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October 11, 2017

Mr. Brian Anderson
BMA Architecture, LLC
207 N. Gilbert Rd, Ste 001
Gilbert, AZ 85234

Subject: **89A Apartments Noise Letter Review, City of Sedona, AZ**
Memorandum #1

Dear Mr. Anderson:

1.0 Introduction

MD Acoustics (MD) is pleased to provide this memorandum letter as it relates to a noise review of the proposed project site plan layout as it relates to the adjacent Relics Restaurant. The project site is located at 3285 W State Route 89A in the City of Sedona, AZ. The project proposes to construct 45 apartment units on approximately 2.26 acres. The project site is located directly adjacent (east and south) to the existing Relics Restaurant. The purpose of this review is to explore live music and patio (talking/conversation) noise propagation from Relics to project site. A list of acoustical terms is provided in Appendix A.

2.0 Acoustical Requirements

The City of Sedona has outlined their policies as it relates to noise within the municipal code. Chapter 8.25.060(A)(1) outlines the City's maximum permissible limits at the property line and is provided below:

TABLE I

MAXIMUM PERMISSIBLE SOUND LEVEL LIMITS

dB(A)

Residential and All Other Zones 7:00 a.m. – 10:00 p.m.	Residential and All Other Zones 10:00 p.m. – 7:00 a.m.	C1, C2, C3 Zone Districts 24 hours
60	50	65

Chapter 8.25.060(C) outlines the City's allowable interior limits for amplified sound as shown below:

TABLE II

AMPLIFIED SOUND REPRODUCTION DEVICE MAXIMUM PERMISSIBLE SOUND LEVEL LIMITS INDOOR ACROSS A REAL PROPERTY LINE dB(C) ABOVE NEIGHBORHOOD RESIDUAL SOUND LEVEL

10:00 p.m. to 7:00 a.m.	All Other Times
3 db(C)	5 db(C)

Note that the C-scale is more sensitive to low frequency sound levels than the A-scale. According to the municipal code, the average interior noise level must not change by the levels outlined in Table II.

3.0 Study Method and Procedures

For this assessment, two (2) general scenarios were evaluated.

Scenario 1 assumes live music occurs within the restaurant with a reference outdoor measurement of 62 dBA at 15 feet from the source (Relic Restaurant building facade). The site distances used for the calculation is provided in Appendix B. A distance of 115 feet (Building 1) and 140 feet (Building 2) from the source (restaurant) to the project site's nearest building facades (receptor) was utilized. This assumes that noise level is attenuated by 30 dB due to the Relic restaurant building shell design.

Scenario 2 assumes conversation/talking noise from restaurant patrons at the restaurant patio with a reference outdoor measurement of 75 dBA at 3 feet from the source (Relic Restaurant patio). It should be noted that typical conversational noise ranges between 60 to 70 dBA, but for this assessment a conservative 75 dBA is assumed to account for loud voices. The site distances and calculation outputs are provided in Appendix B. A distance of 25 feet (Building 1) and 180 feet (Building 2) from the source (restaurant) to the project site's nearest building facades (receptor) was utilized. In addition, the existing 5-ft patio wall was included in the modeling assumptions.

Interior noise calculations for the apartments were calculated assuming a "windows open" condition. Windows open refers to the amount of noise reduction achieved by the exterior wall's ability to attenuate noise with the windows open[1]. A 12 dBA reduction in noise level was assumed for a "windows open" condition. A 20 dBA reduction in noise level was assumed for a "windows closed" condition.

All calculations are based on inverse square law, flat topography, minimal wall heights and the reference sound levels identified above. The inverse square law basically states that in a free field the intensity of sound drops by 6 dB for each doubling of distance from the source[2].

4.0 Findings

Scenario 1 – When live music events occur within the Relic restaurant, noise levels have the potential to reach 44.3 dBA at Building 1 facade and 42.6 dBA at Building 2. The difference in the noise level is 1.7 dBA and would be considered negligible. In other words, the noise level difference would be difficult to distinguish. The levels would not exceed the City's daytime 60 dBA and nighttime 50 dBA municipal noise ordinance at both locations.

In addition, the interior noise level at the apartments would range between 30.6 to 32.3 dBA (with the windows open) which would be considered acceptable to HUD housing 45 dBA interior levels.

