

Appendix E Noise Analysis

Appendix

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N O I S E F U N D A M E N T A L S

Fundamentals of Noise

NOISE

Noise is most often defined as unwanted sound; whether it is loud, unpleasant, unexpected, or otherwise undesirable. Although sound can be easily measured, the perception of noise and the physical response to sound complicate the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as “noisiness” or “loudness.”

Noise Descriptors

The following are brief definitions of terminology used in this chapter:

- **Sound.** A disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB).** A unitless measure of sound, expressed on a logarithmic scale and with respect to a defined reference sound pressure. The standard reference pressure is 20 micropascals (20 μPa).
- **Vibration Decibel (VdB).** A unitless measure of vibration, expressed on a logarithmic scale and with respect to a defined reference vibration velocity. In the U.S., the standard reference velocity is 1 micro-inch per second (1×10^{-6} in/sec).
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Equivalent Continuous Noise Level (L_{eq}); also called the Energy-Equivalent Noise Level.** The value of an equivalent, steady sound level which, in a stated time period (often over an hour) and at a stated location, has the same A-weighted sound energy as the time-varying sound. Thus, the L_{eq} metric is a single numerical value that represents the equivalent amount of variable sound energy received by a receptor over the specified duration.
- **Statistical Sound Level (L_n).** The sound level that is exceeded “n” percent of time during a given sample period. For example, the L_{50} level is the statistical indicator of the time-varying noise signal that is exceeded 50 percent of the time (during each sampling period); that is, half of the sampling time, the changing noise levels are above this value and half of the time they are below it. This is called the “median sound level.” The L_{10} level, likewise, is the value that is exceeded 10 percent of the time (i.e., near the maximum) and this is often known as the “intrusive sound level.” The L_{90} is the sound level exceeded 90 percent of the time and is often considered the “effective background level” or “residual noise level.”

- **Maximum Sound Level (L_{\max}).** The highest RMS sound level measured during the measurement period.
- **Root Mean Square Sound Level (RMS).** The square root of the average of the square of the sound pressure over the measurement period.
- **Day-Night Sound Level (L_{dn} or DNL).** The energy-average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the sound levels occurring during the period from 10:00 PM to 7:00 AM.
- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 5 dB added from 7:00 PM to 10:00 PM and 10 dB from 10:00 PM to 7:00 AM. NOTE: For general community/environmental noise, CNEL and L_{dn} values rarely differ by more than 1 dB (with the CNEL being only slightly more restrictive – that is, higher than the L_{dn} value). As a matter of practice, L_{dn} and CNEL values are interchangeable and are treated as equivalent in this assessment.
- **Peak Particle Velocity (PPV).** The peak rate of speed at which soil particles move (e.g., inches per second) due to ground vibration.
- **Sensitive Receptor.** Noise- and vibration-sensitive receptors include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, motels and hotels, libraries, religious institutions, hospitals, and nursing homes are examples.

Characteristics of Sound

When an object vibrates, it radiates part of its energy in the form of a pressure wave. Sound is that pressure wave transmitted through the air. Technically, airborne sound is a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure that creates sound waves.

Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). Loudness or amplitude is measured in dB, frequency or pitch is measured in Hertz [Hz] or cycles per second, and duration or time variations is measured in seconds or minutes.

Amplitude

Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale. Because of the physical characteristics of noise transmission and perception, the relative loudness of sound does not closely match the actual amounts of sound energy. Table 1 presents the subjective effect of changes in sound pressure levels. Ambient sounds generally range from 30 dBA (very quiet) to 100 dBA (very loud). Changes of 1 to 3 dB are detectable under quiet, controlled conditions, and changes of less than 1 dB are usually not discernible (even under ideal conditions). A 3 dB change in noise levels is considered the minimum change that is detectable with human hearing in outside environments. A change of 5 dB is readily discernible to most people in an exterior environment, and a 10 dB change is perceived as a doubling (or halving) of the sound.

Table 1 Noise Perceptibility

Change in dB	Noise Level
± 3 dB	Barely perceptible increase
± 5 dB	Readily perceptible increase
± 10 dB	Twice or half as loud
± 20 dB	Four times or one-quarter as loud

Source: California Department of Transportation (Caltrans). 2013, September. Technical Noise Supplement ("TeNS").

Frequency

The human ear is not equally sensitive to all frequencies. Sound waves below 16 Hz are not heard at all, but are “felt” more as a vibration. Similarly, though people with extremely sensitive hearing can hear sounds as high as 20,000 Hz, most people cannot hear above 15,000 Hz. In all cases, hearing acuity falls off rapidly above about 10,000 Hz and below about 200 Hz.

When describing sound and its effect on a human population, A-weighted (dBA) sound levels are typically used to approximate the response of the human ear. The A-weighted noise level has been found to correlate well with people’s judgments of the “noisiness” of different sounds and has been used for many years as a measure of community and industrial noise. Although the A-weighted scale and the energy-equivalent metric are commonly used to quantify the range of human response to individual events or general community sound levels, the degree of annoyance or other response also depends on several other perceptibility factors, including:

- Ambient (background) sound level
- General nature of the existing conditions (e.g., quiet rural or busy urban)
- Difference between the magnitude of the sound event level and the ambient condition
- Duration of the sound event
- Number of event occurrences and their repetitiveness
- Time of day that the event occurs

Duration

Time variation in noise exposure is typically expressed in terms of a steady-state energy level equal to the energy content of the time varying period (called L_{eq}), or alternately, as a statistical description of the sound level that is exceeded over some fraction of a given observation period. For example, the L_{50} noise level represents the noise level that is exceeded 50 percent of the time; half the time the noise level exceeds this level and half the time the noise level is less than this level. This level is also representative of the level that is exceeded 30 minutes in an hour. Similarly, the L_2 , L_8 and L_{25} values represent the noise levels that are exceeded 2, 8, and 25 percent of the time or 1, 5, and 15 minutes per hour, respectively. These “n” values are typically used to demonstrate compliance for stationary noise sources with many cities’ noise ordinances. Other values typically noted during a noise survey are the L_{min} and L_{max} . These values represent the minimum and maximum root-mean-square noise levels obtained over the measurement period, respectively.

Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, state law and many local jurisdictions use an adjusted 24-hour noise descriptor called the Community Noise Equivalent Level (CNEL) or Day-Night Noise Level (L_{dn}). The CNEL descriptor requires that an artificial increment (or “penalty”) of 5 dBA be added to the actual noise level for the hours from 7:00 PM to 10:00

PM and 10 dBA for the hours from 10:00 PM to 7:00 AM. The L_{dn} descriptor uses the same methodology except that there is no artificial increment added to the hours between 7:00 PM and 10:00 PM. Both descriptors give roughly the same 24-hour level, with the CNEL being only slightly more restrictive (i.e., higher). The CNEL or L_{dn} metrics are commonly applied to the assessment of roadway and airport-related noise sources.

Sound Propagation

Sound dissipates exponentially with distance from the noise source. This phenomenon is known as “spreading loss.” For a single-point source, sound levels decrease by approximately 6 dB for each doubling of distance from the source (conservatively neglecting ground attenuation effects, air absorption factors, and barrier shielding). For example, if a backhoe at 50 feet generates 84 dBA, at 100 feet the noise level would be 79 dBA, and at 200 feet it would be 73 dBA. This drop-off rate is appropriate for noise generated by on-site operations from stationary equipment or activity at a project site. If noise is produced by a line source, such as highway traffic, the sound decreases by 3 dB for each doubling of distance over a reflective (“hard site”) surface such as concrete or asphalt. Line source noise in a relatively flat environment with ground-level absorptive vegetation decreases by an additional 1.5 dB for each doubling of distance.

