

Appendix E

Noise Modeling Calculation



Representative Construction Equipment and Levels Site Preparation (LEQ)

Location	Distance to Nearest Receptor in feet	Combined Predicted Noise Level (L _{eq} dBA)	Equipment	Reference Emission Noise Levels (L _{max}) at 50 feet ¹	Usage Factor ¹
threshold	741	55.0	Backhoe	80	0.4
1887 Q Street	60	82.2	Excavator	85	0.4
2125 Foster Avenue	200	68.4	Dump Truck	84	0.4

Ground Type soft
Source Height 8
Receiver Height 5
Ground Factor² 0.63

Predicted Noise Level ³	L _{eq} dBA at 50 feet ³
Backhoe	76.0
Excavator	81.0
Dump Truck	80.0

Combined Predicted Noise Level (L_{eq} dBA at 50 feet)
 84.3

Sources:

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

² Based on Figure 6-5 from the Federal Transit Noise and Vibration Impact Assessment, 2006 (pg 6-23).

³ Based on the following from the Federal Transit Noise and Vibration Impact Assessment, 2006 (pg 12-3).

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

Where: E.L. = Emission Level;

U.F.= Usage Factor;

G = Constant that accounts for topography and ground effects (FTA 2006: pg 6-23); and

D = Distance from source to receiver.

Equipment Description	Acoustical Usage Factor (%)	Spec 721.560 Lmax @ 50ft (dBA slow)	Actual Measured Lmax @ 50ft (dBA slow)	No. of Actual Data Samples (count)	Spec 721.560 LmaxCalc	Spec 721.560 Leq	Distance	Actual Measured LmaxCalc	Actual Measured Leq
	Auger Drill Rig	20	85	84	36	79.0	72.0	100	78.0
Backhoe	40	80	78	372	74.0	70.0	100	72.0	68.0
Bar Bender	20	80	na	0	74.0	67.0	100		
Blasting	na	94	na	0	88.0		100		
Boring Jack Power Unit	50	80	83	1	74.0	71.0	100	77.0	74.0
Chain Saw	20	85	84	46	79.0	72.0	100	78.0	71.0
Clam Shovel (dropping)	20	93	87	4	87.0	80.0	100	81.0	74.0
Compactor (ground)	20	80	83	57	74.0	67.0	100	77.0	70.0
Compressor (air)	40	80	78	18	74.0	70.0	100	72.0	68.0
Concrete Batch Plant	15	83	na	0	77.0	68.7	100		
Concrete Mixer Truck	40	85	79	40	79.0	75.0	100	73.0	69.0
Concrete Pump Truck	20	82	81	30	76.0	69.0	100	75.0	68.0
Concrete Saw	20	90	90	55	84.0	77.0	100	84.0	77.0
Crane	16	85	81	405	79.0	71.0	100	75.0	67.0
Dozer	40	85	82	55	79.0	75.0	100	76.0	72.0
Drill Rig Truck	20	84	79	22	78.0	71.0	100	73.0	66.0
Drum Mixer	50	80	80	1	74.0	71.0	100	74.0	71.0
Dump Truck	40	84	76	31	78.0	74.0	100	70.0	66.0
Excavator	40	85	81	170	79.0	75.0	100	75.0	71.0
Flat Bed Truck	40	84	74	4	78.0	74.0	100	68.0	64.0
Front End Loader	40	80	79	96	74.0	70.0	100	73.0	69.0
Generator	50	82	81	19	76.0	73.0	100	75.0	72.0
Generator (<25KVA, VMS s	50	70	73	74	64.0	61.0	100	67.0	64.0
Gradall	40	85	83	70	79.0	75.0	100	77.0	73.0
Grader	40	85	na	0	79.0	75.0	100		
Grapple (on Backhoe)	40	85	87	1	79.0	75.0	100	81.0	77.0
Horizontal Boring Hydr. Jac	25	80	82	6	74.0	68.0	100	76.0	70.0
Hydra Break Ram	10	90	na	0	84.0	74.0	100		
Impact Pile Driver	20	95	101	11	89.0	82.0	100	95.0	88.0
Jackhammer	20	85	89	133	79.0	72.0	100	83.0	76.0
Man Lift	20	85	75	23	79.0	72.0	100	69.0	62.0
Mounted Impact Hammer	20	90	90	212	84.0	77.0	100	84.0	77.0
Pavement Scarafier	20	85	90	2	79.0	72.0	100	84.0	77.0
Paver	50	85	77	9	79.0	76.0	100	71.0	68.0
Pickup Truck	40	55	75	1	49.0	45.0	100	69.0	65.0
Pneumatic Tools	50	85	85	90	79.0	76.0	100	79.0	76.0
Pumps	50	77	81	17	71.0	68.0	100	75.0	72.0
Refrigerator Unit	100	82	73	3	76.0	76.0	100	67.0	67.0
Rivit Buster/chipping gun	20	85	79	19	79.0	72.0	100	73.0	66.0
Rock Drill	20	85	81	3	79.0	72.0	100	75.0	68.0
Roller	20	85	80	16	79.0	72.0	100	74.0	67.0
Sand Blasting (Single Nozzl	20	85	96	9	79.0	72.0	100	90.0	83.0
Scraper	40	85	84	12	79.0	75.0	100	78.0	74.0
Shears (on backhoe)	40	85	96	5	79.0	75.0	100	90.0	86.0
Slurry Plant	100	78	78	1	72.0	72.0	100	72.0	72.0
Slurry Trenching Machine	50	82	80	75	76.0	73.0	100	74.0	71.0
Soil Mix Drill Rig	50	80	na	0	74.0	71.0	100		
Tractor	40	84	na	0	78.0	74.0	100		

