APPENDIX E
NOISE TABLES

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Table E-1 was generated from the Federal Highway Administration (FHWA) Road Construction Noise Handbook (2006) and represents accepted noise levels produced from a range of typical road construction equipment. These values were developed to be used for the estimation of noise impacts from construction activities related to the building of roads. The values described below are only for in-air noise levels. These values are used in the database associated with the FHWA's Road Construction Noise Model; free software that assists in the estimation of noise impacts from roadway construction. The values below were used in developing the in-air noise impacts for construction of the Causeway Bridge presented in Section 3.1, Noise.

Table E-1. In-Air Construction-Related Noise Emissions

Equipment Description	Actual Measured L_{max} at 50 feet (dBA)
Flat Bed Truck	74
Welder/Torch	74
Man Lift	75
Dump Truck	76
Paver	77
Backhoe	78
Compressor (air)	78
Slurry Plant	78
Concrete Mixer Truck	79
Drill Rig Truck	79
Front End Loader	79
Rivet Buster/Chipping Gun	79
Ventilation Fan	79
Drum Mixer	80
Roller	80
Slurry Trenching Machine	80
Vibratory Concrete Mixer	80
Concrete Pump Truck	81
Crane	81
Excavator	81
Generator	81
Pumps	81
Dozer	82
Horizontal Boring Hydraulic Jack	82
Vacuum Street Sweeper	82
Boring Jack Power Unit	83
Compactor (ground)	83
Gradall	83
Warning Horn	83
Auger Drill Rig	84
Chain Saw	84
Scraper	84
Pneumatic Tools	85
Vacuum Excavator	85
Vibrating Hopper	87
Jackhammer	89
Concrete Saw	90

Table E-1. In-Air Construction-Related Noise Emissions (cont.)	
Equipment Description	**Actual Measured L_{max} at 50 feet (dBA)**
Mounted Impact Hammer (hoe ram)	90
Sheers (on backhoe)	96
Impact Pile Driver	101
Vibratory Pile Driver	101

Source: FHWA 2006.

Table E-2 below was developed using methods outlined by the Washington State Department of Transportation's Biological Assessment Advanced Training Manual (2015). The method involves choosing the three noisiest pieces of construction equipment that would be used for construction and using a series of mathematical equations for noise addition, attenuation, and transmission loss, yields a series of distances and noise levels at those distances. Table E-2 was developed to estimate airborne construction noise and the potential for disturbance from general construction projects at the WFF Main Base, Wallops Mainland, and Wallops Island, in Section 3.1, Noise.

Table E-2. Noise Attenuation Table for Typical Construction			
Distance (m/ft)	**Equipment Noise Level (dBA)**	**Traffic Noise Level (dBA)**	**Ambient Noise Level (dBA)**
0	102	30	55
15 (50)	94.5	55.5	55
30 (100)	87	51	55
60 (200)	79.5	46.5	55
120 (400)	72	42	55
240 (800)	64.5	37.5	55
480 (1,600)	57	33	55
960 (3,200)	49.5	28.5	55

Source: Generated using Washington State Department of Transportation (WSDOT) 2015 methodology.

Table E-3 provides a summary of unattenuated sound pressure levels for marine pile driving. The data presented in Table E-3 characterize actual measurements of underwater sound pressure levels from various types of piles and pile driving equipment. These values are used to assist in the estimation of underwater noise impacts and the distances to which underwater noise thresholds will be reached or exceeded. The values were used in conjunction with the National Oceanic and Atmospheric Administration's Underwater Noise Calculator that uses an equation for transmission loss (attenuation) for underwater sounds. The results of this are discussed in Section 3.11, Marine Mammals and Fish.