Scenario 2 – When conversations occur at the patio of the Relic restaurant, noise levels have the potential to reach 49.2 dBA at Building 1 facade and 30.1 dBA at Building 2. The difference in the noise level is 19.1 dBA and would be noticeable. The levels would not exceed the City's daytime 60 dBA and nighttime 50 dBA municipal noise ordinance at both locations.

[1] https://www.fhwa.dot.gov/ENVIRONMENT/noise/noise_barriers/abatement/insulation/high03.cfm
[2] http://hyperphysics.phy-astr.gsu.edu/hbase/Acoustic/invsqs.html

In addition, the interior noise level at the apartments would range between 18.1 to 37.2 dBA (with the windows open) which would be considered acceptable to HUD housing 45 dBA interior limit. When the windows are closed the noise level would be reduced even more.

Table 1 within Appendix A outlines the change in noise level perceptiveness associated with decibels.

5.0 Noise Abatement Recommendations for Building Facades

The most effective way to increase noise reduction for a building shell design is to incorporate sound transmission class (STC) rated windows. The higher the STC rating the better the noise reduction. STC ratings for windows can range between 24 to 48. A typical dual pane vinyl window has an STC 28 rating.

Another way to increase the noise reduction is to add acoustical baffles at gables, flex duct connection with duct liner at the exhausts and insulation within attic spaces. This ensures that as noise enters into the building (through the various opening/penetrations of the building), the sound is absorbed by the insulation.

The following recommendations are provided to further increase the sound attenuating properties of the exterior building shell design for Building 1's facade directly facing Relic Restaurant.

1. MD recommends windows with a minimum STC-30 or higher be implemented into Building 1 facade design for units directly facing the patio.

6.0 Conclusion

MD is pleased to provide this review. If you have any questions regarding this memo please call our office at (602) 774-1950.

Sincerely,
MD Acoustics

Mike Dickerson

Mike Dickerson, INCE
Principal

Appendix A
Glossary of Acoustical Terms

Glossary of Terms

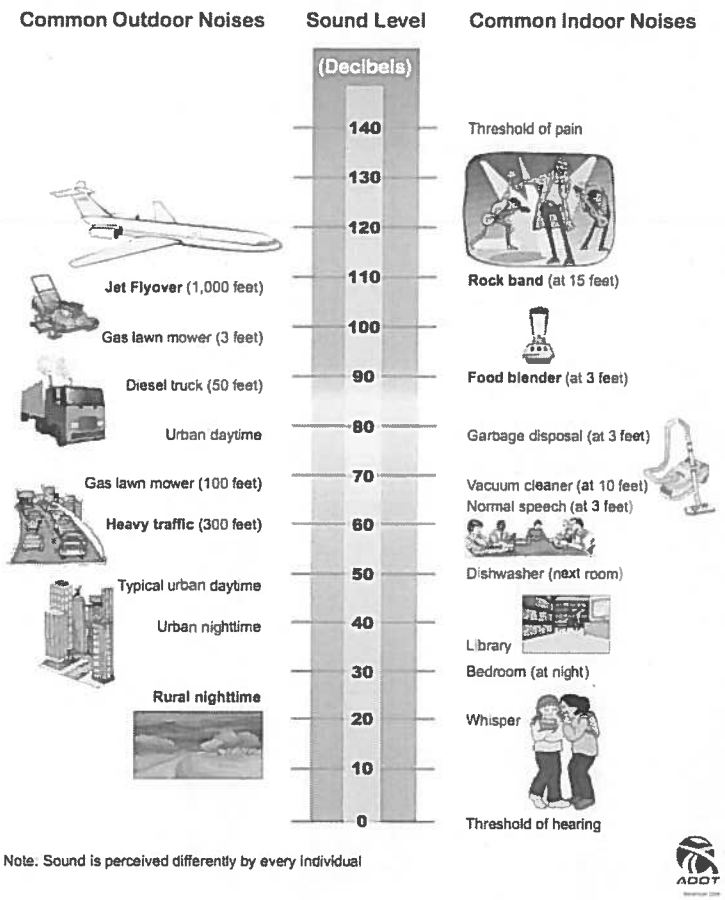
A-Weighted Sound Level: The sound pressure level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear. A numerical method of rating human judgment of loudness.

