Appendix I

Exposure Matrices

Table I-1: Exposure Matrix for Fish – CRC Project and Selected Interrelated and Interdependent Actions

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Noise at 206 dB peak injury threshold	Impact pile driving (Section 3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017	CR: 5 to 54 m NPH: 5 to 40 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Mortality, injury, temporary or permanent hearing loss, interference with movement and predator avoidance, and/or avoidance of area.	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring.	LAA (SS, E) NLAA (BT, GS) - presence discountable
Noise at 187 dB SEL injury threshold	Impact pile driving (Section 3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017	CR: 9 - 243 m NPH: 9 - 243 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Mortality, injury, temporary or permanent hearing loss, interference with movement and predator avoidance, and/or avoidance of area. (See Table I-2 and I-3 for additional details on run-scale response)	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring.	LAA (SS, E) NLAA (BT, GS) - presence discountable
Noise at 183 dB SEL injury threshold	Impact pile driving (Section 3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017	CR: 50 – 446 m NPH: 50 – 446 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	Chum 0+ E la	Mortality, injury, temporary or permanent hearing loss, interference with movement and predator avoidance, and/or avoidance of area. (See Table I-2 and I-3 for additional details on run-scale response)	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring.	LAA
Noise at 150 dB RMS disturbance threshold	Impact pile driving (Section 3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017	CR: 858 – 20,166 m NPH: 858 – 5,632 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Startling, disruption in feeding, avoidance, impaired ability to avoid predators, brief migrational delay.	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring.	LAA (SS, E) NLAA (BT, GS) - presence discountable
Elevated noise (not pertaining to any threshold)	Drilling shafts (3.5.2.5, 3.5.3.1), vibratory pile driving (3.5.2.4, 3.5.3.1, 3.6.2), install cofferdams (3.5.2.4, 3.6.2)	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; CR demo: 9/2019 – 3/202; NPH: ~9/2015 – 03/2017	6 – 9 m (20 – 30 feet)	24 hrs/day CR con: ~1015 days CR demo: ~550 days NPH ~334 days	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Avoidance of areas within 6 – 9 m. Effect insignificant due to limited area and low intensity of activity.	None.	NLAA (SS, E) – NLAA (BT, GS) - presence discountable
Work-Area Isolation and Fish salvage	Installation of cofferdams (3.5.2.4, 3.6.2)	CR: 1. PC 2 2. PC 7 3. demo existing piers	1. 12/2013 –3/2014 2. 12-2/2014 3. 03/2020 – 03/2021	~7,900 sf ~7,900 sf ~7,500 sf each (~22,500 at one time)	1, 2. ~50 days at each location 3. 90 days (~10 days at each of nine piers)	Once at each location	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Harassment, avoidance, injury, mortality.	Install from upstream to downstream. Use NMFS, ODFW, WDFW fish salvage protocols (Appendix E).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Shading	Presence of overwater structures (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	CR con: ~9/2013 – 8/2017; CR demo: ~12/2019 – 03/2021; NPH: ~9/2014 – 02/2016 See Figures 6-19, 20, 21.	Varies: CR con: 400 – 17,500 sf; CR demo: 6,000 – 21,000 sf; NPH: 900 – 105,000 sf See Figures 6-19, 20, 21.	Varies: CR con: 9 – 316 days CR demo: 2 – 62 days; NPH: 10 – 42 days See Figures 6-19, 20, 21.	N/A	SS 0+, 1+ E la	1. Increased predation. 2. Disorientation, migrational delay. 3. Insignificant decrease in primary productivity.	None	1. LAA (all) 2. NE (E, chum) - not subject to disorientation, LAA (all others) 3. NLAA (all)

