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August 3, 2017

Carey Algaze
Pacifica Companies
1775 Hancock Street, Suite #200
San Diego, CA 92110
Via email: calgaze@pacificacompanies.com

Subject: Haystack Project in Petaluma
Update of 3.24.16 Noise Analysis for Current Project Design

Dear Carey:
Illingworth & Rodkin's (I&R) has reviewed our Environmental Noise Assessment (ENA) for the Haystack Mixed Use Project[1] at Washington and Copeland Streets in Petaluma to determine whether changes in the current plans (shown in the Presentation Packet dated 1.26.17) result in the need for changes to the ENA. Following are the results and findings of this review:

Regulatory Changes
The ENA references the 2010 California Building Code (CBC), the 2010 Green Building (GB) Standards, and the Health and Safety Element of the City of Petaluma's 2025 General Plan. At this time the City's 2025 General Plan is still in effect, but both the 2010 Building Code and Green Building Standards where last updated in 2016. However, the 2016 updates resulted in no substantial changes to the CBC and GB Standard noise and acoustics policies, and therefore the policies referenced in the 3.24.16 ENA are still applicable to the current project.

Future Noise Environment
Future development in the site area, including the use of the nearby rail line for SMART commuter rail traffic and the downtown Petaluma SMART Station and existing commercial uses in the area remain largely the same and therefore the future noise levels established at the project frontages are still applicable to the current project.

Site Development
Though the current project plans have changed from that originally analyzed, the project continues to include mixed use commercial and residential uses on the first level and residential uses on the second through fourth levels. The project also continues to incorporate a central roadway between Weller and Copeland Streets and Residential uses arranged around central outdoor use areas in the blocks created by the central roadway.

[1] The ENA was first issued on May 21, 2014 and then updated March 3, 2016

Based on this site layout, noise levels in the common areas will continue to be consistent with the allowable outdoor noise exposure allowed under the City's General Plan and the ENA's recommendations that, an acoustical consultant should be retained to determine the needed window STC ratings necessary to achieve the 55 dBA L_{max} and 45 dBA L_{dn} interior noise limits when final building plans and elevations are available for the project remain applicable to the current project.

Based on the above review, changes in the current plans (dated 1.26.17) do not result in the need for any changes to the findings and conclusion in our Environmental Noise Assessment (ENA) for the Haystack Mixed Use Project (dated 3.24.16), and this prior acoustical analysis is found to be acceptable for evaluating the current project.

Sincerely,

Fred M. Svinth, INCE, Assoc., AIA
Senior Consultant, Principal
Illingworth & Rodkin, Inc.

HAYSTACK PACIFICA MIXED USE PROJECT PETALUMA, CALIFORNIA ENVIRONMENTAL NOISE ASSESSMENT

May 21, 2014

Updated March 24, 2016

Prepared for:

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Job No.: 14-039

INTRODUCTION

The following report presents the results of an environmental noise assessment conducted for the proposed Haystack Pacifica Mixed Use project in Petaluma, California, which proposes to develop the land encompassed by East D, Weller, East Washington and Copeland Streets in central Petaluma to create a mixed-use incorporating ground level commercial uses, townhomes, and apartments (see Figure 1). This report includes a summary of applicable regulations, the results of a noise monitoring survey conducted for the project, an evaluation of the site's noise exposure with respect to applicable standards, and recommendations to mitigate environmental noise impacts on the proposed project. Persons not familiar with environmental noise and vibration analysis are referred to Appendix A and B for additional discussion.

