

Appendix D

Noise and Vibration Calculations

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Construction Noise - Equipment

Table 1. 8-Hour Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 100'	Equipment Leq(h) @ 100'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 100'	Total Leq(h) @ 100'	
Site Preparation	Air Compressors	Compressor (air)	40%	72	68	3	5	77	73	
	Graders	Grader	40%	79	75	1	0	79	75	
	Rollers	Roller	20%	74	67	1	0	74	67	
	Rough Terrain Forklifts	Front End Loader	40%	73	69	3	5	78	74	
	Skid Steer Loaders	Front End Loader	40%	73	69	2	3	76	72	
	Tractors/Loaders/Backhoes	Backhoe	40%	72	68	1	0	72	68	
	Site Preparation Total									
	Graders	Grader	40%	79	75	1	0	79	75	
	Rubber Tired Dozers	Dozer	40%	76	72	1	0	76	72	
	Tractors/Loaders/Backhoes	Backhoe	40%	72	68	1	0	72	68	
Grading Total										
Building Construction	Cranes	Crane	16%	75	67	1	0	75	67	
	Forklifts	Man Lift	20%	69	62	1	0	69	62	
	Generator Sets	Generator	50%	75	72	1	0	75	72	
	Tractors/Loaders/Backhoes	Backhoe	40%	72	68	1	0	72	68	
	Welders	Welder/Torch	40%	68	64	3	5	73	69	
	Building Construction Total									
	Paving	Cement and Mortar Mixers	Vibratory Concrete Mixer	20%	74	67	1	0	74	67
Pavers		Paver	50%	71	68	1	0	71	68	
Paving Equipment		Paver	50%	71	68	1	0	71	68	
Rollers		Roller	20%	74	67	1	0	74	67	
Tractors/Loaders/Backhoes		Backhoe	40%	72	68	1	0	72	68	
Paving Total										
Architectural Coatings	Air Compressors	Compressor (air)	40%	72	68	1	0	72	68	
	Architectural Coatings Total									

Table 2. 8-Hour Construction Noise Level (dBA) at City Hall

Phase Type	Site Preparation	Grading	Building Construction	Paving	Architectural Coatings	Min	Max
Distance from the Center of Construction Activity to a Receptor (ft)	285	285	285	285	285		
	80	77	76	75	68		
	9	9	9	9	9		
8-Hour Construction Noise Level at 100 ft (dBA)	0.2	0.2	0.2	0.2	0.2		
	71	68	66	65	59	59	71
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	71	69	67	66	62	62	71
	11	9	7	6	2	2	11

Table 3. 8-Hour Construction Noise Level (dBA) at First Baptist Church of Pasadena

Phase Type	Site Preparation	Grading	Building Construction	Paving	Architectural Coatings	Min	Max
Distance from the Property Line to a Receptor (ft)	125	125	125	125	125		
8-Hour Construction Noise Level at 100 ft (dBA)	80	77	76	75	68		
Distance Divergence (dBA)	2	2	2	2	2		
Atmospheric Attenuation (dBA)	0.1	0.1	0.1	0.1	0.1		
Maximum Construction Noise Level at the Receptor (dBA)	78	75	74	73	66	66	78
Daytime Unmitigated Lmax (Construction Noise + Existing) (dBA)	78	75	74	73	67	67	78
Daytime Increase Over Existing (dBA)	18	15	14	13	7	7	18

Table 4. 8-Hour Construction Noise Level (dBA) at Centennial Place

Phase Type	Site Preparation	Grading	Building Construction	Paving	Architectural Coatings	Min	Max
Distance from the Property Line to a Receptor (ft)	210	210	210	210	210		
8-Hour Construction Noise Level at 100 ft (dBA)	80	77	76	75	68		
Distance Divergence (dBA)	6	6	6	6	6		
Atmospheric Attenuation (dBA)	0.2	0.2	0.2	0.2	0.2		
Maximum Construction Noise Level at the Receptor (dBA)	73	71	69	68	61	61	73
Daytime Unmitigated Lmax (Construction Noise + Existing) (dBA)	74	71	70	69	64	64	74
Daytime Increase Over Existing (dBA)	14	11	10	9	4	4	14

