Environmental Noise and Vibration Analysis

Quarry Ridge Professional Office Park

Placer County, California

BAC Job # 2016-050

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Introduction

This report addresses the potential noise impacts associated with the proposed Quarry Ridge Professional Office Park (project) located at the corner of Berg Street and Douglas Boulevard in Placer County, California. The developer proposes to build four (4) office buildings in the complex. The buildings would range from 3,200 to 5,510 square feet. The Assessor Parcel Number(s) for this project is 048-084-030. The 2.8 acre site is currently vacant. The project area and site plan are provided as Figures 1 and 2, respectively.

Due to the potential noise and vibration generation of the project relative to nearby sensitive receptors, Placer County has requested that an acoustical analysis be performed to ensure that applicable state and county noise and vibration criteria for this project are satisfied. In response to the County's request, Bollard Acoustical Consultants, Inc. (BAC) was retained by the project applicant to prepare this analysis. This analysis focuses on noise generated by on-site commercial-related activity (i.e., rooftop mechanical equipment and parking lot operations), off-site traffic noise level increases, and construction noise and vibration generation. Specific noise mitigation recommendations are provided in this analysis to mitigate project noise impacts.

Noise & Vibration Fundamentals

Noise

Noise is simply described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. Discussing sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel (dB) scale was devised. The decibel scale uses the hearing threshold (20 micropascals of pressure), as a point of reference, defined as 0 dB. Other sound pressures are compared to the reference pressure and the logarithm is taken to keep the numbers in a practical range. The dB scale allows a million-fold increase in pressure to be expressed as 120 dB.

To better relate overall sound levels and loudness to human perception, frequency-dependent weighting networks were developed. There is a strong correlation between the way humans perceive sound and A-weighted sound levels. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment for community exposures. All sound levels expressed as dB in this section are A-weighted sound levels, unless noted otherwise. Definitions of acoustical terminology are provided in Appendix A.

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 composite noise descriptors, day-night average level (L_{dn}) and the community noise equivalent level (CNEL), and shows very good correlation with community response to noise for the average person. 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}.

The L_{dn} is based upon the average noise level over a 24-hour day, with a +10 dB 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 L_{dn} represents a 24-hour average, it tends to disguise short-term variations in the noise environment.

The perceived loudness of sounds and corresponding reactions to noise are dependent upon many factors, including sound pressure level, duration of intrusive sound, frequency of occurrence, time of occurrence, and frequency content. As mentioned above; 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. Figure 3 shows examples of noise levels for several common noise sources and environments.

It is generally recognized that an increase of at least 3 dB of similar sources is usually required before most people will perceive a change in noise levels in the community, and an increase of 5 dB is required before the change will be clearly noticeable. A common practice is to assume that a minimally perceptible increase of 3 dB represents a significant increase in ambient noise levels. This approach is very conservative, however, when applied to noise conditions substantially below levels deemed acceptable in general plan noise elements or in noise ordinances.

Vibration

Vibration is like noise in that it involves a source, a transmission path, and a receiver. While vibration is related to noise, it differs in that noise is generally considered to be pressure waves transmitted through air, while vibration is usually associated with transmission through the ground or structures. As with noise, vibration consists of an amplitude and frequency. A person's response to vibration will depend on their individual sensitivity as well as the amplitude and frequency of the source.

As vibrations travel outward from the source, they excite the particles of rock and soil through which they pass and cause them to oscillate. Differences in subsurface geologic conditions and distance from the source of vibration will result in different vibration levels characterized by different frequencies and intensities. In all cases, vibration amplitudes will decrease with increasing distance. The maximum rate, or velocity of particle movement, is the commonly accepted descriptor of the vibration "strength".

Human response to vibration is difficult to quantify. Vibration can be felt or heard well below the levels that produce any damage to structures. The duration of the event has an effect on human response, as does frequency. Generally, as the duration and vibration frequency increase, the potential for adverse human response increases.

Figure 1

Project Area and Noise Measurement Locations
Quarry Ridge Professional Office Park - Placer County, California

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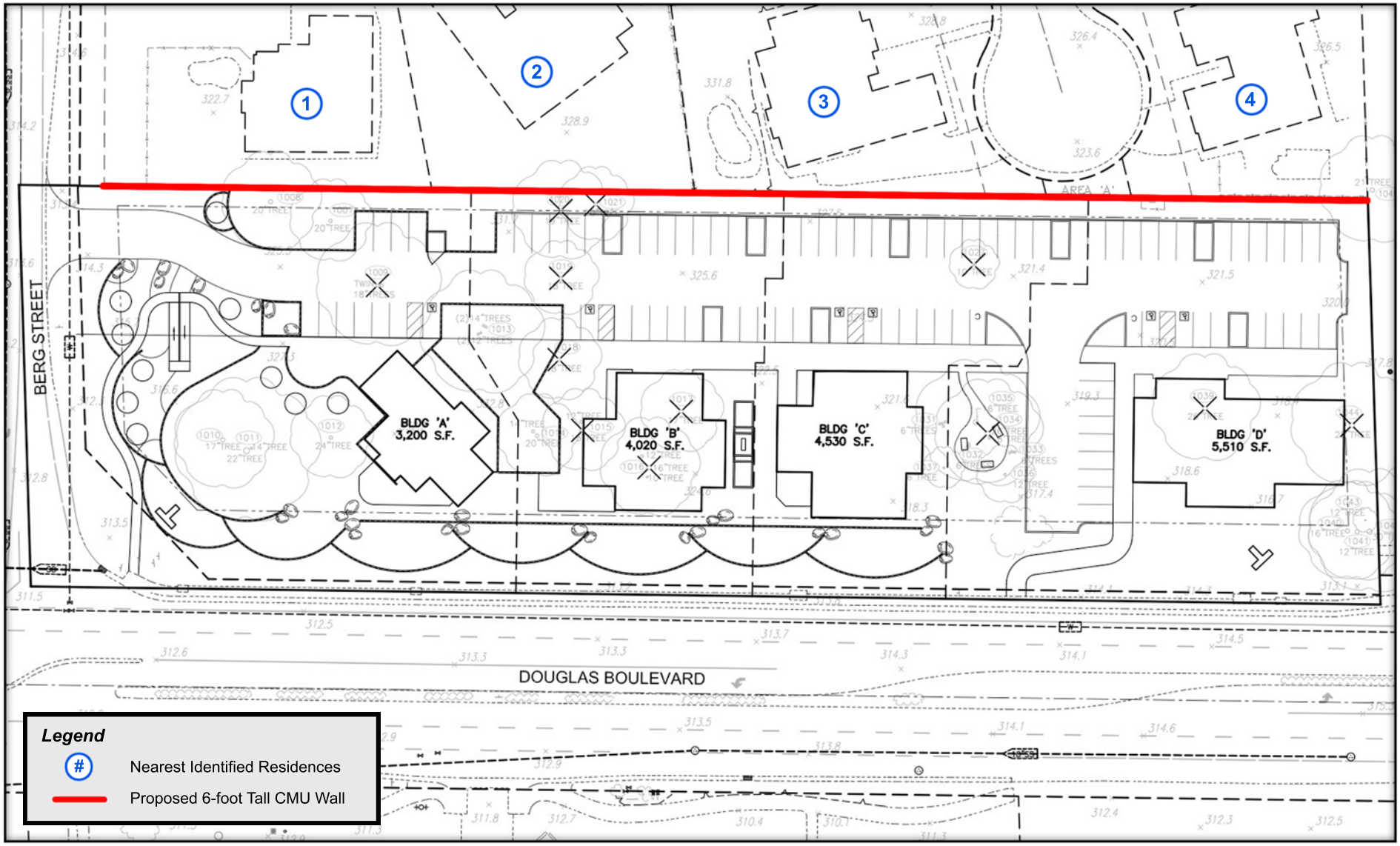
Scale (feet)
0 80 160