Psychological and Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. Extended periods of noise exposure above 90 dBA results in permanent cell damage, which is the main driver for employee hearing protection regulations in the workplace. For community environments, the ambient or background noise problem is widespread, though generally worse in urban areas than in outlying, less-developed areas. Elevated ambient noise levels can result in noise interference (e.g., speech interruption/masking, sleep disturbance, disturbance of concentration) and cause annoyance. Since most people do not routinely work with decibels or A-weighted sound levels, it is often difficult to appreciate what a given sound pressure level number means. To help relate noise level values to common experience, Table 2 shows typical noise levels from familiar sources.

Table 2 Typical Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
Onset of physical discomfort	120+	
	110	Rock Band (near amplification system)
Jet Flyover at 1,000 feet		
	100	
Gas Lawn Mower at three feet		
	90	
Diesel Truck at 50 feet, at 50 mph		Food Blender at 3 feet
	80	Garbage Disposal at 3 feet
Noisy Urban Area, Daytime		
	70	Vacuum Cleaner at 10 feet
Commercial Area		Normal speech at 3 feet
Heavy Traffic at 300 feet	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: California Department of Transportation (Caltrans). 2013, September. Technical Noise Supplement ("TeNS").

Vibration Fundamentals

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Vibration is normally associated with activities stemming from operations of railroads or vibration-intensive stationary sources, but can also be associated with construction equipment such as jackhammers, pile drivers, and hydraulic hammers. As with noise, vibration can be described by both its amplitude and frequency. Vibration displacement is the distance that a point on a surface moves away from its original static position; velocity is the instantaneous speed that a point on a surface moves; and acceleration is the rate of change of the speed. Each of these descriptors can be used to correlate vibration to human response, building damage, and acceptable equipment vibration levels. During construction, the operation of construction equipment can cause groundborne vibration. During the operational phase of a project, receptors may be subject to levels of vibration that can cause annoyance due to noise generated from vibration of a structure or items within a structure.

Vibration amplitudes are usually described in terms of either the peak particle velocity (PPV) or the root mean square (RMS) velocity. PPV is the maximum instantaneous peak of the vibration signal and RMS is the

square root of the average of the squared amplitude of the signal. PPV is more appropriate for evaluating potential building damage and RMS is typically more suitable for evaluating human response.

As with airborne sound, annoyance with vibrational energy is a subjective measure, depending on the level of activity and the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Persons accustomed to elevated ambient vibration levels, such as in an urban environment, may tolerate higher vibration levels. Table 3 displays the human response and the effects on buildings resulting from continuous vibration (in terms of various levels of PPV).

Table 3 Human Reaction to Typical Vibration Levels

Vibration Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.006–0.019	Threshold of perception, possibility of intrusion	Vibrations unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibration begins to annoy people	Virtually no risk of “architectural” (i.e. not structural) damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk to “architectural” damage to normal dwelling – houses with plastered walls and ceilings
0.4–0.6	Vibrations considered unpleasant by people subjected to continuous vibrations and unacceptable to some people walking on bridges	Vibrations at a greater level than normally expected from traffic, but would cause “architectural” damage and possibly minor structural damage

Source: California Department of Transportation (Caltrans). 2020, April. *Transportation and Construction Vibration Guidance Manual*. Prepared by ICF International.

N O I S E M O N I T O R I N G D A T A

Measurement Report

Report Summary

Meter's File Name	LxT_Data.046.s	Computer's File Name	LxT_0005426-20240516 131154-LxT_Data.046.lbin
Meter	LxT1 0005426	Firmware	2.404
User	AC/LZ	Location	ST-1
Job Description	RIOS-01.0		
Note	0		
Start Time	2024-05-16 13:11:54	Duration	0:15:11.7
End Time	2024-05-16 13:27:06	Run Time	0:15:11.7
Pre-Calibration	2024-05-16 12:14:56	Post-Calibration	None
		Pause Time	0:00:00.0
		Calibration Deviation	---

Results

Overall Metrics

LA _{eq}	61.1 dB		
LAE	90.7 dB	SEA	--- dB
EA	130.5 μPa²h		
EA8	4.1 mPa²h		
EA40	20.6 mPa²h		
LZS _{peak}	94.5 dB	2024-05-16 13:22:51	
LAS _{max}	70.3 dB	2024-05-16 13:22:55	
LAS _{min}	56.4 dB	2024-05-16 13:25:15	
LA _{eq}	61.1 dB		
LC _{eq}	68.6 dB	LC _{eq} - LA _{eq}	7.5 dB
LAI _{eq}	62.3 dB	LAI _{eq} - LA _{eq}	1.2 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LZSpk > 135.0 dB	0	0:00:00.0
LZSpk > 137.0 dB	0	0:00:00.0
LZSpk > 140.0 dB	0	0:00:00.0

Community Noise

L _{DN}	L _{Day}	L _{Night}
--- dB	--- dB	0.0 dB
L _{DEN}	L _{Day}	L _{Eve}
--- dB	--- dB	---
		L _{Night}
		--- dB

Any Data

	A		C		Z	
	Level	Time Stamp	Level	Time Stamp	Level	Time Stamp
L _{eq}	61.1 dB		--- dB		--- dB	
LS _(max)	70.3 dB	2024-05-16 13:22:55	--- dB	None	--- dB	None
LS _(min)	56.4 dB	2024-05-16 13:25:15	--- dB	None	--- dB	None
L _{Peak(max)}	---	None	--- dB	None	94.5 dB	2024-05-16 13:22:51

Overloads

Count	Duration	OBA Count	OBA Duration
0	0:00:00.0	0	0:00:00.0

Statistics

LAS 2.0	66.3 dB
LAS 8.0	62.8 dB
LAS 25.0	61.6 dB
LAS 50.0	60.5 dB
LAS 90.0	58.6 dB
LAS 99.0	56.9 dB

Time History

Measurement Report

Report Summary

Meter's File Name	LxT_Data.044.s	Computer's File Name	LxT_0005426-20240516 122539-LxT_Data.044.lbin		
Meter	LxT1 0005426	Firmware	2.404		
User	AC/LZ	Location	ST-2		
Job Description	RIOS-01.0				
Note					
Start Time	2024-05-16 12:25:39	Duration	0:15:00.8		
End Time	2024-05-16 12:40:40	Run Time	0:15:00.8	Pause Time	0:00:00.0
Pre-Calibration	2024-05-16 12:14:56	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA _{eq}	69.8 dB		
LAE	99.3 dB	SEA	--- dB
EA	955.8 μPa²h		
EA8	30.6 mPa²h		
EA40	152.8 mPa²h		
LZS _{peak}	103.8 dB	2024-05-16 12:37:59	
LAS _{max}	78.9 dB	2024-05-16 12:37:59	
LAS _{min}	57.1 dB	2024-05-16 12:27:07	
LA _{eq}	69.8 dB		
LC _{eq}	74.5 dB	LC _{eq} - LA _{eq}	4.7 dB
LAI _{eq}	70.8 dB	LAI _{eq} - LA _{eq}	1.0 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LZSpk > 135.0 dB	0	0:00:00.0
LZSpk > 137.0 dB	0	0:00:00.0
LZSpk > 140.0 dB	0	0:00:00.0