Table 5. Construction Traffic - Equivalent Noise Levels

Type	Roadway	Existing AADT	Maximum Daily Truck Trips	Maximum Daily Worker Trips	Average Speed	Equivalency Factor for Heavy-Duty Vehicles	Equivalent Vehicles	Total with Project	Increase Ratio	Noise Level Increase (dBA)
Local	Holly St	1,444	25	64	35	19.1	542	1,986	1.38	1.38
Local	Marengo Ave	16,234	25	64	35	19.1	542	16,776	1.03	0.14
Local	Union St	7,327	25	64	35	19.1	542	7,869	1.07	0.31
Local	Garfield Ave	3,953	25	64	35	19.1	542	4,495	1.14	0.56

Table 6. Equivalent Vehicles Based on Federal Highway Administration Traffic Noise Model Reference Energy Mean Emission Levels

Speed (km/h [mph])	Equivalent Vehicles		
	1 Heavy Truck	1 Medium Truck	1 Auto
56 (35)	19.1	7.1	1
64 (40)	15.1	5.8	1
72 (45)	12.9	5	1
80 (50)	11.5	4.5	1
88.5 (55)	10.4	4.1	1
97 (60)	9.6	3.7	1
105 (65)	7.9	3.5	1
113 (70)	8.3	3.2	1

Source: Caltrans. 2013. Technical Noise Supplement to the Traffic Noise Analysis Protocol. September.

Existing Noise Levels

Land Use Type

Urban Residential

Background Noise (dBA)

60

Significance Level

5 dBA

(daytime increase over existing noise levels)

Operational Noise - Traffic

Table 7. Operation Traffic - Increased Noise Levels

Roadway	Existing AADT	Total with Project	Increase Ratio	Noise Level Increase (dBA)	Significant?
Holly St	1,444	4,638	3.21	5	no
Marengo Ave	16,234	19,428	1.20	1	no
Union St	7,327	10,521	1.44	2	no
Garfield Ave	3,953	7,147	1.81	3	no

Project-Related Trips 3,194

Significance Level

5 dBA

Pool Activities

Distance from pool to closest receptor 290 feet
 Maximum noise level from pool @ 5 ft 70 dBA
 Distance divergence 35 dBA
 Operational noise level at receptor 35 dBA
 Daytime increase over existing -25 dBA

Ambient 60 dBA

Construction Vibration

Table 8. Estimated Vibration Levels (Damage Assessment)

			YWCA	First Baptist Church	Centennial Place	City Hall	Loweman Building
Equipment Description	Distance (ft)	25	20	125	210	205	100
	Equivalent Equipment	PPV (in/sec)					
Air Compressors	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cement and Mortar Mixers	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cranes	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forklifts	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Generator Sets	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Graders	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pavers	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Paving Equipment	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rollers	Vibratory Roller	0.21	0.29	0.019	0.0086	0.0089	0.026
Rough Terrain Forklifts	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rubber Tired Dozers	Large Bulldozer	0.089	0.12	0.0080	0.0037	0.0038	0.011
Skid Steer Loaders	Small bulldozer	0.003	0.0042	0.00027	0.00012	0.000128	0.0004
Tractors/Loaders/Backhoes	Small bulldozer	0.003	0.0042	0.00027	0.00012	0.000128	0.0004
Welders	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Maximum	0.21	0.29	0.019	0.0086	0.0089	0.026
	Significant?		yes	no	no	no	no

Significance Threshold

0.12 in/sec

Table 9. Estimated Vibration Levels (Annoyance Assessment)

		Reference Distance	First Baptist Church	Centennial Place	City Hall	Loweman Building
Equipment Description	Distance (ft)	25	125	210	205	50
	Equivalent Equipment	Lv (VdB)				
Air Compressors	n/a	n/a	n/a	n/a	n/a	n/a
Cement and Mortar Mixers	n/a	n/a	n/a	n/a	n/a	n/a
Cranes	n/a	n/a	n/a	n/a	n/a	n/a
Forklifts	n/a	n/a	n/a	n/a	n/a	n/a
Generator Sets	n/a	n/a	n/a	n/a	n/a	n/a
Graders	n/a	n/a	n/a	n/a	n/a	n/a
Pavers	n/a	n/a	n/a	n/a	n/a	n/a
Paving Equipment	n/a	n/a	n/a	n/a	n/a	n/a
Rollers	Vibratory Roller	94	73	66	67	85
Rough Terrain Forklifts	n/a	n/a	n/a	n/a	n/a	n/a
Rubber Tired Dozers	Large Bulldozer	87	66	59	60	78
Skid Steer Loaders	Small bulldozer	58	37	30	31	49
Tractors/Loaders/Backhoes	Small bulldozer	58	37	30	31	49
Welders	n/a	n/a	n/a	n/a	n/a	n/a
	Total	95	74	67	67	86
	Significance Threshold		75	72	75	75
	Significant?		no	no	no	yes
	Mitigated Vibration Levels	90	69	62	63	81
	Significant?		no	no	no	yes

