

**BIOLOGICAL ASSESSMENT**  
**COLUMBIA RIVER CROSSING**

Interstate 5

Multnomah County, Oregon  
Clark County, Washington

170800030701 Columbia River, Hayden Island  
170800010901 Salmon Creek, Vancouver  
170900120301 Columbia Slough/Willamette River, Willamette River/Columbia River

**Chinook salmon (*Oncorhynchus tshawytscha*)**

Upper Columbia River Spring-Run ESU  
Lower Columbia River ESU  
Snake River Fall-Run ESU  
Snake River Spring/Summer-Run ESU  
Upper Willamette River ESU

**Steelhead (*Oncorhynchus mykiss*)**

Lower Columbia River DPS  
Middle Columbia River DPS  
Upper Columbia River DPS  
Snake River DPS  
Upper Willamette River DPS

**Sockeye salmon (*Oncorhynchus nerka*)**

Snake River ESU

**Coho salmon (*Oncorhynchus kisutch*)**

Lower Columbia River ESU

**Chum salmon (*Oncorhynchus keta*)**

Columbia River ESU

**Bull trout (*Salvelinus confluentus*)**

Columbia River DPS

**Eulachon (*Thaleichthys pacificus*)**

Southern DPS

**Green sturgeon (*Acipenser medirostris*)**

Southern DPS

**Northern (Steller) sea lion (*Eumetopias jubatus*)**

Eastern DPS

**Killer Whale (*Orcinus orca*)**

Southern DPS





# United States Department of Transportation

FEDERAL HIGHWAY  
ADMINISTRATION

FEDERAL TRANSIT  
ADMINISTRATION



**Washington State  
Department of Transportation**

TRI  MET

**C-TRAN** 

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Columbia River  
 **CROSSING**

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27 **APPENDICES**

28 *All appendices are contained on a compact disc at the end of this report.*

29 Appendix A: Draft Columbia River Bridge Construction Sequence Sheets

30 Appendix B: Site Photos

31 Appendix C: Species Descriptions and Life Histories

32 Appendix D: Candidate Species

33 Appendix E: Draft In-Water Work Isolation and Fish Removal Performance Standard for the  
34 Columbia River Crossing

35 Appendix F: National Marine Fisheries Service and U.S. Fish and Wildlife Service Matrices

36 Appendix G: Pre-Biological Assessment and InterCEP Subgroup Meetings

- 1 Appendix H: Southern Resident Killer Whales
- 2 Appendix I: Exposure Matrices
- 3 Appendix J: Documented Records of Bull Trout in the Lower Mainstem Columbia River
- 4 Appendix K: CRC Hydroacoustics Technical Report
- 5 Appendix L: USFWS Species Lists
- 6 Appendix M: Statement of No Effect for Selected Listed Species Potentially Occurring Within
- 7 Clark County, WA and Multnomah County, OR – Columbia River Crossing





## 1 ACRONYMS

μ	micro-; 10 <sup>-6</sup>
μPa	Micropascal
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADD	Acoustic Deterrent Devices
ADT	Average Daily Traffic
API	Area of Potential Impact
BA	Biological Assessment
BES	Bureau of Environmental Services, City of Portland
BIA	Bridge Influence Area
bike/ped	Bicycle/Pedestrian
BLM	Bureau of Land Management
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BO	Biological Opinion
BRT	NMFS Biological Review Team
C	Celsius
Caltrans	California Department of Transportation
CAO	Clark County Critical Areas Ordinances
CBR	Columbia Basin Research
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfs	Cubic Feet per Second
CPUE	(Eulachon) Catch per Unit Effort
CR	Columbia River (ESU/DPS)
CRC	Columbia River Crossing
CRD	Columbia River Datum
CREDDP	Columbia River Estuary Data Development Program
C-TRAN	Clark County Public Transit Benefit Area Authority
CWA	Clean Water Act
CY	Cubic Yard
DAHP	Washington Department of Archaeological and Historical Properties
DART	Data Analysis in Real Time
dB	Decibel

dB <sub>peak</sub>	Peak Injury Threshold (in decibels)
dB <sub>RMS</sub>	Root Mean Square of Sound Pressure Levels (measured in decibels)
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DEQ	Oregon Department of Environmental Quality
DLCD	Oregon Department of Land Conservation and Development
DOE	U.S. Department of Energy
DOT	Department of Transportation
DPS	Distinct Population Segment
DSL	Oregon Department of State Lands
DWR	Oregon Department of Water Resources
Ecology	Washington State Department of Ecology
ECSI	Environmental Cleanup Site Information
EFH	Essential Fish Habitat
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESC	Erosion And Spill Control
ESH	Essential Salmonid Habitat
ESU	Evolutionarily Significant Unit
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group
FPAC	Fish Passage Advisory Committee
FPC	Fish Passage Center
fps	Feet per Second
FR	Federal Register
FTA	Federal Transit Administration
g	Gram
GIS	Geographical Information System
GMA	Growth Management Act