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Artificial Lighting	Lighting on temporary and permanent structures (3.5.2.4, 3.5.3.1, 3.6.2).	CR, NPH	CR con: ~9/2013 – 8/2017; CR demo: ~12/2019 – 03/202; NPH: ~9/2014 – 02/2016 See Figures 6-19, 20, 21.	Varies: CR con: 400 – 17,500 sf; CR demo: 6,000 – 21,000 sf; NPH: 900 – 105,000 sf See Figures 6-19, 20, 21.	Varies: CR con: 9 – 316 days CR demo: 2 – 62 days; NPH: 10 – 42 days See Figures 6-19, 20, 21.		SS 0+, 1+ E la	1. Increased predation. 2. Disorientation, migrational delay.	Shield lights, direct away from water surface. Limit to minimum necessary.	1. LAA (all) 2. NE (E, chum) – not subject to disorientation, LAA (all others)
Chemical contamination	In-water, over-water work, and/or near-water work, including removal of treated timber piles. Accidental spills. (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	Year-round CR con: ~1/2013 – 8/2017; CR demo: ~9/2020 – 03/2021 NPH: ~12/2013 – 10/2016	Minimal.	Brief to none.	Infrequent to none.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	None anticipated. Exposure will be none or extremely limited due to use of BMPs.	Standard containment BMPs such as erosion control and spill prevention. Comply with conditions of numerous regulatory permits, including: WDFW HPA, DEQ and Ecology Water Quality Cert., USACE Section 404 Removal/Fill Permit.	NLAA
Turbidity	Impact pile driving (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	9/15 – 4/15 ~2013 – 2017	~25 feet	40 mins/day, CR 138 days NPH 134 days	CR: 5 / 7 work days NPH: 3 to 5 / 7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Vibratory installation (3.5.2.4, 3.5.3.1, 3.6.2, 3.6.3)	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; CR demo: 9/2019 – 3/2021; NPH: ~9/2015 – 03/2017	~25 feet	24 hrs/day CR con: ~1015 days CR demo: ~550 days NPH: ~334 days	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Pile and cofferdam removal (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; demo: 9/2019 – 3/2021; NPH: ~9/2015 – 03/2017	Minimal (< 25 ft)	24 hrs/day CR con: ~1015 days CR demo: ~550 days NPH: ~334 days	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Install steel casings and drill/excavate shafts (3.5.2.5, 3.5.3.1)	CR, NPH	Year-round CR: ~ 9/2013 - ~5/2017 NPH: ~9/2015 – 03/2017	~25 feet	8 – 10 hrs/day CR: ~85 – 120 days/pier complex NPH: ~8 days/shaft	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Operate barges in shallow water (3.5.2.4, 3.5.3.1, 3.6.2.1)	1. CR PC 2 2. CR PC 7 3. CR demo 4. NPH	1. 10/13/14 – 1/22/16; 2. 9/29/14 – 1/23/17; 3. 12/16/2020 – 03/11/2021 4. 9/2015 – 3/2017	< 300 feet	1. 259 days, 2. 606 days; 3. ~85 days 4. ~640 days	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume). Barges will not be grounded.	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Debris removal (3.5.3.2)	NPH	Between 11/1 and 2/28	~ 300 feet	~ 4 – 6 hours/ day, ~4 times/day, 7 days	Once.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Pinpoint location of debris to minimize footprint. Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Demo inside of cofferdam (3.6.2.1)	CR	3/5/20 – 3/11/21	Minimal distance outside of cofferdam (< 25 ft)	~ 8 – 10 hrs/day, ~370 days	7 days/week	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	None anticipated. Exposure will be none or extremely limited due to use of BMPs..	Cofferdam is a minimization measure. Comply with state water quality standards (mixing zones, duration of plume).	NLAA

