2012, as well as the predicted volumes for the year 2030. As our noise survey took place in 2005, we calculated the expected variation in L_{dn} noise levels based on the aggregate AM+PM traffic volume variation between the year 2005, when the survey took place and the future condition predictions for the year 2030. The following chart summarizes the traffic volume conditions used to extrapolate future noise conditions:

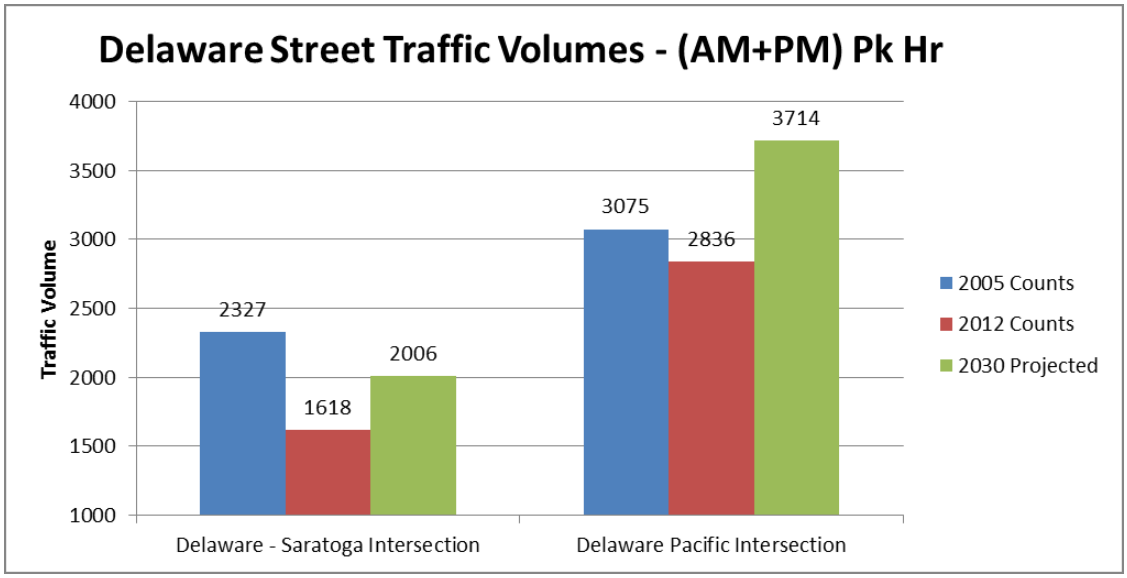


Figure 2: Delaware St. Traffic Volumes (from Hexagon Transportation Consultants)

As the project is closest to the Delaware/Pacific intersection of the two intersections studied by Hexagon, we have used the predicted increase in traffic volume of 3075/3714 vehicles as the basis for prediction of future traffic noise level increases. When expressed in decibels, such increase is approximately 0.8 decibels, which has been rounded to 1 decibel L_{dn}. Such an increase is normally regarded as not perceptible. The following table presents the approximate relationship between increases in noise levels and human perception:

Table 2: Approximate relationship between increases in environmental noise level and human perception

Noise level increase (decibels – dB)	Human perception (typical)
up to about 3	not perceptible
about 3	barely perceptible
about 5	distinctly noticeable
about 10	twice as loud
about 20	four times as loud

In additional to Hexagon's traffic volume counts, we also reviewed the CalTrain schedule and CalTrans traffic volumes to determine whether or not additional data collection beyond that measured previously is necessary for this project. As the source of the noise due to rail operations is not expected to change in nature because the equipment used by Caltrain has not changed significantly since our survey took place in 2005 and is expected to be the same in the next ten years and so is the the horn-sounding requirement, further survey of Caltrain operational noise was not warranted for the purposes of this study.

The following potential changes are based on information presented in the Caltrain Website.

- Caltrain's 2004 Strategic Plan predicted the number weekday total trains would grow from 86 to 100 between 2005 to 2030 and the number of weekday express trains would grow from 10 to 20 between 2005 and 2030. According to this plan, the number of weekday trains will increase, ultimately increasing the frequency of trains operating on the CalTrain line.

Summary of Future Noise Increases

The total future change in weekday L_{dn} noise levels at South Delaware Place Site is expected to be 1-2 dB by 2030 at the project's South Delaware Street facade, considering the many factors above. Maximum levels from individual events are not expected to increase or decrease, but the frequency of these events is expected to increase based on increased traffic volume and a higher frequency of trains.

Based upon measured existing noise levels and projected future changes, approximate noise levels for the South Delaware Project site have been developed in terms of L_{dn} levels. Table II summarizes the existing and future noise levels. Figure 3 shows contour lines of the predicted L_{dn}.

Although the project is not located within a two mile radius of a public airport, or within an airport land use plan or within the vicinity of a private airstrip, occasional aircraft noise was observed, as this is common throughout San Mateo and neighboring cities. This type of noise is of short duration and of a moderate to low level, hence it does not represent a significant impact at this location, as it does not raise the daily average (Ldn) level of noise appreciably at the site.

Table 3: Summary of measured existing and predicted future Ldn noise levels by measurement location (see Figures 4 through 7)

Measured date	Noise Survey Location			
	L1	L2	L3	L4
L_{dn} – Fri, 18 Nov	72	70	68	65
L_{dn} – Sat, 19 Nov	69	69	66	63
L_{dn} – Sun, 20 Nov	67	67	65	61
L_{dn} – Mon, 21 Nov	70	69	67	64
Existing Typical L_{dn} (four day average)	70	69	67	64
Existing Typical L_{dn} (extrapolated to a full week)	* 71	*69	*67	*64
Future Predicted L_{dn}	72	70	68	65

Note: *Extrapolated from long-term data based on typical weekday L_{dn} levels.

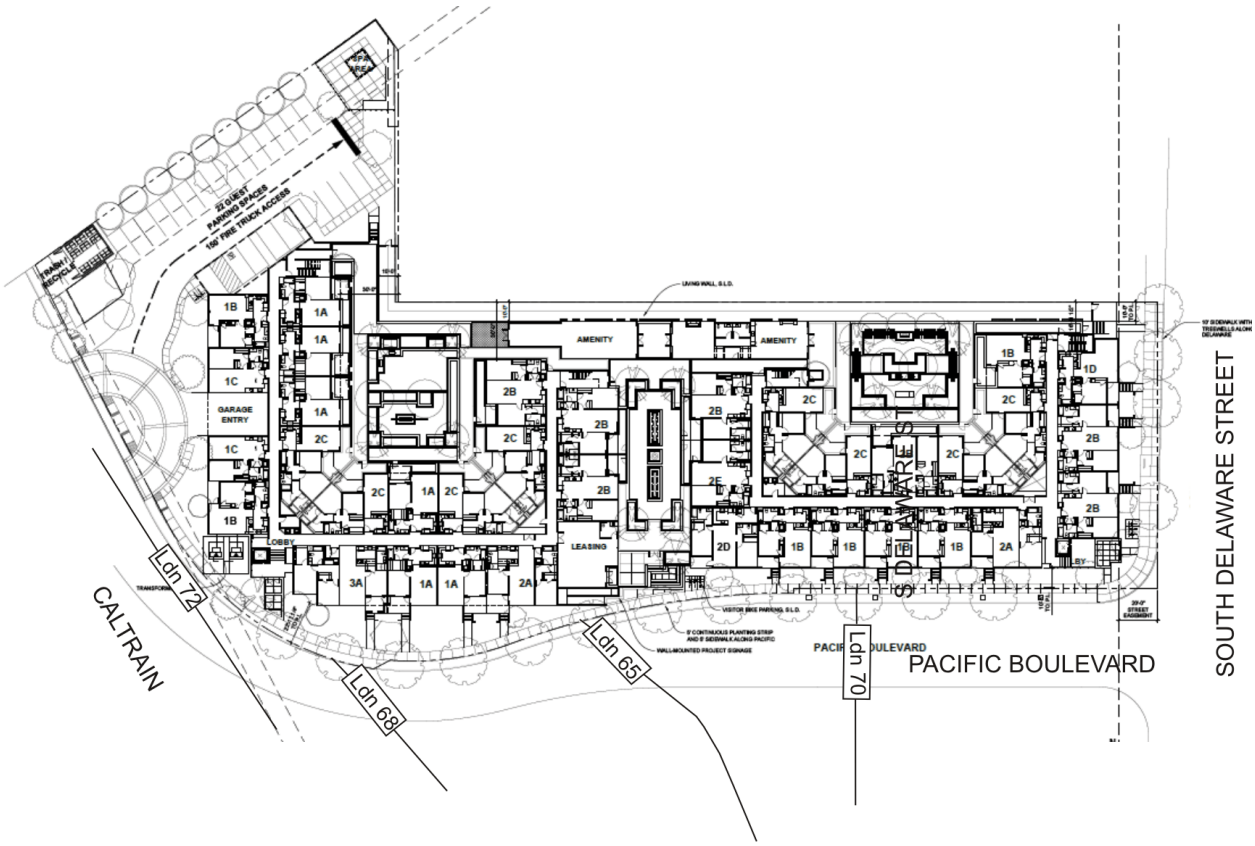


Figure 3: Predicted future Ldn contours

Project Noise Generation

Typical sources of noise in multi-family residential projects include:

