NOISE AND VIBRATION IMPACT ANALYSIS

TRACT 3138 PROJECT

TEMPLETON, SAN LUIS OBISPO, CALIFORNIA

LSA

September 2021

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TEMPLETON, SAN LUIS OBISPO, CALIFORNIA

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TABLE OF CONTENTS

FIGURES AND TABLES

FIGURES

TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

County	County of San Luis Obispo
dB	decibel(s)
dBA	A-weighted decibel(s)
EPA	United States Environmental Protection Agency
FHWA	Federal Highway Administration
ft	foot/feet
L_{dn}	day-night average noise level
L_{eq}	equivalent continuous sound level
L_{max}	maximum instantaneous noise level
proposed project	Tract 3138 Project
SPL	Sound Power Level

INTRODUCTION

This noise and vibration impact analysis has been prepared to evaluate the potential noise and vibration impacts and mitigation measures associated with the proposed Tract 3138 Project (proposed project) in Templeton, San Luis Obispo County (County), California. This report is intended to satisfy the County requirements for a project-specific noise impact analysis by examining the impacts of the proposed uses and identifies whether any noise or vibration mitigation measures to reduce project impacts would be necessary.

PROJECT LOCATION AND DESCRIPTION

The project site is on a lot of vacant land located west of Bennett Way and north of Casper Road. It is bounded to the south, east, and north by other residential properties. The project involves the subdivision of Lot 10 of Oak Ridge Orchards into 15 residential lots. Earthwork would include excavation and grading. A main road with a cul-de-sac will be constructed in the central portion of the property, as well as a half road in the southern portion. The project would allow for the construction of single-family houses. The project location map and site plan are located on Figures 1 and 2, respectively.

LSA

FIGURE 1

0 500 1000

FEET

Project Site Boundary

Templeton Tract 3138 Project

Project Location Map

SOURCES: Google Earth, 2/26/2021; LSA, 2021

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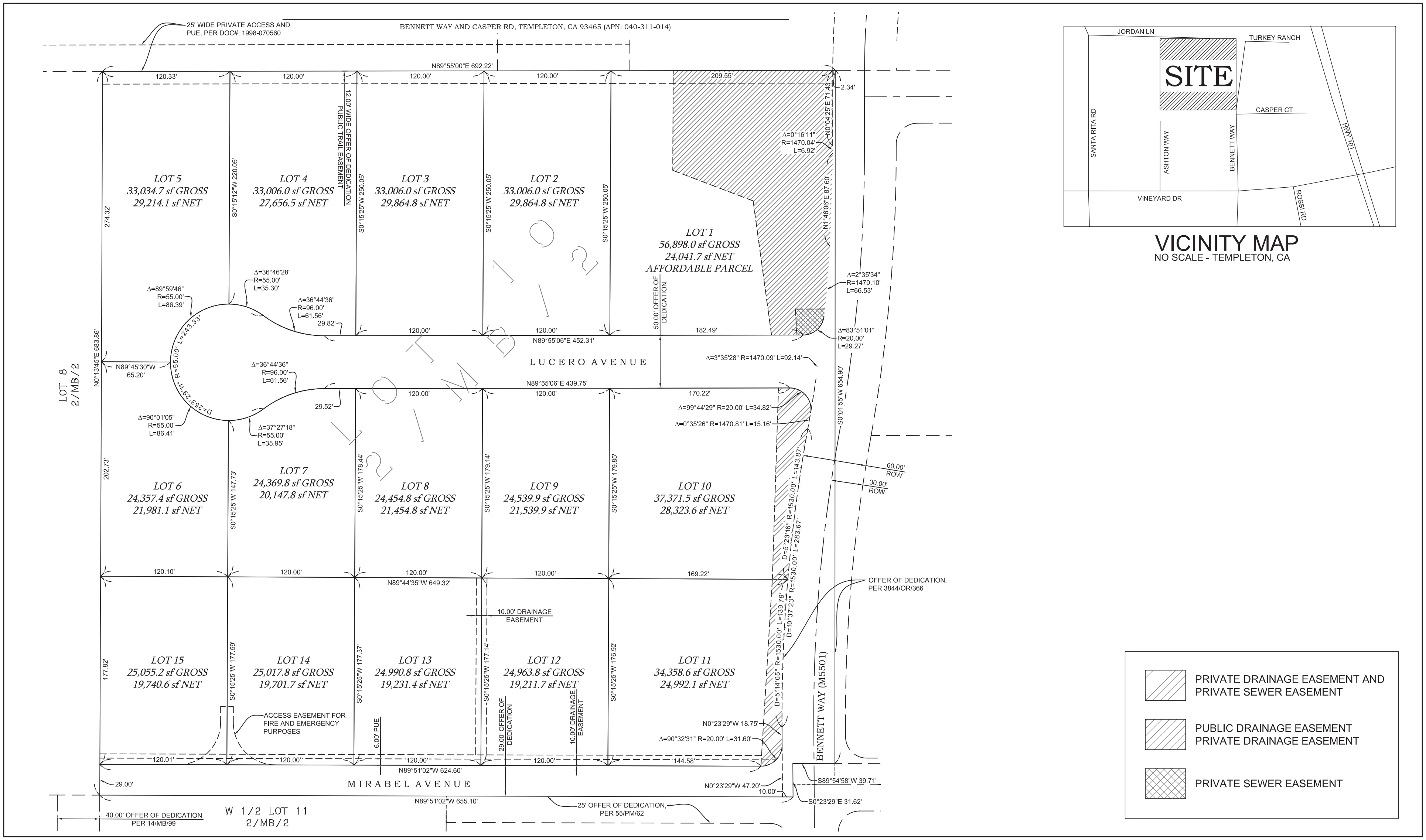
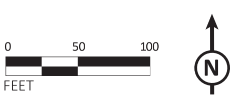