Community Noise

L _{DN}	L _{Day}	L _{Night}	
--- dB	--- dB	0.0 dB	
L _{DEN}	L _{Day}	L _{Eve}	L _{Night}
--- dB	--- dB	--- dB	--- dB

Any Data

	Level	A Time Stamp	Level	C Time Stamp	Level	Z Time Stamp
L _{eq}	69.8 dB		--- dB		--- dB	
L _{S(max)}	78.9 dB	2024-05-16 12:37:59	--- dB	None	--- dB	None
L _{S(min)}	57.1 dB	2024-05-16 12:27:07	--- dB	None	--- dB	None
L _{Peak(max)}	--- dB	None	--- dB	None	103.8 dB	2024-05-16 12:37:59

Overloads

Count	Duration	OBA Count	OBA Duration
0	0:00:00.0	0	0:00:00.0

Statistics

LAS 2.0	75.3 dB
LAS 8.0	73.5 dB
LAS 25.0	71.2 dB
LAS 50.0	68.6 dB
LAS 90.0	62.3 dB
LAS 99.0	58.1 dB

Measurement Report

Report Summary

Meter's File Name	LxT_Data.045.s	Computer's File Name	LxT_0005426-20240516 125022-LxT_Data.045.ldbin		
Meter	LxT1 0005426	Firmware	2.404		
User	AC/LZ	Location	ST-3		
Job Description	RIOS-01.0				
Note					
Start Time	2024-05-16 12:50:22	Duration	0:15:03.4		
End Time	2024-05-16 13:05:25	Run Time	0:15:03.4	Pause Time	0:00:00.0
Pre-Calibration	2024-05-16 12:14:56	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA _{eq}	63.1 dB		
LAE	92.7 dB	SEA	--- dB
EA	204.9 μPa²h		
EA8	6.5 mPa²h		
EA40	32.7 mPa²h		
LZS _{peak}	97.9 dB	2024-05-16 12:52:32	
LAS _{max}	75.1 dB	2024-05-16 12:56:01	
LAS _{min}	55.3 dB	2024-05-16 12:58:53	
LA _{eq}	63.1 dB		
LC _{eq}	70.1 dB	LC _{eq} - LA _{eq}	7.0 dB
LAI _{eq}	66.7 dB	LAI _{eq} - LA _{eq}	3.6 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LZSpk > 135.0 dB	0	0:00:00.0
LZSpk > 137.0 dB	0	0:00:00.0
LZSpk > 140.0 dB	0	0:00:00.0

Community Noise

L _{DN}	L _{Day}	L _{Night}	
--- dB	--- dB	0.0 dB	
L _{DEN}	L _{Day}	L _{Eve}	L _{Night}
--- dB	--- dB	--- dB	--- dB

Any Data

	Level	A Time Stamp	Level	C Time Stamp	Level	Z Time Stamp
L _{eq}	63.1 dB		--- dB		--- dB	
LS _(max)	75.1 dB	2024-05-16 12:56:01	--- dB	None	--- dB	None
LS _(min)	55.3 dB	2024-05-16 12:58:53	--- dB	None	--- dB	None
L _{Peak(max)}	--- dB	None	--- dB	None	97.9 dB	2024-05-16 12:52:32

Overloads

Count	Duration	OBA Count	OBA Duration
0	0:00:00.0	0	0:00:00.0

Statistics

LAS 2.0	71.0 dB
LAS 8.0	68.0 dB
LAS 25.0	62.6 dB
LAS 50.0	59.2 dB
LAS 90.0	57.3 dB
LAS 99.0	56.3 dB

Time History

Measurement Report

Report Summary

Meter's File Name	LxT_Data.047.s	Computer's File Name	LxT_0005426-20240516 133151-LxT_Data.047.lbin		
Meter	LxT1 0005426	Firmware	2.404		
User	AC/LZ	Location	ST-4		
Job Description	RIOS-01.0				
Note					
Start Time	2024-05-16 13:31:51	Duration	0:15:08.6		
End Time	2024-05-16 13:47:00	Run Time	0:15:08.6	Pause Time	0:00:00.0
Pre-Calibration	2024-05-16 12:14:56	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA _{eq}	61.1 dB		
LAE	90.7 dB	SEA	--- dB
EA	130.1 μPa²h		
EA8	4.1 mPa²h		
EA40	20.6 mPa²h		
LZS _{peak}	97.3 dB	2024-05-16 13:42:29	
LAS _{max}	72.1 dB	2024-05-16 13:44:17	
LAS _{min}	53.1 dB	2024-05-16 13:46:16	
LA _{eq}	61.1 dB		
LC _{eq}	67.8 dB	LC _{eq} - LA _{eq}	6.7 dB
LAI _{eq}	63.3 dB	LAI _{eq} - LA _{eq}	2.2 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LZSpk > 135.0 dB	0	0:00:00.0
LZSpk > 137.0 dB	0	0:00:00.0
LZSpk > 140.0 dB	0	0:00:00.0

Community Noise

L _{DN}	L _{Day}	L _{Night}	
--- dB	--- dB	0.0 dB	
L _{DEN}	L _{Day}	L _{Eve}	L _{Night}
--- dB	--- dB	--- dB	--- dB

Any Data

	A		C		Z	
	Level	Time Stamp	Level	Time Stamp	Level	Time Stamp
L _{eq}	61.1 dB		--- dB		--- dB	
LS _(max)	72.1 dB	2024-05-16 13:44:17	--- dB	None	--- dB	None
LS _(min)	53.1 dB	2024-05-16 13:46:16	--- dB	None	--- dB	None
L _{Peak(max)}	--- dB	None	--- dB	None	97.3 dB	2024-05-16 13:42:29

Overloads

Count	Duration	OBA Count	OBA Duration
0	0:00:00.0	0	0:00:00.0

Statistics

LAS 2.0	68.6 dB
LAS 8.0	65.5 dB
LAS 25.0	61.1 dB
LAS 50.0	58.0 dB
LAS 90.0	55.6 dB
LAS 99.0	53.7 dB

C O N S T R U C T I O N M O D E L I N G R E S U L T S

Roadway Construction Noise Model (RCNM), Version 1.1

Report date: 06/19/2024
 Case Description: RIOS-01.0 Grading

**** Receptor #1 ****

Description	Land Use	Baselines (dBA)		
		Daytime	Evening	Night
Residential Use	Residential	65.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment			
			Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Scraper	No	40		83.6	50.0	0.0
Grader	No	40	85.0		50.0	0.0
Dozer	No	40		81.7	50.0	0.0

Results

Equipment	Noise Limits (dBA)									Noise Limit Exceedance (dBA)					
	Calculated (dBA)		Day		Evening		Night		Day		Evening		Night		
	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	
Scraper	83.6	79.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Grader	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Dozer	81.7	77.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Total	85.0	84.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 06/19/2024
 Case Description: RIOS-01.0 Building Construction

**** Receptor #1 ****

Description	Land Use	Baselines (dBA)		
		Daytime	Evening	Night
Residential Use	Residential	65.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment			
			Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Crane	No	16		80.6	50.0	0.0
Tractor	No	40	84.0		50.0	0.0
Welder / Torch	No	40		74.0	50.0	0.0