- Increases in local traffic due to trips generated by the project
- Air-conditioning equipment (outdoor condenser units)
- Exhaust and make-up air fans (Garage, unit ventilation, common kitchen and bath exhaust, etc.
- Rooftop elevator equipment

As already discussed, traffic volume increases are expected to result in less-than-significant increases in noise levels. These traffic volume increases include trips generated by the project.

Similarly, given the prevailing and expected future levels of environmental noise from transportation sources, project-generated noise from stationary sources such as air-conditioning equipment, fans, etc. are not expected to result in adverse noise impacts to nearby residential land uses.

The generation of noise by sources in a residential project such as 2090 S. Delaware is regulated by means of the Noise Ordinance of the San Mateo Municipal Code, Chapter 7.30. This document limits the maximum allowable level of noise to be produced by sources within the project on any other property. Specific noise limits are presented in Section 7.30.040 for daytime (7am-10pm) and nighttime (10pm-7am) hours.

At this early stage in the project design, it is not possible to provide specific recommendations on outdoor equipment. However, such equipment shall be designed, oriented and shielded from sensitive receptors such that the noise it produces does not exceed the limits imposed by the Noise Ordinance.

Construction Noise

The site is surrounded by mostly single story single family residences (SFRs) on the east side, across from Delaware Street, by two and three story multi-family residences (MFR) on the north and by commercial properties on the south and east. Please refer to Figure 4 for a map of the surrounding lots and their use.

The City of San Mateo controls the generation of noise during construction by means of the San Mateo Municipal Code, Chapter 7.30.060, subsection (e), as follows:

> *(e) Construction.Construction, alteration, repair or land development activities which are authorized by a valid city permit shall be allowed on weekdays between the hours of seven a.m. and seven p.m., on Saturdays between the hours of eight a.m. and five p.m., and on Sundays and holidays between the hours of noon and*

four p.m., or at such other hours as may be authorized or restricted by the permit, if they meet at least one of the following noise limitations:
(1) No individual piece of equipment shall produce a noise level exceeding ninety dB at a distance of twenty-five feet. If the device is housed within a structure or trailer on the property, the measurement shall be made outside the structure at a distance as close to twenty-five feet from the equipment as possible.
(2) The noise level at any point outside of the property plane of the project shall not exceed ninety dB.
(3) The operation of leaf blowers shall additionally comply with Chapter 10.80 "Operation of Leaf Blowers".

Figure 4: Project Area and Noise Sensitive Land Uses (source: Google Maps)

At this early stage in the project design, it is not possible to anticipate the specific construction equipment to be used or the duration of such uses, however, in general, the anticipated noise sources for the construction work would include:

- Demolition/Excavation/Grading equipment such as:
  - JCB Excavator (JS 260 or similar)
  - Mini skid shear loaders

  - Dozer (Cat D6 or similar)
- Concrete mixer, forklifts and pumping trucks
- Saws and Nailing guns

None of the sources identified are extreme noise generators. Furthermore, no pile driving is anticipated.

Long-term noise projections for construction equipment commonly used in projects such as 2090 S. Delaware have been made using the following formula:

$$Leq(hour) = E.L. + 10 \log (U.F.) - 20 \log(D/50) - 10G \log(D/50) - A_{shielding}$$

where:

E.L. = reference equipment noise emission level (based on Lmax at 50 ft)
U.F. = equipment usage factor (percentage in use per typical hour as a fraction of 100%)
D = distance between source and receiver (ft)
G = ground effects constant (zero for acoustically hard ground surface conditions)
$A_{shielding}$ = attenuation provided by intervening buildings, barriers, etc.

A summary of calculations for the anticipated types of equipment operations is provided below in Table 4. The calculations assume general noise reference levels based on the Federal Highway Administration (FHWA) Roadway Construction Noise Model[1]. Usage factors are based on assumptions from FHWA. No acoustical shielding is assumed in these preliminary projections. Review of these preliminary calculations indicates that none of the concrete and excavation work is expected to exceed the 90 dBA Maximum noise standard, when the work is closest to noise sensitive receptors. The assumption has been made that most of the construction work will take place at distances of between 50 and 120 feet from the nearest residential receptors to the north of the property. However, occasionally, some of the equipment is likely to operate closer than 50 feet from these receptors in which case noise levels will temporarily be higher.

Table 4: Noise Calculations for Nearest Receivers

Equipment	Qty	Usage Factor, %	Ref. Level, dBA	Ref. Distance, ft	Receptor	Horizontal Distance	Projected Leq, dBA	Projected Lmax, dBA
Concrete pump truck	1	20	82	50	Residential	80 to 120	67 to 74	78
Dozer	1	40	82	50	Residential	50 to 120	70 to 80	84
Front end loader	1	20	95	50	Residential	50 to 120	67 to 75	79
Pneumatic hammer tool	1	50	85	50	Residential	50 to 120	70 to 80	85
Auger drill rig	1	20	84	50	Residential	50 to 120	71 to 79	86

[1] Federal Highway Administration – *FHWA Roadway Construction Noise Model. Final Report* January 2006.

6. Design Recommendations

Outdoor Areas

The level of exterior noise projected from our noise study exceeds the 60 L_{dn} threshold in CCR Title 24 across the entire project site. Therefore, to the extent possible, common outdoor use areas and courtyards that are exposed to noise sources exterior to the project should be provided with noise mitigating design features, such as architectural sound barriers, as per the requirements CCR Title 24.

The proposed building layout, as shown in the 15 May 2012 drawings for 2090 South Delaware Apartments, prepared by Christiani Johnson Architects, already provides for some mitigation of noise levels at the project's outdoor use areas and project-interior facades. In particular, the proposed central courtyards (just above grade) are open to the existing residential buildings to the North of the site and surrounded on the south, east and west sides by the proposed building. This arrangement helps to shield noise from South Delaware Street, the CalTrain rail line and portions of the elevated freeway (SR92) to the north. Noise levels within these interior courtyards are expected to be 67 L_{dn} or below, which will comply with the City of San Mateo Noise Element's exterior goals and are in keeping with the desirable levels for outdoor spaces in an urban setting.

The project also includes an outdoor Spa area on the northwest side, which is normally considered a common outdoor use. According to the City of San Mateo Noise Element, any "common open space intended for the use and enjoyment of residents" (such as spas) must maintain an L_{dn} less than or equal to 67 dBA. The adjacent commercial building to the northwest of the South Delaware property, the present townhome residential development to the north of the project and the project buildings themselves will provide acoustical shielding to the spa area. Therefore, only noise from Caltrain operations will dominate the noise environment at the spa.

Measurements of train noise were made in November 2005 for 5 different passing trains over a period of one hour. The noise energy from these 5 passbys was then extrapolated to the expected noise energy produced by all trains in one day using the current Caltrain schedule. According to the current Caltrain schedule, a total of 86 trains travel by the project site each weekday. According to the 2004 Caltrain Strategic Plan, an increase from 86 to 100 trains is expected between 2005 and 2023, hence calculations of the expected future noise at the spa area were based on 100 train passbys per day.

Therefore, taking into consideration the significant acoustical shielding to be provided by present and future structures, the setback distance of the spa area from the tracks and the expected future volume of 100 trains/day, we have predicted the future noise environment at the spa area to be

approximately 55 L_{dn} decibels, well below the maximum 67 L_{dn} allowed by the San Mateo Noise Element.