LSA

FIGURE 2



Templeton Tract 3138 Project

Site Plan

SOURCE: Above Grade Engineering, September 2020

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NOISE AND VIBRATION FUNDAMENTALS

CHARACTERISTICS OF SOUND

Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a sound wave, which results in the tone's range from high to low. Loudness is the strength of a sound, and it describes a noisy or quiet environment; it is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound wave combined with the reception characteristics of the human ear. Sound intensity refers to the power carried by sound waves per unit area in a direction perpendicular to that area. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound pressure level and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound pressure level is measured with the A-weighted decibel scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound, similar to the human ear's de-emphasis of these frequencies. Decibels, unlike linear units (e.g., inches or pounds), are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 decibels (dB) is 10 times more intense than 1 dB, 20 dB is 100 times more intense than 1 dB, and 30 dB is 1,000 times more intense than 1 dB. Thirty decibels (30 dB) represents 1,000 times as much acoustic energy as 1 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the sound's loudness. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound levels dissipate exponentially with distance from their noise sources. For a single point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source (e.g., highway traffic or railroad operations) the sound decreases 3 dB for each doubling of distance in a hard site environment. Line source sound levels decrease 4.5 dB for each doubling of distance in a relatively flat environment with absorptive vegetation.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and Community Noise Equivalent Level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels (dBA). CNEL is the time-varying noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noise occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours) and a 10 dBA weighting factor applied to noise occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the relaxation and sleeping hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest exponential time-averaged sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. It is often used together with another noise scale, or noise standards in terms of percentile noise levels, in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level, and half the time it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

Noise impacts can be described in three categories. The first category includes audible impacts that refer to increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. Additionally, an increase of more than 5 dBA is typically considered readily perceptible in an exterior environment. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to sound levels higher than 85 dBA. Exposure to high sound levels affects the entire system, with prolonged sound exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of sound exposure above 90 dBA would result in permanent cell damage. When the sound level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of sound is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by a feeling of pain in the ear (i.e., the threshold of pain). A sound level of 160–165 dBA will result in dizziness or a loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less-developed areas.

Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of sound level that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., the number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. 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 fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period, respectively.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time. It is usually a composite of sound from many sources from many directions, near and far; no particular sound is dominant.
Intrusive	The noise that 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.

Source: *Handbook of Acoustical Measurements and Noise Control* (Harris 1991).

Table B: Common Sound Levels and Their Noise Sources

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet fly-over at 1,000 ft		
	— 100 —	
Gas lawn mower at 3 ft		
	— 90 —	
Diesel truck at 50 ft at 50 mph		Food blender at 3 ft
	— 80 —	Garbage disposal at 3 ft
Noisy urban area, daytime		
Gas lawn mower, 100 ft	— 70 —	Vacuum cleaner at 10 ft
Commercial area		Normal speech at 3 ft
Heavy traffic at 300 ft	— 60 —	
		Large business office
Quiet urban daytime	— 50 —	Dishwasher next room
Quiet urban nighttime	— 40 —	Theater, large conference room (background)
Quiet suburban nighttime		
	— 30 —	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	— 0 —	Lowest threshold of human hearing

Source: *Technical Noise Supplement,* California Department of Transportation (September 2013).
dBA = A-weighted decibels
ft = feet
mph = miles per hour

CHARACTERISTICS OF VIBRATION

Vibration refers to ground-borne noise and perceptible motion. Ground-borne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors, where the motion may be discernible. Typically, there is more adverse reaction to effects associated with the shaking of a building. Vibration energy propagates from a source through intervening soil and rock layers to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by occupants as the motion of building surfaces, the rattling of items on shelves or hanging on walls, or a low-frequency rumbling noise. The rumbling noise is caused by the vibration of walls, floors, and ceilings that radiate sound waves. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 dB or less. This is an order of magnitude below the damage threshold for normal buildings.

Typical sources of ground-borne vibration are construction activities (e.g., blasting, pile driving, and operating heavy-duty earthmoving equipment), steel-wheeled trains, and occasional traffic on rough roads. As presented in the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018) (FTA Manual), problems with both ground-borne vibration and noise from these sources are usually localized to areas within approximately 100 feet of the vibration source, although there are examples of ground-borne vibration causing interference out to distances greater than 200 feet. When roadways are smooth, vibration from traffic, even heavy trucks, is rarely perceptible. It is assumed for most projects that the roadway surface will be smooth enough that ground-borne vibration from street traffic will not exceed the impact criteria; however, the construction of the project could result in ground-borne vibration that may be perceptible and annoying.