Results

Equipment	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
	Lmax	Leq	Day		Evening		Night		Day		Evening		Night	
			Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Crane	80.6	72.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tractor	84.0	80.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Welder / Torch	74.0	70.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	84.0	81.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM), Version 1.1

Report date: 06/19/2024
 Case Description: RIOS-01.0 Paving

**** Receptor #1 ****

Description	Land Use	Baselines (dBA)		
		Daytime	Evening	Night
Residential Use	Residential	65.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment			
			Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Paver	No	50		77.2	50.0	0.0
Roller	No	20		80.0	50.0	0.0

Results

Equipment	Calculated (dBA)	Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
		Day		Evening		Night		Day		Evening		Night	
		Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Paver	77.2 74.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Roller	80.0 73.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.0 76.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM), Version 1.1

Report date: 06/19/2024
 Case Description: RIOS-01.0 Architectural Coating

**** Receptor #1 ****

Description	Land Use	Baselines (dBA)		
		Daytime	Evening	Night
Residential Use	Residential	65.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment			
			Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Compressor (air)	No	40		77.7	50.0	0.0

Results

Equipment	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)						
	Lmax	Leq	Day		Evening		Night		Day		Evening		Night		
			Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	
Compressor (air)	77.7	73.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	77.7	73.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

RIOS-01 - Construction Noise Modeling Attenuation Calculations

Levels in dBA Leq

Phase	RCNM Reference Noise Level	Residential Receptors to North	Residential Receptors to East	Residential Receptors to South	Residential Receptors to West
<i>Distance in feet</i>	50	360	275	340	250
Site Prep	82	65	67	65	68
Grading	84	67	69	67	70
<i>Distance in feet</i>	50	120	280	170	1340
Building Construction	81	73	66	70	52
Architectural Coating	74	66	59	63	45
<i>Distance in feet</i>	50	50	50	80	70
Paving	77	77	77	73	74

Attenuation calculated through Inverse Square Law: $L_p(R2) = L_p(R1) - 20\text{Log}(R2/R1)$

RIOS-01.0 - Vibration Damage Attenuation Calculations

Levels, PPV (in/sec)

<i>Distance in feet</i>	Vibration Reference Level	Receptor to North	Receptor to South	Receptor to East	Receptor to West
	at 25 feet	<i>50</i>	<i>50</i>	<i>80</i>	<i>70</i>
Vibratory Roller	0.21	0.074	0.074	0.037	0.045
Hoe Ram	0.089	0.031	0.031	0.016	0.019
Large Bulldozer	0.089	0.031	0.031	0.016	0.019
Loaded Trucks	0.076	0.027	0.027	0.013	0.016
Jackhammer	0.035	0.012	0.012	0.006	0.007
Small Bulldozer	0.003	0.001	0.001	0.001	0.001

RIOS-01.0 - Vibration Damage Attenuation Calculations

Levels, PPV (in/sec)

<i>Distance in feet</i>	Vibration Reference Level	Receptor to North	Receptor to South	Receptor to East	Receptor to West
	at 25 feet	<i>50</i>	<i>50</i>	<i>80</i>	<i>70</i>
Vibratory Roller	0.21	0.074	0.074	0.037	0.045
Hoe Ram	0.089	0.031	0.031	0.016	0.019
Large Bulldozer	0.089	0.031	0.031	0.016	0.019
Loaded Trucks	0.076	0.027	0.027	0.013	0.016
Jackhammer	0.035	0.012	0.012	0.006	0.007
Small Bulldozer	0.003	0.001	0.001	0.001	0.001

T R A F F I C M O D E L I N G R E S U L T S

Traffic Noise Calculator: FHWA 77-108																							City Park Revitalization Project Addendum (RIOS-01.0) Weekday - Existing No Project Traffic Noise Traffic Conditions																						
ID	Output						Inputs														Auto Inputs																								
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																							
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																								
1	64.5	67.3	68	37	79	170	East Grand Boulevard	North of East Third Street	19,441	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
2	55.2	58.0	59	9	19	41	East 3rd Street	West of East Grand Boulevard	3,471	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																							
3	58.6	61.4	62	15	32	69	Quarry Street	East of East Grand Boulevard	3,672	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																							
4	64.2	67.0	68	35	75	162	East Grand Boulevard	North of East Sixth Street	18,061	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
5	62.9	65.7	66	29	62	133	East Grand Boulevard	South of East Sixth Street	13,537	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
6	63.2	66.0	67	30	64	139	East Sixth Street	West of East Grand Boulevard	14,345	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
7	66.5	69.3	70	50	108	232	East Sixth Street	East of East Grand Boulevard	22,175	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
8	67.6	70.4	71.1	59	127	274	East Sixth Street	Between Kress Court & Rimpau Avenue	21,887	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
9	68.0	70.8	71.5	63	135	291	East Sixth Street	East of Rimpau Avenue	22,021	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																							
10	58.8	61.5	62.2	15	33	70	Rimpau Avenue	North of East Sixth Street	4,094	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																							
11	58.4	61.2	61.9	14	31	67	Rimpau Avenue	South of East Sixth Street	9,530	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																							
12	62.0	64.7	65.4	25	53	115	Fullerton Avenue	South of East Grand Boulevard	8,919	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																							

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Weekday - Existing with Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	64.6	67.4	68.1	37	80	173	East Grand Boulevard	North of East Third Street	20,013	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	55.4	58.2	58.9	9	20	42	East 3rd Street	West of East Grand Boulevard	3,629	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	59.3	62.0	62.7	16	35	76	Quarry Street	East of East Grand Boulevard	4,283	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	64.3	67.1	67.7	35	76	164	East Grand Boulevard	North of East Sixth Street	18,464	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	63.1	65.9	66.5	29	63	137	East Grand Boulevard	South of East Sixth Street	14,015	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	63.2	66.0	66.7	30	65	140	East Sixth Street	West of East Grand Boulevard	14,556	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	66.6	69.4	70.1	51	109	235	East Sixth Street	East of East Grand Boulevard	22,537	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	67.6	70.4	71.1	59	127	273	East Sixth Street	Between Kress Court & Rimpau Avenue	21,842	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	68.0	70.8	71.5	63	136	292	East Sixth Street	East of Rimpau Avenue	22,165	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	59.3	62.1	62.7	16	35	76	Rimpau Avenue	North of East Sixth Street	4,614	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	58.6	61.4	62.0	15	32	68	Rimpau Avenue	South of East Sixth Street	9,896	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	62.1	64.9	65.6	25	54	117	Fullerton Avenue	South of East Grand Boulevard	9,171	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