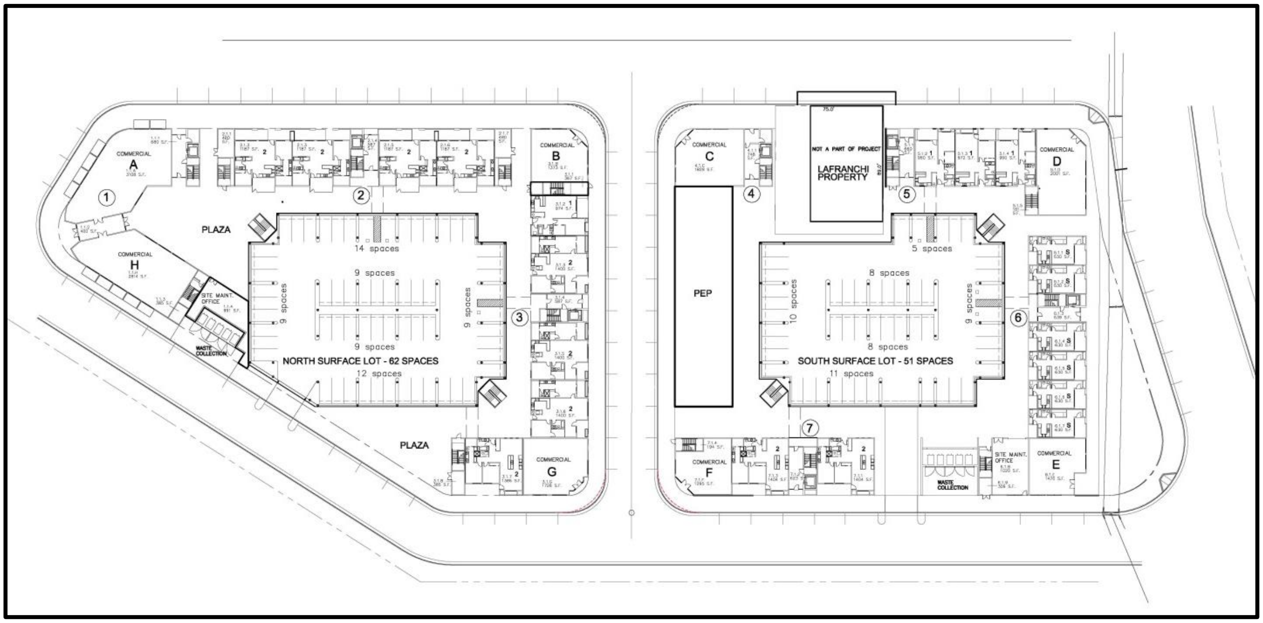


Figure 1: Project Site and First Floor Plan

REGULATORY BACKGROUND

STATE OF CALIFORNIA

<u>2010 California Building Code, Title 24, Part 2.</u>

The State of California establishes exterior sound transmission control standards for new hotels, motels, dormitories, apartment houses, and dwellings other than detached single-family dwellings as set forth in the 2010 California Building Code (Chapter 12, Section 1207.11). Interior noise levels attributable to exterior environmental noise sources shall not exceed 45 dBA L_{dn} in any habitable room. When exterior noise levels (the higher of existing or future) where residential structures are to be located exceed 60 dBA L_{dn} , a report must be submitted with the building plans describing the noise control measures that have been incorporated into the design of the project to meet the noise limit.

2010 California Building *Cal Green* Code, Title 24, Part 11[1]

The Green Building Standards of the State of California Code of Regulations (Title 24, Part 11) establishes mandatory exterior sound transmission control standards for new non-residential buildings as set forth in the 2010 California Green Building Standards Code Sections 5.507.4.1 and 5.507.4.2 Exterior noise transmission as follows[2]:

5.507.4.1 Exterior noise transmission, prescriptive method. Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 in the following locations:

1. Within the 65 CNEL noise contour of an airport.

Exceptions:

1. L_{dn} or CNEL for military airports shall be determined by the facility Air Installation Compatible Land Use Zone (AICUZ) plan.
2. L_{dn} or CNEL for other airports and heliports for which a land use plan has not been developed shall be determined by the local general plan noise element.

2. Within the 65 CNEL or L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source as determined by the Noise Element of the General Plan.

5.507.4.1.1 Noise exposure where noise contours are not readily available. Buildings exposed to a noise level of 65 dB L_{eq}-1-hr during any hour of operation shall have exterior wall and roof-ceiling assemblies exposed to the noise source meeting a composite STC rating of at least 45 (or OITC 35), with exterior windows of a minimum STC of 40 (or OITC 30).

5.507.4.2 Performance method. For buildings located as defined in Sections A5.507.4.1 or A5.507.4.1.1, wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level (L_{eq}-1Hr) of 50 dBA in occupied areas during any hour of operation.

5.507.4.2.1 Site features**.** Exterior features such as sound walls or earth berms may be utilized as appropriate to the project to mitigate sound migration to the interior.

5.507.4.2.2 Documentation of compliance. An acoustical analysis documenting complying interior sound levels shall be prepared by personnel approved by the architect or engineer of record.

CITY OF PETALUMA

Health & Safety Element of the 2025 General Plan

Section 10.2 of the City of Petaluma's Health and Safety Element includes objectives and policies applicable to noise and land use concerns at the project. The City's objective is to, "Protect public health and welfare by eliminating or minimizing the effects of existing noise problems, and by minimizing the increase of noise levels in the future." Multi-family residential land uses are considered "normally acceptable" up to 65 dBA L_{dn}, "conditionally unacceptable" up to 70 dBA L_{dn}, "normally unacceptable" up to 75 dBA L_{dn}, and "clearly unacceptable" above 75 dBA L_{dn} The following policies support the City's goal.

[1] Including changes effective July 1, 2012.

[2] Exception: Buildings with few or no occupants and where occupants are not likely to be affected by exterior noise, as determined by the enforcement authority, such as factories, stadiums, storage, enclosed parking structures and utility buildings.

Policies related to community noise are set forth in Section 10.2 of the Health & Safety Chapter of the City of Petaluma 2025 General Plan. The following discussion summarizes the policies and programs applicable to this project.

Policy 10-P-3: Protect public health and welfare by eliminating or minimizing the effects of existing noise problems, and by minimizing the increase of noise levels in the future.

A. Continue efforts to incorporate noise considerations into land use planning decisions, and guide the location and design of transportation facilities to minimize the effects of noise on adjacent land uses.
B. Discourage location of new noise-sensitive uses, primarily homes, in areas with projected noise levels greater than 65 dB CNEL. Where such uses are permitted, require incorporation of mitigation measures to ensure that interior noise levels do not exceed 45 dB CNEL.
C. Ensure that the City's Noise Ordinance and other regulations:
   - Require that applicants for new noise sensitive development in areas subject to noise levels greater than 65 dB CNEL obtain the services of a professional acoustical engineer to provide a technical analysis and design of mitigation measures.
   - Require placement of fixed equipment, such as air conditioning units and condensers, inside or in the walls of new buildings or on roof-tops of central units in order to reduce noise impacts on any nearby sensitive receptors.
   - Establish appropriate noise-emission standards to be used in connection with the purchase, use, and maintenance of City vehicles.
D. Continue to require control of noise or mitigation measures for any noise-emitting construction equipment or activity.