Ambient Noise Level: The composite of noise from all sources, near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Community Noise Equivalent Level (CNEL): The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five (5) decibels to sound levels in the evening from 7:00 to 10:00 PM and after addition of ten (10) decibels to sound levels in the night before 7:00 AM and after 10:00 PM.

Figure 1

Common Indoor and Outdoor Noise Levels



Decibel (dB): A unit for measuring the amplitude of a sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micro-pascals. Table 1 (below) describes a change in noise level and how the level is generally perceived.

Table 1: Change in Sound Level Characteristics[3]

Changes in Intensity Level, dBA	Changes in Apparent Loudness
1	Not perceptible
3	Just perceptible
5	Clearly noticeable
10	Twice (or half) as loud

[3] https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/ (*Highway Traffic Noise: Analysis and Abatement Guidance, Jun 2010*)

dB(A): A-weighted sound level (see definition above).

Equivalent Sound Level (LEQ): The sound level corresponding to a steady noise level over a given sample period with the same amount of acoustic energy as the actual time varying noise level. The energy average noise level during the sample period.

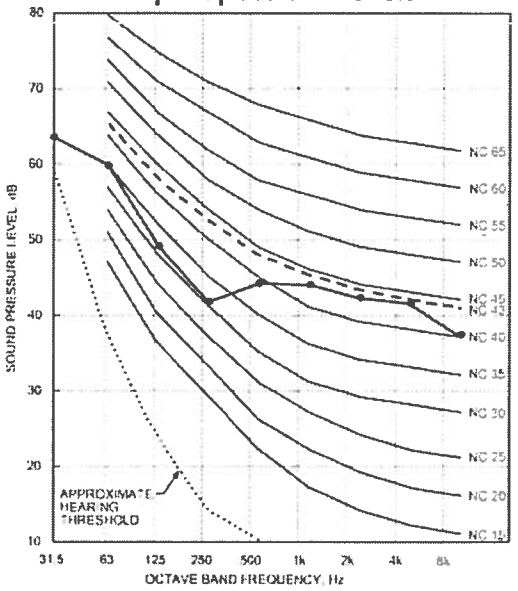
Habitable Room: Any room meeting the requirements of the Uniform Building Code or other applicable regulations which is intended to be used for sleeping, living, cooking or dining purposes, excluding such enclosed spaces as closets, pantries, bath or toilet rooms, service rooms, connecting corridors, laundries, unfinished attics, foyers, storage spaces, cellars, utility rooms and similar spaces

L(n): The A-weighted sound level exceeded during a certain percentage of the sample time. For example, L10 in the sound level exceeded 10 percent of the sample time. Similarly L50, L90 and L99, etc.

Noise: Any unwanted sound or sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying. The State Noise Control Act defines noise as "...excessive undesirable sound...".

Noise Criteria (NC) Method: This metric plots octave band sound levels against a family of reference curves, with the number rating equal to the highest tangent line value as demonstrated in Figure 1.

Figure 2: Sample NC Curves and Sample Spectrum Levels



Percent Noise Levels: See L(n).

Room Criterion (RC) Method: When sound quality in the space is important, the RC metric provides a diagnostic tool to quantify both the speech interference level and spectral imbalance.

Sound Level (Noise Level): The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

Sound Level Meter: An instrument, including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement and determination of noise and sound levels.

Sound Transmission Class (STC): To quantify STC, a Transmission Loss (TL) measurement is performed in a laboratory over a range of 16 third-octave bands between 125 – 4,000 Hertz (Hz). The average human voice creates sound within the 125 – 4,000 Hz 1/3rd octave bands.

STC is a single-number rating given to a particular material or assembly. The STC rating measures the ability of a material or an assembly to resist airborne sound transfer over the specified frequencies (see ASTM International Classification E413 and E90). In general, a higher STC rating corresponds with a greater reduction of noise transmitting through a partition.

STC is highly dependent on the construction of the partition. The STC of a partition can be increased by: adding mass, increasing or adding air space, adding absorptive materials within the assembly. The STC rating does not assess low frequency sound transfer (e.g. sounds less than 125 Hz). Special consideration must be given to spaces where the noise transfer concern has lower frequencies than speech, such as mechanical equipment and or/or music. The STC rating is a lab test that does not take into consideration weak points, penetrations, or flanking paths.