Ground-borne vibration has the potential to disturb people and damage buildings. Although it is very rare for typical construction activities to cause even cosmetic building damage, it is not uncommon for construction processes such as blasting and pile driving to cause vibration of sufficient amplitudes to damage nearby buildings. Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). The RMS is best for characterizing human response to building vibration, and PPV is used to characterize potential for damage. Decibel notation acts to compress the range of numbers required to describe vibration. Vibration velocity level in decibels is defined as:

$$L_v = 20 \log_{10} [V/V_{ref}]$$

where L_v is the vibration velocity in decibels (VdB), "V" is the RMS velocity amplitude, and "V_{ref}" is the reference velocity amplitude, or 1×10^{-6} inches/second (in/sec) used in the United States.

REGULATORY SETTING

APPLICABLE NOISE STANDARDS

County of San Luis Obispo General Plan Noise Element

The following specific policies are adopted by the County to accomplish the goals of the *Noise Element within the General Plan* (County of San Luis Obispo 1992):

Transportation Sources

Policy 3.3.2 of the Noise Element states that new development of noise-sensitive land uses shall not be permitted in areas exposed to existing or projected future levels of noise from transportation noise sources which exceed 60 dB Ldn or CNEL unless the project design includes effective mitigation measures to reduce noise in outdoor activity areas and interior spaces to or below the levels specified for the given land use.

As it relates to off-site transportation related impacts, Policy 3.3.3 states that noise created by new transportation noise sources, including roadway improvement projects, shall be mitigated so as not to exceed 60 dBA CNEL within the outdoor activity areas of existing noise sensitive land uses.

Stationary Noise Sources

Policy 3.3.4 states that new development of noise-sensitive land uses shall not be permitted where the noise level due to existing stationary noise sources will exceed the noise level standards in the County's noise element, unless effective noise mitigation measures have been incorporated into the design of the development to reduce noise exposure to or below the levels specified in Table 3-2 of the noise element.

Per Table 3-2 in the Noise Element, maximum allowable noise exposure from stationary sources, as determined at receiving property line, is 50 dBA L_{eq} (1-hour) during daytime hours (7:00 a.m. to 10:00 p.m.) and 45 dBA L_{eq} (1-hour) during nighttime hours (10:00 p.m. to 7:00 a.m.). Instantaneous noise levels from stationary sources cannot exceed 70 dBA L_{max} during the day and 65 L_{max} at night.

Existing and Cumulative Noise Impacts

Policy 3.3.6 states that a project shall consider implementing mitigation measures where existing noise levels produce significant noise impacts to noise-sensitive land uses or where new development may result in cumulative increases of noise upon noise-sensitive land uses.

San Luis Obispo County Municipal Code

Section 22.10.120 of San Luis Obispo County Municipal Code includes the following exceptions to noise standards that are applicable to the project:

> *Noise sources associated with construction, provided such activities do not take place before 7:00 a.m. or after 9:00 p.m. on any day except Saturday or Sunday, or before 8:00 a.m. or after 5:00 p.m. on Saturday or Sunday.*

Limitations for Grading Hours

No grading work (except for agricultural exemptions and emergency operations specified in Section 22.52.070C and 22.52.090C.2, respectively), which requires a grading permit under the provisions of this Chapter shall take place between the hours of 7:00 p.m. and 7:00 a.m. weekdays and between the hours of 5:00 p.m. and 8:00 a.m. on the weekends, unless the Building Official or approved conditions of a land use permit finds that such operation is not likely to cause a significant public nuisance and authorizes expanded or night operations in writing. Hours of operation on the weekends may be further regulated by conditions of the grading permit.

Vibration

Section 23.06.060, Vibration Standards, states that any operation at a lot within one half mile of an urban or village reserve line is to be operated to not produce detrimental earth borne vibrations perceptible at or beyond any lot line of the lot containing the use.

Section 23.06.062 of San Luis Obispo County Municipal Code includes the following exceptions to vibration standards that are applicable to the project:

- Vibrations from construction, the demolition of structures, surface mining activities or geological exploration between 7:00 a.m. and 9:00 p.m.;
- Vibrations from moving sources such as trucks and railroads.

Because the County does not have established specific vibration impact criteria, the FTA Manual criteria presented below will be utilized to assess potential damage and human annoyance during construction activities.

Federal Transit Administration

The criteria for environmental impacts resulting from ground-borne vibration and noise are based on the maximum levels for a single event. The County's Municipal Code does not include specific criteria for assessing vibration impacts associated with structural damage. Therefore, for the purpose of determining the significance of vibration impacts experienced at structures surrounding the project site, the guidelines within the FTA Manual have been used to determine vibration impacts associated with potential damage and are presented in Table C below.

Table C: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)
Reinforced concrete, steel, or timber (no plaster)	0.50
Engineered concrete and masonry (no plaster)	0.30
Non-engineered timber and masonry buildings	0.20
Buildings extremely susceptible to vibration damage	0.12

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018), Table 12-3.
FTA = Federal Transit Administration
PPV = peak particle velocity
in/sec = inches per second

The FTA Manual guidelines show that a vibration level of up to 0.12 in/sec in PPV is considered safe for buildings extremely susceptible to vibration damage and would not result in any construction vibration damage. Therefore, to be conservative, the 0.12 in/sec in PPV threshold has been used when evaluating vibration impacts at the nearest structures to the site (i.e., single-family homes).

To provide numerical thresholds related to human annoyance of ground-borne vibration impacts, criteria included in the FTA Manual are shown in Table D. The criteria account for the variation in building types as well as the frequency of events, which differ widely among projects. It is logical that when there would be fewer events per day, it should take higher vibration levels to evoke the same community response. The variation in building type and the frequency of events is accounted for in the criteria by distinguishing between vibration events that are frequent and infrequent, in which the term “frequent events” is defined as more than 70 events per day.