   The City's Noise Ordinance establishes controls on construction-related noise.
E. As part of development review, use Figure 10-2: Land Use Compatibility Standards (see Figure 1) to determine acceptable uses and installation requirements in noise-impacted areas.
F. Discourage the use of sound walls anywhere except along Highway 101 and/or along the NWPRA corridor, without findings that such walls will not be detrimental to community character. When sound walls are deemed necessary, integrate them into the streetscape.
G. In making a determination of impact under the California Environmental Quality Act (CEQA), consider an increase of four or more dBA to be "significant" if the resulting noise level would exceed that described as normally acceptable for the affected land use in Figure 10-3: Land Use Compatibility for Community Noise Environments.

City of Petaluma Zoning Ordinance

Section 21.040 A of the City of Petaluma Zoning Ordinance performance standards contains the following Noise Regulations which are generally applicable to operational (non-traffic) related noise in the City: The ordinance limits noise-generating construction activities to the hours of 7:00 AM to 10:00 PM on weekdays and 9:00 AM and 10:00 PM on weekends and holidays. The noise ordinance generally establishes daytime and nighttime hourly average noise levels of 60 dBA as the maximum that may be generated on one land use that would be affecting another land use.

Groundborne Vibration

The City of Petaluma has not identified quantifiable vibration limits that can be used to evaluate the compatibility of land uses with the expected vibration environment, however the Federal Transit Administration (FTA) has established vibration impact criteria to evaluate the land use compatibility along railroad lines. The FTA[1] vibration impact criteria has been developed to

[1] U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment, May 2006, FTA-VA-90-1003-06.

assess vibration impacts associated with rapid transit projects based on maximum overall levels for a single event. The criteria for groundborne vibration impact are shown in Table 4. Note that there are criteria for frequent events (more than 70 events per day), occasional (between 30 and 70 events per day) and infrequent events (less than 30 events per day).

Table 4: Groundborne Vibration Impact Criteria

Land Use Category	Vibration Impact Limits (VdB re: 1 µin./sec, RMS)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events [3]
Category 1: Buildings where low ambient is essential for interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB

Notes:
1. "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events per day. This category includes most commuter rail systems.
4. This limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes.

SUPPLEMENTAL SLEEP DISTURBANCE CRITERIA

Though the City, and State noise criteria are typically sufficient to achieve an acceptable interior noise environment with common environmental noise source, when dealing with loud intermittent noise sources, such as the sounding of train horns near railroad tracks, achieving a CNEL/ L_{dn} of 45 dBA within homes may still result in maximum noise levels within interiors great enough to result in significant sleep disturbance. Studies have been undertaken to determine the effect of short term maximum noise levels on sleep disturbance. The conclusions of these studies typically give a probability of sleep disturbance related to the maximum noise level of the event at the sleep location and the duration of the event. A review of sleep disturbance study data shows that limiting maximum noise levels to 55 dBA within sleeping rooms will limit the probability of waking residents at the subject project when trains pass the site to less than five percent per occurrence[1]. Therefore, the adopting an interior sound level criterion limiting maximum noise levels to 55 dBA within bedrooms at the project is recommended.

EXISTING NOISE ENVIRONMENT

The project site is currently undeveloped. The major source of noise affecting the site is vehicular and transit traffic on the surrounding roadways. Industrial noise from Jerico Products southeast of the site and loading dock activity at the grocery store to the southwest also contributes to background noise on the project site. The North West Pacific Railroad (NWPRR) line, which parallels

FIGURE 2: PROJECT SITE AND SURROUNDINGS

[1] Kryter Karl D., The effects of Noise on Man, Second Edition, Academic Press, Inc. London, 1985, p.444-446