Figure 2

Project Site Plan

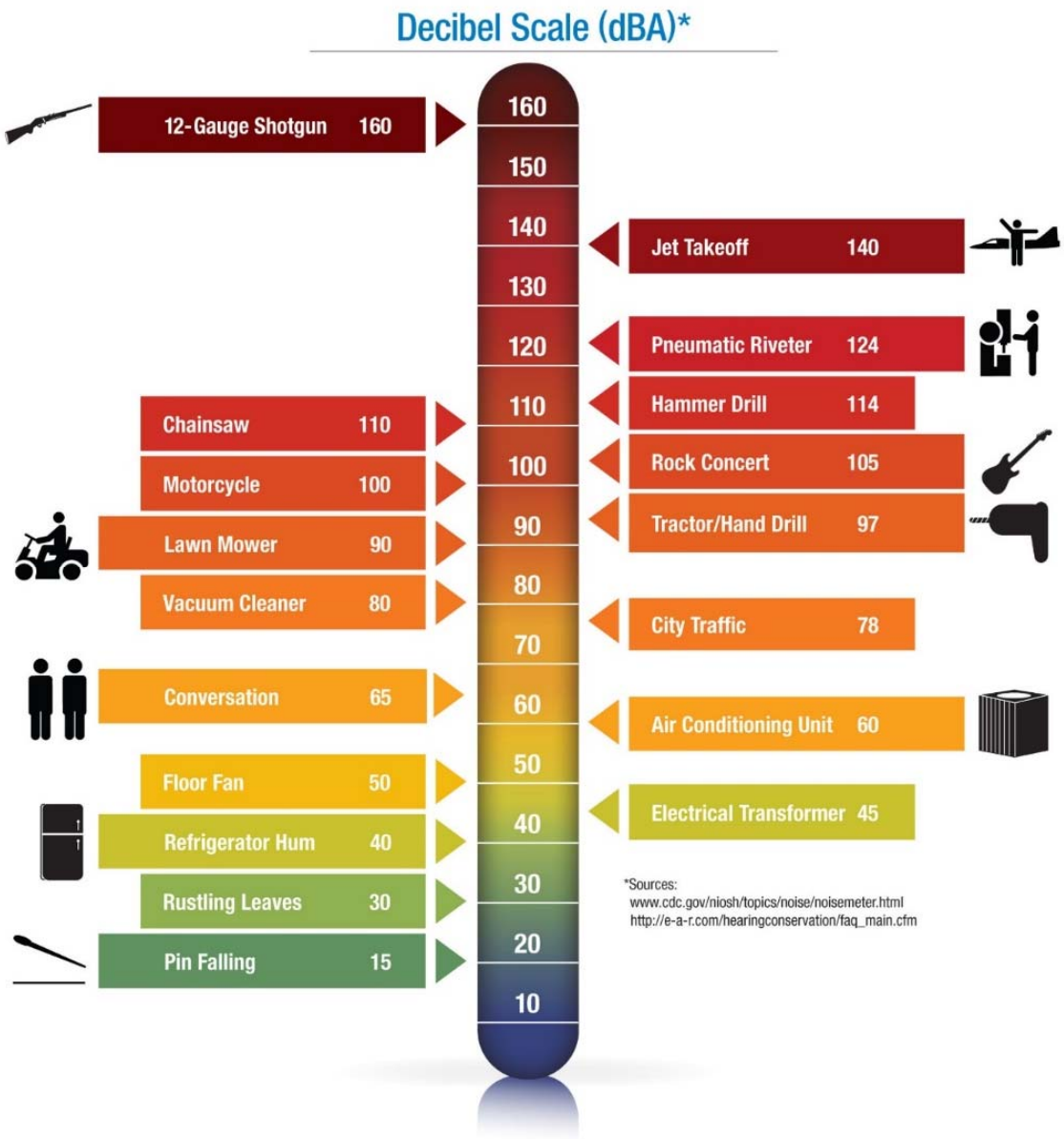
Quarry Ridge Professional Office Park - Placer County, California



BOLLARD
Acoustical Consultants

Scale (feet)
0 50 100

Figure 3
Typical A-Weighted Sound Levels of Common Noise Sources



According to the Transportation and Construction-Induced Vibration Guidance Manual (Caltrans, June 2004), operation of construction equipment and construction techniques generate ground vibration. Traffic traveling on roadways can also be a source of such vibration. At high enough amplitudes, ground vibration has the potential to damage structures and/or cause cosmetic damage. Ground vibration can also be a source of annoyance to individuals who live or work close to vibration-generating activities. However, traffic, rarely generates vibration amplitudes high enough to cause structural or cosmetic damage.

Regulatory Setting

State of California

The State of California has established regulatory criteria that are applicable to this assessment. Specifically, Appendix G of the State of California Environmental Quality Act (CEQA) Guidelines are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. According to Appendix G of the CEQA guidelines, the project would result in a significant noise or vibration impact if the following occur:

A. exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;

B. a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;

C. a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project;

D. exposure of persons to or generation of excessive groundborne vibration or noise levels;

E. for a project located within an ALUP or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, the project would expose people residing or working in the project area to excessive noise levels;

F. or a project within the vicinity of a private airstrip, the project would expose people residing or working in the project area to excessive noise levels.

CEQA does not define what noise level increase would be considered substantial. However, it is generally recognized that a 3 dB L_{dn}/CNEL or greater increase in noise levels due to a project would be considered significant where exterior noise levels would exceed 60 dB L_{dn} (for residential uses). Where pre-project ambient conditions are at or below 60 dB L_{dn}/CNEL, a 5 dB increase is applied as the standard of significance.

It should be noted that audibility is not a test of significance according to CEQA. If this were the case, any project which added any audible amount of noise to the environment would be considered unacceptable according to CEQA. Because every physical process creates noise, whether by the addition of a single vehicle on a roadway, or a tractor in an agricultural field, the use of audibility alone as significance criteria would be unworkable. CEQA requires a substantial increase in noise levels before noise impacts are identified, not simply an audible change.

Placer County General Plan

The Placer County Noise Element of the General Plan establishes exterior noise exposure criteria for new non-transportation noise sources affecting noise-sensitive land uses. Specifically, for this project, the County applies a noise exposure criterion of 50 dB L_{dn} at the property line of the nearest residential land uses.