Table D: Ground-Borne Vibration Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 µin/sec)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with 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

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018), Table 8-1.
1 Frequent events are defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2 Occasional events are 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 are defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
µin/sec = micro-inches per second
FTA = Federal Transit Administration
HVAC = heating, ventilation, and air-conditioning
VdB = vibration velocity decibels

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

The primary existing noise sources in the project area are transportation facilities, including US 101, Bennett Way, and Casper Road.

EXISTING NOISE LEVEL MEASUREMENTS

To assess the existing noise conditions in the area, long-term noise measurements were conducted at the project site. Two long-term, 24-hour measurements were taken from August 5, 2021, to August 6, 2021. The locations of the noise measurements are shown on Figure 3 and the results are summarized in Table E. Noise measurement data information is provided in Appendix A of this analysis.

Table E: Existing Noise Level Measurements

Location Number	Location Description	Daytime Noise Levels[1] (dBA L_{eq})	Evening Noise Levels[2] (dBA L_{eq})	Nighttime Noise Levels[3] (dBA L_{eq})	Average Daily Noise Levels (dBA CNEL)	Primary Noise Sources
LT-1	Northeast portion of site in tree, 85 ft from intersection of Bennet Way & Turkey Ranch Road, and approximately 650 ft from US 101.	45.5-52.2	46.8-55.0	45.7-53.2	57	Traffic on US 101 and local roadways, farm animals and wildlife.
LT-2	Southeast portion of site in tree, 920 ft from US 101, and 10 ft from southern property line.	43.1-51.5	45.3-45.7	39.5-47.3	51	Traffic on US 101 and local roadways, wildlife.

Source: Compiled by LSA (August 2021).
1 Daytime Noise Levels = noise levels during the hours of 7:00 a.m. to 7:00 p.m.
2 Evening Noise Levels = noise levels during the hours of 7:00 p.m. to 10:00 p.m.
3 Nighttime Noise Levels = noise levels during the hours of 10:00 p.m. to 7:00 a.m.
CNEL = Community Noise Equivalent Level
dBA = A-weighted decibels
ft = foot/feet

SENSITIVE LAND USES IN THE PROJECT VICINITY

Certain land uses are considered more sensitive to noise than others are. Examples of these include residential areas, educational facilities, hospitals, childcare facilities, and senior housing. The project site is surrounded by residential, places of worship, and vacant/farmland uses. The areas adjacent to the project site include the following uses:

- North: Single-family residences 50 ft from nearest project property line
- East: Single-family residences 60 ft from nearest project property line
- South: Single-family residence 25 ft from nearest project property line, places of worship beyond
- Southwest: Single-family residence 75 ft from nearest project property line

LSA

FIGURE 3

Templeton Tract 3138 Project

Noise Monitoring Locations

SOURCES: Google Earth, 2/26/2021; LSA, 2021

P:\ABV2101\Figures\Figure 3.ai (8/12/2021)

- West: Vacant/farmland, single-family residences beyond

AIRCRAFT NOISE

The project site is approximately 4.4 miles southeast of Oak County Ranch Airport (private use) and over 9 miles southwest of Paso Robles Municipal Airport. The proposed project is located well outside of the 65 CNEL noise contours for the above airports and is not within two miles of any other public or public use airport. Therefore, no further analysis of aircraft noise is needed.

PROJECT IMPACT ANALYSIS

The proposed project could result in short-term construction noise and vibration impacts, as described below.

SHORT-TERM CONSTRUCTION-RELATED IMPACTS

Project construction would result in short-term noise and vibration impacts on adjacent land uses. Maximum construction impacts would be short-term, generally intermittent depending on the construction phase, and variable depending on receiver distance from the active construction zone. The duration of impacts generally would be from 1 day to several weeks depending on the phase of construction. The following describes the level and types of impacts that would occur during construction.

Construction Noise Impacts

Two types of short-term noise impacts would occur during project construction: (1) equipment delivery and construction worker commutes and (2) project construction operations.

The first type of short-term construction noise would result from transport of construction equipment and materials to the project site and construction worker commutes. These transportation activities would incrementally raise noise levels on access roads leading to the site. It is expected that larger trucks used in equipment delivery would generate higher noise impacts than trucks associated with worker commutes. The single-event noise from equipment trucks passing at a distance of 50 ft from a sensitive noise receptor would reach a maximum level of 84 dBA L_{max}. However, the pieces of heavy equipment for grading and construction activities would be moved on site just one time and would remain on site for the duration of each construction phase. This one-time trip, when heavy construction equipment is moved on and off site, would not add to the daily traffic noise in the project vicinity. The total number of daily vehicle trips would be minimal when compared to existing traffic volumes on the affected streets, and the long-term noise level changes associated with these trips would not be perceptible. Therefore, equipment transport noise and construction-related worker commute impacts would be short term and would not result in a significant off-site noise impact.