Exterior Glazing

Windows are inherently the weak link of a residential project's exterior acoustical envelope. Therefore, proper selection and installation of exterior glazing elements are paramount to achieving CCR Title 24 interior noise limits. Frames of windows and doors must be caulked with resilient, acoustical sealant to provide an airtight seal. Also, a bead of resilient, acoustical caulking must be applied to window casings before installation. Manufacturer's instructions for installation of acoustically rated window assemblies must be followed carefully, so that installed windows retain their rated acoustical performance.

Acoustical glazing recommendations at specific façade areas of the project are presented in Figure 5 through Figure 7. Recommendations are presented in terms of the Outdoor-Indoor Transmission Class (OITC) and Sound Transmission Class (STC) acoustical performance ratings, *both of which should be met by the window manufacturer by providing test data for the specific window assembly types submitted for this project.*

Traditionally, manufacturers of exterior doors and windows have used the single-number Sound Transmission Class (STC) metric to rate the acoustical performance of their products. However, STC is a metric optimized for the spectral shape (or tonal quality) of human speech, as it was originally developed as a means to rate the degree of sound isolation between dwelling units in the late 1950's.

The Outdoor-Indoor Transmission Class (OITC), as defined in the ASTM Standard E1332, is the *preferred metric* for rating the sound performance of building shell materials. OITC ratings are tied to a typical noise spectrum shape from transportation sources, which are rich in low frequency, bass-type sounds, as opposed to the frequencies of human speech or television audio. Both OITC and STC rating values are calculated from 1/3-octave band transmission loss data for specific building shell components.

Three types of exterior window glazing are indicated on the construction plans: (1) minimum OITC 30 / STC 36 rated glazing, (2) OITC 27 / STC 34, and (3) minimum OITC 24 / STC 30. A sample window assembly that will achieve an OITC 30 / STC 36 rating typically consists of a double-pane system with 1/4" plate glass panes separated by a 1/2" air space. Many other glazing configurations are produced that meet the above categories. If practical, glazing systems with dissimilar thickness panes are preferred. However, all of this project's recommended acoustical design ratings should be achievable with commercially available window assemblies that do not require triple glazing.

Exterior Doors

According to Section 1207.7 of the California UBC, the following applies to residential unit entry doors from interior corridors:

> *Entrance doors . . . together with their perimeter seals shall have STC ratings not less than 26. Such tested doors shall operate normally with commercially available seals. Solid-core wood-slab doors 1 3/8 inches (35 mm) thick minimum or 18 gage insulated steel-slab doors with compression seals all around, including the threshold, may be considered adequate without other substantiating information.*

Based upon the results of our exterior noise study for the project, standard entrance doors for interior corridors, as described above, should provide adequate acoustical insulation at exterior project entries. These should have a combined STC 28 rating for any door and frame assemblies. Any balcony and ground floor entry doors located at bedrooms should have an STC rating similar to the minimum STC window ratings indicated in Figure 5 through Figure 7. While design criteria are the same for all habitable spaces, bedrooms are the most sensitive spaces in a residential unit.

In general, an STC 28 door rating can be achieved with a standard door that is supplied with improved acoustical gaskets at the jambs and threshold, although any supplier must provide an acoustical rating submittal. It is typical for an STC 30 rated exterior entry to include side and head jamb gaskets of the non-porous kind, such as Pemko™ Siliconseal (S88) or approved equal, to avoid flanking transmission of sound into the project units. The door bottom should be fitted with a fully gasketed, lap-joint type threshold or with another form of door bottom/threshold with gasket that provides a proper acoustical seal. Thresholds and frames of all exterior doors should be carefully caulked before setting.

Exterior Walls

The exterior wall assemblies for this project have not been specified at this time. However, typical constructions would likely consist of a stucco or engineered building skin system over sheathing, with 4" to 6" deep metal or wood studs, fiberglass batt insulation in the stud cavity, and one or two layers of 5/8" gypsum board on the interior face of the wall. As the project design is developed, sections and details for the exterior facades will require further review.

The ultimate degree of sound isolation provided by the building shell is highly dependent on the quality of workmanship and attention to detail that is followed during construction. The following recommendations are aimed at delivering the full sound isolating potential of the building shell:

- If possible, avoid electrical outlets in exterior walls. If this is not possible, apply outlet box pads such as those manufactured by Lowry's or Dottie (#68 pads) to all electrical boxes. Carefully caulk around all edges of electrical outlet boxes and other penetrations with non-hardening acoustical sealant.
- Have proposed construction details of the exterior assemblies, including intersection details at adjoining walls and partitions, reviewed by a qualified professional acoustical consultant before bidding the project. The project plans to incorporate building shell, doors and frame assemblies suitable for conformance to the ratings noted above.

Supplemental Ventilation

Noise levels between 65 and 72 L_{dn} are predicted for all of the project's exterior facades. A typical bedroom/living room window will allow for a reduction of approximately 15 decibels when partially open. Therefore, it is not expected that interior noise requirements can be met with any open windows. Supplemental ventilation adhering to the same OITC/STC recommendations from Figures 3 and 4 must be provided for all of the project's residential units facing South Delaware and Pacific Boulevard, so that the opening of windows is not necessary to meet ventilation requirements.

Supplemental ventilation can be provided in several forms. If a "Z-duct" method is chosen to provide outside air intake at individual units, the duct should be at least 4ft in length, and lined with at least 1" thick acoustical duct liner. These requirements are essential to make the Z-duct provide adequate noise insulation and not compromise the noise insulating performance of the window and wall assemblies. The Industrial Acoustics Company (IAC) also manufactures Z-ducts as pre-fabricated components.

Supplemental ventilation can also be provided by passive or by fan-powered, ducted air inlets that extend from the building's rooftop into the units. Ducted air inlets must also be acoustically lined through the top-most 6 ft in length and incorporate one or more 90-degree bends between openings, so as not to compromise the noise insulating performance of the residential unit's exterior envelope. We will gladly review and comment on designs provided by the project's architect or mechanical engineer as these are developed.

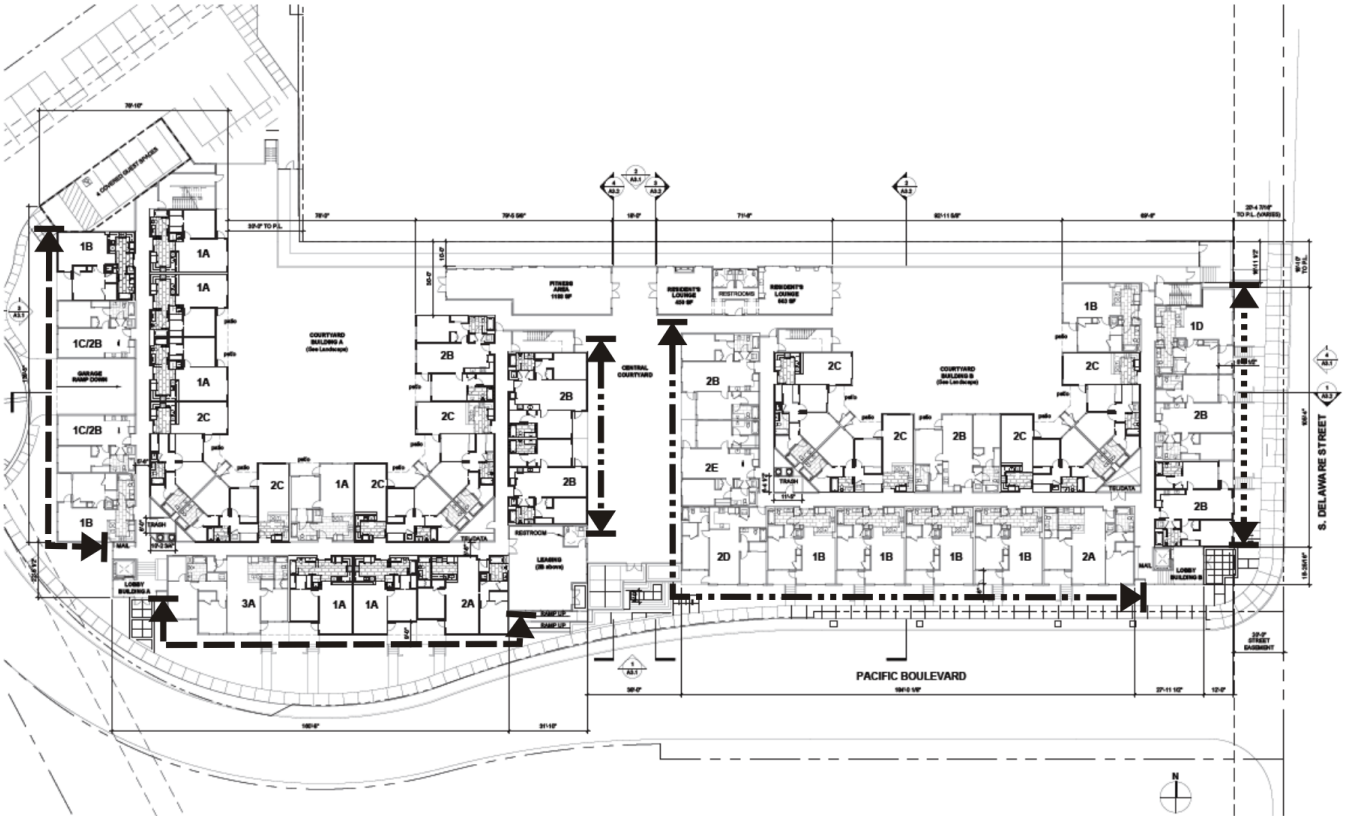
Construction Noise - Mitigation Measures from Prior Negative Declaration

