Construction Noise & Vibration Assessment

Grant Street Residential Development

Calistoga, California

BAC Job # 2021-057

Prepared For:

De Nova Homes

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Introduction

The Grant Street Residential Development (project) is a single-family residential development located at 2008 Grant Street in Calistoga, California. The project proposes the construction of 15 single-family residential lots on land currently undeveloped. The project area and site plan are shown on Figures 1 and 2, respectively.

Due to the potential for elevated construction noise and vibration levels at nearby existing residential uses, Bollard Acoustical Consultants, Inc. (BAC) was retained by the project applicant to prepare this assessment. Specifically, the purposes of this assessment are to quantify noise and vibration generated by on-site construction activities at nearby existing residential uses, and to compare those levels against the applicable City of Calistoga noise and vibration criteria for residential uses.

Noise Fundamentals and Terminology

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. If the pressure variations occur frequently enough (at least 20 times per second), they can be heard, and thus are called sound. Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dB. Another useful aspect of the decibel scale is that changes in levels (dB) correspond closely to human perception of relative loudness. Appendix A contains definitions of Acoustical Terminology. Figure 3 shows common noise levels associated with various sources.

The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by weighing the frequency response of a sound level meter by means of the standardized A-weighing network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels in decibels.

Community noise is commonly described in terms of the “ambient” noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent, sound level (L_{eq}) over a given time period (usually one hour). The L_{eq} is the foundation of the Day-Night Average Level noise descriptor, L_{dn} or DNL, and shows very good correlation with community response to noise. The median noise level descriptor, denoted L_{50}, represents the noise level which is exceeded 50% of the hour. In other words, half of the hour ambient conditions are higher than the L_{50} and the other half are lower than the L_{50}.

Legend

Project Area Boundary (Approximate)

N

Scale (Feet)

0 75 150

Grant Street Residential Development
Calistoga, California

Project Area

Figure 1

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Legend

Project Area Boundary

N

Scale (Feet)

0 40 80

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Project Site Plan

Figure 2

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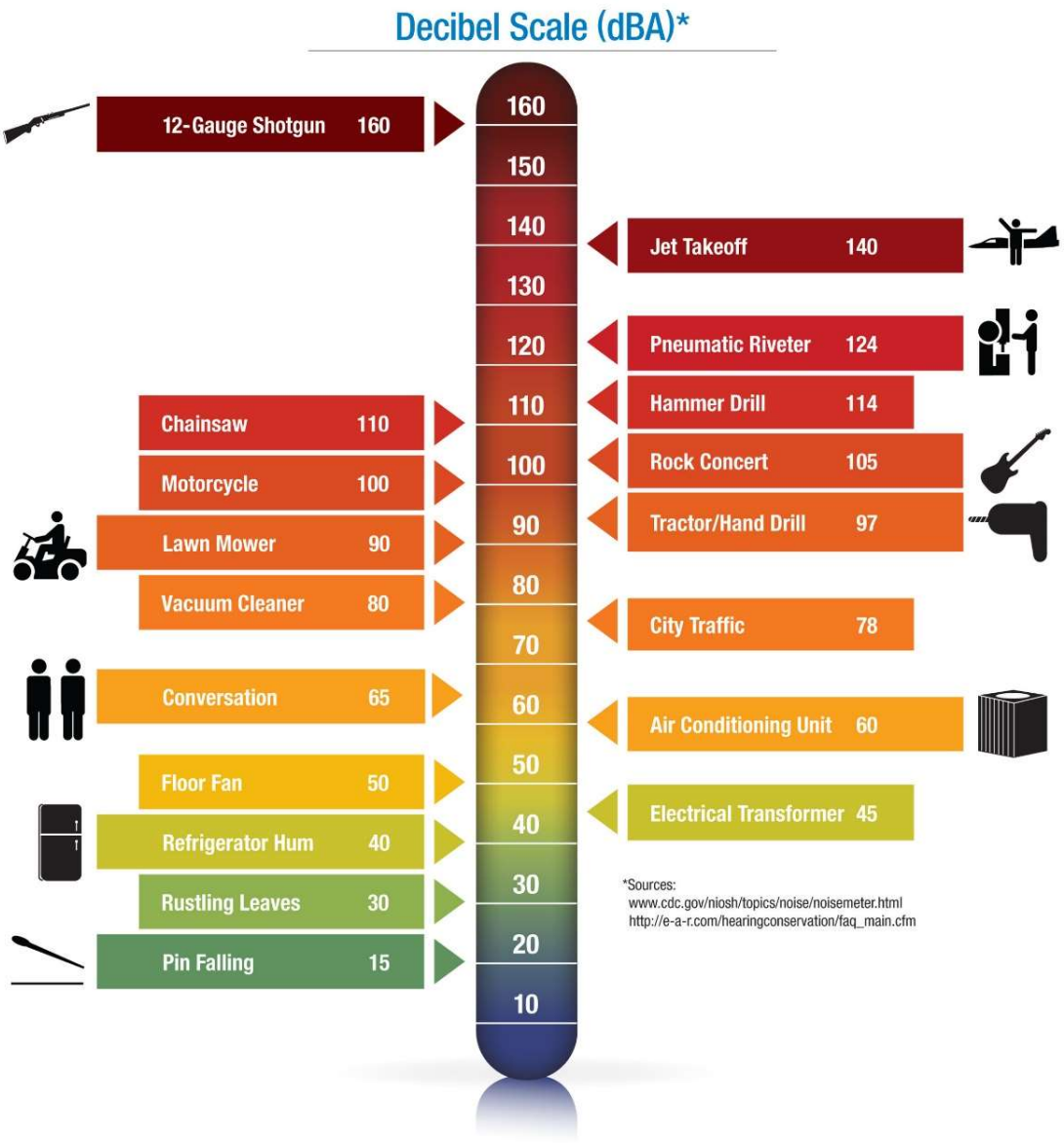
Figure 3
Noise Levels Associated with Common Noise Sources