HAZMAT	Hazardous Materials
HIWWW	Hydroacoustic In-Water Work Window
HPA	Hydraulic Project Approval
HUC	Hydrologic Unit Code
I-5	Interstate 5
ICTRT	Interior Columbia Technical Recovery Team
InterCEP	Interstate Collaborative Environmental Process
ISAB	Independent Scientific Advisory Board
ITS	Intelligent Transportation System
IWWW	In-Water Work Window
JCRMS	Joint Columbia River Management Staff
JISAO	Joint Institute for the Study of Atmosphere and Ocean
km	Kilometer
LCFRB	Lower Columbia Fish Recovery Board
LCR	Lower Columbia River (ESU/DPS)
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
LUST	Leaking Underground Storage Tank
m	Meter
m/s	Meters per Second
Mm	Millimeter
MAX	Metropolitan Area Express
MCDD	Multnomah County Drainage District
MCR	Middle Columbia River (ESU/DPS)
MHRR	Mount Hood Railroad
MLK	Martin Luther King, Jr., Boulevard
MMPA	Marine Mammal Protection Act
MPG	Major Population Group
Mph	Miles per Hour
MS4	Municipal Separate Storm Sewer System
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MUP	Multi-Use Path
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act of 1969

NFH	USFWS National Fish Hatchery
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPH	North Portland Harbor
NRCS	Natural Resources Conservation Service
NRM	Northern Rocky Mountain
NTU	Nephelometric Turbidity Unit
NWFSC	Northwest Fisheries Science Center
OCS	Overhead Catenary System
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OHW	Ordinary High Water
ORNHIC	Oregon Natural Heritage Information Center
OSU	Oregon State University
PAH	Polycyclic Aromatic Hydrocarbon
Pa	Pascal
Pa-s	Pascal-seconds
PBAC	Pedestrian and Bicycle Advisory Committee
PBDE	Polybrominated Diphenyl Ether
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element
PDX	Portland International Airport
PFMC	Pacific Fishery Management Council
PGIS	Pollution-Generating Impervious Surfaces
PIDP	San Francisco-Oakland Bay Bridge Pile Installation Demonstration Program
PIT	Passive Integrated Transponder
PL	Public Law
PTS	Permanent Threshold Shift
Q <sub>P</sub>	Flow Rate of the Project Runoff, in cfs;
Q <sub>R</sub>	Flow Rate of the Receiving Waterbody, in cfs
RKm	River Kilometer
RM	River Mile

RMS	Root Mean Square
RTC	Regional Transportation Council
SEL	Sound Exposure Level
SEL <sub>cum</sub>	Cumulative Sound Exposure Level
SEPA	State Environmental Policy Act of 1971
SHPO	Oregon State Historic Preservation Office
$\sigma$	Sigma; Standard Deviation
SMA	Shoreline Management Act
SPCC	Spill Prevention, Control, and Countermeasures
SPL	Sound Pressure Level
SPUI	Single Point Urban Interchange
sq. ft.	Square Foot/Square Feet
SR	State Route or Snake River (ESU/DPS)
SWCD	East Multnomah Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
TDA	Threshold Discharge Area
TDM	Travel Demand Management
TES	Thermal Energy Storage
TESC	Temporary Erosion and Sediment Control
TMDL	Total Maximum Daily Load
TNAP	Temporary Noise-Attenuation Pile
TOD	Transit-Oriented Oriented Development
TriMet	Tri-County Metropolitan Transportation District of Oregon
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UCR	Upper Columbia River (ESU/DPS)
UGB	Urban Growth Boundary
URB	Upriver Bright (Chinook)
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UW	University of Washington

UWR	Upper Willamette River (ESU/DPS)
VCCV	Vancouver City Center Vision
VMC	Vancouver Municipal Code
WDFW	Washington Department of Fish and Wildlife
WDNR-NHP	Washington Department of Natural Resources, Natural Heritage Program
WLCTRT	Willamette/Lower Columbia Technical Recovery Team
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries

## 1 GLOSSARY

2 **action** – Any activity or program of any kind authorized, funded, or carried out, in whole or in  
3 part, by federal agencies in the United States or upon the high seas. Examples include but are not  
4 limited to actions directly or indirectly causing modifications to the land, water, or air; actions  
5 intended to conserve listed species or their habitat; and the promulgation of regulations  
6 (50 CFR 402.02).