The second type of short-term noise impact is related to noise generated during site preparation, grading, building construction, architectural coating, and paving on the project site. Construction is undertaken in discrete steps, each of which has its own mix of equipment, and, consequently, its own noise characteristics. These various sequential phases would change the character of the noise generated on the project site. Therefore, the noise levels vary as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase. Table F lists the maximum noise levels recommended for noise impact assessments for typical construction equipment based on a distance of 50 ft between the construction equipment and a noise receptor. Typical operating cycles for these types of construction equipment may involve 1–2 minutes of full power operation followed by 3–4 minutes at lower power settings.

Table F: Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor (%)	Maximum Noise Level (L_{max}) at 50 ft
Compressor	100	81
Concrete Mixer	40	85
Concrete Pump	40	85
Crane	16	83
Dozer	40	80
Forklift	20	75
Front [End] Loader	40	79
Generator	100	78
Grader	8	85
Scraper	40	88
Welder	40	74

Sources: *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances* (EPA 1971), Roadway Construction Noise Model (FHWA 2006).
ft = foot/feet
L_{max} = maximum instantaneous sound level

In addition to the reference maximum noise level, the usage factor provided in Table F is used to calculate the hourly noise level impact for each piece of equipment based on the following equation:

$$L_{eq}(equip) = E.L. + 10\log(U.F.) - 20\log\left(\frac{D}{50}\right)$$

where:

- L_{eq} *(equip)* = L_{eq} at a receiver resulting from the operation of a single piece of equipment over a specified time period
- E.L. = Noise emission level of the particular piece of equipment at a reference distance of 50 ft
- U.F. = Usage factor that accounts for the fraction of time that the equipment is in use over the specified period of time
- D = Distance from the receiver to the piece of equipment

Each piece of construction equipment operates as an individual point source. Using the following equation, a composite noise level can be calculated when multiple sources of noise operate simultaneously:

$$Leq\ (composite) = 10 * \log_{10}\left(\sum_{1}^{n} 10^{\frac{Ln}{10}}\right)$$

Table G shows the composite noise levels of the pieces of equipment for each construction phase at a distance of 50 ft from the construction area. Once composite noise levels are calculated, reference noise levels can then be adjusted for distance using the following equation:

$$Leq\ (at\ distance\ X) = Leq\ (at\ 50\ feet) - 20 * \log_{10}\left(\frac{X}{50}\right)$$

In general, this equation shows that doubling the distance would decrease noise levels by 6 dBA while halving the distance would increase noise levels by 6 dBA.

Table G: Construction Noise Levels by Phase

Phase	Duration (days)	Equipment	Composite Noise Level at 50 ft (dBA L_{eq})	Distance to Sensitive Receptor (ft)[1]	Noise Level at Receptor (dBA L_{eq})
Site Preparation	10	3 Dozers, 4 Tractors/Loaders/ Backhoes	85	350	68
Grading	30	2 Excavators, 1 Grader, 1 Dozer, 2 Scrapers, 2 Tractors/Loaders/ Backhoes	90	350	73
Building Construction	60	1 Crane, 3 Forklifts, 1 Generator Set, 3 Tractors/Loaders/ Backhoes, 1 Welder	84	350	68
Paving	30	1 Paver, 2 Concrete Mixer, 2 Paving Equipment, 2 Rollers, 1 Loader	84	350	68
Architectural Coating	10	1 Compressor	81	350	64

Source: Compiled by LSA (2021).
[1] Distances are from the average location of construction activity for each phase, center of project site. Residential zoned properties would be 25 to 75 ft from the nearest edge of construction activity.
dBA L_{eq} = average A-weighted hourly noise level
ft = foot/feet

As presented above, Table G shows the construction phases, the expected duration of each phase, the equipment expected to be used during each phase, the composite noise levels of the equipment at 50 ft, the distance of the nearest residential building from the average location of construction activities (a distance of 350 ft), and noise levels expected during each phase of construction. These noise level projections do not take into account intervening topography or barriers. Appendix B provides construction noise calculations.

During the grading phase, which would take place for approximately 6 weeks, it is expected that average construction noise levels would approach 73 dBA L_{eq} at the nearest residences, the single-family home to the south. Average noise levels during other construction phases would range from 64 dBA L_{eq} to 68 dBA L_{eq}. At the single-family residences to the east and north, average noise levels would range from 63 dBA L_{eq} to 72 dBA L_{eq} during all phases of construction.

While construction noise levels generated during the permitted hours are exempt from compliance with County noise standards, there is potential for average construction equipment noise levels to exceed 96 dBA L_{eq} at the nearest residential land uses, 25 feet away, when louder equipment is used near the project site boundaries. Therefore, the following best management practices are provided to limit construction activity to the less noise-sensitive periods of the day and reduce potential construction-period noise impacts for the indicated sensitive receptors to the extent feasible.

Best Management Practices: The project contractor shall implement the following best management practice measures during construction of the project:

- Equip all construction equipment, fixed or mobile, with properly operating and maintained mufflers consistent with manufacturers' standards.
- Place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the active project site.
- Locate equipment staging in areas that would create the greatest possible distance between construction-related noise sources and noise-sensitive receptors nearest the active project site during all project construction.
- Prohibit extended idling time of internal combustion engines.
- Where feasible, all noise producing construction activities should be limited to between the hours of 8:00 a.m. and 5:30 p.m.
- Designate a "disturbance coordinator" at the County of San Luis Obispo 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) and would determine and implement reasonable measures warranted to correct the problem.