DNL is based upon the average noise level over a 24-hour day, with a +10-decibel weighting applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because DNL represents a 24-hour average, it tends to disguise short-term variations in the noise environment. DNL-based noise standards are commonly used to assess noise impacts associated with traffic, railroad, and aircraft noise sources.

Criteria for Acceptable Noise & Vibration Exposure

Noise

Calistoga General Plan

The Noise Element (Chapter 10) of the Calistoga General Plan establishes land use compatibility guidelines for noise exposure based on land use type. For residential uses, such as those located adjacent to the project site, the General Plan establishes an exterior noise level standard of 60 dB L_{dn} (or DNL) at outdoor activity areas (rear yards) as normally acceptable. In addition, the General Plan guidelines identify exterior noise levels of up to 75 dB DNL as conditionally acceptable for residential uses.

Calistoga Municipal Code

The Calistoga Municipal Code contains specific noise criteria for construction activity noise within the city. The code section containing those criteria is presented below.

8.20.025 Construction activity – Noise – Prohibited hours.

A. It shall be unlawful for professional construction activity to occur on Sunday or between 7:00 p.m. and 7:00 a.m., any time during the week.

B. For the purpose of this chapter "professional construction activity" shall mean construction by any person other than:

   1. An individual homeowner working on that person's primary residence;

   2. A public utility in response to an emergency situation; or

   3. City public works crew in response to an emergency situation or scheduled maintenance.

Vibration

California Department of Transportation (Caltrans)

The City of Calistoga does not currently have adopted standards for groundborne vibration. As a result, the vibration impact criteria developed by the California Department of Transportation (Caltrans) was applied to the project. The Caltrans criteria applicable to damage and annoyance from transient and continuous vibration typically associated with construction activities are presented in Tables 1 and 2. Equipment or activities typical of continuous vibration include: excavation equipment, static compaction equipment, tracked vehicles, vibratory pile drivers, pile-extraction equipment, and vibratory compaction equipment. Equipment or activities typical of single-impact (transient) or low-rate repeated impact vibration include impact pile drivers, blasting, drop balls, "pogo stick" compactors, and crack-and-seat equipment (California Department of Transportation 2013).

Table 1
Guideline Vibration Damage Potential Threshold Criteria

Structure and Condition	Maximum PPV (inches/second)	
	Transient Sources	Continuous/Frequent Intermittent Sources
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.20	0.10
Historic and some old buildings	0.50	0.25
Older residential structures	0.50	0.30
New residential structures	1.00	0.50
Modern industrial/commercial buildings	2.00	0.50

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.
PPV = Peak Particle Velocity
Source: Caltrans Transportation and Construction Vibration Guidance Manual (2013)

Table 2
Guideline Vibration Annoyance Potential Criteria

Human Response	Maximum PPV (inches/second)	
	Transient Sources	Continuous/Frequent Intermittent Sources
Barely perceptible	0.40	0.01
Distinctly perceptible	0.25	0.04
Strongly perceptible	0.90	0.10
Severe	2.00	0.40

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent intermittent sources include pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.
PPV = Peak Particle Velocity
Source: Caltrans Transportation and Construction Vibration Guidance Manual (2013).

Evaluation of Project-Generated Construction Noise

Section 8.20.025 of the Calistoga Municipal Code establishes criteria to minimize the temporary noise impacts associated with construction, such as limitations on the time of day and week when construction activities are acceptable. Construction of the project would result in temporary noise disturbances that could potentially impact nearby sensitive receptors due to the site's proximity to surrounding existing residential uses. According to the project applicant (DeNova Homes, Inc.), construction activities are estimated to occur in the phasing identified in Table 3.