The General Plan also establishes noise exposure criteria for transportation noise sources affecting office buildings, such as those proposed for the project. The interior noise level standard for office buildings is 45 dB Hourly L_{eq}. The noise criteria is assessed during a typical worst-case hour of daily use of the office building.

Placer County Code

Chapter 9 of the Placer County Code provides sound level standards pertinent to this project. Specifically, Article 9.36.060 is reproduced below:

9.36.060 Sound limits for sensitive receptors

A. It is unlawful for any person at any location to create any sound, or to allow the creation of any sound, on property owned, leased, occupied or otherwise controlled by such person that:

1. Causes the exterior sound level when measured at the property line of any affected sensitive receptor to exceed the ambient sound level by five dBA; or
2. Exceeds the sound level standards as set forth in Table 1, whichever is the greater.

Table 1
Sound Level Standards
Placer County Code

Sound Level Descriptor	Daytime (7 AM to 10 PM)	Nighttime (7 AM to 10 PM)
Hourly L_{eq}, dB	55	45
Maximum Level, (L_{max}) dB	70	65

Source: Article 9.36.060 of the Placer County Code

B. Each of the sound level standards specified in Table 1 shall be reduced by five dB for simple tone noises, consisting of speech and music. However, in no case shall the sound level standard be lower than the ambient sound level plus five dB.

C. If the intruding sound source is continuous and cannot reasonably be discontinued or stopped for a time period whereby the ambient sound level can be measured, the sound level measured while the source is in operation shall be compared directly to the sound level standards of Table 1.

Vibration Criteria

Placer County does not have adopted vibration standards. As a result, Caltrans-recommended criteria are applied for this project, as described below. Human and structural response to different vibration levels is influenced by a number of factors, including ground type, distance between source and receptor, duration, and the number of perceived vibration events. The Caltrans publication, *Transportation-and Construction-Induced Vibration Guidance Manual*, written for Caltrans by Jones & Stokes in June 2004, provides guidelines for acceptable vibration limits for transportation and construction projects in terms of the induced peak particle velocity (PPV). Those standards are reproduced below in Table 2.

Table 2
Vibration Criteria for Structures

Structure and Condition	Maximum PPV (in/sec)	
	Transient Sources[1]	Continuous or Frequent Intermittent Sources[2]
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.20	0.10
Historic and some old building	0.50	0.25
Older residential structures	0.50	0.30
New residential structures	1.00	0.50
Modern industrial/commercial building	2.00	0.50

Notes:
1 Transient sources create a single isolated vibration event.
2 Continuous/frequent intermittent sources include repetitive single events.

Current Caltrans research illustrates that there are different thresholds of perception for different types of vibration sources. Section XI(b) of Appendix G of the CEQA guidelines requires that a project result in exposure of persons to, or generation of, *excessive* groundborne vibration levels or groundborne noise levels, for the finding of a significant impact. The CEQA guidelines specifically mention “excessive” vibration, rather than just perceptible vibration. Because the general range at which vibration becomes distinctly to strongly perceptible ranges from 0.1 – 0.50 in/sec ppv (Caltrans 2004), project-generated vibration levels exceeding 0.1 inches/second PPV at the nearest residences are considered significant for this study.

Noise Standards Applied to this Project

The project area is bordered to the south and west by Douglas Boulevard and Berg Street, respectively. The nearest sensitive receptors to the project site are located to the north (residences) and east (church). As a result, the Placer County General Plan 60 dB L_{dn} property line noise standard for noise-sensitive (residential) uses were applied to the project. In addition,

the Placer County Code property line noise standards identified in Table 1 were also applied to the project. Because the project does not propose nighttime operations, and because the mechanical equipment would operate in excess of an hour in duration, mechanical equipment noise levels were compared to the County's daytime noise level standard of 55 dB L_{eq}.

The Placer County General Plan interior noise level standard for office buildings of 45 dB Hourly L_{eq} was also applied to the project.

Vibration Standards Applied to this Project

As mentioned previously, Placer County does not have adopted vibration standards. As a result, the Caltrans-recommended vibration criteria was applied to the project. Specifically, because the general range at which vibration becomes distinctly to strongly perceptible ranges from 0.1 – 0.50 in/sec ppv (Caltrans 2004), project-related (construction activity) vibration levels exceeding 0.1 inches/second PPV at the nearest residences are considered significant for this study.

Existing Ambient Noise Environment in the Project Vicinity

The ambient noise environment in the immediate project vicinity is primarily defined by traffic on Douglas Boulevard and to a lesser extent, traffic on Berg Street. The nearest noise-sensitive receptors in the immediate project vicinity are single-family residences to the north.

To quantify the existing ambient noise environment in the immediate project vicinity, long-term (24-hour) noise level measurements were conducted at the project site on March 16-17, 2016. The noise measurement locations are shown on Figure 1.

Larson-Davis Laboratories (LDL) Model LxT precision integrating sound level meters were used to complete the noise level measurement survey. The meters were calibrated before use with an LDL Model CA200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all pertinent specifications of the American National Standards Institute for Type 1 sound level meters (ANSI S1.4). The noise level measurement survey results are summarized in Table 3 with the detailed results contained in Appendices B and C.

Table 3
Summary of 24-Hour Ambient Noise Monitoring Results
Quarry Ridge Professional Office Park – March 16-17, 2016

	Average Measured Hourly Noise Levels (dB)						
	Daytime (7 a.m. to 10 p.m.)			Nighttime (10 p.m. to 7 a.m.)			
Location[1]	L_{eq}	L_{50}	L_{max}	L_{eq}	L_{50}	L_{max}	L_{dn}
Site A	58	57	66-82	51	47	62-74	60
Site B	56	55	61-82	52	49	60-70	61

Notes:
[1] See Figure 1 for noise measurement locations.
Source: Bollard Acoustical Consultants, Inc. 2016.

The Table 3 data indicate that measured existing daytime ambient levels are very close to the County Noise Ordinance performance standards identified in Table 1. Therefore, provided project-generated noise levels do not exceed the Table 1 noise standards, the project would not result in a substantial increase in existing ambient noise levels.

Evaluation of Existing Traffic Noise Environment

Traffic Noise Prediction Methodology

The Federal Highway Administration Highway Traffic Noise Prediction Model (FHWA-RD-77-108) was used to model existing traffic noise levels in the project vicinity. The model is based upon the CALVENO noise emission factors for automobiles, medium trucks, and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receiver, and the acoustical characteristics of the site. The FHWA Model was developed to predict hourly L_{eq} values for free flowing traffic conditions, and is considered to be accurate within 1.5 dB in most situations.

Existing Traffic Noise Levels in the Project Vicinity

The FHWA Model was used with existing traffic data obtained from the project traffic study by KD Anderson & Associates, Inc. to model existing traffic noise levels on the local roadway network. The FHWA Model inputs are shown in Appendix E, and the results are summarized below in Table 4.