The following mitigation measures are recommended to reduce noise generated by construction:

- Construct temporary noise barriers around the perimeter of project phases before construction begins.
- No work shall occur between the hours of 7 p.m. and 7 a.m., Monday through Friday, nor prior to 9 a.m. or after 5 p.m. on Saturday, nor prior to 12 noon or after 4 p.m. on Sundays. These hours do not apply to construction work that takes place inside a completely enclosed

building and does not exceed the exterior ambient noise level as measured ten feet from the exterior property lines.

- Properly muffle and maintain all construction equipment powered by internal combustion engines.
- Prohibit unnecessary idling of internal combustion engines.
- Locate all stationary noise-generating construction equipment such as air compressors as far as practical from existing nearby residences and other noise-sensitive land uses. Acoustically shield such equipment.
- Select quiet construction equipment, particularly air compressors, whenever possible. (Fit motorized equipment with proper mufflers in good working order.)
- 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 complaint (e.g., starting too early, bad muffler, etc.) and would require that reasonable measures warranted to correct the problem be implemented. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include it in the notice sent to neighbors regarding the construction schedule. (The Agency should be responsible for designating a noise disturbance coordinator and the individual project sponsor should be responsible for posting the phone number and providing construction schedule notices.)



LEGEND

- Glazing Type 1: Minimum OITC30/STC36
- Glazing Type 2: Minimum OITC27/STC34
- Glazing Type 3: Minimum OITC24/STC30

Figure 5: Recommended window ratings at first floor units

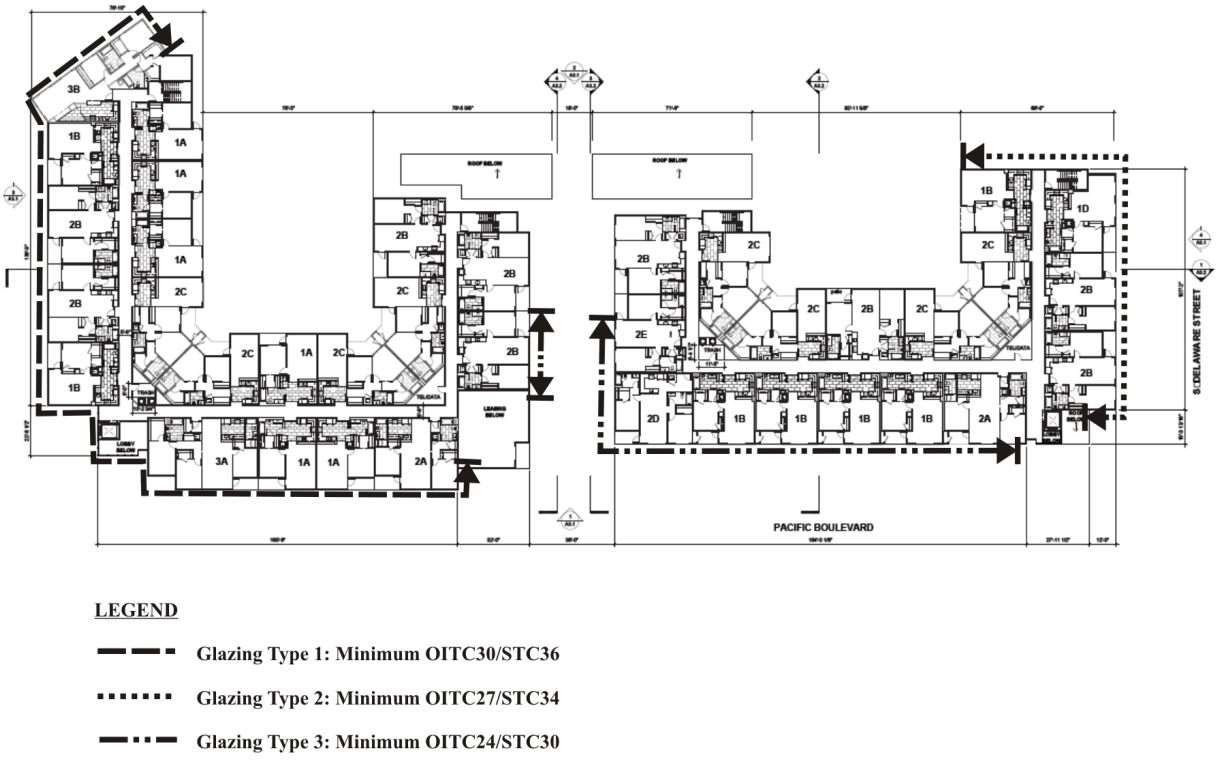
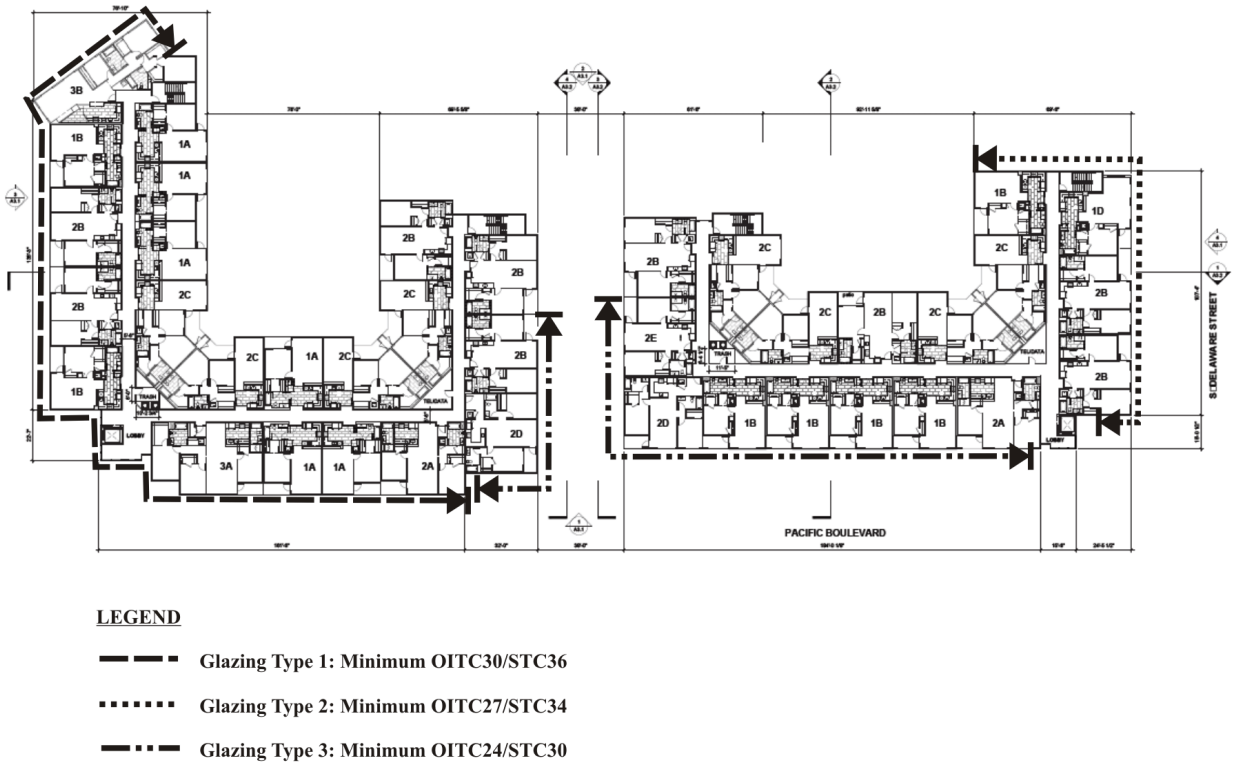