Table 3
Construction Sequence Description

Phase #	Phase Summary
1	Demolition and tree removal
2	Land development (grading, utilities, concrete, paving)
3	Home construction

Noise generated during construction would vary depending on the construction phase and the type and amount of equipment used at the construction site. Construction activities that would generate noise include site grading, excavation, hauling and deliveries, foundation work, and to a lesser extent framing, and exterior and interior finishing. The highest noise levels would be generated during grading of the site, with lower noise levels occurring during building construction and finishing. No pile driving, jack hammering, or extensive work that would generate substantial groundborne vibration is anticipated. Table 4 presents typical ranges of the energy-equivalent sound noise levels (L_{eq}) at distance of 50 feet, for domestic housing production.

Table 4
Typical Construction Phase Noise Levels

Construction Phase	Noise Level at 50 feet (dBA)
Foundations	81
Building Erection	81
Ground clearing	83
Excavation	88
Paving	88
Source: Federal Highway Administration (2006)	

The Table 4 data illustrates that construction of the project would increase ambient noise levels during all phases of construction activities. Noise would be generated by trucks delivering and recovering materials at the site, grading and paving equipment, saws, hammers, the radios and voices of workers, and other typical provisions necessary to construct a residential housing project.

When demolition, ground clearing, excavation, paving, and foundation work are occurring near adjacent residences, daytime noise levels can be expected to exceed existing noise levels at the nearest residences located approximately 30 to 50 feet from the project area. When construction occurs towards the interior of the site, noise levels at the surrounding existing residences will be reduced. Nonetheless, construction activities associated with the proposed development have the potential to result in temporary noise levels that would impact adjacent homes periodically over the course of the construction period. According to the project applicant, project construction will require approximately 18 months to complete and no pile driving, or other extraordinary noise-generating activities would occur.

Construction related noise impacts are typically only occasionally intrusive and cease once construction is complete. Nonetheless, to ensure that noise levels due to on-site construction activities are minimized, and to reduce the potential for an exceedance of applicable City of Calistoga day-night average (DNL) noise level criteria at nearby residential uses, the construction noise abatement measures outlined below should be implemented. Adherence to the construction noise abatement measures identified below, which goes beyond the construction-related requirements established in the City of Calistoga Municipal Code, will ensure that potential noise impacts due to the temporary exposure of sensitive receptors to excessive noise during construction are reduced to less than significant levels.

Due to the proximity of sensitive receptors to the project area, all construction activities should comply with the following noise abatement measures and be noted accordingly on construction contracts:

1. **Construction Hours/Scheduling:** The following are recommended to limit construction activities to the portion of the day when occupancy of the adjacent sensitive receptors is at the lowest:
    a. Pursuant to Calistoga Municipal Code Section 8.20.025(A), construction activities for all phases of construction, including servicing of construction equipment, shall not occur on Sundays or between 7:00 p.m. and 7:00 a.m., any time during the week.
    b. Delivery of materials or equipment to the site and truck traffic coming to and from the site should not occur during the restricted hours specified above in 1.a.

2. **Construction Equipment Mufflers and Maintenance:** All construction equipment powered by internal combustion engines should be properly muffled and maintained.

3. **Idling Prohibitions:** All equipment and vehicles should be turned off when not in use. Unnecessary idling of internal combustion engines should be prohibited.

4. **Equipment Location and Shielding:** All stationary noise-generating construction equipment, such as air compressors, should be located as far as practical from the adjacent residences. Such equipment should be acoustically shielded when it must be located within close proximity to adjacent residences.

5. **Quiet Equipment Selection:** Select quiet equipment, particularly air compressors, whenever possible. All noise-producing project equipment and vehicles using internal-combustion engines should be equipped with manufacturer-recommended mufflers and be maintained in good working condition. Electrically powered equipment should be used instead of pneumatic or internal-combustion-powered equipment, where feasible.

6. **Staging and Equipment Storage:** Material stockpiles and mobile equipment staging, parking, and maintenance areas should be located as far as practicable from noise-sensitive receptors.

7. **Equipment and Vehicle Movements:** Project area and site access road speed limits should be established and enforced during the construction period.

8. **Schedule Notification:** Nearby residences should be notified of construction schedules so that arrangements can be made, if desired, to limit their exposure to short-term increases in ambient noise levels.

9. **Noise Disturbance Coordinator:** The project developer should designate a "noise disturbance coordinator" who will be responsible for responding to any local complaints about construction noise. This individual would most likely be the contractor or a contractor's representative. 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. The telephone number for the disturbance coordinator should be conspicuously posted at the construction site.

Evaluation of Project-Generated Construction Vibration

During project construction, heavy equipment would be used for grading, excavation, paving, and building construction, which would generate localized vibration in the immediate vicinity of the construction. The nearest identified existing off-site structures are residences located approximately 30 feet from where construction activities could occur within the project area.