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

Significance Threshold

72 VdB (residential uses)
75 VdB (institutional uses)

Traffic Data

Table 10. Traffic Analysis for Project Buildout

Drop-off location	AT&T garage			Holly garage			Ramona garage		
	Marengo ADT + Project	Garfield ADT + project	Holly ADT + project	Marengo ADT + Project	Garfield ADT + project	Holly ADT + project	Marengo ADT + Project	Garfield ADT + project	Holly ADT + project
Marengo	19,428	No ADT for Garfield+239.55	1,444	19,428	No ADT for Garfield+1,038	2,243	19,428	No ADT for Garfield+1,038	1,444
Garfield	17,831	No ADT for Garfield+3,194	3,480	17,831	No ADT for Garfield+3,194	2,682	17,831	No ADT for Garfield+3,194	3,480
Holly	17,512	No ADT for Garfield+1,118	4,638	17,512	No ADT for Garfield+1,118	4,638	16,713	No ADT for Garfield+319.4	4,638

Table 11. Existing Traffic Count

Street	Location	AADT
Holly St	Bt Marengo Ave & Garfield Ave	1,444
Marengo Ave	Bt Holly & Union St	16,234
Union St	Bt Marengo Ave & Garfield Ave	7,327
Garfield Ave	Bt Union St & Holly St	3,953

Project ADT 3,194

Table 12. Atmospheric Attenuation

Assumptions	
Ambient pressure (kPa)	101.3
Temperature (F)	68
Relative humidity (%)	90
Frequency of noise source (Hz)	500
Air Attenuation Coefficient (α, dB/km)	2.7
(dB/ft)	0.0008

Conversion:

0.3048 m/ft

1000 m/km

$$A_{\text{air}} = \alpha d$$

Weather in Los Angeles County

Average temperature 64.2 °F

Average relative humidity 79.23 %

Reference:

<http://www.usa.com/los-angeles-county-ca-weather.htm>**Table 13. Air Attenuation Coefficient, dB/km, for an Ambient Pressure of 101.3 kPa (One Standard Sea-Level Atmosphere) for Sound Propagation in Open Air**

Temperature	Relative Humidity, %	Frequency, Hz					
		125	250	500	1000	2000	4000
30°C (86°F)	10	0.96	1.8	3.4	8.7	29	96
	20	0.73	1.9	3.4	6.0	15	47
	30	0.54	1.7	3.7	6.2	12	33
	50	0.36	1.3	3.6	7.0	12	25
	70	0.26	0.96	3.1	7.4	13	23
	90	0.20	0.78	2.7	7.3	14	24
20°C (68°F)	10	0.78	1.6	4.3	14	45	109
	20	0.71	1.4	2.6	6.5	22	74
	30	0.62	1.4	2.5	5.0	14	49
	50	0.45	1.3	2.7	4.7	9.9	29
	70	0.34	1.1	2.8	5.0	9.0	23
	90	0.27	0.97	2.7	5.3	9.1	20
10°C (50°F)	10	0.79	2.3	7.5	22	42	57
	20	0.58	1.2	3.3	11	36	92
	30	0.55	1.1	2.3	6.8	24	77
	50	0.49	1.1	1.9	4.3	13	47
	70	0.41	1.0	1.9	3.7	9.7	33
	90	0.35	1.0	2.0	3.5	8.1	26
0°C (32°F)	10	1.3	4.0	9.3	14	17	19
	20	0.61	1.9	6.2	18	35	47
	30	0.47	1.2	3.7	13	36	69
	50	0.41	0.82	2.1	6.8	24	71
	70	0.39	0.76	1.6	4.6	16	56
	90	0.38	0.76	1.5	3.7	12	43

Source: Harris, Cyril M. 1998. Handbook of Acoustical Measurements and Noise Control. 3rd ed. - Chapter 3 Calculation of Attenuation