Figure 6: Recommended window ratings at second floor units



LEGEND

- Glazing Type 1: Minimum OITC30/STC36
- Glazing Type 2: Minimum OITC27/STC34
- Glazing Type 3: Minimum OITC24/STC30

Figure 7: Recommended window ratings at third floor units

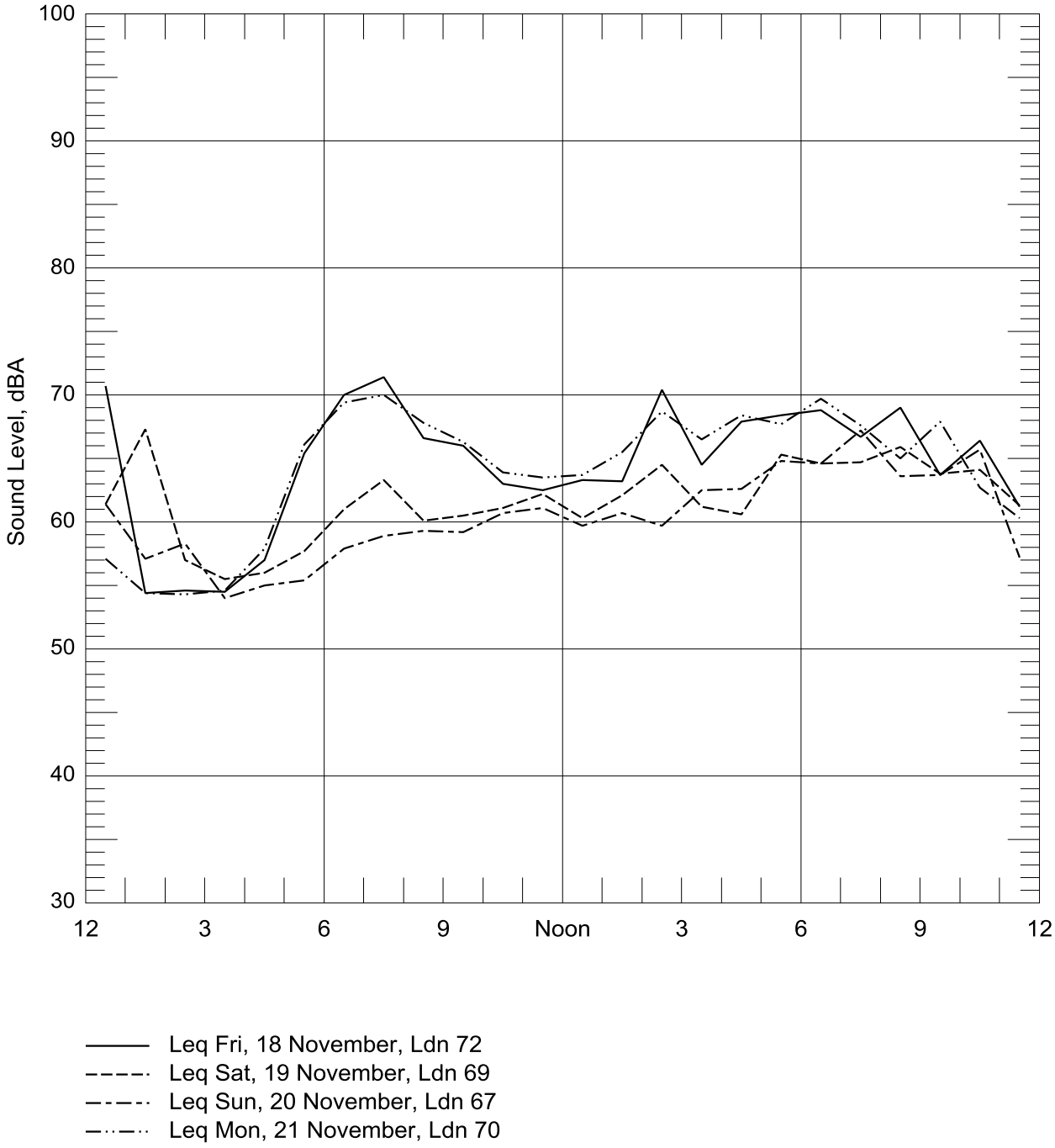


Figure 7: Summary of hourly L_{eq} noise levels on Pacific Blvd. Location 1, 18 to 21 November 2005

Note: An unknown noise source was present during the 12:00am hour on Friday, November 18, leading to an unusually high Leq. This noise event is not expected to affect the calculated Ldn's.

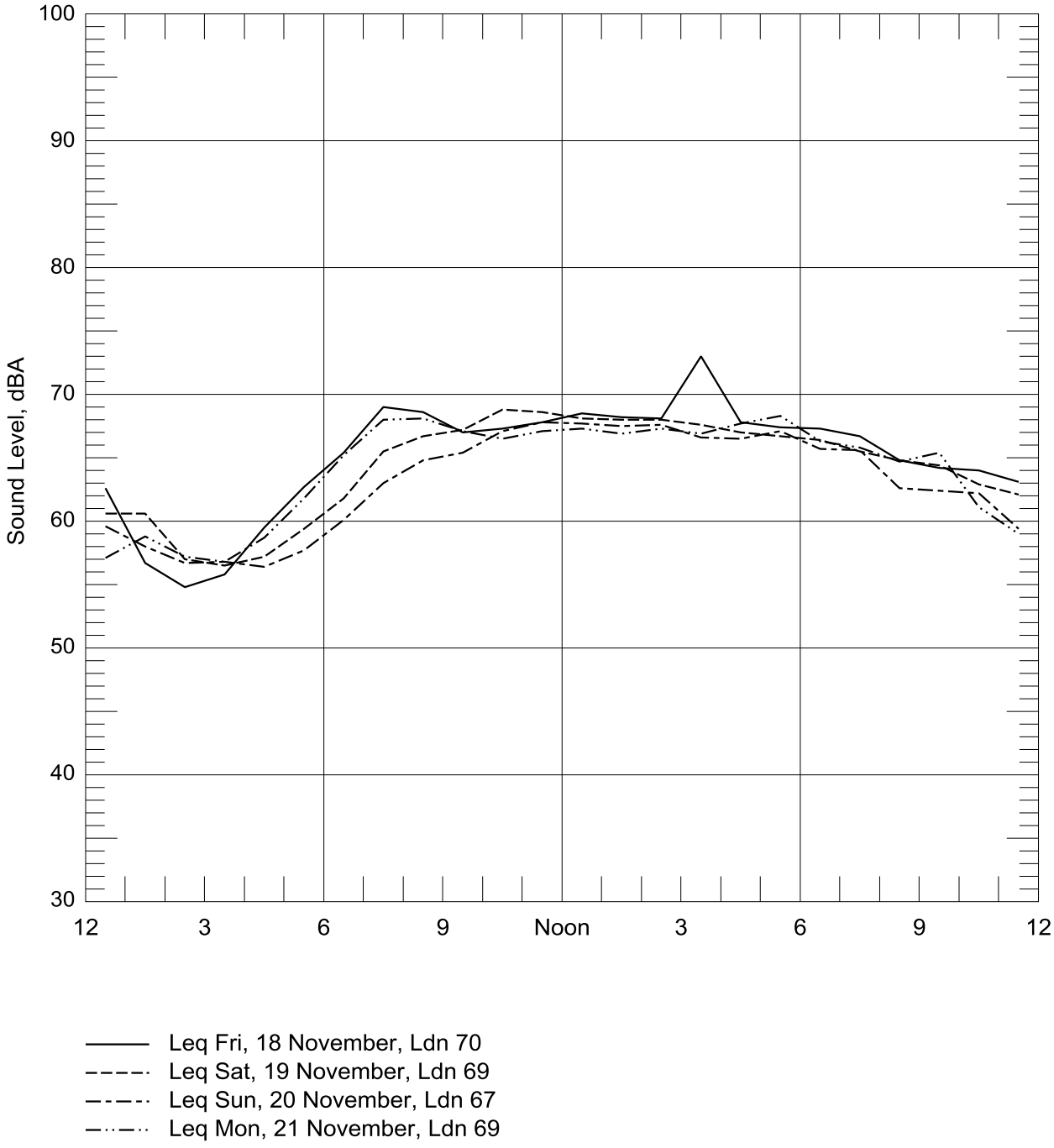


Figure 8: Summary of hourly L_{eq} noise levels on South Delaware St. Location 2, 18 to 21 November 2005