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Contaminated sediments	Activities that mobilize substrate, including turbidity-generating activities above (3.5.2.4, 5; 3.5.3.1, 2; 3.6.2, 3; 3.6.2.1).	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; demo: 9/2019 – 3/2021. NPH: ~9/2015 – 03/2017	None or minimal due to avoidance and/or containment of contaminated sediments.	Brief to none.	N/A	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	None anticipated. Exposure will be none or extremely limited due to use of BMPs.	Phase I and (if necessary) Phase II Environmental Site Assessments. Avoid work in areas of contaminated sediments. Clean up contaminated areas before work begins. Comply with regulatory criteria (DEQ, Ecology).	NLAA
Avian Predation	Presence of overwater structures (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	When structures are not in use. CR con: ~9/2013 – 8/2017; CR demo: ~12/2019 – 03/2021; NPH: ~9/2014 – 02/2016 See Figures 6-19, 20, 21.	CR con: 400 – 17,500 sf; CR demo: 6,000 – 21,000 sf; NPH: 900 – 105,000 sf See Figures 6-19, 20, 21.	CR con: 9 – 316 days; CR demo: 2 – 62 days; NPH: 10 – 42 days See Figures 6-19, 20, 21.	N/A	SS 0+, 1+ E la	Increased predation.	None.	LAA
Stormwater runoff – impacts to water quality (discharge of untreated runoff)	Installation of new PGIS and stormwater treatment facilities (3.12)	CR, NPH, CS, BBC	Potentially any month, but more likely spring through winter. In perpetuity.	CR - minimal NPH - minimal CS - none BBC - to Vancouver Lake	Brief, due to high levels of dilution.	During events that exceed design storm.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Potential improvement to environmental baseline; potential beneficial effect.	Treatment of new PGIS, high level of retrofit for CIA and existing PGIS well above regulatory requirements.	NLAA
Stormwater runoff – impacts to water quantity	Installation of new PGIS and stormwater treatment facilities (3.12)	BBC	Year-round, in perpetuity.	Minimal due to high levels of infiltration.	Year-round.	During events that exceed design storm.	LCR steelhead, coho, Chinook.	Potential improvement to environmental baseline; potential beneficial effect.	Treatment of new PGIS, high level of retrofit for CIA and existing PGIS well above regulatory requirements. High level of infiltration.	NLAA
Effects due to land use and traffic changes (impacts to water quality and/or quantity, work in water or riparian areas, increased overwater coverage)	Land use and traffic changes	CR, NPH, CS, BBC	After project completion, in perpetuity.	Varies.	Varies.	Varies.	Potentially SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Limited due to minimization measures, minimization of sprawl, and likely decease in traffic congestion.	High level of stormwater treatment; numerous regulations limiting impacts to riparian areas, wetlands, and water bodies.	NLAA
Shallow-water habitat – temporary physical loss	Presence of temporary in-water structures.	CR, NPH	CR con: 9/16/13 – 1/23/17; CR demo: 4/30 – 4/28/20; 12/2/20 – 3/11/21. NPH: 9/15/13 – 2/11/16 See Figures 6-29, 30, 31	Max at one time CR con: 350 – 550 sf CR demo: 56 – 16,000 sf NPH: ~460 sf See Figures 6-29, 30, 31	CR con: ~850 days CR demo: ~84 days NPH: ~334 days See Figures 6-29, 30, 31	N/A	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	1. Insignificant increase in predation (SS 0+, E la). 2. Insignificant loss of foraging, migration, holding habitat (all).	None.	1. NLAA 2. NLAA
Shallow-water habitat – permanent physical loss	Presence of permanent in-water structures	CR, NPH	Year-round, in perpetuity.	CR: net gain of 5,345 sf due to removal of existing bridge piers. NPH: net loss of 2,435 sf	Year-round.	Permanent.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	1. Insignificant increase in predation (SS 0+, E la). 2. Insignificant loss of foraging, migration, holding habitat (all). 3. Slight, insignificant gain of shallow-water habitat in CR due to removal of piers.	Remove all or portion of pier from Red Lion at the Quay.	1. NLAA 2. NLAA 3. NLAA