Table 5 includes the range of vibration levels for equipment commonly used in general construction projects at a distance of 25 feet. The Table 5 data also include projected equipment vibration levels at the nearest existing residences to the project area located approximately 30 feet away.

Table 5
Reference and Projected Vibration Source Amplitudes for Typical Construction Equipment

Equipment	Reference PPV at 25 Feet (in/sec)	Projected PPV at 30 Feet (in/sec)
Roller	0.210	0.160
Large bulldozer	0.089	0.068
Caisson drilling	0.089	0.068
Loaded trucks	0.076	0.058
Backhoe	0.051	0.039
Excavator	0.051	0.039
Grader	0.051	0.039
Loader	0.051	0.039
Small bulldozer	0.003	0.002
Paver	0.003	0.002

Source: 2018 FTA Transit Noise and Vibration Impact Assessment Manual and BAC calculations

As indicated in Table 5, vibration levels generated from on-site construction activities at the nearest sensitive structures located 30 feet away are projected to be well below the strictest Caltrans threshold for damage to residential structures of 0.30 in/sec PPV shown in Table 1.

Further, the projected vibration levels are well below the range for a "severe" human response as defined in the Caltrans guidelines for vibration annoyance presented in Table 2. Based on the analysis and results presented above, it is expected that on-site construction within the project area would not result in excessive groundborne vibration levels at nearby sensitive structures. Nonetheless, to reduce the potential for structural damage and human annoyance at nearby existing residential structures, the following specific construction vibration control measures are recommended:

1. **Vibration-Generating Equipment:** Use of heavy vibration-generating construction equipment, such as large vibratory rollers, should not be used within 30 feet of the nearest residences. The project contractor should use smaller vibratory rollers when compacting materials within the 30 foot setback distance.

2. **Dropping of Equipment**: The project should not drop heavy equipment within 30 feet of existing residences. Alternative methods for breaking up existing pavement, such as a pavement grinder, should be used instead of dropping heavy objects within these setback distances.

3. **Heavy Equipment Operators**: The contractor should alert heavy equipment operators to sensitive adjacent structures (i.e., residences within 30 feet) so they can exercise caution.

Conclusions and Recommendations

Based on the analysis and results presented in this report, on-site construction activities associated with the Grant Street Residential Development are not expected to result in significant vibration level exposure at existing adjacent residences relative to structural damage and human annoyance potential criteria established by the California Department of Transportation (Caltrans). Nonetheless, to reduce the potential for structural damage and human annoyance at nearby existing residential structures, specific construction equipment vibration control measures outlined in this report are recommended for implementation by the construction contractor(s).

In addition, on-site project construction activities have the potential to result in temporary noise levels that would impact adjacent homes periodically over the course of the construction period. Construction related noise impacts are typically only occasionally intrusive and cease once construction is complete. Nonetheless, to ensure that noise levels due to on-site construction activities are minimized, and to reduce the potential for an exceedance of applicable City of Calistoga noise level criteria at nearby existing residential uses, the construction noise abatement measures outlined in this report should be implemented. Adherence to the construction noise abatement measures identified in this report, which goes beyond the construction-related requirements established in the City of Calistoga Municipal Code, will ensure that potential noise impacts due to the temporary exposure of sensitive receptors to excessive noise during construction are reduced to less than significant levels.

This concludes our construction noise and vibration assessment for the Grant Street Residential Development in Calistoga, California. Please contact BAC at (530) 537-2328 or dariog@bacnoise.com with comments or questions regarding this assessment.

Appendix A
Acoustical Terminology

Acoustics The science of sound.

Ambient Noise The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.

Attenuation The reduction of an acoustic signal.

A-Weighting A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.

Decibel or dB Fundamental unit of sound. A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.

CNEL Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging.

Frequency The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.

IIC Impact Insulation Class (IIC): A single-number representation of a floor/ceiling partition's impact generated noise insulation performance. The field-measured version of this number is the FIIC.

L_{dn} Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.

L_{eq} Equivalent or energy-averaged sound level.

L_{max} The highest root-mean-square (RMS) sound level measured over a given period of time.

Loudness A subjective term for the sensation of the magnitude of sound.

Masking The amount (or the process) by which the threshold of audibility is for one sound is raised by the presence of another (masking) sound.

Noise Unwanted sound.

Peak Noise The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the "Maximum" level, which is the highest RMS level.

RT_{60} The time it takes reverberant sound to decay by 60 dB once the source has been removed.

STC Sound Transmission Class (STC): A single-number representation of a partition's noise insulation performance. This number is based on laboratory-measured, 16-band (1/3-octave) transmission loss (TL) data of the subject partition. The field-measured version of this number is the FSTC.