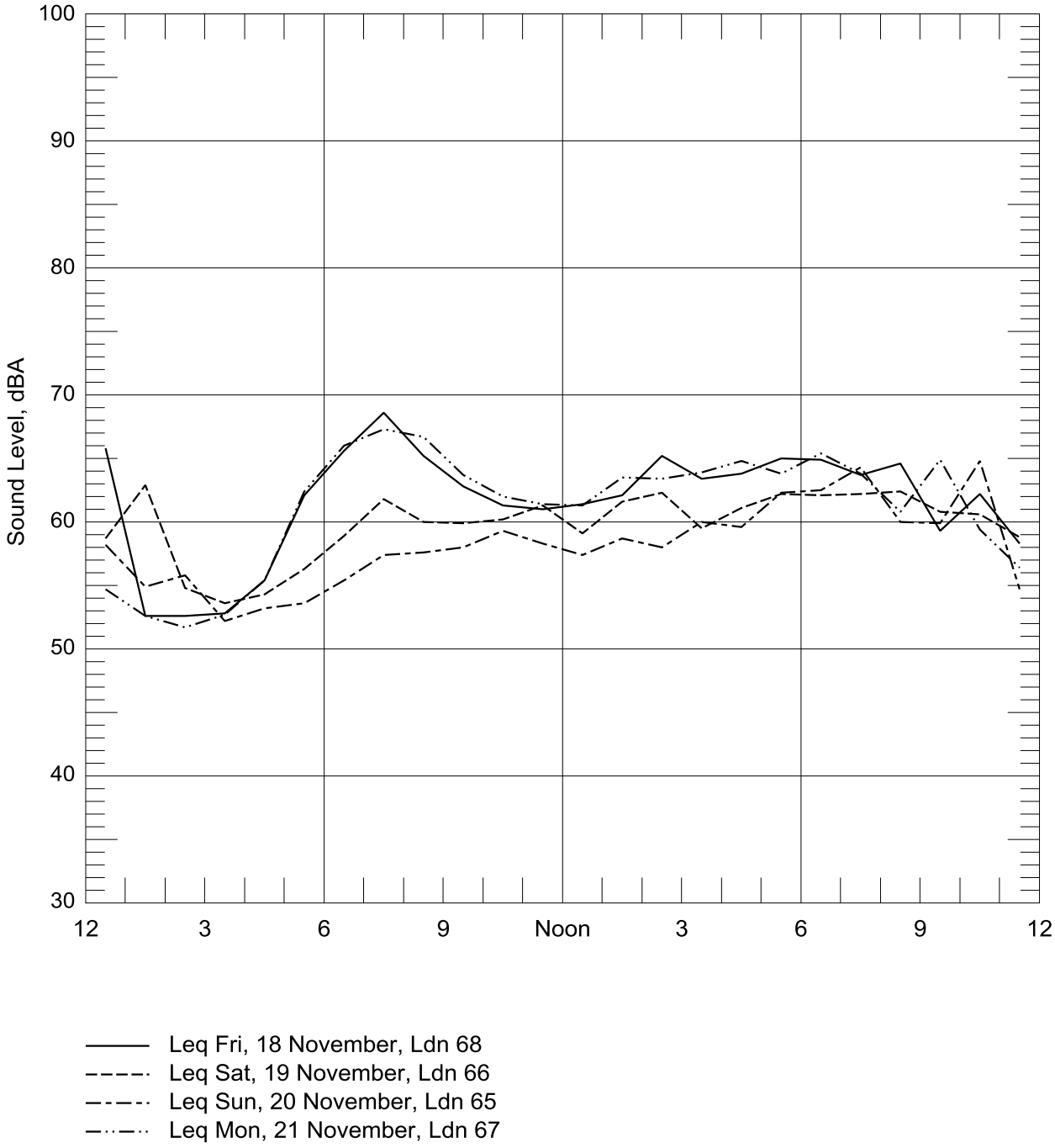


Figure 9: Summary of hourly L_{eq} noise levels on Pacific Blvd. Location 3, 18 to 21 November 2005

Note: An unknown noise source was present during the 12:00am hour on Friday, November 18, leading to an unusually high L_{eq}. Therefore, data for such hour has been corrected for the evaluation of the daily Ldn.

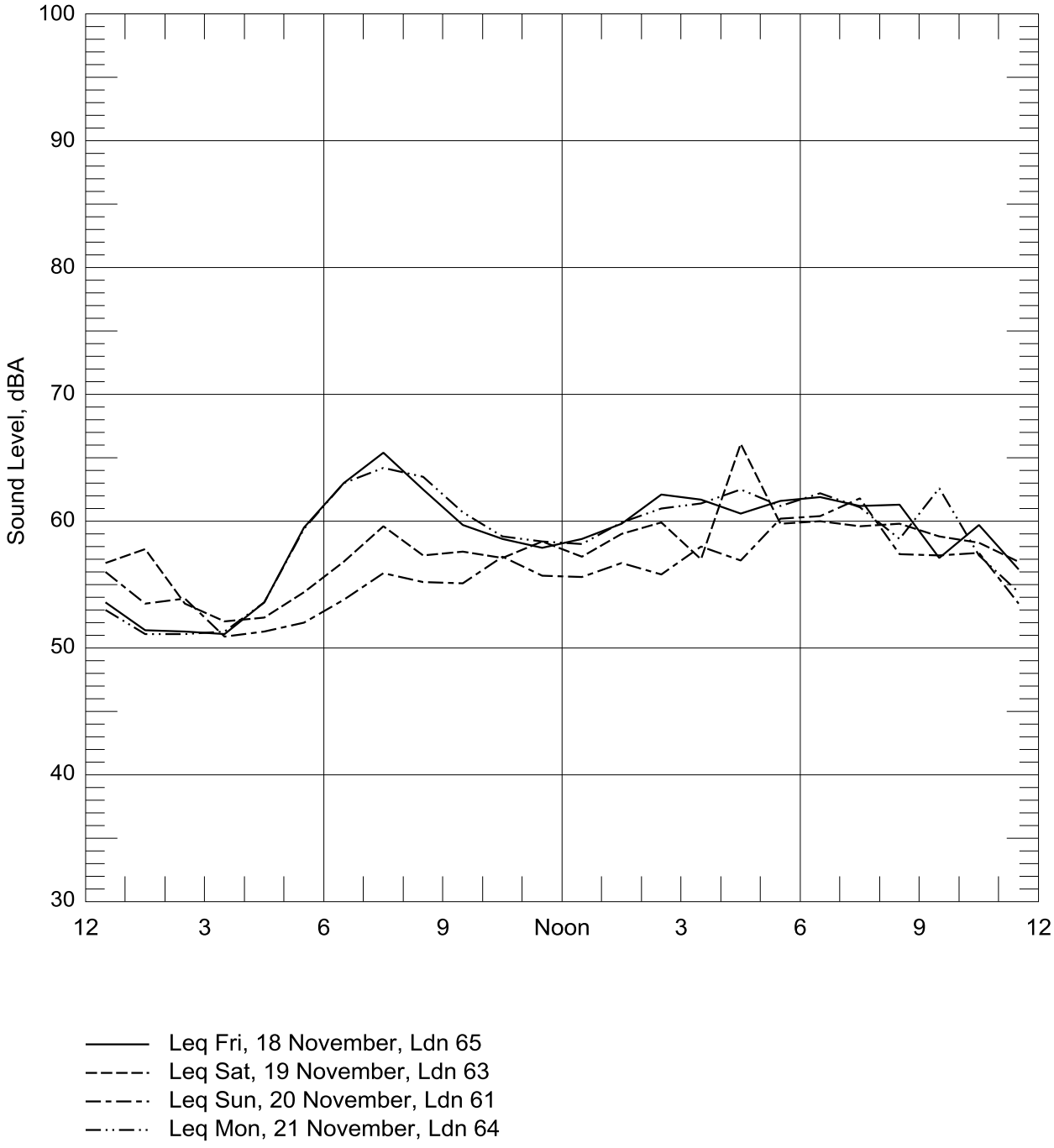


Figure 10: Summary of hourly L_{eq} noise levels on Pacific Blvd. Location 4, 18 to 21 November 2005

