Appendix H

Noise Modeling

Construction Source Noise Prediction Model

Location	Distance to Nearest Receptor in feet	Combined Predicted Noise Level (L_{eq} dBA)
Threshold	436	70
Threshold	138	80
Noise-sensitive receptor	50	88.8

Equipment	Reference Noise Levels (L_{max}) at 50 feet[1]	Usage Factor[1]
Excavator	85	0.4
Dozer	85	0.4
Concrete Mixer Truck	85	0.4
Excavator	85	0.4
Dozer	85	0.4
Concrete Mixer Truck	85	0.4

Ground Type	hard
Source Height	8
Receiver Height	5
Ground Factor[2]	0.00

Predicted Noise Level [3]	L_{eq} dBA at 50 feet[3]
Excavator	81.0
Dozer	81.0
Concrete Mixer Truck	81.0
Excavator	81.0
Dozer	81.0
Concrete Mixer Truck	81.0
Combined Predicted Noise Level (L_{eq} dBA at 50 feet)	
	88.8

Sources:

[1] Obtained from the FHWA Roadway Construction Noise Model, January 2006. Table 1.

[2] Based on Table 4-26 from the Federal Transit Noise and Vibration Impact Assessment, 2018 (pg 86).

[3] Based on the following from the Federal Transit Noise and Vibration Impact Assessment, 2018 (pg 176 and 177).

L_{eq}(equip) = E.L.+10*log (U.F.) - 20*log (D/50) - 10*G*log (D/50)

Where: E.L. = Emission Level;

U.F.= Usage Factor;

G = Constant that accounts for topography and ground effects (FTA 2018: pg 86); and

D = Distance from source to receiver.

Construction Source Noise Prediction Model

Location	Distance to Nearest Receptor in feet	Combined Predicted Noise Level (Lmax dBA)
Threshold	1,225	65
Threshold	689	70
Noise-sensitive receptor	50	92.8

Equipment	Reference Noise Levels (L_{max}) at 50 feet[1]	Usage Factor[1]
Excavator	85	1
Dozer	85	1
Concrete Mixer Truck	85	1
Excavator	85	1
Dozer	85	1
Concrete Mixer Truck	85	1

Ground Type	hard
Source Height	8
Receiver Height	5
Ground Factor[2]	0.00

Predicted Noise Level [3]	L_{eq} dBA at 50 feet[3]
Excavator	85.0
Dozer	85.0
Concrete Mixer Truck	85.0
Excavator	85.0
Dozer	85.0
Concrete Mixer Truck	85.0
Combined Predicted Noise Level (L_{eq} dBA at 50 feet)	
92.8	

Sources:

[1] Obtained from the FHWA Roadway Construction Noise Model, January 2006. Table 1.

[2] Based on Table 4-26 from the Federal Transit Noise and Vibration Impact Assessment, 2018 (pg 86).

[3] Based on the following from the Federal Transit Noise and Vibration Impact Assessment, 2018 (pg 176 and 177).

$L_{eq}(equip) = E.L.+10*\log (U.F.) - 20*\log (D/50) - 10*G*\log (D/50)$

Where: E.L. = Emission Level;

U.F.= Usage Factor;

G = Constant that accounts for topography and ground effects (FTA 2018: pg 86); and

D = Distance from source to receiver.

Distance Propagation Calculations for Stationary Sources of Ground Vibration

KEY: Orange cells are for input.

Grey cells are intermediate calculations performed by the model.

Green cells are data to present in a written analysis (output).

STEP 1: Determine units in which to perform calculation.

— If vibration decibels (VdB), then use Table A and proceed to Steps 2A and 3A.

— If peak particle velocity (PPV), then use Table B and proceed to Steps 2B and 3B.

STEP 2A: Identify the vibration source and enter the reference vibration level (VdB) and distance.

STEP 3A: Select the distance to the receiver.

Table A. Propagation of vibration decibels (VdB) with distance

Noise Source/ID	Reference Noise Level			Attenuated Noise Level at Receptor		
	vibration level (VdB)	@	distance (ft)	vibration level (VdB)	@	distance (ft)
Vibratory Roller	94	@	25	79.7	@	75
Large Bulldozer	87	@	25	79.3	@	45
Loaded Truck	86.0	@	25	79.9	@	40
Jackhammer	79	@	25	79.0	@	25
Small Bulldozer	58	@	25	79.0	@	5
Vibratory Roller	94	@	25	64.8	@	235
Large Bulldozer	87	@	25	66.0	@	125
Loaded Truck	86.0	@	25	65.0	@	125
Jackhammer	79	@	25	64.7	@	75
Small Bulldozer	58	@	25	64.7	@	15

The Lv metric (VdB) is used to assess the likelihood for vibration to result in human annoyance.