Construction Vibration Building Damage Potential

Construction of the proposed project could result in the generation of groundborne vibration. This construction vibration impact analysis discusses the level of human annoyance using vibration levels in VdB and assesses the potential for building damages using vibration levels in PPV (in/sec). As shown in Table C above, the FTA Manual guidelines indicate that the construction vibration damage criterion is 0.2 in/sec PPV for non-engineered timber and masonry buildings. Additionally, based on the criteria in Table D, the level at which annoyance would occur within residences and buildings where people normally sleep is 80 VdB for infrequent events.

Table H shows the reference PPV and VdB values at 25 ft from a construction vibration source. Bulldozers and other heavy-tracked construction equipment generate approximately 87 VdB or 0.089 PPV in/sec of groundborne vibration when measured at 25 ft, based on the FTA Manual.

Table H: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Hoe Ram	0.089	87
Large Bulldozer	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] RMS VdB re 1 µin/sec.
µin/sec = micro-inches per second
ft = foot/feet
FTA = Federal Transit Administration
in/sec = inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity in decibels

The closest structure to the project site is the single-family home to the south of the project site, approximately 50 ft from the limits of construction activity. Given that this structure is more than 25 ft from the project construction area limits, the estimated vibration impacts are propagated for distance based on the following equation.

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.1}$$

Using the reference data from Table H and the equation above, the operation of typical construction equipment would generate ground-borne vibration levels of up to 0.042 PPV (in/sec) at the closest building to the project site. This vibration level would not exceed the 0.12 PPV (in/sec) threshold considered safe for fragile buildings. Vibration levels at all other buildings would be lower. Therefore, construction would not result in any vibration damage, impacts would be less than significant, and no mitigation is required.

Construction Vibration Human Annoyance Potential

As stated above, the existing single-family homes, located 50 ft south of the project site, are the nearest sensitive receptor and would experience vibration levels approaching 78 VdB based on the following equation.

$$LvdB\ (D) = LvdB\ (25\ ft) - 30\ Log\ (D/25)$$

Based on the standards provided in Table D above, this level of ground-borne vibration is below the human annoyance vibration impact criteria of 80 VdB for infrequent events at uses where people sleep. Additionally, the County's Municipal Code excludes temporary construction vibration, and construction activity will be limited to daytime hours. Therefore, the proposed project would not result in the exposure of persons to excessive groundborne vibration.

LONG-TERM OFF-SITE TRAFFIC NOISE IMPACTS

The proposed project is estimated to generate an average of 167 vehicles per day based on the project trip generation and distributions in the *Bennett Way APN 040-311-014 Traffic Impact Analysis* (Central Coast Transportation Consulting, 2019). The Templeton Circulation Study includes the connection of Bennett Way between Vineyard Drive and Las Tablas Road (to the north of the project site), with a cumulative volume of 1,400 vehicles per day. It takes a doubling of traffic to increase traffic noise levels by 3 dBA per the following equation that was used to determine potential traffic noise increases:

$$\text{Change in CNEL} = 10 \log_{10} [V_{e+pt}/V_{existing}]$$

where: $V_{existing}$ = the existing daily volume
V_{e+pt} = existing daily volumes plus project trips
Change in CNEL = the increase in noise level due to project trips

The project-related traffic would increase traffic noise along Bennett Way by up to 0.6 dBA. This noise level increase would not be perceptible to the human ear in an outdoor environment. Therefore, traffic noise impacts from project-related traffic on off-site sensitive receptors would be less than significant, and no mitigation measures are required.

Long-Term Ground-Borne Noise and Vibration from Vehicular Traffic

Because the rubber tires and suspension systems of buses and other on-road vehicles provide vibration isolation and reduce noise, it is unusual for on-road vehicles to cause ground-borne noise or vibration. When on-road vehicles cause such effects as the rattling of windows, the source is almost always airborne noise. Most problems with on-road vehicle-related noise and vibration can be directly related to a pothole, bump, expansion joint, or other discontinuity in the road surface. Smoothing the bump or filling the pothole will usually solve the problem. The proposed project would have roads with smooth pavement and would not result in significant ground-borne noise or vibration impacts from vehicular traffic.

CUMULATIVE IMPACTS

As defined in the *State CEQA Guidelines*, cumulative impacts are the incremental effects of an individual project when viewed in connection with the effects of past, current, and probable future projects. A cumulative noise or vibration impact would occur if multiple sources of noise and vibration combine to create impacts near a sensitive receptor. Therefore, the cumulative area for noise impacts is the project site and any sensitive receptors in the immediately surrounding area.

Construction Noise

Construction activities associated with the proposed project and other construction projects in the area may overlap, resulting in construction noise in the area. However, construction noise impacts primarily affect the areas immediately adjacent to each construction site. Construction noise for the proposed project was determined to be less than significant with compliance with the construction hour restrictions in the County's Municipal Code and best management practices. Cumulative development in the vicinity of the project site could result in elevated construction noise levels at sensitive receptors in the project area. However, each project would be required to comply with the applicable County's Municipal Code limitations on construction. Therefore, cumulative construction noise impacts would be less than significant.

Long-Term Traffic Noise Impacts

As described above, project trips would represent a small increase in noise levels, up to approximately 0.6 dBA CNEL, which would not exceed the 3 dBA increase considered to be perceptible by the human ear in an outdoor environment. Given the small increase in noise levels generated by the proposed project on the transportation network and location of cumulative projects and anticipated increase in traffic noise anticipated in the vicinity, the proposed project would not result in a cumulatively considerable increase in transportation-related noise.