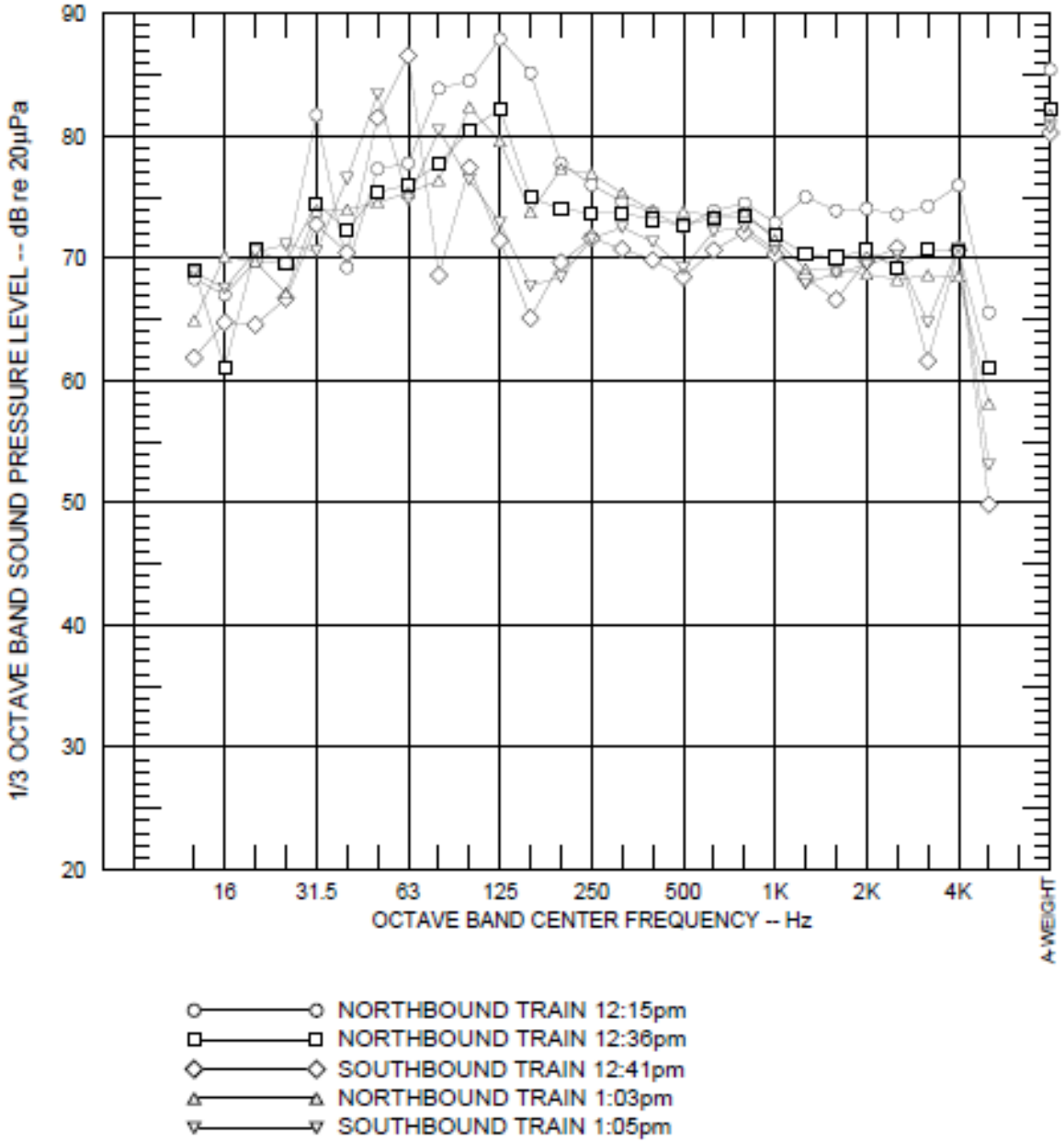


Figure 11: Maximum sound level spectra due to Caltrain operations Location 1b, 22 November 2005

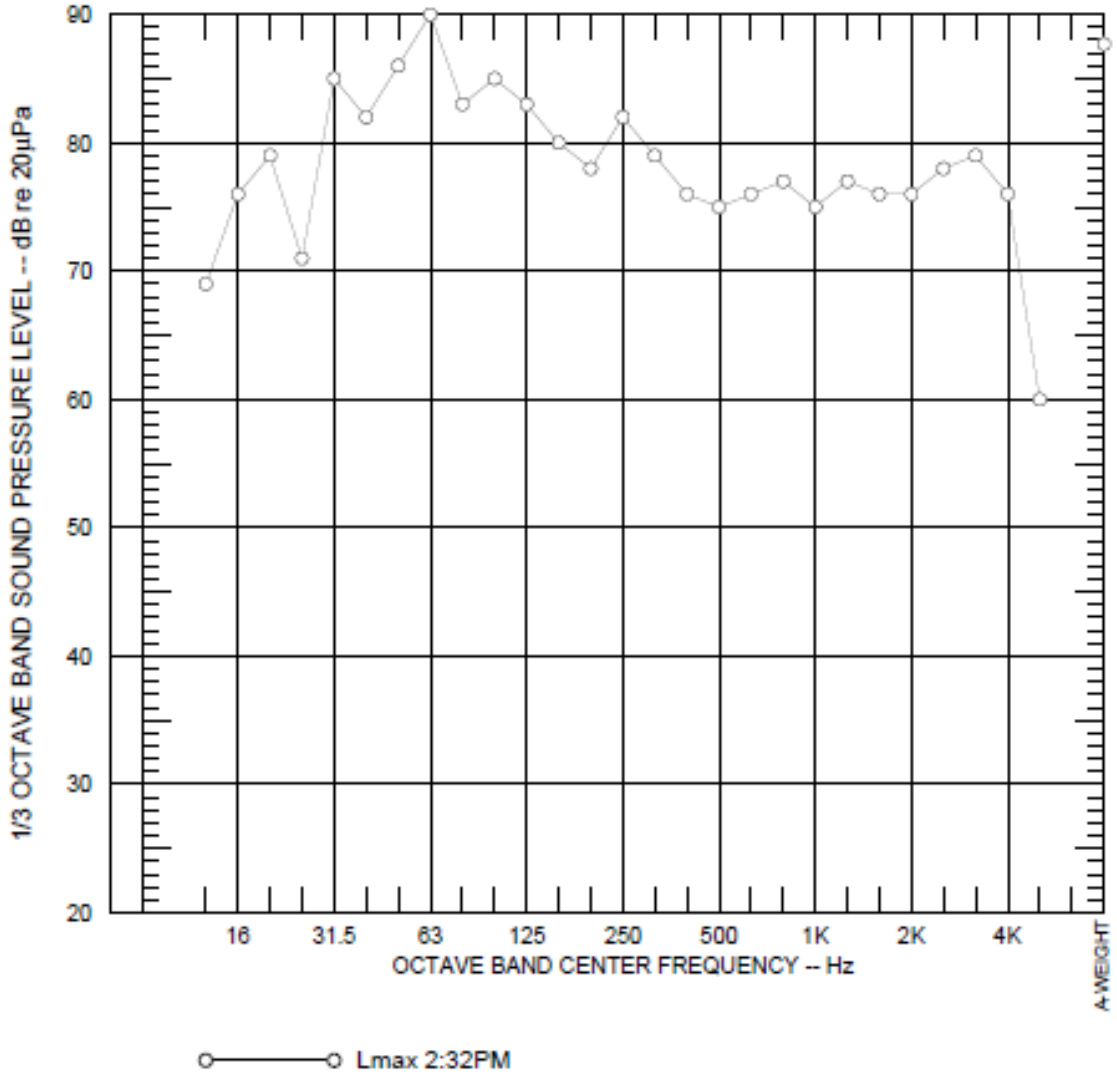


Figure 12: Maximum sound level spectra. South Delaware traffic Location 2a, 22 November 2005