Even with a high STC rating, any penetration, air-gap, or "flanking path can seriously degrade the isolation quality of a wall. Flanking paths are the means for sound to transfer from one space to another other than through the wall. Sound can flank over, under, or around a wall. Sound can also travel through common ductwork, plumbing or corridors. Noise will travel between spaces at the weakest points. Typically, there is no reason to spend money or effort to improve the walls until all weak points are controlled first.

Outdoor Living Area: Outdoor spaces that are associated with residential land uses typically used for passive recreational activities or other noise-sensitive uses. Such spaces include patio areas, barbecue areas, jacuzzi areas, etc. associated with residential uses; outdoor patient recovery or resting areas associated with hospitals, convalescent hospitals, or rest homes; outdoor areas associated with places of worship which have a significant role in services or other noise-sensitive activities; and outdoor school facilities routinely used for educational purposes which may be adversely impacted by noise. Outdoor areas usually not included in this definition are: front yard areas, driveways, greenbelts, maintenance areas and storage areas associated with residential land uses; exterior areas at hospitals that are not used for patient activities; outdoor areas associated with places of worship and principally used for short-term social gatherings; and, outdoor areas associated with school facilities that are not typically associated with educational uses prone to adverse noise impacts (for example, school play yard areas).

Percent Noise Levels: See L(n).

Sound Level (Noise Level): The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

Sound Level Meter: An instrument, including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement and determination of noise and sound levels.

Single Event Noise Exposure Level (SENEL): The dB(A) level which, if it lasted for one second, would produce the same A-weighted sound energy as the actual event.

Appendix B
Site Distances and Calculations

Appendix B

Site Distances – Scenario 1 – Live Music Event Inside Space

NOISE BARRIER CALCULATIONS - BASED UPON FHWA - RD-77-108

PROJECT:	89A APARTMENTS	JOB #:	0132-2017-01
SOURCE:	LIVE MUSIC WITHIN RELIC RESTAURANT (SCENARIO 1)	DATE:	11-Oct-17
LOCATION:	89A APTS BLDG 1 FACADE - 115'	BY:	M.DICKERSON

NOISE INPUT DATA

OBS DIST=	115.0			
DT WALL=	105.0			
DT W/OB=	10.0			
HTH WALL=	0.0	********		
BARRIER =	0.0	(0=WALL,1=BERM)		
OBS HTH=	5.0			
NOISE HTH=	0.0		BARRIER+	
OBS EL =	0.0		TOPO SHIELDING =	0.00
NOISE EL =	0.0		NOISE HTH EL=	0.0
DROP-OFF=	20.0	(20 = 6 dBA PER DOUBLING OF DISTANCE)		
COFF				

NOISE OUTPUT DATA (dBA)

	DIST (FT)	Leq	Lmax	L2	L8	L25	L50
REF LEVEL	15	62.0	62.0	62.0	62.0	62.0	62.0
PROJ LEVEL	115	44.3	44.3	44.3	44.3	44.3	44.3
SHIELDING	115	0.0	0.0	0.0	0.0	0.0	0.0
ADJ LEVEL	115	***44.3***	***44.3***	***44.3***	***44.3***	***44.3***	***44.3***
INTERIOR LEVEL (-12dB) W/ WINDOWS OPEN		32.3	32.3	32.3	32.3	32.3	32.3

NOISE LEVEL REDUCTION DUE TO DISTANCE = -17.6921316

NOISE BARRIER CALCULATIONS - BASED UPON FHWA - RD-77-108

PROJECT:	89A APARTMENTS	JOB #:	0132-2017-01
SOURCE:	LIVE MUSIC WITHIN RELIC RESTAURANT (SCENARIO 1)	DATE:	11-Oct-17
LOCATION:	89A APTS BLDG 2 FACADE - 140'	BY:	M.DICKERSON