Table 4
Modeled Existing Traffic Noise Levels
Quarry Ridge Professional Office Park – Placer County, California

Roadway Name	Segment Description	Daily Volume[1]	L_{dn} (dB) at 100 feet[2,3]
Douglas Boulevard	Sierra College Blvd. to Cavitt Stallman Rd.	47,564	70
	Cavitt Stallman Rd. to Woodgrove Way	46,825	70
	Woodgrove Way to Seeno Ave.	45,232	69
	Seeno Ave. to Berg St.	44,795	69
	Berg St. to Barton Rd.	42,803	69
	Barton Rd. to Auburn Folsom Rd.	42,623	69
	Joe Rodgers Rd. to Auburn Folsom Rd.	40,789	69
Berg Street	Olive Ranch Rd. to Project	1,200	54
	Olive Ranch Rd. to Douglas Blvd.	1,200	54

Notes:
1 Roadway volumes obtained from project traffic impact analysis conducted by KD Anderson & Associates (June 6, 2018).
2 Predicted Day/Night (L_{dn}) traffic noise level, 100 feet from centerline of roadway.
3 Detailed FHWA Model traffic inputs provided in Appendix E.

Evaluation of Future On-Site Generated Noise Levels

Mechanical Equipment Noise

Heating, ventilating, and air conditioning (HVAC) requirements for the office complex will be met using either packaged roof-mounted systems or ground-level condensers. Rooftop units would be shielded from view of neighboring parcels by the proposed building parapets. At the time of this report, the choice between packaged rooftop units and ground-mounted condenser units had not been made.

BAC reference file data for HVAC systems indicate that a 12.5-ton packaged unit can be expected to generate an A-weighted sound power level of 85 dB. Assuming standard spherical spreading loss (-6 dB per doubling of distance), HVAC noise exposure was projected from an estimated equipment location (15 feet into the proposed buildings) to the property lines of the nearest sensitive receptors to the north and east. The results of those projections are presented in Table 5.

In order to calculate parking area movement noise exposure relative to Placer County's L_{eq} noise standard, it was conservatively assumed that all parking stalls could be used within a worst-case hour (it is likely that parking area activity would be more spread out). In order to calculate parking area noise exposure relative to Placer County's L_{dn} noise level standard, worst-care hour parking movements were used and conservatively assumed to occur during daytime hours (7:00 a.m. to 10:00 p.m.).

For the purposes of this analysis, predicted HVAC noise exposure at the property lines of the nearest sensitive receptors have been calculated from the rooftops of the proposed buildings. Thus, the results presented in Table 5 include a -5 dB offset to account for the screening provided by the proposed building parapets that would break line of sight from these property lines.

Table 5
Predicted HVAC Equipment Noise Exposure at Nearest Sensitive Receptors Property Lines
Quarry Ridge Professional Office Park – Placer County, California

Description[1]	Distance From HVAC Equipment to Property Line (feet)[2]	Predicted Noise Levels (dBA)[3]	
		L_{eq}	L_{dn}
Building A to APN: 048-640-012	95	40	38
Building B to APN: 048-640-011	105	40	38
Building C to APN: 048-640-009	105	40	38
Building D to APN: 048-084-031	30	50	48
	Placer County Noise Standards:	**55**	**50**

Notes:
[1] Nearest property lines are shown on Figure 2.
[2] Distances measured from a point 15 feet into proposed buildings to nearest property lines.
[3] Predicted levels take into consideration the screening provided by the proposed building parapets, and have been conservatively adjusted by -5 dB.

Rooftop-Mounted Equipment

The Table 5 data indicate that predicted rooftop-mounted HVAC equipment noise exposure would satisfy the applicable Placer County noise level standards at the property lines of the nearest sensitive receptors, including the shielding provided by the proposed building parapets. As a result, no further consideration of rooftop-mounted HVAC noise mitigation measures would be warranted for the project.

Ground-Mounted Equipment

As indicated in Figure 2, the project proposes a 6-foot tall masonry noise barrier along the northern property barrier. Including the shielding provided by the proposed 6-foot tall noise barrier, ground-mounted condenser units for Buildings A-C would satisfy the applicable Placer County noise level standards at the nearest residential property lines to the north provided a 100-foot property line setback is maintained. However, due to the location of Building D relative to the nearest church use property line to the east (APN: 048-084-031), and due to the lack of noise barrier, ground-mounted condenser units would exceed the County's noise criteria if they were to located on the east side of the proposed building. In order comply with the County's noise criteria at the nearest property line to the east, ground-mounted condenser units at Building D would need to be located on the west side of the building where they would break line of sight. The shielding of the proposed Building D relative to the eastern property line would provide an estimated -7 dB of noise reduction. The location of the units on the west side of Building D would still need to maintain a 100-foot setback from the residential property lines to the north.

Parking Area Noise

The project proposes four parking areas located near the northern and eastern ends of the property. Based on the project site plans, the proposed parking areas could accommodate up to approximately 92 vehicles. The location of the parking areas are identified on Figure 2.

As a means of determining potential noise exposure due to project parking lot activities, Bollard Acoustical Consultants, Inc. (BAC) utilized specific parking lot noise level measurements conducted by BAC. Specifically, a series of individual noise measurements were conducted of multiple vehicle types arriving and departing a parking area, including engines starting and stopping, car doors opening and closing, and persons conversing as they entered and exited the vehicles. The results of those measurements revealed that individual parking lot movements generated mean noise levels of 70 dB SEL and 65 dB L_{max} at a reference distance of 50 feet.

In order to calculate parking area movement noise exposure relative to Placer County's L_{eq} noise standard, it was conservatively assumed that all parking stalls could be used within a worst-case hour (it is likely that parking area activity would be more spread out). In order to calculate parking area noise exposure relative to Placer County's L_{dn} noise level standard, worst-case hour parking movements were conservatively assumed to occur during daytime hours (7:00 a.m. to 10:00 p.m.). Parking lot noise exposure was determined using the following equation:

$$\text{Peak Hour } L_{eq} = 70+10*\log(N) - 35.6$$

Where 70 is the SEL for a single automobile parking operation, N is the number of parking lot operations in a peak hour, and 35.6 is 10 times the logarithm of the number of seconds in an hour. Using BAC parking lot noise measurement data, the equation provided above, and assuming standard spherical spreading loss (-6 dB per doubling of distance), data were projected from the effective noise center of the nearest proposed parking areas to the adjacent property lines to the north and east. The results of the parking lot noise assessment at those nearest residential parcels are shown in Table 6.

The predicted parking area noise levels at the nearest parcels to the north (APN's: 048-640-012, 011, and 008) take into consideration the shielding provided by the proposed 6-foot tall masonry noise barrier along the northern property boundary, and have been conservatively adjusted by -5 dB. Figure 2 shows the location of the proposed property line noise barrier. No adjustment was made to predicted noise levels at the nearest parcel to the east (APN: 048-084-031).