7 **action agency** – The federal agency proposing to undertake a major construction project (action).

8 **action area** – All areas to be affected directly or indirectly by the federal action and not merely  
9 the immediate area involved in the action (50 CFR 402.02).

10 **affect/effect** – To *affect* (a verb) is to bring about a change. The *effect* (usually a noun) is the  
11 result.

12 **ambient noise level** – The background sound level, which is a composite of sound from all  
13 sources near and far.

14 **attenuation** – See *transmission loss*.

15 **auxiliary lanes** – Can improve safety reduce congestion by accommodating cars and trucks  
16 entering or exiting the highway or traveling short distances between adjacent interchanges, and  
17 reduce conflicting weaving and merging movements.

18 **baseline** – The starting point for analysis; ambient conditions from which to measure and  
19 compare potentially altered conditions caused by project activities.

20 **best management practices (BMPs)** – Methods, facilities, built elements, and techniques  
21 implemented or installed during project construction to reduce short- and long-term project  
22 impacts on listed and sensitive species and habitat. These measures are included as part of the  
23 federal agency’s proposed action.

24 **biofiltration** – The process of filtering water through biological materials, such as vegetation.

25 **biological assessment (BA)** – The information prepared by or under the direction of an action  
26 agency to determine whether a proposed action (major construction activity) is likely to affect  
27 listed and proposed species and designated and proposed critical habitat that may be present in  
28 the project action area, including the evaluation of potential effects of the action on such species  
29 and habitat. The outcome of the BA determines whether formal consultation or a conference is  
30 necessary.

31 **biological opinion (BO)** – The document prepared by the U.S. Fish and Wildlife Service  
32 (USFWS) or National Oceanic and Atmospheric Administration (NOAA) Fisheries that states  
33 the opinion of the Service as to whether a federal action is likely to jeopardize the continued  
34 existence of listed species or result in the destruction or adverse modification of critical habitat.

- 1 **bioretention** – The process of temporarily retaining water in a natural terrestrial community of  
2 plants, microbes, and soil.
- 3 **bycatch** – The unintentional harvest of a fish species while intending to catch another fish  
4 species.
- 5 **candidate species** – A species for which the Service has on file sufficient information on  
6 biological vulnerability and threats to support a proposal to list it as threatened or endangered.
- 7 **coalescing plates** – A device with parallel plates to separate oil from water by means of gravity.
- 8 **cofferdam** – An enclosure to isolate work activities from the active channel of a waterbody; it  
9 may be dewatered.
- 10 **compost** – Organic residue, or a mixture of organic residues and soil, that has undergone  
11 biological decomposition until it has become relatively stable humus.
- 12 **congestion** – For highways, congestion occurs when average speed is below 30 mph.
- 13 **conservation measure** – Activities or measures that help recover listed species.
- 14 **couplet** – A fixed method of routing two directions of travel on two adjacent, parallel streets,  
15 instead of placing both directions of travel on a single street.
- 16 **critical habitat** – Specific geographical areas that possess physical or biological features that are  
17 essential to the conservation of listed species. These designated areas may require special  
18 management consideration or protection.
- 19 **cumulative effects** – The effects of other, future state or private actions that are reasonably  
20 certain to occur within the federal project action area (50 CFR 402.02).
- 21 **decibel (dB)** – A unit describing the amplitude of sound, equal to 20 times the logarithm to the  
22 base 10 of the ratio of the pressure of the sound measured to the reference pressure. The  
23 reference pressure for water is 1 micropascal ( $\mu\text{Pa}$ ) and air is 20 micropascals (the threshold of  
24 healthy human audibility).
- 25 **delayed mortality** – When a fish dies more than 1 hour and less than 48 hours after exposure to  
26 an effect.
- 27 **demand** – The total number of users attempting to access the transportation system, including  
28 those caught in congestion.
- 29 **detention** – The temporary storage of runoff, which is released at a slower rate than it was  
30 collected. Detention facilities are most commonly used for flow control.
- 31 **direct effects** – Impacts resulting from the proposed action.