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Shallow-water habitat – temporary increase in overwater coverage, shading	Presence of temporary overwater structures (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	CR con: 10/16/13 – 1/23/17; CR demo: 5/12-28/20 and 12/2/20 – 3/11/21; NPH: 9/15/13 – 2/11/16 See Figures 6-32, 33	Max at one time CR con: 18,500 sf CR demo: 12,000 sf NPH: ~112,180 sf See Figures 6-32, 33	CR con: ~517 days CR demo: ~85 days NPH: ~640 days See Figures 6-32, 33	N/A	SS 0+, 1+ E la	1. Increased predation. 2. Disorientation, migrational delay. 3. Insignificant decrease in primary productivity.	None	1. LAA (all) 2. LAA (all SS except chum), NE (E, chum) – not subject to disorientation 3. NLAA (all)
Shallow-water habitat – permanent change in overwater coverage, shading	Presence of permanent overwater structures (3.5.2.4, 3.5.3.1, 3.6.2)	CR	Year-round, in perpetuity.	Net loss of ~17,300 sf of overwater coverage.	Year-round.	N/A	SS 0+, 1+ E la	Potential decrease in predation, removal of migratory barrier, insignificant increase in primary productivity.	Remove portion of pier at Red Lion at the Quay.	NLAA
Shallow-water habitat - Turbidity	Activities that mobilize substrate. See turbidity-generating activities above (3.5.2.4, 5; 3.5.3.1, 2; 3.6.2, 3; 3.6.2.1).	CR, NPH	Varies. See Table 6-35.	0 – 300 feet See Table 6-35.	Varies CR: up to ~600 days; CR demo: up to ~130 days NPH: up to ~640 days. See Table 6-35.	Varies. See Table 6-35.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Deep-water habitat – temporary physical loss	Presence of temporary in-water structures	CR	CR con: 10/16/13 – 1/23/2017 CR demo: 9/16/19 – 1/14/21 See Figure 6-34, 35	Max at one time CR con: ~1,725 sf CR demo: ~18,000 sf See Figure 6-34, 35	CR con: ~1100 days CR demo: ~486 days See Figure 6-34, 35	N/A	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Insignificant loss of migration habitat.	None.	NLAA
Deep-water habitat – permanent physical loss	Presence of permanent in-water structures	CR	Year-round, in perpetuity.	Net gain of ~21,600 sf due to removal of existing piers.	Year-round.	N/A	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Insignificant increase in migration habitat may lead to slight benefit.	None.	NLAA
Deep-water habitat – increase in temporary overwater coverage, shading	Presence of temporary overwater structures (3.5.2.4, 3.6.2)	CR	CR con: 10/16/2013 – 1/23/2019 CR demo: 12/12/19 – 1/14/21 See Figure 6-36, 37	Max at one time CR con: ~160,000 sf CR demo: ~22,500 sf See Figure 6-36, 37	CR con: ~1100 days CR demo: ~400 days See Figure 6-36, 37	N/A	SS 0+, 1+ E ad/la	1. Increased predation. 2. Insignificant disorientation, migrational delay.	None.	1. LAA 2. NLAA (all except chum), NE (chum and E) – not subject to disorientation
Deep-water habitat – increase in permanent overwater coverage, shading	Presence of permanent overwater structures (3.5.2.4, 3.6.2).	CR	Year-round, in perpetuity.	~56,813 sf	Year-round.	N/A	SS 0+, 1+ E ad/la	1. Increased predation. 2. Insignificant disorientation, migrational delay.	None.	1. LAA 2. NLAA
Deep-water habitat – Turbidity	Activities that mobilize substrate, including turbidity-generating activities above (3.5.2.4, 5; 3.6.2, 3; 3.6.2.1).	CR	Varies. See Table 6-38.	0 – 25 feet. See Table 6-38.	Varies. CR con: Up to ~928 days CR demo: ~315 days See Table 6-38	Varies. Up to 7 days/ week See Table 6-38	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance (all). Spawning (E only).	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Riparian impacts	Vegetation removal along shoreline.	CR, NPH	TBD	15 trees	N/A	N/A	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Insignificant. Area of lost riparian vegetation very small relative to size of water body.	Replanting to increase amount of riparian vegetation in the long term.	NLAA

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
In-water, overwater, and/or near-water work related to maintenance and operation of completed project.	Maintenance and Operation (3.14.1)	Potentially CR, NPH, CS, BBC	Continually for foreseeable future.	Varies.	Varies.	Varies.	Potentially SS 0+, 1+, ad E ad/la BT ad/su GS ad/su Depending on location.	Unknown. Work will undergo individual or programmatic consultation if necessary to determine effect.	Standard BMPs as outlined by programmatic or individual consultations and/or regulatory permits.	Varies.
Utility relocation	Utility Relocation (3.14.4)	Throughout project area (on land).	Continuous throughout construction period.	Varies.	Varies.	Varies.	None.	None. No in-water work.	Standard BMPS including but not limited to erosion control plans, spill prevention plans.	NE
Unanticipated staging and casting areas	Unanticipated staging and casting areas (3.14.4)	On-land location, TBD.	Unknown.	Unknown.	Unknown.	Unknown.	None.	None. No in-water work.	Standard BMPS including but not limited to erosion control plans, spill prevention plans.	NE
Potential increase in pump station capacity.	Rebuilding pump station (3.14.4)	CS	Unknown.	Unknown.	Unknown.	Unknown.	None.	None. Additional pump capacity not anticipated to affect water quality or quantity in Columbia Slough.	None.	NLAA
Change in shading due to floating home relocation.	Floating home relocation	NPH	Unknown.	Unknown.	Unknown.	Unknown.	Potentially SS 0+, 1+ E la Depending on location.	Not likely to increase shade footprint. Could potentially decrease shading.	None.	NLAA