Table 6
Predicted Parking Area Noise Exposure at Nearest Sensitive Receptors Property Lines
Quarry Ridge Professional Office Park – Placer County, California

APN[1]	Number of Nearest Parking Stalls	Distance to Nearest Parking Area Focal Point (feet)[2]	Predicted Parking Area Noise Levels (dBA)[3,4]		
			L_{eq}	L_{max}	L_{dn}
048-640-012	11	40	42	62	40
048-640-011	23	40	45	62	43
048-640-009	26	40	46	62	44
048-640-008	28	40	46	62	44
048-084-031	28	80	45	61	43
		Placer County Noise Standards:	**55**	**70**	**50**

Notes:

1 Nearest property lines of sensitive receptors are shown on Figure 1.

2 Distances measured from parking area focal points to the nearest property lines to the north and east.

3 Predicted levels based on reference noise level of 70 dB SEL and 65 dB L_{max} at a distance of 50 feet and a sound attenuation rate of 6 dB per doubling of distance.

4 Predicted levels take into consideration the screening provided by the proposed 6-foot tall masonry wall along the northern property boundary, and have been conservatively adjusted by -5 dB.

The Table 6 data indicate that predicted parking area noise exposure would satisfy the applicable Placer County noise level standards at the nearest property lines, including the shielding provided by the proposed 6-foot tall masonry noise barrier along the northern property boundary. As a result, no further consideration of parking area noise mitigation measures would be warranted for the project.

Evaluation of Off-Site Traffic Noise Level Increases

Construction of this project would result in increased traffic on the local roadway network. BAC utilized the FHWA Model with the traffic study prepared by KD Anderson & Associates, Inc. to determine whether traffic noise impacts would occur as a result of this project. The FHWA Model inputs are provided in Appendix E, and the results are shown below in Tables 7, 8, and 9.

Table 7
Existing vs Existing Plus Project Traffic Noise Levels, dB L_{dn}
Quarry Ridge Professional Office Park – Placer County, California

Roadway Name	Segment Description	Existing	Existing + Project	Change	Substantial Increase?
Douglas Boulevard	Sierra College Blvd. to Cavitt Stallman Rd.	69.7	69.7	0.0	No
	Cavitt Stallman Rd. to Woodgrove Way	69.6	69.6	0.0	No
	Woodgrove Way to Seeno Ave.	69.4	69.5	0.1	No
	Seeno Ave. to Berg St.	69.4	69.4	0.0	No
	Berg St. to Barton Rd.	69.2	69.2	0.0	No
	Barton Rd. to Auburn Folsom Rd.	69.2	69.2	0.0	No
	Joe Rodgers Rd. to Auburn Folsom Rd.	69.0	69.0	0.0	No
Berg Street	Olive Ranch Rd. to Project	53.7	53.8	0.1	No
	Olive Ranch Rd. to Douglas Blvd.	53.7	55.3	1.6	No

Sources: FHWA-RD-77-108, project traffic study, and Bollard Acoustical Consultants, Inc.

Table 8
Existing Plus Approved Projects (EPAP) vs EPAP Plus Project Traffic Noise Levels, dB L_{dn}
Quarry Ridge Professional Office Park – Placer County, California

Roadway Name	Segment Description	EPAP	EPAP + Project	Change	Substantial Increase?
Douglas Boulevard	Sierra College Blvd. to Cavitt Stallman Rd.	70.0	70.0	0.0	No
	Cavitt Stallman Rd. to Woodgrove Way	69.9	69.9	0.0	No
	Woodgrove Way to Seeno Ave.	69.8	69.8	0.0	No
	Seeno Ave. to Berg St.	69.7	69.7	0.0	No
	Berg St. to Barton Rd.	69.5	69.5	0.0	No
	Barton Rd. to Auburn Folsom Rd.	69.4	69.4	0.0	No
	Joe Rodgers Rd. to Auburn Folsom Rd.	69.2	69.2	0.0	No
Berg Street	Olive Ranch Rd. to Project	54.5	54.6	0.1	No
	Olive Ranch Rd. to Douglas Blvd.	55.9	56.9	1.0	No

Sources: FHWA-RD-77-108, project traffic study, and Bollard Acoustical Consultants, Inc.

Table 9
Year 2036 vs Year 2036 Plus Project Traffic Noise Levels, dB L_{dn}
Quarry Ridge Professional Office Park – Placer County, California

Roadway Name	Segment Description	2036	2036 + Project	Change	Substantial Increase?
Douglas Boulevard	Sierra College Blvd. to Cavitt Stallman Rd.	70.2	70.3	0.1	No
	Cavitt Stallman Rd. to Woodgrove Way	70.0	70.1	0.1	No
	Woodgrove Way to Seeno Ave.	69.9	70.0	0.1	No
	Seeno Ave. to Berg St.	69.9	69.9	0.0	No
	Berg St. to Barton Rd.	69.7	69.7	0.0	No
	Barton Rd. to Auburn Folsom Rd.	69.7	69.7	0.0	No
	Joe Rodgers Rd. to Auburn Folsom Rd.	69.6	69.7	0.1	No
Berg Street	Olive Ranch Rd. to Project	54.5	54.6	0.1	No
	Olive Ranch Rd. to Douglas Blvd.	54.4	55.8	1.4	No

Sources: FHWA-RD-77-108, project traffic study, and Bollard Acoustical Consultants, Inc.

A conservative impact significance threshold of 3 dB was utilized for this analysis. The data shown in Tables 7, 8, and 9 indicate that the project-related increase in traffic noise levels on the local roadway network would not be substantial. As a result, no off-site traffic noise impacts are predicted to occur as a result of this project.

Evaluation of Interior Traffic Noise within Proposed Office Buildings

The Placer County General Plan applies a transportation-related interior noise level standard of 45 dB Hourly L_{eq} within the proposed office buildings. The interior noise standard is assessed during a worst-case hour when the office buildings could potentially be in use. The highest hourly traffic noise levels on the project site occur during peak hour traffic conditions. The worst-case future (Year 2036 Plus Project) AM and PM peak hour traffic volumes on Douglas Boulevard were obtained from the project traffic study. Because the PM peak hour traffic volumes (3,785) were slightly greater than AM peak hour volumes (3,460), the PM peak hour traffic volumes were conservatively utilized for this assessment.

The proposed office buildings maintain a setback of approximately 90 feet from the centerline of Douglas Boulevard. Assuming vehicle speeds of 45 MPH, medium- and heavy-truck mix of 2%/1%, a soft intervening ground type, and a future PM peak hour volume of 3,785, the FHWA Model predicts a roadway noise level of 69 dB Hourly L_{eq} at a distance of 90 feet from the centerline of Douglas Boulevard. Typical construction (stucco or wood siding, STC-27 windows, exterior wall insulation, composition plywood roof) results in a transmission loss value of approximately 25-30 dB. Therefore, conservatively assuming a transmission loss value of 25 dB, predicted interior noise levels within the office buildings would be 44 dB Hourly L_{eq}. Because the predicted interior noise level of 44 dB Hourly L_{eq} would be in compliance with the Placer County interior noise level standard of 45 dB Hourly L_{eq}, no further consideration of mitigation measures for building envelope construction would be warranted.