Traffic Noise Calculator: FHWA 77-108			City Park Revitalization Project Addendum (RIOS-01.0) Weekday - Future No Project Traffic Noise Traffic Conditions																			
ID	Output			Inputs															Auto Inputs			
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment From - To	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																	
1	64.8	67.5	68.2	38	82	177	East Grand Boulevard	North of East Third Street	20,631	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
2	56.1	58.9	59.6	10	22	47	East 3rd Street	West of East Grand Boulevard	4,247	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20
3	58.9	61.6	62.3	15	33	71	Quarry Street	East of East Grand Boulevard	3,897	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20
4	64.4	67.2	67.9	36	78	168	East Grand Boulevard	North of East Sixth Street	19,179	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
5	63.3	66.1	66.8	31	66	142	East Grand Boulevard	South of East Sixth Street	14,888	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
6	63.6	66.4	67.1	32	69	148	East Sixth Street	West of East Grand Boulevard	15,807	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
7	66.8	69.6	70.3	52	112	242	East Sixth Street	East of East Grand Boulevard	23,634	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
8	67.9	70.7	71.3	62	133	285	East Sixth Street	Between Kress Court & Rimpau Avenue	23,328	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
9	68.3	71.1	71.7	65	141	303	East Sixth Street	East of Rimpau Avenue	23,471	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44
10	59.0	61.8	62.5	16	34	73	Rimpau Avenue	North of East Sixth Street	4,345	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20
11	58.7	61.5	62.1	15	32	69	Rimpau Avenue	South of East Sixth Street	10,114	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20
12	62.4	65.2	65.9	27	58	124	Fullerton Avenue	South of East Grand Boulevard	9,973	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Weekday - Future with Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment From - To	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	64.9	67.7	68.3	39	84	180	East Grand Boulevard	North of East Third Street	21,203	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	56.3	59.1	59.8	10	22	48	East 3rd Street	West of East Grand Boulevard	4,405	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	59.5	62.3	63.0	17	37	79	Quarry Street	East of East Grand Boulevard	4,508	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	64.5	67.3	68.0	37	79	171	East Grand Boulevard	North of East Sixth Street	19,582	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	63.5	66.3	66.9	31	67	145	East Grand Boulevard	South of East Sixth Street	15,366	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	63.7	66.4	67.1	32	69	149	East Sixth Street	West of East Grand Boulevard	16,018	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	66.9	69.7	70.3	53	114	245	East Sixth Street	East of East Grand Boulevard	23,996	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	67.9	70.7	71.3	61	132	285	East Sixth Street	Between Kress Court & Rimpau Avenue	23,283	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	68.3	71.1	71.8	66	141	305	East Sixth Street	East of Rimpau Avenue	23,615	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	59.5	62.3	63.0	17	37	79	Rimpau Avenue	North of East Sixth Street	4,865	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	58.8	61.6	62.3	15	33	71	Rimpau Avenue	South of East Sixth Street	10,480	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	62.6	65.3	66.0	27	59	126	Fullerton Avenue	South of East Grand Boulevard	10,225	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Saturday - Existing No Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	62.9	65.7	66	29	62	133	East Grand Boulevard	North of East Third Street	13,408	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	53.4	56.2	57	7	14	31	East 3rd Street	West of East Grand Boulevard	2,290	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	56.2	59.0	60	10	22	48	Quarry Street	East of East Grand Boulevard	2,136	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	62.8	65.6	66	28	61	131	East Grand Boulevard	North of East Sixth Street	13,105	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	61.5	64.3	65	23	50	108	East Grand Boulevard	South of East Sixth Street	9,838	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	62.4	65.2	66	26	57	123	East Sixth Street	West of East Grand Boulevard	11,966	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	65.5	68.2	69	42	91	197	East Sixth Street	East of East Grand Boulevard	17,325	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	66.6	69.4	70.1	50	109	234	East Sixth Street	Between Kress Court & Rimpau Avenue	17,299	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	66.6	69.4	70.1	51	110	236	East Sixth Street	East of Rimpau Avenue	16,126	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	61.2	64.0	64.6	22	47	102	Rimpau Avenue	North of East Sixth Street	7,146	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	52.3	55.1	55.8	6	12	26	Rimpau Avenue	South of East Sixth Street	2,349	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	60.5	63.3	64.0	20	43	92	Fullerton Avenue	South of East Grand Boulevard	6,392	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Saturday - Existing with Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	63.0	65.8	66.5	29	63	135	East Grand Boulevard	North of East Third Street	13,811	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	53.6	56.4	57.1	7	15	32	East 3rd Street	West of East Grand Boulevard	2,398	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	57.0	59.8	60.5	12	25	54	Quarry Street	East of East Grand Boulevard	2,553	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	62.9	65.7	66.3	29	62	133	East Grand Boulevard	North of East Sixth Street	13,393	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	61.7	64.5	65.2	24	51	110	East Grand Boulevard	South of East Sixth Street	10,170	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	62.4	65.2	65.9	27	58	124	East Sixth Street	West of East Grand Boulevard	12,122	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	65.5	68.3	69.0	43	92	199	East Sixth Street	East of East Grand Boulevard	17,590	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	66.6	69.4	70.0	50	109	234	East Sixth Street	Between Kress Court & Rimpau Avenue	17,287	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	66.7	69.5	70.1	51	110	237	East Sixth Street	East of Rimpau Avenue	16,236	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	61.4	64.2	64.9	23	49	105	Rimpau Avenue	North of East Sixth Street	7,501	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	52.8	55.6	56.2	6	13	28	Rimpau Avenue	South of East Sixth Street	2,605	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	60.6	63.4	64.1	20	44	94	Fullerton Avenue	South of East Grand Boulevard	6,570	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Saturday - Future No Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment From - To	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	63.1	65.9	66.6	30	64	138	East Grand Boulevard	North of East Third Street	14,229	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	54.7	57.5	58.2	8	18	38	East 3rd Street	West of East Grand Boulevard	3,086	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	56.5	59.3	60.0	11	23	50	Quarry Street	East of East Grand Boulevard	2,267	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	63.0	65.8	66.5	29	63	136	East Grand Boulevard	North of East Sixth Street	13,910	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	62.0	64.8	65.5	25	54	117	East Grand Boulevard	South of East Sixth Street	11,044	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	62.9	65.7	66.3	28	61	132	East Sixth Street	West of East Grand Boulevard	13,356	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	65.7	68.5	69.2	44	95	205	East Sixth Street	East of East Grand Boulevard	18,443	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	66.9	69.6	70.3	53	113	244	East Sixth Street	Between Kress Court & Rimpau Avenue	18,416	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	66.9	69.7	70.4	53	114	246	East Sixth Street	East of Rimpau Avenue	17,171	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	61.4	64.2	64.9	23	49	106	Rimpau Avenue	North of East Sixth Street	7,583	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	52.6	55.4	56.1	6	13	27	Rimpau Avenue	South of East Sixth Street	2,493	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	61.1	63.9	64.6	22	47	102	Fullerton Avenue	South of East Grand Boulevard	7,387	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