[a] **Activity Abbreviations**

Con – construction; Demo – demolition

[b] **Location Abbreviations**

CR – Columbia River; NPH – North Portland Harbor; PC – Pier Complex; CS – Columbia Slough; BBC – Burnt Bridge Creek; HR – Hood River; LR – Lewis River

[c] **Species / Life History Abbreviations**

SS – Salmon and steelhead; E – Eulachon; BT – Bull trout; GS – Green sturgeon; Ad – Adult; Su – Subadult; La – Larval; 0+ – Subyearling salmon and steelhead (includes CR chum, LCR Chinook, UCR spring Chinook, UWR Chinook, LCR steelhead, LCR coho); 1+ – Yearling salmon and steelhead (includes all runs except CR chum)

[d] **Effect Determinations**

NE – No Effect; NLAA – Not likely to adversely affect; LAA – Likely to adversely affect

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Table I-2. Project-Calculated Exposure Factors

Exposure Factor Type	Maximum Value
Maximum weekly exposure factor (based on one calendar week)	0.18649
Maximum yearly total exposure factor (the sum of all weekly exposure factors in one calendar year)	0.20218
Average maximum yearly exposure factor (the mean value of all yearly total exposure factors)	0.12009
Maximum total exposure factor (the sum of all weekly exposure factors throughout the project)	0.048036

Note: Exposure factors were calculated for all construction scenarios using the moving fish model, based on a fish of over 2 grams with a movement rate of 0.1 meters per second.

Table I-3. Average Annual Impact to Run by ESU/DPS Passing Through Project Area Based on Exposure Factors (Based on an Approximately 4-Year Schedule for Impact Pile Driving)

Adults	Average Annual Impact	Annual Impact Range
CR Chum	0.2020%	0.1080-0.2510%
UCR SP Chinook	0.0015%	0.0015-0.0015%
LCR Chinook	0.1845%	0.1013-0.2345%
SR F Chinook	0.0565%	0.0365-0.0710%
SR SS Chinook	0.0035%	0.0003-0.0088%
UWR Chinook	0.0185%	0.0068-0.0393%
LCR Steelhead	0.0295%	0.0270-0.0315%
MCR Steelhead	0.0120%	0.0085-0.0145%
UCR Steelhead	0.0103%	0.0068-0.0128%
SRB Steelhead	0.0215%	0.0140-0.0273%
UWR Steelhead	0.1035%	0.0780-0.1395%
SR Sockeye	0.0273%	0.0270-0.0275%
LCR Coho	0.1773%	0.0998-0.2248%
Eulachon	0.0440%	0.0150-0.1030%.
Juveniles (outmigrants)	**Average Annual Impact**	**Annual Impact Range**
CR Chum	0.0585%	0.0225-0.1260%
UCR SP Chinook	0.0095%	0.0050-0.0178%
LCR Chinook	0.0080%	0.0038-0.0160%
SR F Chinook	0.0043%	0.0030-0.0065%
SR SS Chinook	0.0038%	0.0030-0.0058%

UWR Chinook	0.0528%	0.0435-0.0610%
LCR Steelhead	0.0048%	0.0023-0.0105%
MCR Steelhead	0.0035%	0.0020-0.0073%
UCR Steelhead	0.0048%	0.0033-0.0090%
SRB Steelhead	0.0018%	0.0008-0.0043%
UWR Steelhead	0.0038%	0.0030-0.0058%
SR Sockeye	0.0033%	0.0025-0.0053%
LCR Coho	0.0265%	0.0218-0.0288%
Eulachon	0.0048%	0.0008-0.0123%.