STEP 2B: Identify the vibration source and enter the reference peak particle velocity (PPV) and distance.

STEP 3B: Select the distance to the receiver.

Table B. Propagation of peak particle velocity (PPV) with distance

Noise Source/ID	Reference Noise Level			Attenuated Noise Level at Receptor		
	vibration level (PPV)	@	distance (ft)	vibration level (PPV)	@	distance (ft)
Vibratory Roller	0.210	@	25	0.210	@	25
Large Bulldozer	0.089	@	25	0.191	@	15
Loaded Truck	0.076	@	25	0.164	@	15
Jackhammer	0.035	@	25	0.138	@	10
Small Bulldozer	0.0	@	25	0.1	@	2

The PPV metric (in/sec) is used for assessing the likelihood for the potential of structural damage.

Notes:

Computation of propagated vibration levels is based on the equations presented on pg. 185 of FTA 2018. Estimates of attenuated vibration levels do not account for reductions from intervening underground barriers or other underground structures of any type, or changes in soil type.

Sources:

Federal Transit Administration. 2018. Transit Noise and Vibration Impact Assessment. FTA Report No. 0123. Prepared by John A. Volpe National Transportation Systems Center, Cambridge, MA. Available: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf. Accessed April 8, 2020.

Attenuation Calculations for Stationary Noise Sources

KEY: Orange cells are for input.
Grey cells are intermediate calculations performed by the model.
Green cells are data to present in a written analysis (output).

STEP 1: Identify the noise source and enter the reference noise level (dBA and distance).

STEP 2: Select the ground type (hard or soft), and enter the source and receiver heights.

STEP 3: Select the distance to the receiver.

Noise Source/ID	Reference Noise Level			Attenuation Characteristics				Attenuated Noise Level at Receptor		
	noise level (dBA)	@	distance (ft)	Ground Type (soft/hard)	Source Height (ft)	Receiver Height (ft)	Ground Factor	noise level (dBA)	@	distance (ft)
Loading Dock Activity Lmax	86.0	@	50	hard	8	5	0.00	69.9	@	320
Loading Dock Activity Lmax	86.0	@	50	hard	8	5	0.00	65.0	@	560
HVAC unit	78.0	@	3	hard	8	5	0.00	53.6	@	50
HVAC unit (Leq)	53.6	@	50	hard	8	5	0.00	50.1	@	75
HVAC unit (Leq)	53.6	@	50	hard	8	5	0.00	45.0	@	135
							0.66			
							0.66			
							0.66			
							0.66			
							0.66			
							0.66			
							0.66			
							0.66			
							0.66			

Notes:

Estimates of attenuated noise levels do not account for reductions from intervening barriers, including walls, trees, vegetation, or structures of any type.

Computation of the attenuated noise level is based on the equation presented on pg. 176 and 177 of FTA 2018.

Computation of the ground factor is based on the equation presentd in Table 4-26 on pg. 86 of FTA 2018, where the distance of the reference noise leve can be adjusted and the usage factor is not applied (i.e., the usage factor is equal to 1).

Sources:

Federal Transit Association (FTA). 2018 (September). Transit Noise and Vibration Impact Assessment. Washington, D.C. Available: <http://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-

Traffic Noise Spreadsheet Calculator

Project: UC Santa Cruz - 2020 LRDP EIR

Noise Level Descriptor: Ldn
Site Conditions: Hard
Traffic Input: ADT
Traffic K-Factor:

Segment Description and Location				Input										Output				
Number	Name	From	To	ADT	Speed (mph)	Distance to Directional Centerline, (feet)$_4$ Near	Far	% Auto	% Medium	% Heavy	% Day	% Eve	% Night	Ldn, (dBA)$_{5,6,7}$	Distance to Contour, (feet)$_3$ 70 dBA	65 dBA	60 dBA	55 dBA
Existing Conditions																		
1	Bay Street			19,657	30	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.1	16	51	162	512
2	Empire Grade			7,498	40	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	61.2	13	41	130	412
3	Glenn Coolidge Drive			20,764	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	60.7	12	37	117	370
4	Hagar Drive			15,484	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.7	19	59	187	592
5	Heller Drive			3,197	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	55.9	4	12	39	122
6	High Street			10,663	30	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.4	9	28	88	278
7	Highway 17			52,932	50	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	72.4	175	555	1754	5547
8	King Street			1,926	25	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	53.4	1	3	11	34
9	McLaughlin Drive			3,197	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	52.6	2	6	18	57
10	Mission Street/Cabrillo Highway			58,064	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	65.2	33	104	328	1036
11	Natural Bridges Drive			4,356	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	57.2	5	17	53	166
12	Western Drive			2,337	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	54.5	3	9	28	89
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Traffic Noise Spreadsheet Calculator