NOISE INPUT DATA

OBS DIST=	140.0			
DT WALL=	130.0			
DT W/OB=	10.0			
HTH WALL=	0.0	********		
BARRIER =	0.0	(0=WALL,1=BERM)		
OBS HTH=	5.0			
NOISE HTH=	0.0		BARRIER+	
OBS EL =	0.0		TOPO SHIELDING =	0.00
NOISE EL =	0.0		NOISE HTH EL=	0.0
DROP-OFF=	20.0	(20 = 6 dBA PER DOUBLING OF DISTANCE)		
COFF				

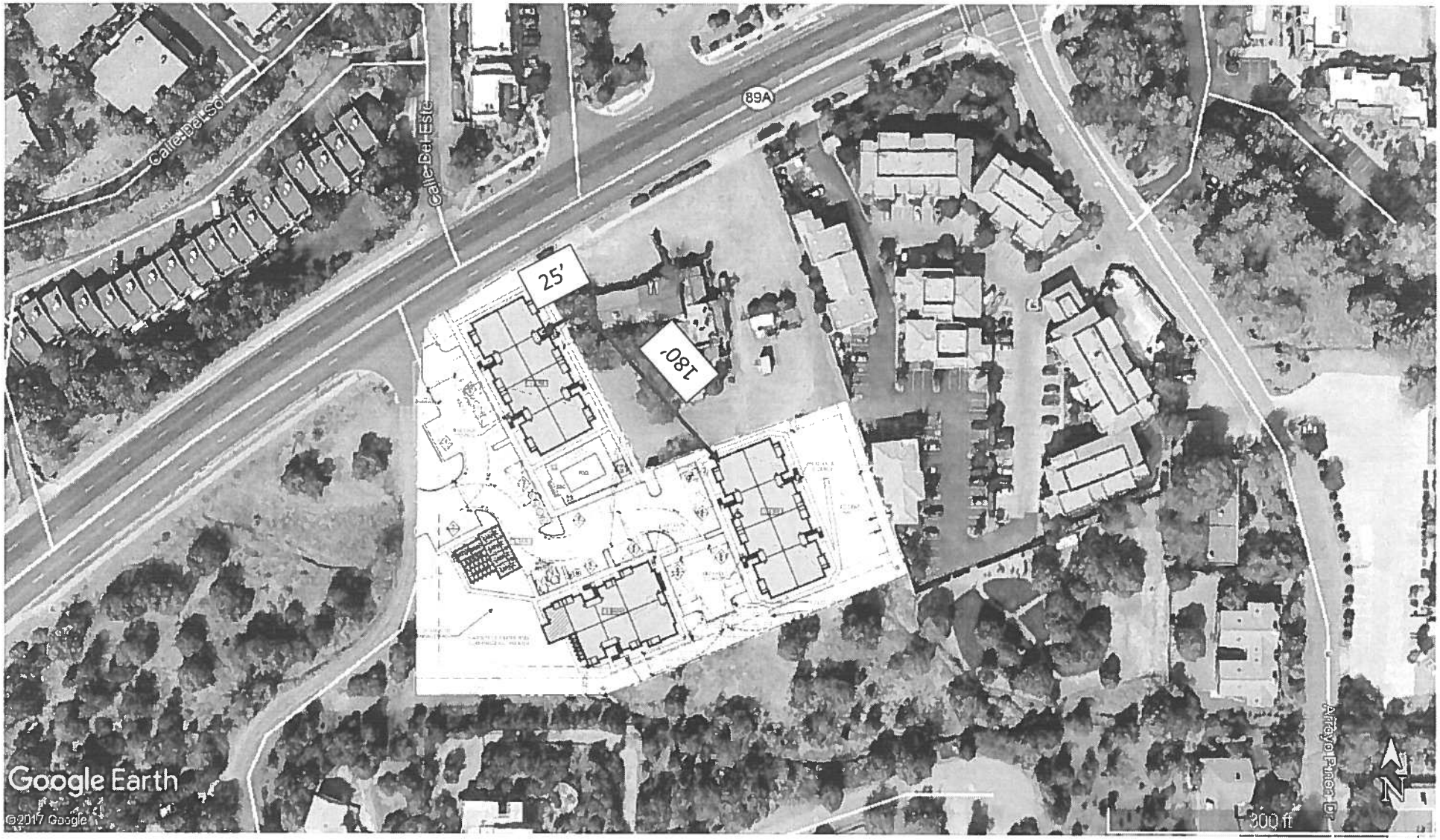
NOISE OUTPUT DATA (dBA)