- 1 ***distinct population segment (DPS)*** – A designation usually used by the USFWS for a discrete  
2 vertebrate stock that is treated as an individual species (e.g., a specified seasonal fish run in a  
3 particular river). This is equivalent to the NOAA Fisheries evolutionarily significant unit (ESU)  
4 classification.
- 5 ***drilled shaft*** – Constructed in diameters ranging from 18 inches to 12 feet or more to provide  
6 deep foundations for buildings, bridges, and retaining walls, and to stabilize landslides. Highly  
7 specialized construction techniques have been developed to install drilled shafts in conditions  
8 ranging from soft soils to hard rock.
- 9 ***drywell*** – A well completed above the water table so that its bottom and sides are typically dry  
10 except when receiving fluids. Drywells are designed to disperse water below the land surface.
- 11 ***effect/affect*** – See *affect/effect*.
- 12 ***effects of the action*** – The direct and indirect effects of a federal action on listed species or  
13 critical habitat, together with the effects of other interrelated and interdependent activities. Direct  
14 effects are those resulting from the proposed action. Indirect effects are those caused by the  
15 proposed action later in time, but still reasonably certain to occur. Interrelated actions are part of  
16 a larger action and depend on the larger action for their justification. Interdependent actions are  
17 those that have no independent utility apart from the action under consideration.
- 18 ***endangered species*** – A species that is in danger of extinction throughout all or a significant  
19 portion of its range.
- 20 ***estuary (the Columbia River)*** – The Columbia River estuary is considered to be that portion of  
21 the Columbia River extending from the mouth upstream to, and including, all tidally influenced  
22 areas (i.e., to Bonneville Dam).
- 23 ***evolutionarily significant unit (ESU)*** – A designation used by NOAA Fisheries for certain local  
24 salmon populations or runs that are treated as individual species. This is equivalent to the distinct  
25 population segment (DPS) classification.
- 26 ***federal action agency*** – The federal agency that proposes a specific action or triggers a federal  
27 nexus for a project (by providing permits, funding, etc.). This agency is responsible for formally  
28 submitting a biological assessment for the proposed action to the Services for review and  
29 informal or formal consultation.
- 30 ***federal nexus*** – A project with a federal nexus either has federal funding, requires federal  
31 permits, or takes place on federal lands.
- 32 ***filter strip*** – A grassy area with gentle slopes that treats stormwater runoff from adjacent paved  
33 areas before it can concentrate into a discrete channel.
- 34 ***formal consultation*** – The process between the Services and the action agency that commences  
35 with the action agency’s written request for consultation under Section 7(a)(2) of the Endangered  
36 Species Act (ESA) and concludes with the Service’s issuance of a biological opinion under  
37 Section 7(b)(3) of the ESA.

- 1 **guideway** – A transit right-of-way separated from general purpose vehicle transit. A guideway  
2 may have train tracks or separated bus lanes.
- 3 **habitat conservation plan (HCP)** – A planning document required under Section 10(a)(1)(b) of  
4 the federal ESA for non-federal entity actions with no federal nexus to conserve the ecosystems  
5 upon which listed species depend. An HCP is part of an application for incidental take for the  
6 non-federal entity.
- 7 **hair cells** – Cells within the inner ear of most vertebrates that contain ciliary bundles that  
8 respond to sound pressure and create the sensation of hearing.
- 9 **harass** – An intentional or negligent act or omission that creates the likelihood of injury to  
10 wildlife by annoying to such an extent as to significantly disrupt normal behavior patterns, which  
11 include but are not limited to breeding, feeding, and sheltering (50 CFR Part 17).
- 12 **hard site conditions** – Areas where there is no excess ground-effect noise attenuation, such as  
13 asphalt, concrete, hard-packed soils, and water surfaces.
- 14 **harm** – In the definition of *take* in the ESA. Harm is defined by the USFWS to include  
15 significant habitat modification or degradation where it actually kills or injures wildlife by  
16 significantly impairing essential behavioral patterns, including breeding, feeding, and sheltering  
17 (50 CFR 17.3). The National Marine Fisheries Service’s (NMFS’s) definition of harm includes  
18 significant habitat modification or degradation where it actually kills or injures fish or wildlife by  
19 significantly impairing essential behavioral patterns, including breeding, feeding, spawning,  
20 migrating, rearing, and sheltering (64 FR 60727, November 8, 1999).
- 21 **hydrology** – Refers to the flow of water—its volume, where it drains, and how quickly the flow  
22 rate changes in a storm.
- 23 **hyporheic flow** – Movement of water just below a stream bed, where groundwater and surface  
24 water may intermix.
- 25 **impervious surface** – A hard surface area that either prevents or retards the entry of water into  
26 the soil and from which water runs off at an increased rate of flow.
- 27 **impulse** – The time integral of the peak pressure, typically described in units of pounds per  
28 square inch per millisecond (psi/msec). It recognizes that a short pulse may do less damage than  
29 a longer duration pulse of the same pressure. Sound pressure is equivalent to kilowatts, while  
30 impulse is equivalent to kilowatt-hours.
- 31 **incidental take** – A *take* of listed species that results from an action but is not the direct purpose  
32 or intent of the action, as defined under the ESA. Incidental *take* can be authorized through  
33 Section 7 consultation or through Section 10 conservation planning, such as an HCP.
- 34 **indirect effects** – Effects caused by the proposed action later in time but still reasonably certain  
35 to occur.
- 36 **infiltration** – The downward movement of water from the surface to the subsoil.