Evaluation of Construction Noise at Nearest Existing Residences

During project construction, heavy equipment would be used for grading excavation, paving, and building construction, which would increase ambient noise levels when in use. Noise levels would vary depending on the type of equipment used, how it is operated, and how well it is maintained. Noise exposure at any single point outside the project site would also vary depending on the proximity of construction activities to that point. Standard construction equipment, such as graders, backhoes, loaders, and trucks, would likely be used for this work.

The range of maximum noise levels for various types of construction equipment at a distance of 50 feet is depicted in Table 10. The noise values represent maximum noise generation, or full-power operation of the equipment. As one increases the distance between equipment, or increases separation of areas with simultaneous construction activity, dispersion and distance attenuation reduce the effects of combining separate noise sources.

Table 10
Construction Equipment Noise Emission Levels

Equipment	Typical Sound Level (dBA) 50 Feet from Source
Air compressor	81
Backhoe	80
Compactor	82
Concrete mixer	85
Concrete pump	82
Concrete vibrator	76
Crane, mobile	83
Dozer	85
Generator	81
Grader	85
Impact wrench	85
Jackhammer	88
Loader	85
Paver	89
Pneumatic tool	85
Pump	76
Roller	74
Saw	76

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, Table 12-1. (May 2006)

The property lines of the nearest sensitive receptors to the project site are located approximately 15+ feet from construction activities which would occur on the project site. As shown in Table 10, construction activities typically generate noise levels ranging from approximately 75 to 90 dB L_{max} at a reference distance of 50 feet from the construction activities. The noise levels from construction operations decrease at a rate of approximately 6 dB per doubling of distance from the source. As a result, maximum construction noise levels would range from 85 to 100 dB L_{max} at the property lines of the nearest receptors.

Noise generated by project construction could exceed the County's standards for short duration events at the property lines of the nearest sensitive receptors. Therefore, noise mitigation measures should be incorporated to minimize the potential for adverse public reaction to project construction noise. Because construction would be short-term in duration near any given property line, significant noise impacts are not anticipated provided the following measures are implemented:

- Project construction activities should be limited to daytime hours unless conditions warrant that certain construction activities occur during evening or early morning hours (i.e., extreme heat).
- All noise-producing project equipment and vehicles using internal-combustion engines shall be equipped with mufflers, air-inlet silencers where appropriate, and any other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specifications. Mobile or fixed “package” equipment (e.g., arc welders, air compressors) shall be equipped with shrouds and noise-control features that are readily available for that type of equipment.
- All mobile or fixed noise-producing equipment used on the project site that are regulated for noise output by a federal, state, or local agency shall comply with such regulations while in the course of project activity.
- Electrically powered equipment shall be used instead of pneumatic or internal-combustion-powered equipment, where feasible.
- Material stockpiles and mobile equipment staging, parking, and maintenance areas shall be located as far as practicable from noise-sensitive receptors.
- Construction site and access road speed limits shall be established and enforced during the construction period.
- The use of noise-producing signals, including horns, whistles, alarms, and bells, shall be for safety warning purposes only.
- No project-related public address or music system shall be audible at any adjacent receptor

Evaluation of Off-Site Construction Vibration Levels

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 sensitive receptor to the project (residence) is located approximately 30+ feet from construction activities which would occur on the project site.

The range of vibration source levels for construction equipment commonly used in similar projects are shown in Table 11. The vibration levels depicted in Table 11 are representative of measurements at a distance of 25 feet from the equipment source.

Table 11
Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 feet (in/sec)	Approximate RMS L_v[1] at 25 feet
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

Notes:

[1] RMS velocity in decibels (VdB) re 1 micro-inch/second

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment: Table 12-2. (2006)

Because vibration levels generated by the type of construction equipment which will be required for this project dissipates very rapidly with distance, and because the nearest residential structure to the project construction area is approximately 30+ feet away, vibration levels at the nearest residences are expected to be below 0.1 inches/second peak particle velocity at those residences over the course of project construction activities. As a result, construction vibration levels would be well below levels which would cause damage to structures or annoyance. As a result, no construction-generated vibration mitigation measures would be warranted for this project.

Conclusions and Recommendations

Noise and vibration generated by the proposed project is expected to be satisfactory with respect to the applicable Placer County General Plan and Code noise standards at the property lines of the nearest sensitive receptors provided that the following specific measures are implemented:

Mechanical Equipment Noise:

1. Mechanical equipment shall be shielded from view of the nearest noise-sensitive receivers by a building rooftop parapet, as proposed.

2. A solid noise barrier 6-feet in height should be constructed, as proposed, along the northern property line as indicated on Figure 2 to provide reduction of parking lot noise at the nearest residences.

3. If ground-mounted condenser units are to be used:

    a. Buildings A-C: The equipment shall maintain a 100-foot setback from the nearest property lines to the north.

    b. Building D: The equipment shall be located on the west side of the building, breaking line of sight relative to the property line to the east. The equipment shall also maintain a 100-foot setback from the nearest property lines to the north.

Construction Noise:

4. To the maximum extent feasible, implement the construction noise mitigation recommendations included on Page 17 of this report.

These conclusions are based on the site plan shown on Figure 2, and on the assumptions contained herein. Deviation from the site plan and assumptions could cause actual noise levels to vary. Implementation of the above-described measures is expected to fully mitigate noise impacts associated with on-site activities at the proposed Quarry Ridge Professional Office Park.

This concludes our environmental noise assessment for the Quarry Ridge Professional Office Park in Placer County, California. Please contact BAC at (916) 663-0500 or paulb@bacnoise.com with any questions or requests for additional information.

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.
Ldn	Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.
Leq	Equivalent or energy-averaged sound level.
Lmax	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.
Sabin	The unit of sound absorption. One square foot of material absorbing 100% of incident sound has an absorption of 1 sabin.
SEL	A rating, in decibels, of a discrete event, such as an aircraft flyover or train passby, that compresses the total sound energy of the event into a 1-s time period.
Threshold of Hearing	The lowest sound that can be perceived by the human auditory system, generally considered to be 0 dB for persons with perfect hearing.
Threshold of Pain	Approximately 120 dB above the threshold of hearing.