Project: UC Santa Cruz - 2020 LRDP EIR

Noise Level Descriptor: Ldn
Site Conditions: Hard
Traffic Input: ADT
Traffic K-Factor:

Number	Name	From	To	ADT	Speed (mph)	Distance to Directional Centerline, (feet)$_4$ Near	Far	% Auto	% Medium	% Heavy	% Day	% Eve	% Night	Ldn, (dBA)$_{5,6,7}$	Distance to Contour, (feet)$_3$ 70 dBA	65 dBA	60 dBA	55 dBA
Existing Conditions																		
1	Bay Street			23,972	30	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	63.0	20	62	197	624
2	Empire Grade			9,837	40	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.3	17	54	171	541
3	Glenn Coolidge Drive			27,477	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	61.9	15	49	155	490
4	Hagar Drive			18,340	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	63.5	22	70	222	701
5	Heller Drive			6,800	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	59.1	8	26	82	260
6	High Street			13,366	30	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	63.4	11	35	110	348
7	Highway 17			53,487	50	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	72.5	177	561	1773	5606
8	King Street			2,989	25	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	55.3	2	5	17	53
9	McLaughlin Drive			6,800	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	55.8	4	12	38	121
10	Mission Street/Cabrillo Highway			61,901	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	65.4	35	110	349	1104
11	Natural Bridges Drive			4,460	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	57.3	5	17	54	170
12	Western Drive			3,041	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	55.7	4	12	37	116
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Traffic Noise Spreadsheet Calculator

Project: UC Santa Cruz - 2020 LRDP EIR

Noise Level Descriptor: Ldn
Site Conditions: Hard
Traffic Input: ADT
Traffic K-Factor:

Segment Description and Location				Input										Output				
					Speed	Distance to Directional Centerline, (feet)[4]		Traffic Distribution Characteristics						Ldn,	Distance to Contour, (feet)[3]			
Number	Name	From	To	ADT	(mph)	Near	Far	% Auto	% Medium	% Heavy	% Day	% Eve	% Night	(dBA)[5,6,7]	70 dBA	65 dBA	60 dBA	55 dBA
Existing Conditions																		
1	Bay Street			7,536	30	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	57.9	6	20	62	196
2	Empire Grade			7,474	40	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	61.1	13	41	130	411
3	Glenn Coolidge Drive			19,441	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	60.4	11	35	110	347
4	Hagar Drive			14,616	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.5	18	56	177	559
5	Heller Drive			2,119	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	54.1	3	8	26	81
6	High Street			10,233	30	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.3	8	27	84	266
7	Highway 17			62,837	50	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	73.2	208	659	2083	6586
8	King Street			1,240	25	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	51.5	1	2	7	22
9	McLaughlin Drive			2,119	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	50.8	1	4	12	38
10	Mission Street/Cabrillo Highway			60,288	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	65.3	34	108	340	1075
11	Natural Bridges Drive			4,564	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	57.4	6	17	55	174
12	Western Drive			1,113	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	51.3	1	4	13	43
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.

Traffic Noise Spreadsheet Calculator

Project: UC Santa Cruz - 2020 LRDP EIR

Noise Level Descriptor: Ldn
Site Conditions: Hard
Traffic Input: ADT
Traffic K-Factor:

	Segment Description and Location			Input										Output				
						Distance to Directional Centerline, (feet)4		Traffic Distribution Characteristics							Distance to Contour, (feet)3			
Number	Name	From	To	ADT	Speed (mph)	Near	Far	% Auto	% Medium	% Heavy	% Day	% Eve	% Night	Ldn, (dBA)5,6,7	70 dBA	65 dBA	60 dBA	55 dBA
Existing Conditions																		
1	Bay Street			9,297	30	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	58.8	8	24	77	242
2	Empire Grade			10,305	40	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	62.5	18	57	179	566
3	Glenn Coolidge Drive			26,503	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	61.7	15	47	149	473
4	Hagar Drive			18,420	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	63.5	22	70	223	704
5	Heller Drive			6,022	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	58.6	7	23	73	230
6	High Street			16,194	30	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	64.3	13	42	133	422
7	Highway 17			63,305	50	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	73.2	210	663	2098	6635
8	King Street			9,609	25	50	50	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	60.4	5	17	54	171
9	McLaughlin Drive			6,022	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	55.3	3	11	34	107
10	Mission Street/Cabrillo Highway			65,551	25	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	65.7	37	117	370	1169
11	Natural Bridges Drive			4,823	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	57.7	6	18	58	184
12	Western Drive			2,351	35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%	54.5	3	9	28	90
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					
					35	100	100	97.0%	2.0%	1.0%	80.0%	15.0%	5.0%					

*All modeling assumes average pavement, level roadways (less than 1.5% grade), constant traffic flow and does not account for shielding of any type or finite roadway adjustments. All levels are reported as A-weighted noise levels.