- 1 ***infiltration pond*** – A facility that contains excess runoff then percolates that runoff into the  
2 surrounding soil.
- 3 ***interdependent action*** – An action having no independent utility apart from the proposed action.
- 4 ***interrelated action*** – An action that is part of a larger action and depends on the larger action for  
5 its justification.
- 6 ***is not likely to adversely affect*** – The appropriate finding in a biological assessment (or  
7 conclusion during informal consultation) when effects on listed species are expected to be  
8 discountable, insignificant, or completely beneficial.
- 9 ***jeopardize the continued existence of*** – To engage in an action that reasonably would be  
10 expected to directly or indirectly reduce the likelihood of both survival and recovery of a listed  
11 species in the wild by reducing the reproduction, numbers, or distribution of that species.
- 12 ***light rail transit (LRT)*** – A form of urban rail public transportation that generally has a lower  
13 capacity and lower speed than heavy rail and metro systems, but higher capacity and higher  
14 speed than traditional street-running tram systems.
- 15 ***listed species*** – Any species of wildlife, fish, or plant that has been listed as endangered or  
16 threatened under Section 4 of the ESA. Listed species are found in 50 CFR 17.11–17.12. Under  
17 the statute, the two types of species are treated in virtually the same way.
- 18 ***metapopulation*** – A metapopulation consists of a group of spatially separated populations of the  
19 same species which interact at some level. A metapopulation is generally considered to consist of  
20 several subpopulations together; each subpopulation may be separated by areas of suitable  
21 habitat which are currently unoccupied.
- 22 ***micropascal ( $\mu\text{Pa}$ )*** – Most underwater acoustic sound pressure measurements are stated in terms  
23 of a pressure relative to 1 micropascal. One micropascal is equal one millionth of one newton per  
24 square meter.
- 25 ***minimization measure*** – Measures that reduce the impact of the project on listed species.
- 26 ***mode split*** – The percentage of travel by different forms of transportation, typically single-  
27 occupant vehicles, high-occupancy vehicles (two or more persons in a car), transit, walk, and  
28 bicycle.
- 29 ***mortality (fish)*** – Cessation of all activity including movements of the operculum, or when all  
30 respiration stops and the fish lies motionless.
- 31 ***National Pollutant Discharge Elimination System (NPDES)*** – The provision in the federal  
32 Clean Water Act that requires point source dischargers of pollutants to obtain permits, called  
33 NPDES permits. In Washington, NPDES permits are administered by the Washington  
34 Department of Ecology.