	DIST (FT)	Leq	Lmax	L2	L8	L25	L50
REF LEVEL	15	62.0	62.0	62.0	62.0	62.0	62.0
PROJ LEVEL	140	42.6	42.6	42.6	42.6	42.6	42.6
SHIELDING	140	0.0	0.0	0.0	0.0	0.0	0.0
ADJ LEVEL	140	***42.6***	***42.6***	***42.6***	***42.6***	***42.6***	***42.6***
INTERIOR LEVEL (-12dB) W/ WINDOWS OPEN		30.6	30.6	30.6	30.6	30.6	30.6

NOISE LEVEL REDUCTION DUE TO DISTANCE = -19.4007355

Appendix B

Site Distances – Scenario 2 – Live Music At Patio



NOISE BARRIER CALCULATIONS - BASED UPON FHWA - RD-77-108

PROJECT:	89A APARTMENTS	JOB #:	0132-2017-01
SOURCE:	TALKING AT RELIC RESTAURANT PATIO (SCENARIO 2)	DATE:	11-Oct-17
LOCATION:	89A APTS BLDG 1 FACADE - 25'	BY:	M.DICKERSON

NOISE INPUT DATA

OBS DIST=	25.0			
DT WALL=	15.0			
DT W/OB=	10.0			
HTH WALL=	5.0	********		
BARRIER =	0.0	(0=WALL,1=BERM)		
OBS HTH=	5.0			
NOISE HTH=	0.0		BARRIER+	
OBS EL =	0.0		TOPO SHIELDING =	-7.40
NOISE EL =	0.0		NOISE HTH EL=	0.0
DROP-OFF=	20.0	(20 = 6 dBA PER DOUBLING OF DISTANCE)		
COFF				

NOISE OUTPUT DATA (dBA)

	DIST (FT)	Leq	Lmax	L2	L8	L25	L50
REF LEVEL	3	75.0	75.0	75.0	75.0	75.0	75.0
PROJ LEVEL	25	56.6	56.6	56.6	56.6	56.6	56.6
SHIELDING	25	-7.4	-7.4	-7.4	-7.4	-7.4	-7.4
ADJ LEVEL	25	***49.2***	***49.2***	***49.2***	***49.2***	***49.2***	***49.2***
INTERIOR LEVEL (-12dB) W/ WINDOWS OPEN		37.2	37.2	37.2	37.2	37.2	37.2

NOISE LEVEL REDUCTION DUE TO DISTANCE = -18.4163751

NOISE BARRIER CALCULATIONS - BASED UPON FHWA - RD-77-108

PROJECT:	89A APARTMENTS	JOB #:	0132-2017-01
SOURCE:	TALKING AT RELIC RESTAURANT PATIO (SCENARIO 2)	DATE:	11-Oct-17
LOCATION:	89A APTS BLDG 2 FACADE - 180'	BY:	M.DICKERSON

NOISE INPUT DATA

OBS DIST=	180.0			
DT WALL=	15.0			
DT W/OB=	165.0			
HTH WALL=	5.0	********		
BARRIER =	0.0	(0=WALL,1=BERM)		
OBS HTH=	5.0			
NOISE HTH=	0.0		BARRIER+	
OBS EL =	0.0		TOPO SHIELDING =	-9.30
NOISE EL =	0.0		NOISE HTH EL=	0.0
DROP-OFF=	20.0	(20 = 6 dBA PER DOUBLING OF DISTANCE)		
COFF				

NOISE OUTPUT DATA (dBA)

	DIST (FT)	Leq	Lmax	L2	L8	L25	L50
REF LEVEL	3	75.0	75.0	75.0	75.0	75.0	75.0
PROJ LEVEL	180	39.4	39.4	39.4	39.4	39.4	39.4
SHIELDING	180	-9.3	-9.3	-9.3	-9.3	-9.3	-9.3
ADJ LEVEL	180	***30.1***	***30.1***	***30.1***	***30.1***	***30.1***	***30.1***
INTERIOR LEVEL (-12dB) W/ WINDOWS OPEN		18.1	18.1	18.1	18.1	18.1	18.1

NOISE LEVEL REDUCTION DUE TO DISTANCE = -35.563025