Appendix E

Noise and Vibration Calculations

May 2024

Jacumba Fire Stataion Construction Noise

Location	Distance to Nearest Receptor in feet	Combined Predicted Noise Level (L_{eq} dBA)
County of SD threshold	575	60.0
Noise level at 50 feet	50	81.2
Residence	255	67.1

Equipment	Reference Emission Noise Levels (L_{max}) at 50 feet[1]	Usage Factor[1]
Backhoe	78	0.4
Front End Loader	79	0.4
Excavator	81	0.4
Paver	77	0.5

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]
Backhoe	74.0
Front End Loader	75.0
Excavator	77.0
Paver	74.0

Combined Predicted Noise Level (L_{eq} dBA at 50 feet)
81.2

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}(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 2006: pg 6-23); and

D = Distance from source to receiver.

Jacumba Fire Stataion Construction Noise

Location	Distance to Nearest Receptor in feet	Combined Predicted Noise Level (L_{eq} dBA)
County of SD threshold	892	60.0
Noise level at 50 feet	50	85.0
Residence	1000	59.0

Equipment	Reference Emission Noise Levels (L_{max}) at 50 feet[1]	Usage Factor[1]
Backhoe	78	1
Front End Loader	79	1
Excavator	81	1
Paver	77	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]
Backhoe	78.0
Front End Loader	79.0
Excavator	81.0
Paver	77.0

Combined Predicted Noise Level (Lmax dBA at 50 feet)
85.0

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}(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 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	71.0
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 signs)	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. Jack	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 (hoe ram)	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 Nozzle)	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		
Vacuum Excavator (Vac-truck)	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
chipper		75							

Source:
FHWA Roadway Construction Noise Model, January 2006. Table 9.1
U.S. Department of Transportation
CA/T Construction Spec. 721.560

Long-Term Noise Measurement Summary

ASCENT ENVIRONMENTAL

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).

Measurement Site: Jacumba Fire Station
Measurement Date: 6/22/2023
Project Name: Jacumba Fire Station

Computation of CNEL

Hour of Day (military time)	Sound Level Leq (dBA)	Sound Power =10*Log(dBA /10)	Period of 24-Hour Day (1=included, 0=not) Day	Evening	Night	Sound Power Breakdown by Period of Day Day	Evening	Night
0:00	0.0	1	0	0	1	0	0	1
1:00	0.0	1	0	0	1	0	0	1
2:00	0.0	1	0	0	1	0	0	1
3:00	0.0	1	0	0	1	0	0	1
4:00	0.0	1	0	0	1	0	0	1
5:00	0.0	1	0	0	1	0	0	1
6:00	0.0	1	0	0	1	0	0	1
7:00	81.2	131,825,674	1	0	0	131,825,674	0	0
8:00	81.2	131,825,674	1	0	0	131,825,674	0	0
9:00	81.2	131,825,674	1	0	0	131,825,674	0	0
10:00	81.2	131,825,674	1	0	0	131,825,674	0	0
11:00	81.2	131,825,674	1	0	0	131,825,674	0	0
12:00	81.2	131,825,674	1	0	0	131,825,674	0	0
13:00	81.2	131,825,674	1	0	0	131,825,674	0	0
14:00	81.2	131,825,674	1	0	0	131,825,674	0	0
15:00	81.2	131,825,674	1	0	0	131,825,674	0	0
16:00	81.2	131,825,674	1	0	0	131,825,674	0	0
17:00	81.2	131,825,674	1	0	0	131,825,674	0	0
18:00	81.2	131,825,674	1	0	0	131,825,674	0	0
19:00	81.2	131,825,674	0	1	0	0	131,825,674	0
20:00	0.0	1	0	1	0	0	1	0
21:00	0.0	1	0	1	0	0	1	0
22:00	0.0	1	0	0	1	0	0	1
23:00	0.0	1	0	0	1	0	0	1
					Sum of Sound Power during Period wo/penalty	1,581,908,086	131,825,676	9
					Log Factor for CNEL Penalty (i.e., 10*log(x))	1	3	10
					Sound Power during Period with penalty	1,581,908,086	395,477,028	90

Total Daily Sound Power, with penalties	1,977,385,204
Hours per Day	24
Average Hourly Sound Power, with penalties	82,391,050
CNEL	79.2

Ldn computation on next page.

Computation of Ldn

Period of 24-Hour Day (1=included, 0=not)		Sound Power Breakdown by Period of Day	
Day	Night	Day	Night
0	1	0	1
0	1	0	1
0	1	0	1
0	1	0	1
0	1	0	1
0	1	0	1
0	1	0	1
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	131,825,674	0
1	0	1	0
1	0	1	0
0	1	0	1
0	1	0	1

Sum of Sound Power during Period wo/penalty	1,713,733,762	9
Log Factor for Penalty (i.e., 10*log(x))	1	10
Sound Power during Period with penalty	1,713,733,762	90

Total Daily Sound Power, with penalties	1,713,733,852
Hours per Day	24
Average Hourly Sound Power, with penalties	71,405,577
Ldn	78.5

<u>Notes:</u>

Computation of the CNEL based on 1-hour Leq measurements for each hour of a day are based on equation 2-27 on pg. 2-57 of Caltrans 2009.