Equipment Description	Acoustical Usage Factor (%)	Spec 721.560 Lmax @ 50ft (dBA slow)	Actual Measured Lmax @ 50ft (dBA slow)	No. of Actual Data Samples (count)	Spec 721.560 LmaxCalc	Spec 721.560 Leq	Distance	Actual Measured LmaxCalc	Actual Measured Leq
Vacuum Excavator (Vac-tri	40	85	85	149	79.0	75.0	100	79.0	75.0
Vacuum Street Sweeper	10	80	82	19	74.0	64.0	100	76.0	66.0
Ventilation Fan	100	85	79	13	79.0	79.0	100	73.0	73.0
Vibrating Hopper	50	85	87	1	79.0	76.0	100	81.0	78.0
Vibratory Concrete Mixer	20	80	80	1	74.0	67.0	100	74.0	67.0
Vibratory Pile Driver	20	95	101	44	89.0	82.0	100	95.0	88.0
Warning Horn	5	85	83	12	79.0	66.0	100	77.0	64.0
Welder / Torch	40	73	74	5	67.0	63.0	100	68.0	64.0

Source:

FHWA Roadway Construction Noise Model, January 2006. Table 9.1

U.S. Department of Transportation

CA/T Construction Spec. 721.560

Citation # Citations

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|----|--|--|
| 1 | Caltrans Technical Noise Supplement. 2009 (November). Table (5-11), Pg 5-60. | Caltrans Technical Noise Supplement. 2013 (September). Table (4-2), Pg 4-17. |
| 2 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-26), Pg 5-60. | Caltrans Technical Noise Supplement. 2013 (September). Equation (4-5), Pg 4-17. |
| 3 | Caltrans Technical Noise Supplement. 2009 (November). Equation (2-16), Pg 2-32. | FHWA 2004 TNM Version 2.5 |
| 4 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-11), Pg 5-47, 48. | FHWA 2004 TNM Version 2.5 |
| 5 | Caltrans Technical Noise Supplement. 2009 (November). Equation (2-26), Pg 2-55, 56. | Caltrans Technical Noise Supplement. 2013 (September). Equation (2-23), Pg 2-51, 52. |
| 6 | Caltrans Technical Noise Supplement. 2009 (November). Equation (2-27), Pg 2-57. | Caltrans Technical Noise Supplement. 2013 (September). Equation (2-24), Pg 2-53. |
| 7 | Caltrans Technical Noise Supplement. 2009 (November). Pg 2-53. | Caltrans Technical Noise Supplement. 2013 (September). Pg 2-57. |
| 8 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-7), Pg 5-45. | FHWA 2004 TNM Version 2.5 |
| 9 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-8), Pg 5-45. | FHWA 2004 TNM Version 2.5 |
| 10 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-9), Pg 5-45. | FHWA 2004 TNM Version 2.5 |
| 11 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-13), Pg 5-49. | FHWA 2004 TNM Version 2.5 |
| 12 | Caltrans Technical Noise Supplement. 2009 (November). Equation (5-14), Pg 5-49. | FHWA 2004 TNM Version 2.5 |
| 13 | Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (16), Pg 67 | |
| 14 | Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (20), Pg 69 | |
| 15 | Federal Highway Administration Traffic Noise Model Technical Manual. Report No. FHWA-PD-96-010. 1998 (January). Equation (18), Pg 69 | |

References

California Department of Transportation (Caltrans). 2009 (November). Technical Noise Supplement. Available: http://www.dot.ca.gov/hq/env/noise/pub/tens_complete.pdf. Accessed August 17, 2017.

California Department of Transportation (Caltrans). 2013 (September). Technical Noise Supplement. Available: http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013A.pdf. Accessed August 17, 2017.