Table E-3. Summary of Unattenuated Sound Pressures for Marine Pile Driving					
Type of Pile	**Relative Water Depth (m)**	**Hammer Type**	**Root Mean Square (dB)**	**Peak Pressure (dB)**	**Sound Exposure Level (dB)**
Concrete Piles					
16-inch Square	10	Steam-powered	173 at 10 m	184 at 10 m	NA
24-inch Square	3-4	Diesel Impact	173 at 10 m; 165 at 20 m	185 at 10 m; 178 at 20 m	NA
24-inch Octagonal	10-15	Diesel Impact	176 at 10 m; 163 at 100 m	188 at 10 m; 174 at 100 m	166 at 10 m; 152 at 100 m
24-inch Octagonal	7-8	Diesel Impact	173 at 10 m	185 at 10 m	163 at 10 m
24-inch Octagonal	8	Diesel Impact	174 at 10 m	184 at 10 m	165 at 10 m
24-inch Octagonal	4	Diesel Impact	172 at 10 m; 170 at 20 m	185 at 10 m; 180 at 20 m	NA
Steel H Pile					
10-inch	2	Diesel Impact	175 at 10 m; 160 at 20 m	190 at 10 m; 170 at 20 m	NA
10-inch	2	Vibratory Hammer	147 at 10 m; 137 at 20 m	161 at 10 m; 152 at 20 m	NA
12-inch	5	Diesel Impact	156 at 70 m; 158 at 90 m	168 at 70 m; 170 at 90 m	NA
15-inch	2-3	Diesel Impact	180 at 10 m	195 at 10 m	170 at 10 m
Steel Pipe					
12-inch	1-2	Diesel Impact	165 at 10 m; 156 at 20 m	177 at 10 m; 170 at 10 m	152 at 10 m
14-inch	>15	Diesel Impact	180 at 20 m; 180 at 30m; 178 at 40 m; 175 at 50 m; 159 at 195 m	196 at 20 m; 190 at 30m; 191 at 40 m; 189 at 50 m; 172 at 195 m	170 at 20 m; NA at 30m; 165 at 40 m; NA at 50 m; NA at 195 m
24-inch	5	Diesel Impact	189 at 10 m; 178 at 50 m	203 at 10 m; 191 at 50 m	178 at 10 m; 167 at 50 m
30-inch	4-5	Diesel Impact	190 at 10 m; 185 at 20 m; 181 at 30 m; 178 at 40 m; 169 at 60 m	205 at 10 m; 200 at 20 m; 199 at 30 m; 194 at 40 m; 195 at 60 m	NA at 10 m; NA at 20 m; 170 at 30 m; NA at 40 m; NA at 60 m
36-inch	10	Diesel Impact	193 at 10 m; 182 at 50 m	210 at 10 m; 198 at 50 m	183 at 10 m; NA at 50 m

Table E-3. Summary of Unattenuated Sound Pressures for Marine Pile Driving (cont.)					
Type of Pile	**Relative Water Depth (m)**	**Hammer Type**	**Root Mean Square (dB)**	**Peak Pressure (dB)**	**Sound Exposure Level (dB)**
Cast-in-Steel Shell Pipe					
36-inch	10	Diesel Impact	193 at 10 m; 182 at 50 m	210 at 10 m; 198 at 50 m	183 at 10 m; NA at 50 m
48-inch	2	Diesel Impact	195 at 10 m; 190 at 20 m; 185 at 45 m; 175 at 65 m	205 at 10 m; 202 at 20 m; 195 at 45 m; 185 at 65 m	185 at 10 m; 180 at 20 m; 175 at 45 m; NA at 65 m
66-inch	4	Diesel Impact	202 at 4 m; 195 at 10 m; 189 at 20 m; 185 at 30 m; 180 at 40 m; 169 at 60 m; 170 at 80 m	219 at 4 m; 210 at 10 m; 205 at 20 m; 203 at 30 m; 198 at 40 m; 187 at 60 m; 187 at 80 m	NA at 4 m; NA at 10 m; NA at 20 m; 173 at 30 m; NA at 40 m; 158 at 60 m; NA at 80 m
96-inch	8-12	Hydraulic Impact	197 at 25 m; 200 at 50 m; 186-192 at 100m; 175 at 400 m	213 at 25 m; 23 at 50 m; 197-204 at 100m; 186 at 400 m	188 at 25 m; 187 at 50 m; 174-180 at 100 m; 165 at 400 m

Source: CalTrans 2015.

Table E-4 shows a summary of the number of strikes required to drive in various types of piles used in pile supported structures. Also shown is the typical number of piles that can be driven in one work day. This data was used in conjunction with the data provided in Table E-3 to develop the distances to underwater noise threshold guidance for marine mammals, as presented in Section 3.11, Marine Mammals and Fish. The number of pile strikes per day and total number of piles driven per day are necessary to determine how many daily pile strikes would occur, which is then used to develop a cumulative underwater noise value that can be used to estimate underwater noise impacts to marine mammals and fish.

Table E-4. Summary of Typical Strike Data			
Pile Type, Size, and Shape	**Typical Use**	**Typical Installation Duration**	**Typical Strikes per Pile**
Concrete, 24-inch Hexagon	Wharf Construction Projects	1 to 5 Piles per Day	580
Thin Steel H, Small	Temporary Construction Projects	6 Piles per Day	550
Steel Pipe, 40-inch Diameter	Permanent Construction Projects	1 to 5 Piles per Day	600
Cast-in-Steel Shell (CISS) Pipe, 30-inch Diameter	Permanent Construction Projects	2 to 4 Piles per Day	1,600 to 2,400
Cast-in-Steel Shell (CISS) Pipe, 96-inch Diameter	Permanent Construction Projects	1 to 3 Piles per Day	7,000

Source: CalTrans 2015.

References:

CalTrans. 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. November.

Federal Highway Administration (FHWA). 2006. Construction Noise Handbook, Appendix A FHWA Roadway Construction Noise Model User's Guide, A-1. http://www.fhwa.dot.gov/environment/noise/construction_noise/rcnm/index.cfm.

Washington State Department of Transportation (WSDOT). 2015. Biological Assessment Preparation Advanced Training Manual Version 02-2015. February. https://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#manual.

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