Computation of the Ldn based on 1-hour Leq measurements for each hour of a day are based on equation 2-26 on pg. 2-56 of Caltrans 2009.

Log factors for the Ldn and CNEL penalties are provided in Table 2-12 on pg. 2-52 of Caltrans 2009.

<u>Source:</u>

California Deaprtment of Transportation (Caltrans), Divisiong of Environmental Analysis. 2009 (November). *2009 Technical Noise Supplement* . Sacramento, CA. Available: <http://www.dot.ca.gov/hq/env/noise/>. Accessed September 24, 2010.

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)
HVAC	70.0	@	50	hard	8	5	0.00	55.8	@	255
Fire truck sirens	100.0	@	100	hard	8	5	0.00	91.9	@	255
Emergency generator	82.0	@	50	hard	8	5	0.00	67.8	@	255
Construction noise	79.2	@	50	hard	8	5	0.00	65.0	@	255
Construction noise	79.2	@	50	hard	8	5	0.00	60.0	@	455
							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-no-0123_0.pdf>Accessed: March 5, 2020.

Long-Term Noise Measurement Summary: HVAC Equipment

ASCENT ENVIRONMENTAL

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).

Measurement Site: N/A
Measurement Date: N/A
Project Name: Jacumba Fire Station

Computation of CNEL

Hour of Day (military time)	Sound Level Leq (dBA)	Sound Power =10*Log(dBA /10)	Period of 24-Hour Day (1=included, 0=not)			Sound Power Breakdown by Period of Day		
			Day	Evening	Night	Day	Evening	Night
0:00	55.8	380,189	0	0	1	0	0	380,189
1:00	55.8	380,189	0	0	1	0	0	380,189
2:00	55.8	380,189	0	0	1	0	0	380,189
3:00	55.8	380,189	0	0	1	0	0	380,189
4:00	55.8	380,189	0	0	1	0	0	380,189
5:00	55.8	380,189	0	0	1	0	0	380,189
6:00	55.8	380,189	0	0	1	0	0	380,189
7:00	55.8	380,189	1	0	0	380,189	0	0
8:00	55.8	380,189	1	0	0	380,189	0	0
9:00	55.8	380,189	1	0	0	380,189	0	0
10:00	55.8	380,189	1	0	0	380,189	0	0
11:00	55.8	380,189	1	0	0	380,189	0	0
12:00	55.8	380,189	1	0	0	380,189	0	0
13:00	55.8	380,189	1	0	0	380,189	0	0
14:00	55.8	380,189	1	0	0	380,189	0	0
15:00	55.8	380,189	1	0	0	380,189	0	0
16:00	55.8	380,189	1	0	0	380,189	0	0
17:00	55.8	380,189	1	0	0	380,189	0	0
18:00	55.8	380,189	1	0	0	380,189	0	0
19:00	55.8	380,189	0	1	0	0	380,189	0
20:00	55.8	380,189	0	1	0	0	380,189	0
21:00	55.8	380,189	0	1	0	0	380,189	0
22:00	55.8	380,189	0	0	1	0	0	380,189
23:00	55.8	380,189	0	0	1	0	0	380,189

	Day	Evening	Night
Sum of Sound Power during Period wo/penalty	4,562,273	1,140,568	3,421,705
Log Factor for CNEL Penalty (i.e., 10*log(x))	1	3	10
Sound Power during Period with penalty	4,562,273	3,421,705	34,217,046

Total Daily Sound Power, with penalties	42,201,023
Hours per Day	24
Average Hourly Sound Power, with penalties	1,758,376
CNEL	62.5

Ldn computation on next page.

Computation of Ldn

Period of 24-Hour Day (1=included, 0=not)		Sound Power Breakdown by Period of Day	
Day	Night	Day	Night
0	1	0	380,189
0	1	0	380,189
0	1	0	380,189
0	1	0	380,189
0	1	0	380,189
0	1	0	380,189
0	1	0	380,189
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
1	0	380,189	0
0	1	0	380,189
0	1	0	380,189

	Day	Night
Sum of Sound Power during Period wo/penalty	5,702,841	3,421,705
Log Factor for Penalty (i.e., 10*log(x))	1	10
Sound Power during Period with penalty	5,702,841	34,217,046

Total Daily Sound Power, with penalties	39,919,887
Hours per Day	24
Average Hourly Sound Power, with penalties	1,663,329
Ldn	62.2

Notes:

Computation of the CNEL based on 1-hour Leq measurements for each hour of a day are based on equation 2-27 on pg. 2-57 of Caltrans 2009.