Federal Highway Administration. 2004. Traffic Noise Model Version 2.5. Available: https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_v25/. Accessed August 17, 2017.

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).

Project Name: Foster Campus Connectivity Project Recirculated Initial Study

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)
Noise Sources compared to City of Arcata Standards										
Average Parking Lot Noise (represented as 417 vehicle trips + 4 bus trips in a AM peak hour) Leq	58.2	@	50	hard	5	5	0.00	38.7	@	470
Maximum Parking Lot Noise (represented as car alarm) Lmax	70.0	@	50	hard	5	5	0.00	50.5	@	470
Noise Sources compared to Humboldt County Standards										
Maximum Parking Lot Noise (represented as car alarm) Lmax	70.0	@	50	hard	5	5	0.00	52.9	@	360

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 presented in Table 4-26 on pg. 86 of FTA 2018, where the distance of the reference noise level 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-no-0123_0.pdf>Accessed: March 5, 2020.

Parking Lot Noise Calculation

KEY: Orange cells are for input.
 Green cells are data to present in a written analysis (output).

Number of automobiles per hour	212
Number of buses per hour	2

Reference Level	Leq @	<u>distance</u>	<u>sound level</u>
		50	58.2

Source

Federal Transit Administration. 2018 (September). Transit Noise and Vibration Impact Assessment. Washington, D.C. 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 February 4, 2019. See pages 45–47, including Equation 4-14.

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).

Project Name: Foster Campus Connectivity Project Recirculated Initial Study

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	80	@	73
Large Bulldozer	87	@	25	80	@	43

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

Land Use Category	Human Annoyance Criteria GBV Impact Levels (VdB re 1 micro-inch/sec)		
	Frequent Events	Occasional Events	Infrequent Events
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB	65 VdB	65 VdB
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

Source: Federal Transit Administration, pg 126

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	0.200	@	26
Large Bulldozer	0.089	@	25	0.200	@	15

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

Building/Structural Category	Construction Vibration Damage Criteria	
	PPV, in/sec	Approximate Lv
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry building	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: Federal Transit Administration, pg 186

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.
- Frequent Events are defined as more than 70 events per day; occasional events as 30-70 events per day; and infrequent events as fewer than 30 events per day

Reference:

Federal Transit Association (FTA). 2018 (September). Transit Noise and Vibration Impact Assessment Manual. FTA Report No. 0123. Washington, D.C.

Accessed: December 20, 2020. Page 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