Traffic Noise Calculator: FHWA 77-108																						City Park Revitalization Project Addendum (RIOS-01.0) Saturday - Future with Project Traffic Noise Traffic Conditions																					
ID	Output						Inputs														Auto Inputs																						
	dBA at 50 feet			Distance to CNEL Contour			Roadway	Segment From - To	ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Receiver	Ground Absorption	Lane Distance																					
L _{eq,24hr}	L _{dn}	CNEL	70 dBA	65 dBA	60 dBA																																						
1	63.3	66.0	66.7	30	65	141	East Grand Boulevard	North of East Third Street	14,632	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
2	54.9	57.7	58.4	8	18	39	East 3rd Street	West of East Grand Boulevard	3,194	30	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
3	57.2	60.0	60.7	12	26	56	Quarry Street	East of East Grand Boulevard	2,684	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
4	63.1	65.9	66.6	30	64	138	East Grand Boulevard	North of East Sixth Street	14,198	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
5	62.2	65.0	65.6	26	55	119	East Grand Boulevard	South of East Sixth Street	11,376	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
6	62.9	65.7	66.4	29	62	133	East Sixth Street	West of East Grand Boulevard	13,512	35	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
7	65.8	68.6	69.3	45	96	207	East Sixth Street	East of East Grand Boulevard	18,708	40	0.0%	96.0%	1.5%	0.5%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
8	66.8	69.6	70.3	53	113	244	East Sixth Street	Between Kress Court & Rimpau Avenue	18,404	40	0.0%	97.6%	0.0%	2.4%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
9	66.9	69.7	70.4	53	115	247	East Sixth Street	East of Rimpau Avenue	17,281	40	0.0%	97.0%	0.0%	3.0%	75.0%	15.0%	10.0%	4	Soft	50	0.5	44																					
10	61.6	64.4	65.1	24	51	109	Rimpau Avenue	North of East Sixth Street	7,938	25	0.0%	94.4%	0.0%	5.6%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
11	53.0	55.8	56.5	6	14	29	Rimpau Avenue	South of East Sixth Street	2,749	25	0.0%	98.8%	0.0%	1.2%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					
12	61.2	64.0	64.7	22	48	103	Fullerton Avenue	South of East Grand Boulevard	7,565	35	0.0%	98.1%	0.0%	1.9%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20																					

S O U N D P L A N R E S U L T S



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MEMORANDUM

DATE:	2025-03-18	RWDI Reference No.:	2407536
TO:	Russell Dykann	EMAIL:	russell@rios.com
FROM:	Omar Bustamante, RWDI Mikk Toome, RWDI Michael Brown, RWDI	EMAIL:	omar.bustamanmte@rwdi.com mikk.toome@rwdi.com michael.brown@rwdi.com
RE:	Amphitheater Events - Noise Impact Predictions Corona City Park		

RWDI was retained to conduct noise modeling with respect to events planned for the outdoor amphitheater that will be developed in the central lawn of the City Park in the City of Corona, California. The outdoor amphitheater is part of the renovation project that includes the relocation of existing recreational facilities and the development of a new Community Center.

The Amphitheater noise modeling detailed below, includes the predicted noise impacts for two categories of events due to crowd and PA noise, showing noise contour results and numerical noise levels at the adjacent single-family and multi-family uses at the nearest building façades taking into account the proposed site design and off-site buildings.

AMPHITHEATER EVENT NOISE MODELING

The City Park is located at 930 E 6TH Street, Corona, California 92879. The site is bounded by E 6TH Street at the South, Kress Ct Street at the West, Rimpau Avenue at the East and Quarry Street at the North.

It is our understanding that an amphitheater will be developed in the central lawn of the City Park to host a variety of events including concerts, outdoor movies, festivals and community gatherings. Based on the site plan provided in the 30% CD set dated 12/10/2024, and the available information provided for the amphitheater, a 3D noise prediction model was created in Cadna/A, an implementation of the ISO 9613 noise propagation calculation algorithms.

Two categories of events were included in the noise prediction modeling:





1. **Live Music Concerts**
2. **General Outdoor Festivals** (includes movies in the park, theatrical performances, announcements and background music).

For “Live Music Concerts”, a music sound level of 100 dBA ($L_{Aeq, 15 \text{ min}}$) evenly distributed over the audience area was assumed based on the World Health Organization Guidelines for Community Noise related to ceremonies, festivals and entertainment events (WHO, 2022). An area source at the location of the audience was designated with a distributed sound power level that achieves 100 dBA through the spectator area.

For “General Outdoor Festivals”, an audience area sound level of 80 dBA ($L_{Aeq, 15 \text{ min}}$) has been assumed for the analysis.

Spectral sound data for the concert was approximated based on data for a rock concert (Pierce, 2004) and applied to capture the potential effects of low frequency noise (i.e. bass). The spectrum adopted in the analysis is included with Table 1.

Table 1: Spectrum levels of a rock concert

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	L_{pA}
Predicted Sound Pressure Level (dB)	109	102	97	97	96	92	90	82	100 dBA

Results

The potential noise impact from the audience area of the amphitheater on the single-family and multi-family uses at the surrounding building façades and exposed backyards was predicted to determine the exterior sound levels. The sound levels at the nearest sensitive receptors are shown in **Table 2**.

Table 2: Predicted sound levels due to events at the amphitheater at 5ft height above grade

Receptor	Predicted Sound Levels at Sensitive Receptors	
	Live Music Concerts ($L_{Aeq, 15 \text{ min}}$)	General Outdoor Festivals ($L_{Aeq, 15 \text{ min}}$)
North	80 dBA	60 dBA
South -East	78 dBA	58 dBA



Receptor	Predicted Sound Levels at Sensitive Receptors	
	Live Music Concerts	General Outdoor Festivals
	(L_{Aeq} , 15 min)	(L_{Aeq} , 15 min)
South	82 dBA	62 dBA
West	76 dBA	56 dBA

The spectral sound level at the worst-case receptor location (South) due to a Live Music Concert is shown in **Table 3**.

Table 3: Worst-case receptor sound level spectrum

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	L_{pA}
Predicted Sound Pressure Level (dB)	92	85	79	79	78	75	70	54	82 dBA

Noise contours for a “Live Music Concert” showing the predicted sound levels at the City Park (including the Community Center and recreational areas), and the surrounding buildings, are shown in **Figure 1** (5ft height above grade) and **Figure 2** (15ft height above grade), appended at the end of the report.

Noise contours for the “General Outdoor Festivals” are included with **Figures 3 and 4**.

Conclusion

Exterior sound levels at the City Park and off-site buildings due to the amphitheater were predicted. Sound levels at the nearest sensitive receptors during “Live Music Concerts” are predicted to be in the range of 76 to 82 dBA. Sound levels at the nearest sensitive receptors during “General Outdoor Festivals” are predicted to range from 56 to 62 dBA.

References

1. Peirce, R.. (2004). Low frequency noise criteria for concerts. 29. 32-34.
2. WHO, 2022. WHO Global standard for safe listening venues & events.