Table I-4: Exposure Matrix for Fish – Hood River Mitigation Site

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Work Area Isolation and Fish Salvage	Mitigation Construction, installation of cofferdams for side channel connection through RR (3.14.2.2)	HR	7/15 – 8/31	<1,000 sf	~45 days – duration of the ODFW IWWW for Hood River	One time event at upstream end of project, one time event at downstream end	SS 0+, 1+, ad; BT ad/su	Harassment, avoidance, injury, mortality	Construct side channel from downstream end first; install cofferdam and work upstream. Use NMFS, ODFW, WDFW, fish salvage protocols (Appendix E).	LAA (SS) NLAA (BT) -presence discountable
Turbidity	Mitigation Construction (3.14.2.2)	HR	7/15 – 8/31	Minimal (< 25 ft)	12 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad; BT ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS) NLAA (BT) -presence discountable
Turbidity	Removal of cofferdams for side channel connection through RR (3.14.2.2)	HR	7/15 – 8/31	Minimal (< 25 ft)	12 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad; BT ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS) NLAA (BT) -presence discountable
Turbidity	Surface flow re-connection between side channel and mainstem Hood River (3.14.2.2)	HR	7/15 – 8/31	100 feet upstream or 300 feet downstream of re-connection locations	<2 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad; BT ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS) NLAA (BT) -presence discountable
Turbidity	Suspended sediment laden runoff from rainfall events where vegetation is not fully established	HR	Potentially any month, but more likely spring through winter.	Minimal	Brief, due to high levels of dilution	Rare. Only during events that exceed design storm.	SS 0+, 1+, ad; BT ad/su	Exposure will be none or extremely limited due to infrequency and short duration of potential rainfall events and the dilution capacity of the receiving water	Establish native vegetation and groundcover post mitigation construction	NLAA
Chemical Contamination	In-water, over-water work, and/or near-water work, accidental petroleum spills or heavy equipment leaks (3.14.2.2)	HR	7/15 – 8/31	Minimal	Brief to none	Minimal to none	SS 0+, 1+, ad; BT ad/su	None anticipated. Exposure will be none or extremely limited due to use of BMPs.	Implement and maintain Spill Prevention, Control and Countermeasures (SPCC)	NLAA
Loss/Gain of shallow-water habitat	Gain of shallow-water habitat through restoration of off-channel habitat (3.14.2.2)	HR	Post project implementation	~21 acres	Permanent	Continuous	SS 0+, 1+, ad; BT ad/su	Improved spawning and rearing success. Improvement to adult and juvenile migration.	Beneficial effect, N/A	NLAA
Riparian Impacts	Mitigation Construction - some vegetation removal and clearing, weed removal, planting native trees and shrubs.	HR	6/1 – 9/30	~40 acres	120 days	5/7 work days	SS 0+, 1+, ad; BT ad/su	Physiological stress (short term). Net benefit to shading, temperature, food chain support, and woody debris recruitment (long term).	Establish native vegetation and groundcover post mitigation construction.	NLAA

[a] **Activity Abbreviations**

Con – construction; Demo – demolition

[b] **Location Abbreviations**

CR – Columbia River; NPH – North Portland Harbor; PC – Pier Complex; CS – Columbia Slough; BBC – Burnt Bridge Creek; HR – Hood River; LR – Lewis River

[c] **Species / Life History Abbreviations**

SS – Salmon and steelhead; E – Eulachon; BT – Bull trout; GS – Green sturgeon; Ad – Adult; Su – Subadult; La – Larval; 0+ – Subyearling salmon and steelhead (includes CR chum, LCR Chinook, UCR spring Chinook, UWR Chinook, LCR steelhead, LCR coho); 1+ – Yearling salmon and steelhead (includes all runs except CR chum)

[d] **Effect Determinations**

NE – No Effect; NLAA – Not likely to adversely affect; LAA – Likely to adversely affect