ON-SITE LAND USE COMPATIBILITY ANALYSIS

The County sets forth noise level standards for land use compatibility and noise exposure of new developments near transportation noise sources.

Exterior Noise Assessment

As identified above, the project site is exposed to noise levels between 51 dBA and 57 dBA CNEL primarily associated with vehicle traffic noise. Based on traffic increases of one percent per year until future buildout year 2040, noise levels from the adjacent roadways were calculated to increase by 1 dB, for a future noise level of 58 dBA CNEL. The County's noise and land use compatibility standards for residential land uses shows that noise levels up to 60 dBA CNEL are considered acceptable and no mitigation is required. Therefore, the proposed subdivision is compatible with the County's noise standards.

Interior Noise Assessment

As discussed above, the County's interior noise level standard of 45 dBA CNEL or less is required for all noise-sensitive rooms. Based on a future exterior noise level of 58 dBA CNEL, a minimum noise reduction of 13 dBA would be required at homes along Bennett Way.

Calculations were completed for a typical bedroom with typical stucco construction, standard windows, and one wall exposed to traffic noise. Based on research completed by LSA, most window companies currently produce windows with minimum STC ratings of 27. These calculations (shown in Appendix C) assume a wall rating of STC-46 (Harris 1997) and window rating of STC-27 (Milgard 2008). The results of the analysis show an approximate 28 dBA exterior-to-interior noise reduction. With windows closed, interior noise levels at homes along Bennett Way would be approximately 30 dBA (i.e., 58 dBA – 28 dBA = 30 dBA), which is well below the 45 dBA CNEL interior noise standard with windows closed for noise-sensitive land uses. For all other homes, interior noise levels would be lower with similar windows installed. Therefore, with standard building construction, central air conditioning allowing windows to remain closed, and windows with a minimum Sound Transmission Class (STC) rating of 27 or higher, interior noise levels would meet the County's noise standard and this impact would be less than significant.

Compliance Measure NOI-1 below requires the installation of specific design features to ensure that the proposed project would comply with the County's noise and land use compatibility standards.

Compliance Measure NOI-1: In order to comply with the County's noise and land use compatibility standards, the following measures shall be implemented:

- The proposed project shall include the installation of air conditioning which would allow windows to remain closed. HVAC equipment must be chosen and located such that the County's exterior nighttime noise level standard of 45 dBA L_{eq} is not exceeded at the surrounding residential property lines.
- Standard building construction requirements consisting of windows and doors with a minimum rating of STC-27 should be incorporated.

REFERENCES

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APPENDIX A

NOISE MONITORING SHEETS

Noise Measurement Survey – 24 HR

Project Number: ABV2101
Project Name: Tract 3138

Test Personnel: Jordan Roberts
Equipment: Larson Davis Spark 706RC

Site Number: LT-1 Dates: 8/5/21 – 8/6/21

Time: From 9:00 AM To 8:59 AM

Site Location: Northeast portion of site in tree, 85 feet from intersection of Bennet Way & Turkey Ranch Road, and approximately 650 feet from Hwy 101 traffic.

Primary Noise Sources: Traffic on Hwy 101 and local roadways, farm animals and wildlife.

Location Photo:

Noise Measurement Survey – 24 HR

Project Number: ABV2101
Project Name: Tract 3138

Test Personnel: Jordan Roberts
Equipment: Larson Davis Spark 706RC

Site Number: LT-2 Dates: 8/5/21 – 8/6/21

Time: From 9:00 AM To 8:59 AM

Site Location: Southeast portion of site in tree, 100 feet from intersection of Bennett Way & Casper Court, and approximately 920 feet from Hwy 101.

Primary Noise Sources: Traffic on Hwy 101 and local roadways, wildlife.

Location Photos:

APPENDIX B

CONSTRUCTION NOISE CALCULATIONS

Construction Calculations

Site Prep

Equipment	Reference (dBA)	Usage	Distance to	Ground	Noise Level (dBA)		Dist to R	EnergyMax	EnergyLeq
	50 ft Lmax	Factor[1]	Receptor (ft)	Effects	Lmax	Leq			
Dozer	80	40	50	0.5	80	76	350	100000000	40000000
Dozer	80	40	50	0.5	80	76		100000000	40000000
Dozer	80	40	50	0.5	80	76		100000000	40000000
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
				Combined at 50 feet	**92**	**85**			
				Combined at Receptor 350 feet	**75**	**68**			

Phase: Grading

Equipment	Reference (dBA)	Usage	Distance to	Ground	Noise Level (dBA)		Dist to R	EnergyMax	EnergyLeq
	50 ft Lmax	Factor[1]	Receptor (ft)	Effects	Lmax	Leq			
Excavator	85	40	50	0.5	85	81	350	316227766	126491106.4
Excavator	85	40	50	0.5	85	81		316227766	126491106.4
Grader	85	8	50	0.5	85	74		316227766	25298221.28
Dozer	80	40	50	0.5	80	76		100000000	40000000
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Scraper	88	40	50	0.5	88	84		630957344	252382937.8
Scraper	88	40	50	0.5	88	84		630957344	252382937.8
				Combined at 50 feet	**95**	**90**			
				Combined at Receptor 350 feet	**78**	**73**			