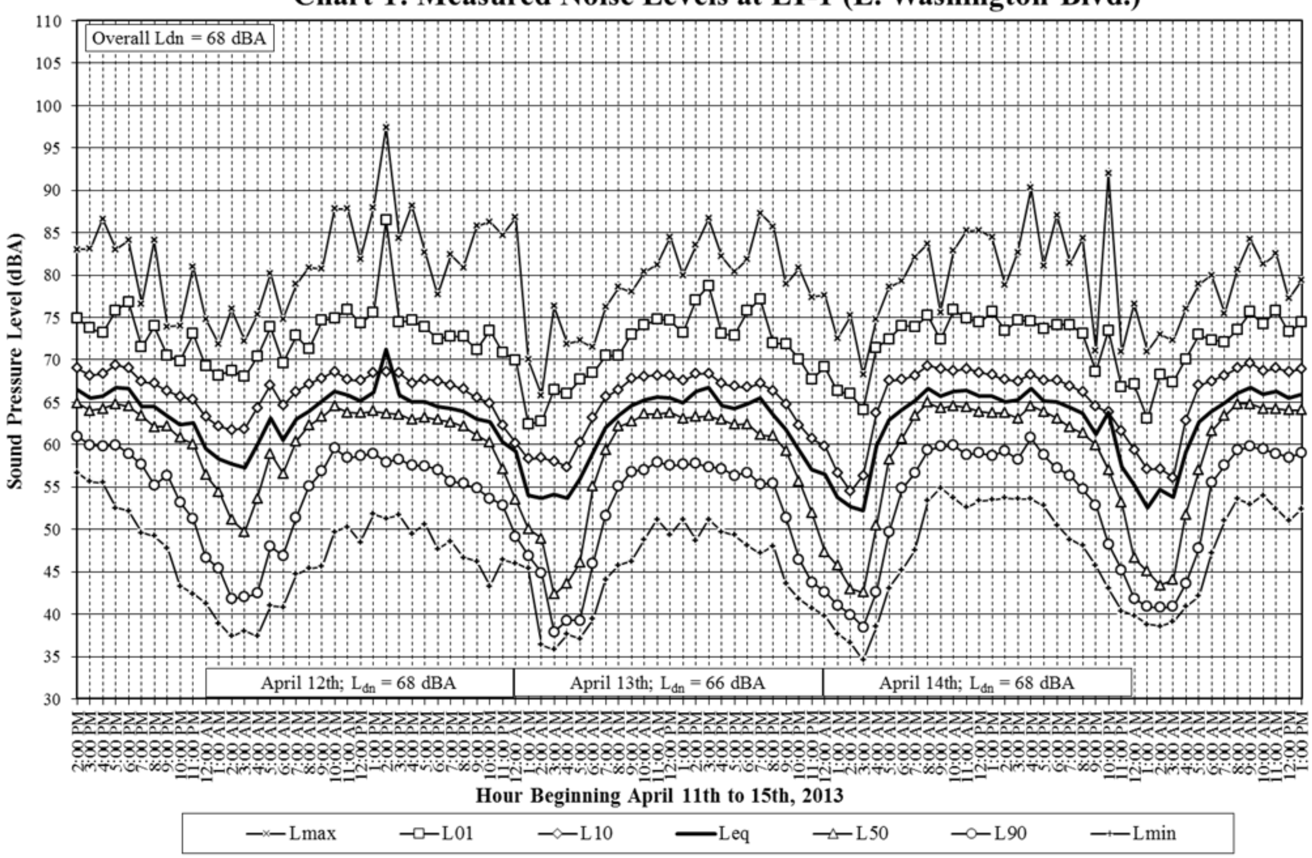
Copeland Street to the north of the site currently is used for limited freight operations, in the future (late 2016), this rail line may be used by the Sonoma-Marin Area Rail Transit (SMART) district for commuter rail service.

To evaluate the noise environment at the site due to the existing noise sources two long-term noise measurements were made. The long-term measurements were conducted in a tree 90 feet from the centerline of East Washington Street (LT-1) and on a utility pole at 50 feet from the centerline of East D Street (LT-2). These measurement locations are shown in Figure 2.

The measurement at location LT-1, adjacent to East Washington Street was conducted between 2 p.m. Friday, April 11th and 2 p.m. Tuesday, April 15th, 2014. The primary source of noise at this location was traffic on East Washington Street. The hourly trend in noise levels at the measurement site including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise level exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) is shown in Chart 1. A review of Chart 1 shows that average (L_{eq}) noise levels ranged from 61 to 71 dBA daytime and 52 to 64 dBA nighttime. The overall average daytime and nighttime L_{eq} levels were found to be 65 and 60 dBA, respectively. The L_{dn} measured at this location was calculated to be 68 dBA.

The residential facades of the East Washington Street project frontage will be positioned at about 50 feet from the roadway centerline. Based on typical sound increases with decreased distance to a traffic noise source, the sound levels at these closest residential facades are expected to be 2 dBA higher than those at the long term monitoring position. Thus, the existing L_{dn} at the residential facades on the East Washington Street project will be 70 dBA.

Chart 1: Measured Noise Levels at LT-1 (E. Washington Blvd.)