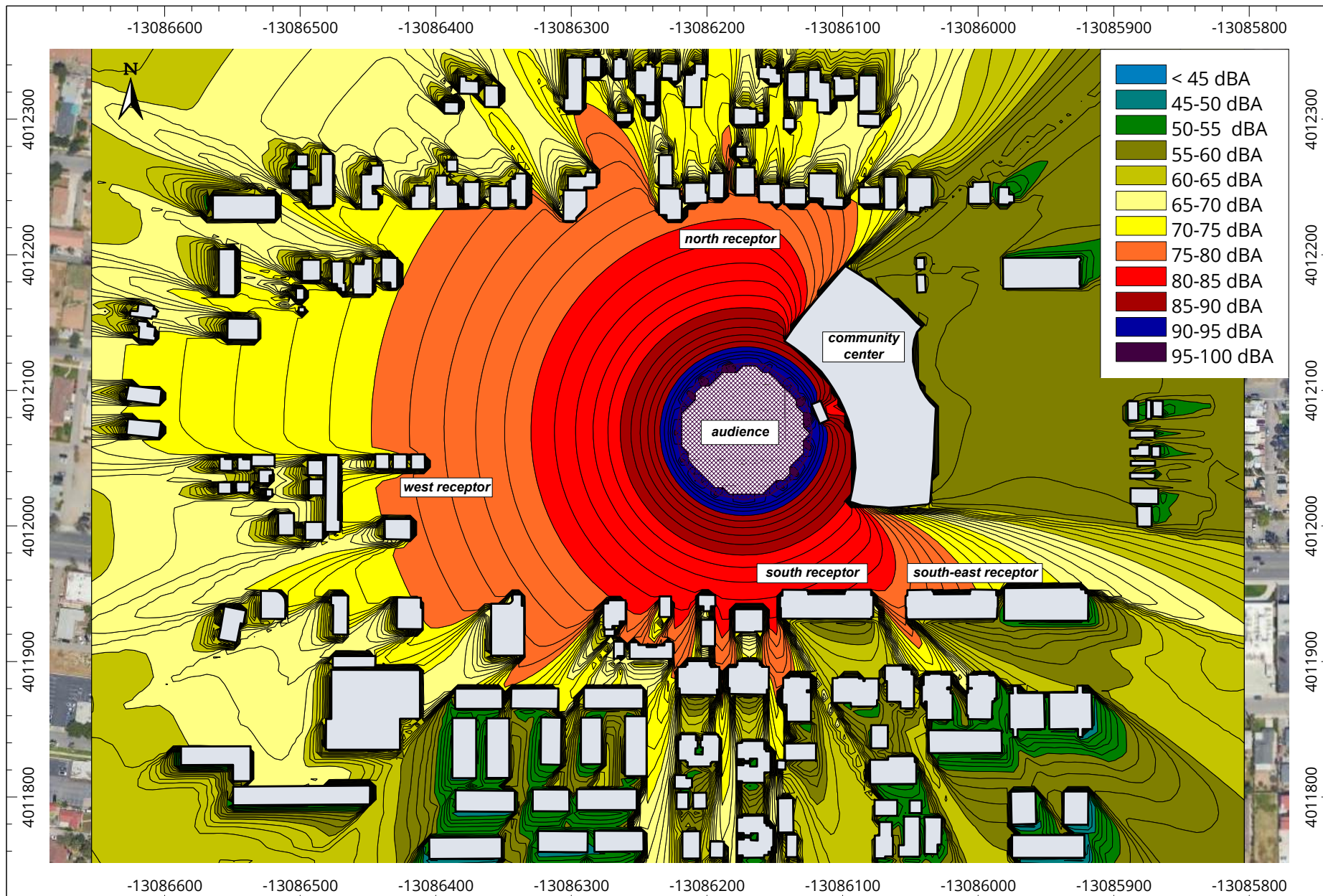


Statement of Limitations

This report entitled Amphitheater Events - Noise Impact Predictions, dated March 18, 2025, was prepared by RWDI USA LLC ("RWDI") for RIOS Los Angeles ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.



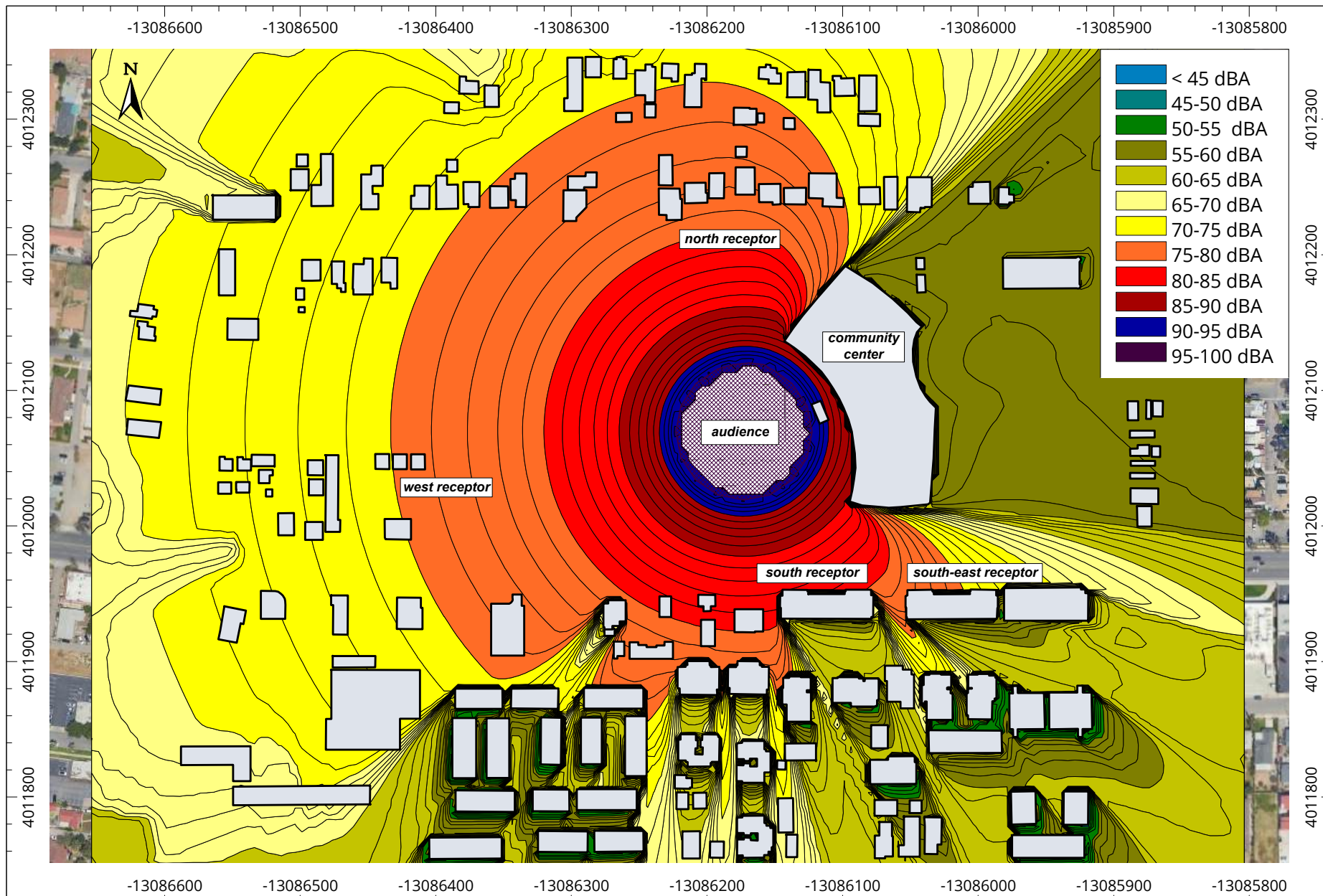
Amphitheater Events - Noise Impact Predictions