Appendix B-1
Ambient Noise Monitoring Results - Site A
Quarry Ridge Professional Office Park
Wednesday, March 16 - Thursday, March 17, 2016

Hour	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
3:00 PM	59	74	45	63	62	60	59	54
4:00 PM	59	70	46	63	62	60	59	55
5:00 PM	60	82	43	64	62	60	58	54
6:00 PM	58	82	47	63	60	58	56	52
7:00 PM	58	71	46	62	61	59	57	53
8:00 PM	57	70	47	61	60	58	56	52
9:00 PM	55	73	40	61	58	56	53	48
10:00 PM	51	62	38	59	56	52	48	42
11:00 PM	49	64	35	57	54	49	45	39
12:00 AM	47	64	32	56	52	46	40	34
1:00 AM	44	62	29	54	49	43	38	32
2:00 AM	45	62	29	54	50	44	38	32
3:00 AM	53	64	31	61	58	53	48	36
4:00 AM	54	65	37	60	59	56	52	46
5:00 AM	57	67	45	62	60	59	57	51
6:00 AM	60	74	47	63	62	61	59	55
7:00 AM	58	71	45	62	61	59	58	53
8:00 AM	58	66	43	63	61	59	58	51
9:00 AM	58	74	42	62	61	59	57	51
10:00 AM	58	71	42	62	61	59	57	51
11:00 AM	58	72	41	63	61	59	57	51
12:00 PM	57	66	43	62	60	59	57	52
1:00 PM	58	71	42	63	61	59	57	52
2:00 PM	60	74	47	68	63	60	58	53

Daytime	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
Average	58	73	44	63	61	59	57	52
High	60	82	47	68	63	60	59	55
Low	55	66	29	61	58	56	53	48

Nighttime	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
Average	51	65	36	58	55	51	47	41
High	60	74	47	63	62	61	59	55
Low	44	62	29	54	49	43	38	32

Ldn:	60

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Appendix B-2
Ambient Noise Monitoring Results - Site B
Quarry Ridge Professional Office Park
Wednesday, March 16 - Thursday, March 17, 2016

Hour	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
3:00 PM	55	64	39	59	58	56	55	49
4:00 PM	55	67	40	60	58	56	54	49
5:00 PM	59	82	36	64	61	59	57	51
6:00 PM	57	72	44	62	60	58	56	50
7:00 PM	58	69	48	62	61	59	58	53
8:00 PM	57	67	48	61	60	58	56	52
9:00 PM	55	71	43	60	58	56	54	49
10:00 PM	51	62	38	58	55	52	49	45
11:00 PM	49	60	35	56	53	50	47	40
12:00 AM	48	66	32	56	52	47	42	35
1:00 AM	46	64	31	55	51	45	40	34
2:00 AM	46	61	30	55	51	45	40	34
3:00 AM	54	70	32	65	58	53	48	36
4:00 AM	55	68	39	62	60	57	54	47
5:00 AM	59	69	44	63	62	60	58	53
6:00 AM	61	67	48	64	63	62	61	56
7:00 AM	60	82	44	64	62	60	59	54
8:00 AM	56	67	43	61	59	58	56	51
9:00 AM	55	68	39	59	57	56	54	49
10:00 AM	54	65	41	59	57	55	53	48
11:00 AM	54	76	39	59	56	54	52	48
12:00 PM	53	65	39	58	56	54	52	47
1:00 PM	53	67	39	59	56	54	52	48
2:00 PM	53	61	40	58	56	54	52	48

Daytime	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
Average	56	70	41	60	58	56	55	50
High	60	82	48	64	62	60	59	54
Low	53	61	30	58	56	54	52	47

Nighttime	Leq	Lmax	Lmin	L02	L08	L25	L50	L90
Average	52	65	37	59	56	52	49	42
High	61	70	48	65	63	62	61	56
Low	46	60	30	55	51	45	40	34

Ldn:	61

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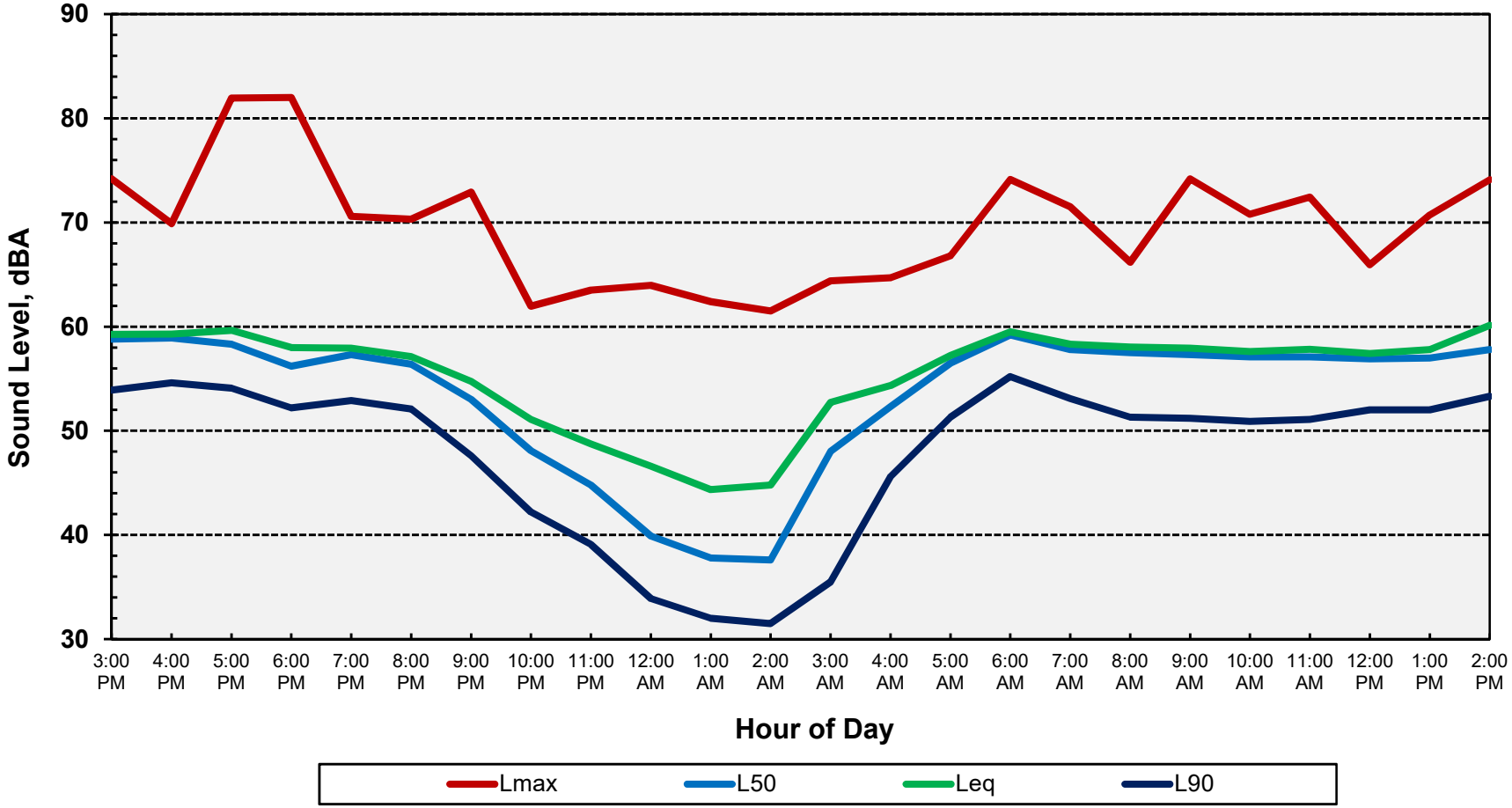
Appendix C-1
Ambient Noise Monitoring Results - Site A
Quarry Ridge Professional Office Park
Wednesday, March 16 - Thursday, March 17, 2016