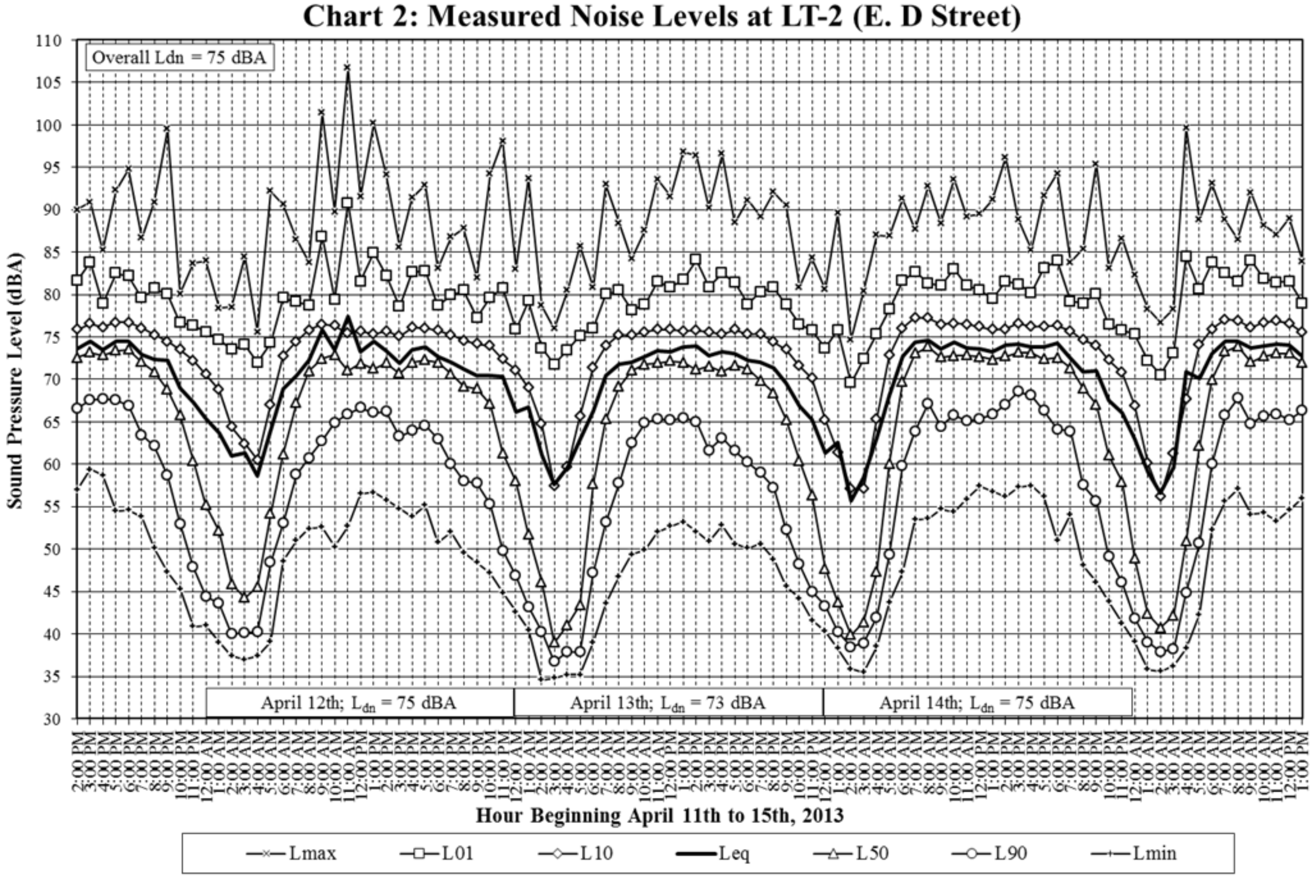


The measurement at location LT-2, adjacent to East D Street, was conducted between 2 p.m. Friday, April 11th and 2 p.m. Tuesday, April 15th, 2014. The primary source of noise at this location was traffic along East D Street. Activities at the Jerico Products plant, where not distinctly measurable over traffic noise contributions. The hourly trend in noise levels at the measurement site including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise level exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) is shown on Chart 2. A review of Chart 2 shows that average (L_{eq}) noise levels ranged from 70 to 77 dBA daytime and 56 to 73 dBA nighttime. The overall average daytime and nighttime L_{eq} levels were found to be 73 and 67 dBA, respectively. The L_{dn} measured at this location was calculated to be 75 dBA.

The closest residential facades to D Street will be positioned between 45 and 85 feet from the roadway centerline. Based on typical sound increase or decrease with distance changes, the sound levels at the closest of these residential facades are expected to be equal to be equal to that measured at the long term monitoring position, and the sound levels at the farthest of these residential facades are expected to be 2 dBA lower than those at the long term monitoring position. Thus, the existing L_{dn} at the residential facades closest to East D Street will be between 73 and 75 dBA.

Noise measurements along Copeland and Weller Streets were not conducted during this noise survey, however based on the findings of I&R's previous noise survey for the project site[1], L_{dn} levels on Copeland Street are about 2 dBA lower and L_{dn} levels on Weller Street are about 7 dBA lower than those at LT-1. Thus, existing noise levels on Copeland Street are about 66 dBA L_{dn}, and those along Weller Street are about 61 dBA L_{dn}.

Chart 2: Measured Noise Levels at LT-2 (E. D Street)



[1] Environmental Noise Assessment, Haystack mixed-use project , September 8, 2008

FUTURE NOISE ENVIRONMENT

Railroad Noise

The North West Pacific Railroad (NWPRR) has at-grade crossings at Washington and East D-Streets approximately 480 feet northwest and northeast of the site, with the proposed Downtown Petaluma Station located between Washington and East D-Streets north of the site. These tracks currently carry limited freight traffic and will carry SMART commuter rail traffic in the future (estimated to begin in late 2016). It is anticipated that noise levels from individual SMART trains would fall somewhere between the noise generated by a BART train and the noise generated by a traditional diesel-powered train. According to the SMART DEIR (page 2-13), the future usage of the rail line at the downtown Petaluma Station could include a total of 28 trans per day (14 northbound and 14 southbound) with a service frequency of 30 minutes in peak periods. We have calculated the noise contours adjacent to the NWPRR line using the Federal Railroad Administration (FRA) Grade Crossing Noise Model. To complete the model, the SMART trains were assumed to run on 30-minute intervals between 6:00 AM to 9:00 AM (during the morning commute) and between 5:00 PM and 8:00 PM (during the evening commute), with trains running less frequently during the daytime hours. We have determined that the future 65 dBA L_{dn} contour at the grade crossing will be at 255 from the track centerline and 180 feet from the track centerline beyond 660 feet from the crossings, using the following factors:

1. The FRA's recommended train horn noise dissipation (attenuation) rate of 4.5 decibels when the distance from the train is doubled,
2. The FRA requirement that a locomotive horn must be sounded 15 to 20 seconds prior to and until the train arrives at the crossing, and
3. The restriction that the horn should not be sounded greater than ¼ mile in advance of a grade crossing,

Therefore, the project site would be exposed to an L_{dn} of less than 65 dBA due to possible future rail traffic on the NWPRR line.