Table 14. Equipment noise emissions and acoustical usage factors database

Equipment Description	Impact Device?	Acoustical Use Factor	Spec 721.560 Lmax @ 50ft (dBA, slow)	Actual Measured Lmax @ 50 ft (dBA, slow)
All Other Equipment > 5 hp	No	50%	85	N/A
Auger Drill Rig	No	20%	85	84
Backhoe	No	40%	80	78
Bar Bender	No	20%	80	N/A
Blasting	Yes	1%	94	N/A
Boring Jack Power Unit	No	50%	80	83
Chain Saw	No	20%	85	84
Clam Shovel (dropping)	Yes	20%	93	87
Compactor (ground)	No	20%	80	83
Compressor (air)	No	40%	80	78
Concrete Batch Plant	No	15%	83	N/A
Concrete Mixer Truck	No	40%	85	79
Concrete Pump Truck	No	20%	82	81
Concrete Saw	No	20%	90	90
Crane	No	16%	85	81
Dozer	No	40%	85	82
Drill Rig Truck	No	20%	84	79
Drum Mixer	No	50%	80	80
Dump Truck	No	40%	84	76
Excavator	No	40%	85	81
Flat Bed Truck	No	40%	84	74
Front End Loader	No	40%	80	79
Generator	No	50%	82	81
Generator (<25KVA, VMS signs)	No	50%	70	73
Gradall	No	40%	85	83
Grader	No	40%	85	N/A
Grapple (on backhoe)	No	40%	85	87
Horizontal Boring Hydr. Jack	No	25%	80	82
Hydra Break Ram	Yes	10%	90	N/A
Impact Pile Driver	Yes	20%	95	101
Jackhammer	Yes	20%	85	89
Man Lift	No	20%	85	75
Mounted Impact Hammer (hoe ram)	Yes	20%	90	90
Pavement Scarifier	No	20%	85	90
Paver	No	50%	85	77
Pickup Truck	No	40%	55	75
Pneumatic Tools	No	50%	85	85
Pumps	No	50%	77	81
Refrigerator Unit	No	100%	82	73
Rivit Buster/Chipping Gun	Yes	20%	85	79
Rock Drill	No	20%	85	81
Roller	No	20%	85	80
Sand Blasting (Single Nozzle)	No	20%	85	96
Scraper	No	40%	85	84
Shears (on backhoe)	No	40%	85	96
Slurry Plant	No	100%	78	78
Slurry Trenching Machine	No	50%	82	80
Soil Mix Drill Rig	No	50%	80	N/A
Tractor	No	40%	84	N/A
Vacuum Excavator (vac-truck)	No	40%	85	85
Vacuum Street Sweeper	No	10%	80	82
Ventilation Fan	No	100%	85	79
Vibrating Hopper	No	50%	85	87
Vibratory Concrete Mixer	No	20%	80	80
Vibratory Pile Driver	No	20%	95	101
Warning Horn	No	5%	85	83
Welder/Torch	No	40%	73	74

Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power. In case of construction blasting, the equipment gives a very short duration blast and can be quantified by using a 1% usage factor in the RCNM to allow for some prediction.

Table 15. Average Ambient Noise Levels for Various Land Uses

Land Use Description	Average Ldn (dBA)	Daytime Leq (dBA)	Nighttime Leq (dBA)
Wilderness	35	35	25
Rural Residential	40	40	30
Quiet Suburban Residential	50	50	40
Normal Suburban Residential	55	55	45
Urban Residential	60	60	50
Noisy Urban Residential	65	65	55
Very Noisy Urban Residential	70	70	60

Source: U.S. EPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974.

Table 16. Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 ft (in/sec)	Approximate Lv[†] at 25 ft
Pile Driver (impact)	0.644	104
Pile Driver (sonic)	0.17	93
Clam shovel drop (slurry wall)	0.202	94
Hydromill (slurry wall) - in soil	0.008	66
Hydromill (slurry wall) - in rock	0.017	75
Vibratory Roller	0.21	94
Hoe Ram	0.089	87
Large Bulldozer	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

Source: Federal Transit Administration, 2006. *Transit Noise and Vibration Impact Assessment*. FTA-VA-90-1003-06. May.

Note:

Values for pile drivers are based on the typical vibration source levels.

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