Phase:Building Construstion

Equipment	Reference (dBA)	Usage	Distance to	Ground	Noise Level (dBA)		Dist to R	EnergyMax	EnergyLeq
	50 ft Lmax	Factor[1]	Receptor (ft)	Effects	Lmax	Leq			
Crane	83	16	50	0.5	83	75	350	199526231	31924197.04
Forklift	75	20	50	0.5	75	68		31622777	6324555.32
Forklift	75	20	50	0.5	75	68		31622777	6324555.32
Forklift	75	20	50	0.5	75	68		31622777	6324555.32
Generator	78	100	50	0.5	78	78		63095734	63095734.45
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Backhoe	85	16	50	0.5	85	77		316227766	50596442.56
Welder	74	40	50	0.5	74	70		25118864	10047545.73
				Combined at 50 feet	**91**	**84**			
				Combined at Receptor 350 feet	**74**	**68**			

Phase: Paving

Equipment	Reference (dBA)	Usage	Distance to	Ground	Noise Level (dBA)		Dist to R	EnergyMax	EnergyLeq
	50 ft Lmax	Factor[1]	Receptor (ft)	Effects	Lmax	Leq			
Paver	89	10	50	0.5	89	79	350	794328235	79432823.47
Paver	89	10	50	0.5	89	79		794328235	79432823.47
Pump	76	100	50	0.5	76	76		39810717	39810717.06
Pump	76	100	50	0.5	76	76		39810717	39810717.06
Roller	80	20	50	0.5	80	73		100000000	20000000
Roller	80	20	50	0.5	80	73		100000000	20000000
				Combined at 50 feet	**93**	**84**			
				Combined at Receptor 350 feet	**76**	**68**			

Phase: Architectural Coating

Equipment	Reference (dBA)	Usage	Distance to	Ground	Noise Level (dBA)		Dist to R	EnergyMax	EnergyLeq
	50 ft Lmax	Factor[1]	Receptor (ft)	Effects	Lmax	Leq			
Compressor	81	100	50	0.5	81	81	350	125892541	125892541.2
				Combined at 50 feet	**81**	**81**			
				Combined at Receptor 350 feet	**64**	**64**			

Sources: Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances (USEPA

[1]- Percentage of time that a piece of equipment is operating at full power.

dBA – A-weighted Decibels

Lmax- Maximum Level

Leq- Equivalent Level

APPENDIX C

INTERIOR NOISE CALCULATIONS

INTERIOR NOISE REDUCTIONS

Project Name: Templeton | *Job Number:* ABV2101
Floor Plan: 1 | *Analyst:* J.T. Stephens
Room: Bedroom

(1) Transmission Loss Calculations (Exterior Wall)

Exterior Wall Assembly	Source	Wall Area	STC	Transmission Loss (dB) by Frequency (Hz) 125	250	500	1000	2000	4000	Fractional Area S/(10^(TL/10)) 125	250	500	1000	2000	4000	dB
Stucco	David Harris p. 371	87.0	46	27	42	44	46	49	54	0.1736	0.0055	0.0035	0.0022	0.0011	0.0003	
	ABC	30.0	27	17	20	23	31	31	29	0.5986	0.3000	0.1504	0.0238	0.0238	0.0378	
Windows/Doors		0.0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0	0	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
										0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Totals		117								0.0066	0.0026	0.0013	0.0002	0.0002	0.0003	
Composite Exterior Wall Sound Transmission Loss		10*LOG(1/t)								21.80	25.83	28.81	36.53	36.72	34.87	33.54

(2) Room Effects (Absorption)

Room Surface/ Material	Source	Area	NRC	Absorption Coefficients by Frequency (Hz) 125	250	500	1000	2000	4000	Absorption (Sabins) 125	250	500	1000	2000	4000	
Floor - Carpet	David Harris p. 347	195.0	0.30	0.15	0.17	0.12	0.32	0.52	0.30	29.25	33.15	23.40	62.40	101.40	58.50	
Floor - Vinyl	David Harris p. 347	0.0	0.05	0.02	0.03	0.05	0.03	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	
Ceiling - Drywall	David Harris p. 348	195.0	0.50	0.10	0.08	0.05	0.03	0.03	0.03	19.50	15.60	9.75	5.85	5.85	5.85	
Walls - Drywall	David Harris p. 348	504.0	0.50	0.10	0.08	0.05	0.03	0.03	0.03	50.40	40.32	25.20	15.12	15.12	15.12	
Totals		894								99.15	89.07	58.35	83.37	122.37	79.47	114.61
Room Effect	10*log (Room Absorption in Sabins)/(Exterior Wall Area)									-0.72	-1.18	-3.02	-1.47	0.19	-1.68	-0.09

(3) Adjustment Factor

	125	250	500	1000	2000	4000	
Sound Source Adjustment Factor	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00

(4) Calculated Interior Noise Reduction (dBA)

	125	250	500	1000	2000	4000	dBA
(Transmission Loss + Room Effects + Adjustment Factor)	15.09	18.65	19.79	29.06	30.91	27.19	
Octave Band Frequency Correction Factors for A-Weighted Sound Levels	16.10	8.60	3.20	0.00	-1.20	-1.00	
A-Weighted Sound Levels	31.19	27.25	22.99	29.06	29.71	26.19	
Noise Reduction (dBA)	31.06	27.12	22.87	28.93	29.59	26.07	**28.3**