Though the average noise levels (i.e. L_{dn}) from train operations will be within General Plan noise standard, the northern and eastern facades of the project (facing, or with a view of, the rail line) will be exposed to high maximum noise levels of between 90 and 92 dBA from horns sound by trains using the grade crossings.

Roadway Traffic Noise

The future exterior noise environment on the roadway frontages would continue to result from traffic along the adjacent roadways. To assess the future noise environment along the roadways, we have assumed that future traffic volumes along the roadway would increase by about 1-2% per year as a result of general growth throughout the City. Based on this future traffic volume estimate, the future noise environment would be approximately 1 decibel higher than existing noise levels. Thus, exterior noise levels due to roadway traffic under future conditions would be between 74 and 76 dBA L_{dn} at the project facades facing East D Street, 71 dBA L_{dn} at the project facades facing Washington Street, 67 dBA L_{dn} at the project facades facing Copeland Street, and 62 dBA L_{dn} at the project facades facing Weller Street

Adjacent Industrial and Commercial Noise

Jerico Products located southeast of the site is a well-established use and is expected to continue operations for the foreseeable future. However, based on the results of site measurements, in which noise from this operation only contributed to background noise levels on the East D Street project site frontage, it may be assumed that this use will continue to be a minor noise source on the project site under future conditions. The loading dock of the grocery store to the southwest of the site along Weller Street, would also be expected to continue to contribute to the overall noise environment. Other, more distant, industrial uses in the project vicinity would also be expected to continue to contribute to the background noise environment.

Railroad Induced Vibration
Information provided in the Draft EIR for the SMART project indicates that at distances between 20 and 100 feet from the tracks, vibration levels may be perceptible; however, they are expected to produce a RMS vibration velocity of less than 0.01 inches per second, which equates to a level of 68 VdB level. This level is less than the applicable FTA impact significance criteria for residential uses.

NOISE ASSESSMENT

NOISE AND LAND USE COMPATIBILITY

Our review of the project plans shows mixed use commercial/residential/senior services uses on the first level and residential and senior housing uses on the second through fourth levels. The project also incorporates a central roadway between Weller and Copeland Streets which divides the site into two blocks. Residential/commercial and senior living uses in each of these blocks face toward area roadways, with each of these blocks arranged around central surface parking lots and outdoor use areas. Based on the results of our noise measurement survey and estimates of future noise levels, residences adjacent to East D Street will be exposed to an Ldn of between 74 and 76 dBA, residences adjacent to Weller Street will be exposed to an Ldn of 62 dBA, residences adjacent to Washington Street will be exposed to an Ldn of 71 dBA, and residences adjacent to Copeland Street will be exposed to an Ldn of 67 dBA. Residences adjacent to the central roadway between Weller and Copeland Streets will be exposed to Ldn levels of between 62 dBA and 67 dBA depending on their proximity to these roadways.

Residences adjacent to East D, Copeland and East Washington Streets may also be exposed to high maximum noise levels of between 90 and 92 dBA from horns of SMART and/or freight trains approaching the East D and East Washington Street grade crossings. Other residential facades, without direct views of passing trains, will experience lower maximum noise from train horns due to the effect of building shielding.

Residential Outdoor Use Area Noise Control

The building plans indicate that the outdoor use area for the residential uses will be in central common space areas at the second floor level over the courtyards over the central surface parking lots. Based on this site layout, noise levels within these common area will be consistent with the allowable outdoor noise exposure allowed under the City's General Plan. Individual residences may also have private outdoor decks or patios facing the perimeter roadways. While these areas would not be noise protected, like the interior courtyards, the Central Petaluma Specific Plan states (on page 76) that, "The City recognizes that meeting the outdoor goal on private decks and patios in the Central Petaluma Area is not feasible and does not apply these standards to private decks and patios in multi-family developments."

Residential Interior Noise Control

The residential facades adjacent to roadway traffic may be exposed to an Ldn of between 62 and 76 dBA under future conditions. Typical wood frame construction techniques with standard thermal insulating glass in moderately sized (less than one-third of the exterior wall area) closed windows will reduce traffic noise levels by about 25 dBA. When windows are opened, traffic noise attenuation from exterior to interior is reduced to an average of 15 dBA. Based on this average exterior to interior noise attenuation, interior levels in the apartments on the site perimeter would be between 37 and 51 dBA Ldn with standard windows closed and 47 and 61 dBA Ldn with windows open. Interior noise levels within new residential units are required by the City of Petaluma to be maintained at or below 45 dBA Ldn. Therefore, all perimeter residential units, adjacent to East Washington, East D, Copeland, or Weller Streets, will need to have closed windows to achieve the interior standard to achieve the City's interior noise goal, but only residences adjacent to East Washington, East D Streets would require the incorporation of sound rated construction techniques or materials at the unit exteriors to meet the 45 dBA Ldn interior noise standard.