Computation of the Ldn based on 1-hour Leq measurements for each hour of a day are based on equation 2-26 on pg. 2-56 of Caltrans 2009.

Log factors for the Ldn and CNEL penalties are provided in Table 2-12 on pg. 2-52 of Caltrans 2009.

Source:

California Deaprtment of Transportation (Caltrans), Divisiong of Environmental Analysis. 2009 (November). *2009 Technical Noise Supplement* . Sacramento, CA. Available: <http://www.dot.ca.gov/hq/env/noise/>. Accessed September 24, 2010.

Long-Term Noise Measurement Summary: Generator

ASCENT ENVIRONMENTAL

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).

Measurement Site: N/A
Measurement Date: N/A
Project Name: Jacumba Fire Station

Computation of CNEL

Hour of Day (military time)	Sound Level Leq (dBA)	Sound Power =10*Log(dBA/10)	Period of 24-Hour Day (1=included, 0=not) Day	Evening	Night	Sound Power Breakdown by Period of Day Day	Evening	Night
0:00	56.0	398,107	0	0	1	0	0	398,107
1:00	56.0	398,107	0	0	1	0	0	398,107
2:00	56.0	398,107	0	0	1	0	0	398,107
3:00	56.0	398,107	0	0	1	0	0	398,107
4:00	56.0	398,107	0	0	1	0	0	398,107
5:00	56.0	398,107	0	0	1	0	0	398,107
6:00	56.0	398,107	0	0	1	0	0	398,107
7:00	56.0	398,107	1	0	0	398,107	0	0
8:00	56.0	398,107	1	0	0	398,107	0	0
9:00	56.0	398,107	1	0	0	398,107	0	0
10:00	56.0	398,107	1	0	0	398,107	0	0
11:00	56.0	398,107	1	0	0	398,107	0	0
12:00	56.0	398,107	1	0	0	398,107	0	0
13:00	56.0	398,107	1	0	0	398,107	0	0
14:00	56.0	398,107	1	0	0	398,107	0	0
15:00	56.0	398,107	1	0	0	398,107	0	0
16:00	56.0	398,107	1	0	0	398,107	0	0
17:00	56.0	398,107	1	0	0	398,107	0	0
18:00	56.0	398,107	1	0	0	398,107	0	0
19:00	56.0	398,107	0	1	0	0	398,107	0
20:00	56.0	398,107	0	1	0	0	398,107	0
21:00	56.0	398,107	0	1	0	0	398,107	0
22:00	56.0	398,107	0	0	1	0	0	398,107
23:00	56.0	398,107	0	0	1	0	0	398,107
Sum of Sound Power during Period wo/penalty						4,777,286	1,194,322	3,582,965
Log Factor for CNEL Penalty (i.e., 10*log(x))						1	3	10
Sound Power during Period with penalty						4,777,286	3,582,965	35,829,645

Total Daily Sound Power, with penalties	44,189,896
Hours per Day	24
Average Hourly Sound Power, with penalties	1,841,246
CNEL	62.7

Ldn computation on next page.

Computation of Ldn

Period of 24-Hour Day (1=included, 0=not)		Sound Power Breakdown by Period of Day	
Day	Night	Day	Night
0	1	0	398,107
0	1	0	398,107
0	1	0	398,107
0	1	0	398,107
0	1	0	398,107
0	1	0	398,107
0	1	0	398,107
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
1	0	398,107	0
0	1	0	398,107
0	1	0	398,107

	Day	Night
Sum of Sound Power during Period wo/penalty	5,971,608	3,582,965
Log Factor for Penalty (i.e., 10*log(x))	1	10
Sound Power during Period with penalty	5,971,608	35,829,645

Total Daily Sound Power, with penalties	41,801,253
Hours per Day	24
Average Hourly Sound Power, with penalties	1,741,719
Ldn	62.4

Notes:

Computation of the CNEL based on 1-hour Leq measurements for each hour of a day are based on equation 2-27 on pg. 2-57 of Caltrans 2009.

Computation of the Ldn based on 1-hour Leq measurements for each hour of a day are based on equation 2-26 on pg. 2-56 of Caltrans 2009.

Log factors for the Ldn and CNEL penalties are provided in Table 2-12 on pg. 2-52 of Caltrans 2009.

Source:

California Deaprtment of Transportation (Caltrans), Divisiong of Environmental Analysis. 2009 (November). *2009 Technical Noise Supplement* . Sacramento, CA. Available: <http://www.dot.ca.gov/hq/env/noise/>. Accessed September 24, 2010.

Distance Propagation Calculations for Stationary Sources of Ground Vibration

ASCENT ENVIRONMENTAL

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)
Roller	94	@	25	45.9	@	1000
Roller	94	@	25	80.0	@	73

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)
Roller	0.210	@	25	0.001	@	1000
Roller	0.210	@	25	0.198	@	26

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.

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