- 1 ***no effect*** – The appropriate conclusion when the proposed action will not affect a listed species  
2 or its critical habitat (i.e., will have no effect whatsoever—neither beneficial effects, nor highly  
3 improbable effects, nor insignificant effects).
- 4 ***outfall*** – The point of water discharge from a stormwater facility.
- 5 ***pascal (Pa)*** – A unit of pressure equal to 1 newton per square meter.
- 6 ***peak period*** – This is a more technically defined description of “rush hour”, when travel patterns  
7 generate the most traffic, especially in a certain direction.
- 8 ***performance measure*** – An observable or measurable benchmark for a particular performance  
9 objective against which a project can be compared. If the standards are met, the related  
10 performance objectives are considered to have been fully achieved. It is something quantifiable.  
11 Standards should be measures, not actions, and should be: 1) achievable, and 2) capable of being  
12 monitored.
- 13 ***piles*** – Steel, concrete, wood, or plastic cylinders or columns that may be hammered, vibrated, or  
14 drilled into the soil until they reach dense soil or bedrock. Load-bearing piles provide support to  
15 hold the weight of a structure and any traffic and equipment. Non-load-bearing piles may be used  
16 for mooring or support.
- 17 ***pool*** – A deep, slow moving area with smooth water surface.
- 18 ***predation*** – The act of preying on another animal.
- 19 ***proposed species*** – Any species of wildlife, fish, or plant that is proposed in the Federal Register  
20 to be listed under Section 4 of the ESA as threatened or endangered.
- 21 ***range (of a species)*** – The area or region over which an organism occurs.
- 22 ***rate*** – Percentage probability of an effect.
- 23 ***receiving water*** – A body of water or a surface water system to which surface runoff is  
24 discharged.
- 25 ***recovery*** – Action that is necessary to reduce or resolve the threats that caused a species to be  
26 listed as threatened or endangered.
- 27 ***riffle*** – A shallow, fast-moving stream section with water broken by rocks and boulders.
- 28 ***root mean square (RMS)*** – The average of the squared pressures over the time that comprise that  
29 portion of the waveform containing 90 percent of the sound energy for one pile-driving impulse,  
30 commonly used in repetitive or relatively continuous measurements such as in speech or  
31 highway noise. It is not applicable to transient signals such as explosions. It is used in calculating  
32 longer-duration sound pulses such as a pile-driving pulse of sound.
- 33 ***Services*** – An abbreviated term for the USFWS and NOAA Fisheries.

- 1 **sound exposure level (SEL)** – A common unit of sound energy used in airborne acoustics to  
2 describe short-duration events. The time integral of frequency-weighted squared instantaneous  
3 sound pressures. It is proportionally equivalent to the time integral of the pressure squared and  
4 can be described in terms of  $\mu\text{ Pa}^2/\text{sec}$  over the duration of the impulse Source: Fisheries and  
5 Hydroacoustic Monitoring Program Compliance Report, San Francisco-Oakland Bay Bridge  
6 East Span Seismic Safety Project 6-11.
- 7 **sound pressure level (SPL)** – Sound pressure is the sound force per unit area, usually expressed  
8 in micropascals ( $\mu\text{Pa}$ ) (or 20 micro newtons per square meter), where 1 pascal is the pressure  
9 resulting from a force of 1 newton exerted over an area of 1 square meter. The sound pressure  
10 level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the  
11 pressure exerted by the sound to a reference sound pressure (e.g., 20  $\mu\text{Pa}$ ).
- 12 **species** – Includes any subspecies of fish, wildlife, or plant, or any distinct population segment of  
13 any species of vertebrate fish or wildlife, which interbreeds when mature.
- 14 **spherical spreading** – Spreading of sound pressure in a dome or sphere shape from the source.
- 15 **stormwater** – A term used to describe water that originates during precipitation events. It may  
16 also be used to apply to water that originates with snowmelt or runoff water from overwatering  
17 that enters the stormwater system.
- 18 **stormwater runoff** – Occurs when precipitation from rain or snowmelt flows over the ground.  
19 Impervious surfaces like driveways, sidewalks, and streets prevent stormwater runoff from  
20 naturally soaking into the ground.
- 21 **suitable habitat** – The area where an organism, including a plant, animal or fish, naturally or  
22 normally lives and grows.
- 23 **strike interval** – The length of time between strikes during pile driving.
- 24 **swale** – A natural depression or shallow drainage conveyance with relatively gentle side slopes,  
25 generally less than 1 foot, used to temporarily store, route, or filter runoff.
- 26 **take (taking)** – Defined under the ESA 16 USC 1532(19) as to harass, harm, pursue, hunt, shoot,  
27 wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.
- 28 **threshold discharge area (TDA)** – An on-site area draining to a single natural discharge location  
29 or multiple natural discharge locations that combine within 0.25 mile downstream (as determined  
30 by the shortest flow path).
- 31 **throughput** – The number of users being served at any time by the transportation system.
- 32 **transmission loss** – The accumulated decrease in acoustic intensity as the acoustic pressure wave  
33 propagates outward from the source due to spreading.
- 34 **trench** – A long cut in the ground, i.e., a ditch or swale.

- 1 ***vault*** – An underground storage facility that collects runoff and either percolates that runoff into  
2 the surrounding soil at various rates or permanently pools the runoff.
- 3 ***water quality*** – Refers to the characteristics of the water—for example, its temperature and  
4 oxygen levels, how clear it is, and whether it contains pollutants.
- 5 ***wet pond*** – A facility that contains a permanent pool of water and removes pollutants from  
6 highway runoff through sedimentation, biological uptake, and plant filtration.
- 7