Figure 1. Live Music Concert - Contour Height: 5 ft

Project Name - Corona City Park

Project #2407536





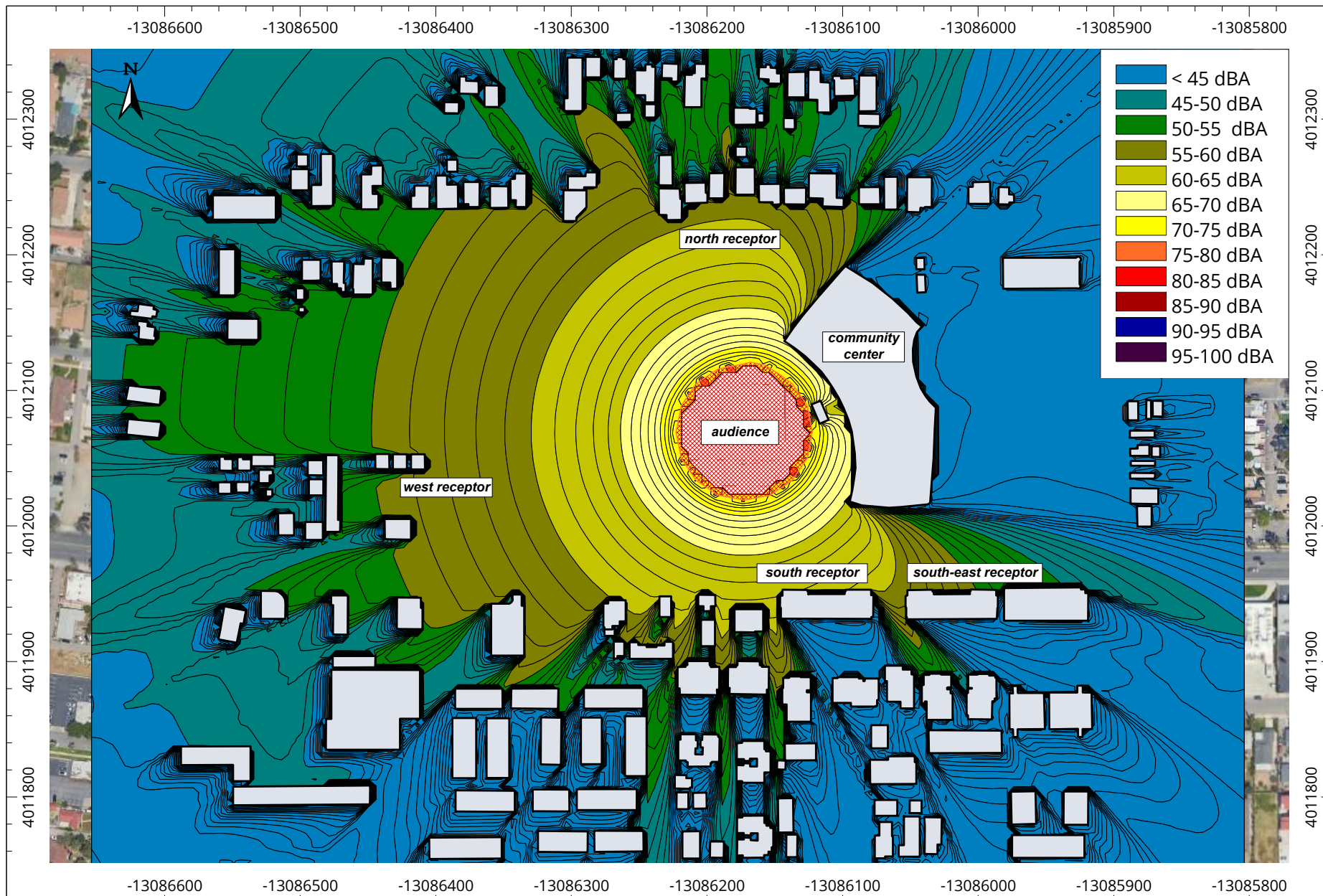
Amphitheater Events - Noise Impact Predictions

Figure 2. Live Music Concert - Contour Height: 15 ft

Project Name - Corona City Park

Project #2407536





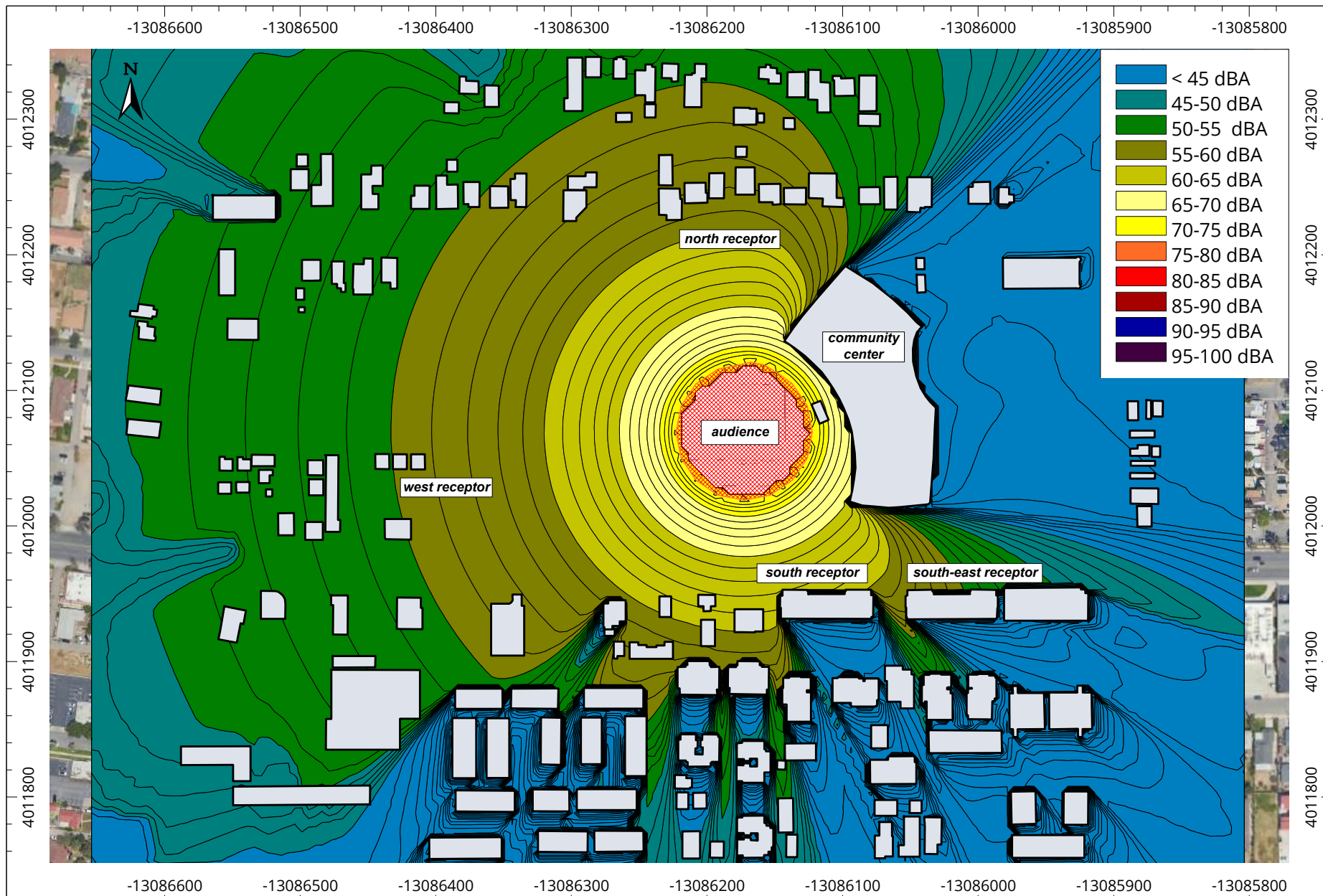
Amphitheater Events - Noise Impact Predictions

Figure 3. General Outdoor Festival - Contour Height: 5 ft

Project Name - Corona City Park

Project #2407536





Amphitheater Events - Noise Impact Predictions

Figure 4. General Outdoor Festival - Contour Height: 15 ft

Project Name - Corona City Park

Project #2407536