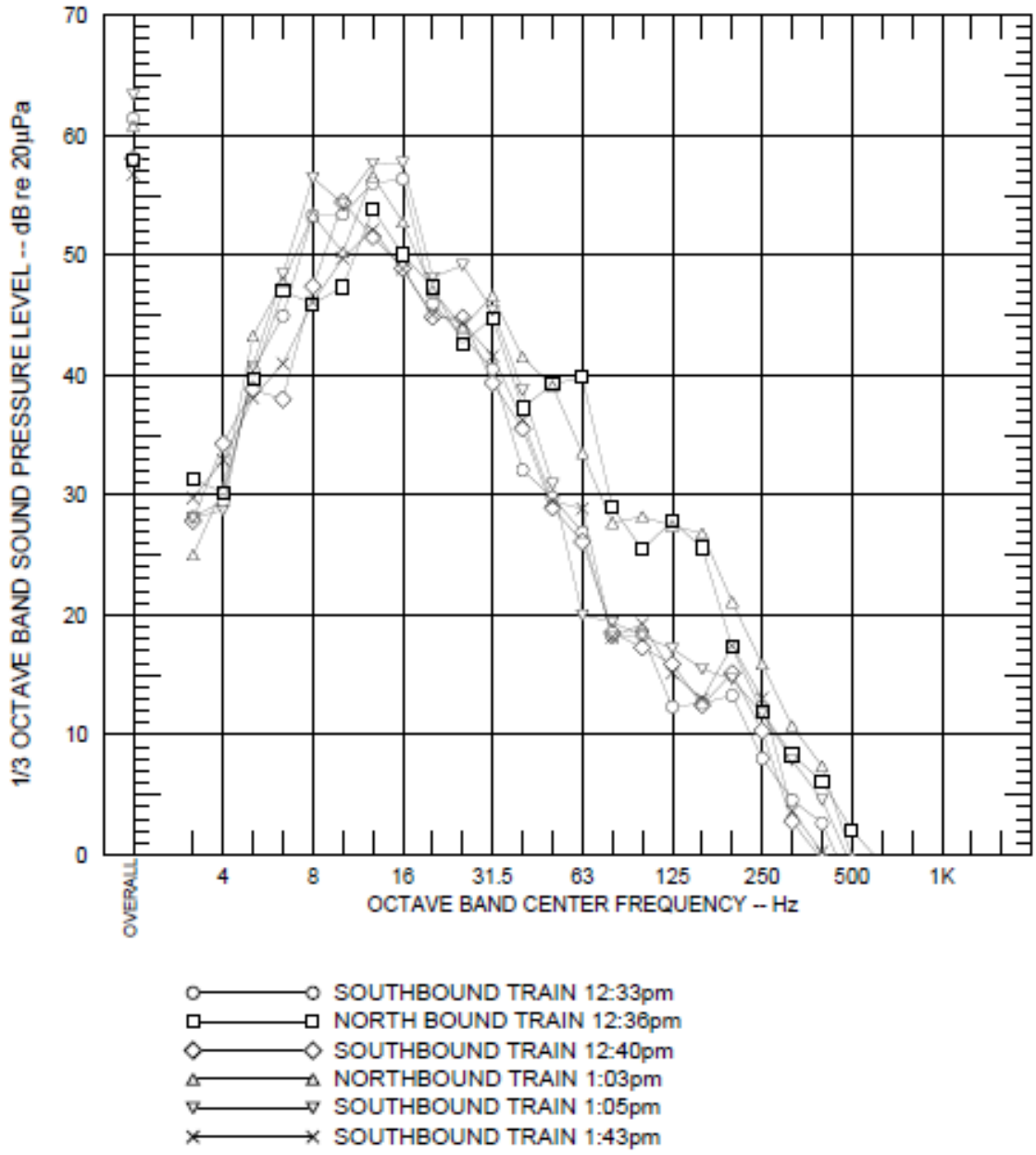


Figure 13: Maximum vibration level spectra due to Caltrain operations Location 1b, 22 November 2005

Appendix A

GLOSSARY OF ACOUSTICAL TERMS

A-Weighted Sound Level (dBA):

The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Airborne Sound:

Sound that travels through the air, as opposed to structure-borne sound.

Ambient Noise:

The prevailing general noise existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far.

Community Noise Equivalent Level (CNEL):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Day-Night Sound Level (L_{dn}):

The L_{eq} of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

Decibel (dB):

The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a reference quantity.

Energy Equivalent Level (L_{eq}):

The level of a steady noise which would have the same energy as the fluctuating noise level integrated over the time period of interest. L_{eq} is widely used as a single-number descriptor of environmental noise. L_{eq} is based on the logarithmic or energy summation and it places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. This energy average is not the same as the

average sound pressure levels over the period of interest, but must be computed by a procedure involving summation or mathematical integration.

Field Impact Insulation Class (FIIC):

A single number rating similar to the IIC except that the impact sound pressure levels are measured in the field.

Field Sound Transmission Class (FSTC):

A single number rating similar to STC, except that the transmission loss values used to derive the FSTC are measured in the field. All sound transmitted from the source room to the receiving room is assumed to be through the separating wall or floor-ceiling assembly.

Frequency (Hz):

The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

Impact Isolation Class (IIC):

A single number rating used to compare the effectiveness of floor-ceiling assemblies in providing reduction of impact generated sounds such as footsteps. It is derived from the measurement of impact sound pressure levels across a series of 16 test bands using a standardized tapping machine.

Noise Isolation Class (NIC):

A single number rating derived from measured values of noise reduction between two enclosed spaces that are connected by one or more paths. The NIC is not adjusted or normalized to a standard reverberation time.

Normalized Noise Isolation Class (NNIC):

A single number rating similar to the NIC, except that the measured noise reduction values are normalized to a reverberation time of 1/2 second.

Outdoor-Indoor Transmission Class (OITC):

A single number classification, specified by the American Society for Testing and Materials (ASTM E 1332 issued 1994), that establishes the A-weighted sound level reduction provided by building facade components (walls, doors, windows, and combinations thereof), based upon a reference sound spectra that is an average of typical air, road, and rail transportation sources. The OITC is the preferred rating when exterior facade components are exposed to a noise environment dominated by transportation sources.

Octave Band - 1/3 Octave Band:

One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2000 Hz to 4000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3 octave bands, where each octave is divided into three 1/3 octave bands.

Sound Absorption Coefficient (α):

The absorption coefficient of a material is the ratio of the sound absorbed by the material to that absorbed by an equivalent area of open window. The absorption coefficient of a perfectly absorbing surface would be 1.0 while that for concrete or marble slate is approximately 0.01 (a perfect reflector would have an absorption of 0.00).

Sound Pressure Level (SPL):

The sound pressure level of sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The standard reference sound pressure is 20 micro-pascals as indicated in ANSI S1.8-1969, "Preferred Reference Quantities for Acoustical Levels".

Sound Transmission Class (STC):

STC is a single number rating, specified by the American Society for Testing and Materials, which can be used to measure the sound insulation properties for comparing the sound transmission capability, in decibels, of interior building partitions for noise sources such as speech, radio, and television. It is used extensively for rating sound insulation characteristics of building materials and products.

Structure-Borne Sound:

Sound propagating through building structure. Rapidly fluctuating elastic waves in gypsum board, joists, studs, etc.

Statistical Distribution Terms:

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise (or vibration) levels observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual noise sources. Generally, the prevalent source of this residual noise is distant street traffic. L_{90} and L_{99} are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical median noise level over the measurement period and does reveal the long-term influence of local traffic.

L_{10} describes typical or average levels for the maximum noise levels occurring, for example, during nearby passbys of trains, trucks, buses and automobiles, when there is relatively steady traffic. Thus, while L_{10} does not necessarily describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle passbys at most locations.

L_1, the noise level exceeded for 1% of the time is representative of the occasional, isolated maximum or peak level which occurs in an area. L_1 is usually strongly influenced by the maximum short-duration noise level events which occur during the measurement time period and are often determined by aircraft or large vehicle passbys.