However, though typical building construction techniques will be sufficient to maintain acceptable average day/night noise levels within the future residential uses along Copeland Street, high maximum noise levels from train horns would be expected to exceed an interior maximum levels of 55 dBA without the incorporation of noise insulation features in the project design. All residential bedrooms which will have a direct view of passing trains (primarily on the northern and eastern project façades of the buildings, but there could be others), will require sound rated windows and construction methods necessary to provide 35 to 37 dBA of noise reduction from exterior to interior. The STC ratings for each of these exterior façade components will vary based on percentage of the overall area each comprises. However, sound isolation ratings of windows and doors will need to generally need to be between 35 STC and 38 STC to meet the required degree of sound isolation.

All perimeter residences should also be equipped with mechanical ventilation capable of supplying the fresh air needs of the residents while exterior windows and doors are closed to allow a habitable interior environment within the residences while keeping windows and doors closed for the purpose of noise control. In our experience a central air-conditioning and heating system, or a central heating system equipped with a "summer switch" which allows the fan to circulate air without the heater on, which is designed to provide a habitable interior environment with the windows closed will meet this requirement.

When final building plans and elevations are available for the project, an acoustical consultant should be retained to determine the needed window STC ratings necessary to achieve the 55 dBA Lmax and 45 dBA Ldn interior noise limits.

Non-Residential Uses

Future noise levels at facades of the project buildings facing East D, Copeland and East Washington Streets will exceed 65 dBA L_{dn}. Following the State of California *Cal Green* Building Code standard, exterior sound transmission control must be incorporated in the design of these buildings using either the prescriptive (section 5.507.4.1) or performance (section 5.507.4.2) analysis methods.

If the prescriptive method is chosen the wall and roof-ceiling assemblies facing these roadways shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40 and exterior windows on the eastern façade should have a minimum STC rating of 40 or minimum OITC rating of 30.

Under the performance method wall, window and roof-ceiling assemblies facing these roadways need to be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level (L_{eq}-1Hr) of 50 dBA in occupied areas during any hour of operation. Because typical building construction techniques with standard thermal insulating glass windows may achieve this rating without sound rated assemblies, the applicant would likely prefer this method. If the performance method is used, once building plans and elevations are available for these buildings they should be reviewed by a qualified acoustical professional to determine compliance with the State Building Code.

PROJECT OPERATIONAL NOISE GENERATION

The proposed project would place new and commercial uses in a commercial and industrial area away from ant noise sensitive residential uses. The occupation and use of the proposed project is expected to result in the typical noises associated with urban residential and commercial development, including voices of the new residents, home maintenance activities, barking dogs and children. Though the noise environment may change noticeably in some areas adjacent to the site due to the occupation of the new residences, the noise associated with the proposed residential and commercial uses would be compatible with the surrounding land uses.

EXPOSURE TO RAILROAD RELATED GROUNDBORNE VIBRATION

As previously discussed, Information provided in the Draft EIR for the SMART project indicates that at distances between 20 and 100 feet from the tracks, rail vibration levels may be perceptible, but would be less than the applicable FTA impact significance criteria for residential uses. The closest multifamily residences are proposed over 500 feet from the track centerline. At this distance rail vibration levels may be perceptible, but would be less than the applicable FTA impact significance criteria for residential uses.

CONSTRUCTION VIBRATION

Construction activities which result in the greatest amount of groundborne vibration are those which occur during site preparation and foundations work such as excavation, grading, utility installation and foundation work. The current design calls for shallow foundations and drilled/drilled-displacement piers as needed to support the parking structures. Construction techniques that generate the highest vibration levels, such as impact or vibratory pile driving, are not expected at this project. Wick drains may be used to provide drainage paths at the site. Wick drains are typically pushed hydraulically, and not driven via impacts into the soil using a crane and boom, resulting in relatively low noise and vibration levels.

The vibration source levels for the expected construction activities on the site are expected to be less than 0.5 in/sec PPV at 25 feet. Construction activities would occur at distances of more than 200 feet from the nearest vibration sensitive (residential) use[1]. Considering accepted distance attenuation for vibratory energy[2], the groundborne vibration levels at the 200 feet would be at or below a level of 0.05 in/sec PPV. Considering this level the vibration levels produced by project construction would not result in any impact on surrounding vibration sensitive uses

CONSTRUCTION NOISE

The construction of the project would generate noise and would temporarily increase noise levels in the project area. Noise impacts resulting from construction depend on the noise generated by various pieces of construction equipment operating on site, the timing and duration of noise generating activities, and the distance between construction noise sources and noise sensitive receptors. Construction of the project would involve removal of existing structures and pavement, site excavation and foundation work, building erection, paving, and landscaping. The hauling of excavated material and construction materials would also generate truck trips on local roadways. Construction activities are typically carried out in stages. During each stage of construction, there would be a different mix of equipment operating. Construction noise levels would vary by stage and vary within stages based on the amount of equipment in operation and location where the equipment is operating. Most demolition and construction noise is in the range of 80 to 90 dBA at a distance of 50 feet from the source.