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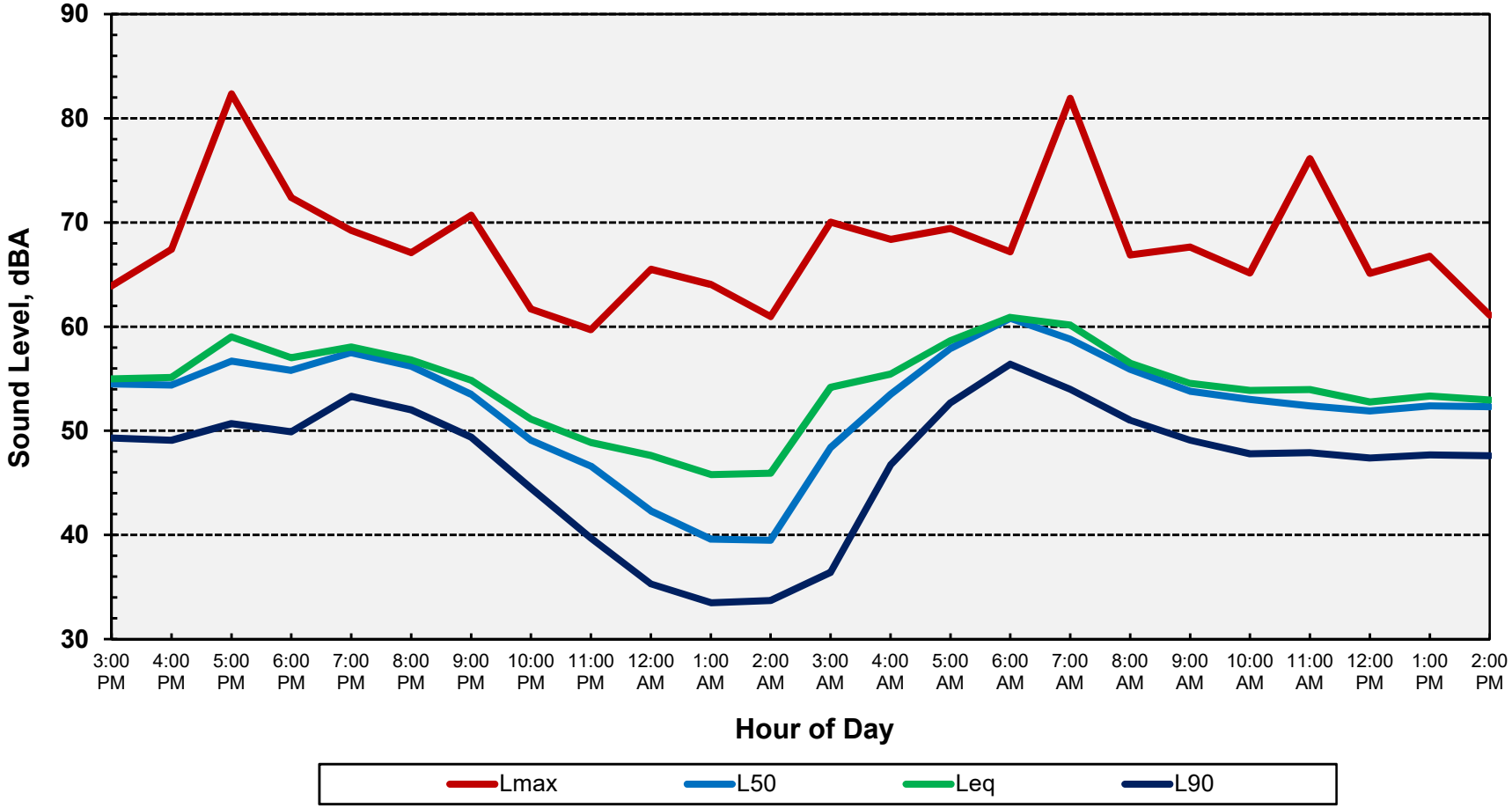
Appendix C-2
Ambient Noise Monitoring Results - Site B
Quarry Ridge Professional Office Park
Wednesday, March 16 - Thursday, March 17, 2016



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Appendix D

Project Site Photos

Quarry Ridge Professional Office Park - Placer County, California

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Appendix E-1

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Existing No Project
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	47,564	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	46,825	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	45,232	84		16	2	1	45	100	
4		Seeno Ave to Berg St	44,795	84		16	2	1	45	100	
5		Berg St to Barton Rd	42,803	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	42,623	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	40,789	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,200	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	1,200	84		16	2	1	45	100	

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Appendix E-2

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Existing Plus Project
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	47,887	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	47,148	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	45,572	84		16	2	1	45	100	
4		Seeno Ave to Berg St	45,135	84		16	2	1	45	100	
5		Berg St to Barton Rd	42,991	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	42,537	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	40,901	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,240	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	1,728	84		16	2	1	45	100	

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Appendix E-3

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Existing Plus Approved/Pending Projects
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	51,320	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	50,159	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	48,605	84		16	2	1	45	100	
4		Seeno Ave to Berg St	47,607	84		16	2	1	45	100	
5		Berg St to Barton Rd	45,478	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	44,692	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	42,739	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,460	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	1,992	84		16	2	1	45	100	

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Appendix E-4

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Existing Plus Approved/Pending Projects Plus Quarry Ridge
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	51,643	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	50,482	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	48,945	84		16	2	1	45	100	
4		Seeno Ave to Berg St	47,947	84		16	2	1	45	100	
5		Berg St to Barton Rd	45,666	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	44,804	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	42,851	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,500	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	2,520	84		16	2	1	45	100	

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Appendix E-5

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Year 2036 No Project
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	54,377	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	51,977	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	50,510	84		16	2	1	45	100	
4		Seeno Ave to Berg St	50,160	84		16	2	1	45	100	
5		Berg St to Barton Rd	47,562	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	48,338	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	47,388	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,460	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	1,422	84		16	2	1	45	100	

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Appendix E-6

FHWA-RD-77-108 Highway Traffic Noise Prediction Model
Data Input Sheet

Project #: 2016-050
Description: Year 2036 Plus Project
Ldn/CNEL: Ldn
Hard/Soft: Soft

Segment	Roadway Name	Segment Description	ADT	Day %	Eve %	Night %	% Med. Trucks	% Hvy. Trucks	Speed	Distance	Offset (dB)
1	Douglas Boulevard	Sierra College Blvd to Cavitt Stallman Rd	54,700	84		16	2	1	45	100	
2		Cavitt Stallman Rd to Woodgrove Way	52,300	84		16	2	1	45	100	
3		Woodgrove Way to Seeno Ave	50,850	84		16	2	1	45	100	
4		Seeno Ave to Berg St	50,500	84		16	2	1	45	100	
5		Berg St to Barton Rd	47,750	84		16	2	1	45	100	
6		Barton Rd to Auburn Folsom Rd	48,450	84		16	2	1	45	100	
7		Joe Rodgers Rd to Auburn Folsom Rd	47,500	84		16	2	1	45	100	
8	Berg Street	Olive Ranch Rd to Project	1,500	84		16	2	1	45	100	
9		Olive Ranch Rd to Douglas Blvd	1,950	84		16	2	1	45	100	

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