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[1] The closest residential use appears to be in a mixed use building at the northeast corner of the E. Washington and Baylis Street intersection

[2] $PPV_{receiver} = PPV_{source} (25/D)^n$ (in/sec), where:
PPVsource=source level at 25 ft, D=distance from source to the receiver (ft), & n=1.1 (ground attenuation rate).

As discussed above the nearest noise sensitive uses will be 200 feet from the closest project construction activities. Average noise levels at this distance during busy construction periods would be expected to range from 68 to 78 dBA. Based on the results of our noise measurements along E. Washington Street, we expect existing daytime noise levels at this noise sensitive use to be between 63 and 73 dBA. Intervening structures or terrain would result in lower noise levels, especially for activities below grade. The closest residences would, therefore be intermittently exposed to high levels of noise throughout the construction period. However, noise impacts do not generally occur when major construction activities do not exceed the ambient noise environment by 5 dBA L_{eq} for a period greater than one construction season (typically one year). The range of construction noise presented above would not exceed the ambient noise environment by 5 dBA at the closest sensitive uses. Additionally, busy (i,e, loud) construction activities are expected to occur for less than one construction season. Considering this, noise from project construction would not result in any impact on the nearest noise sensitive use.

APPENDIX A:
FUNDAMENTAL CONCEPTS OF ENVIRONMENTAL ACOUSTICS

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound may be caused by either its *pitch* or its loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales that are used to describe noise in a particular location. *A decibel (dB)* is a unit of measurement that indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1. There are several methods of characterizing sound. The most common in California is the *A-weighted sound level or dBA.* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2.

Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level, CNEL,* is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level, Ldn,* is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period

TERM	DEFINITIONS
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Day/Night Noise Level, Ldn	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Definitions Of Acoustical Terms **Table 1**

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At a Given Distance From Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100')	130		
Jet Takeoff (200')	120		Pain Threshold
	110	Rock Music Concert	
	100		Very Loud
Diesel Pile Driver (100')	90	Boiler Room Printing Press Plant	
	80		
Freight Cars (50') Pneumatic Drill (50') Freeway (100')	70	In Kitchen With Garbage Disposal Running	Moderately Loud
Vacuum Cleaner (10')	60	Data Processing Center	
	50	Department Store	
Light Traffic (100')	40	Private Business Office	Quiet
Large Transformer (200')	30	Quiet Bedroom	
	20	Recording Studio	
Soft Whisper (5')	10		Threshold of Hearing
	0		

Typical Sound Levels Measured In The Environment And Industry — **Table 2**

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Effects of Noise

Sleep and Speech Interference: The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noise of sufficient intensity; above 35 dBA, and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA Ldn. Typically, the highest steady traffic noise level during the daytime is about equal to the Ldn and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12-17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57-62 dBA Ldn with open windows and 65-70 dBA Ldn if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

Annoyance: Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The Ldn as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 55 dBA Ldn. At an Ldn of about 60 dBA, approximately 2 percent of the population is highly annoyed. When the Ldn increases to 70 dBA, the percentage of the population highly annoyed increases to about 12 percent of the population. There is, therefore, an increase of about 1 percent per dBA between an Ldn of 60-70 dBA. Between an Ldn of 70-80 dBA, each decibel increase increases by about 2 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the Ldn is 60 dBA, approximately 10 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 2 percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a 3 percent increase in the percentage of the population highly annoyed.

APPENDIX B:
FUNDAMENTALS OF GROUNDBORNE VIBRATION

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One is the Peak Particle Velocity (PPV) and another is the Root Mean Square (RMS) velocity. The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. The RMS velocity is defined as the average of the squared amplitude of the signal. The PPV and RMS vibration velocity amplitudes are used to evaluate human response to vibration. In this section, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous vibration levels produce. The annoyance levels shown in Table 1 should be interpreted with care since vibration may be found to be annoying at much lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying.

TABLE 1: Reaction of People and Damage to Buildings for Continuous Vibration Levels

Vibration Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.006 to 0.019	Threshold of perception, Possibility of intrusion	Vibration unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibrations begin to annoy people	Virtually no risk of “architectural” damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk of “architectural” damage to normal dwellings such as plastered walls or ceilings.
0.4 to 0.6	Vibrations considered unpleasant by people subjected to continuous vibrations	Vibration at this level would cause “architectural” damage and possibly minor structural damage.

Source: Transportation Related Earthborne Vibrations (Caltrans Experiences), Technical Advisory, Vibration TAV-02-01-R9601, California Department of Transportation, February 20, 2002.

Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage. In high noise environments, which are more prevalent where groundborne vibration approaches perceptible levels, this rattling phenomenon may also be produced by loud airborne environmental noise causing induced vibration in exterior doors and windows.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generate the highest construction related ground-borne vibration levels. Because of the impulsive nature of such activities, the use of the peak particle velocity descriptor (PPV) has been routinely used to measure and assess ground-borne vibration and almost exclusively to assess the potential of vibration to induce structural damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life are evaluated against different vibration limits. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 in/sec PPV. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels such as people in an urban environment may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to the building. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.