Table I-5 Exposure Matrix for Fish – Lewis River Mitigation Site

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Species / Life History[c]	Potential Response	Minimization Measure	Effect Determination[d]
Work Area Isolation and Fish Salvage	Mitigation Construction, installation of cofferdams for side channel connection through RR (3.14.2.2)	LR	8/1 - 8/15	<1,000 sf	~15 days – duration of the WDFW IWWW for Lewis River	One time event at upstream end of project, one time event at downstream end	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Harassment, avoidance, injury, mortality	Construct side channel from downstream end first; install cofferdam and work upstream. Use NMFS, ODFW, WDFW, fish salvage protocols (Appendix E).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Mitigation Construction (3.14.2.2)	LR	8/1- 8/15	Minimal (< 25 ft)	12 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Removal of cofferdams for side channel connection through RR (3.14.2.2)	LR	8/1 - 8/15	Minimal (< 25 ft)	12 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Surface flow re-connection between Lewis River side channel and Columbia River downstream (3.14.2.2)	LR	8/1 - 8/15	100 feet upstream or 300 feet downstream of re-connection locations	<2 hrs/day; 45 days	5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Gill damage, physiological stress, migration delay, interference with foraging, avoidance	Comply with state water quality standards (mixing zones, duration of plume).	LAA (SS, E) NLAA (BT, GS) - presence discountable
Turbidity	Suspended sediment laden runoff from rainfall events where vegetation is not fully established	LR	Potentially any month, but more likely spring through winter.	Minimal	Brief, due to high levels of dilution	Rare. Only during events that exceed design storm.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Exposure will be none or extremely limited due to infrequency and short duration of potential rainfall events and the dilution capacity of the receiving water	Establish native vegetation and groundcover post mitigation construction	NLAA
Chemical Contamination	In-water, over-water work, and/or near-water work, accidental petroleum spills or heavy equipment leaks (3.14.2.2)	LR	8/1 - 8/15	Minimal	Brief to none	Infrequent to none.	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	None anticipated. Exposure will be none or extremely limited due to use of BMPs.	Implement and maintain Spill Prevention, Control and Countermeasures (SPCC)	NLAA
Loss/Gain of shallow-water habitat	Gain of shallow-water habitat through restoration of off-channel habitat (3.14.2.2)	LR	Post project implementation	~18.5 acres	Permanent	Continuous	SS 0+, 1+, ad E ad/la, eggs BT ad/su GS ad/su	Improved spawning and rearing success. Improvement to adult and juvenile migration.	Beneficial effect, N/A	NLAA
Riparian Impacts	Mitigation Construction - some vegetation removal and clearing, weed removal, planting native trees and shrubs.	LR	6/1 – 9/30	~80 acres	120 days	5/7 work days	SS 0+, 1+, ad E ad/la BT ad/su GS ad/su	Physiological stress (short term). Net benefit to shading, temperature, food chain support, and woody debris recruitment (long term).	Establish native vegetation and groundcover post mitigation construction	NLAA

[a] **Activity Abbreviations**
Con – construction; Demo – demolition

[b] **Location Abbreviations**
CR – Columbia River; NPH – North Portland Harbor; PC – Pier Complex; CS – Columbia Slough; BBC – Burnt Bridge Creek; HR – Hood River; LR – Lewis River

[c] **Species / Life History Abbreviations**
SS – Salmon and steelhead; E – Eulachon; BT – Bull trout; GS – Green sturgeon; Ad – Adult; Su – Subadult; La – Larval; 0+ – Subyearling salmon and steelhead (includes CR chum, LCR Chinook, UCR spring Chinook, UWR Chinook, LCR steelhead, LCR coho); 1+ – Yearling salmon and steelhead (includes all runs except CR chum)

[d] **Effect Determinations**
NE – No Effect; NLAA – Not likely to adversely affect; LAA – Likely to adversely affect

Table I-6 Exposure Matrix for Steller Sea Lions – CRC Project

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Potential Response	Minimization Measure	Effect Determination[c]
Noise above 190 dB RMS underwater injury threshold (impulsive noise)	Impact pile driving (3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017 Figures 6-16, 17	2 – 86 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	Very low potential for injury due to minimization measures.	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring. Curtail pile driving while sea lions are present in injury zone (2 – 86 m from impact pile driving).	NLAA
Noise above 160 dB RMS underwater disturbance threshold (impulsive noise)	Impact pile driving (3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017 Figures 6-16, 17	185 – 8,577 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	No injury. Potential harassment. Brief, temporary behavioral disturbance to adult/subadult transiting individuals.	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Acoustical monitoring.	LAA – harassment only
Noise above 120 dB RMS underwater disturbance threshold (continuous noise)	Vibratory driving of pipe pile (3.5.2.4, 3.5.3.1, 3.6.2)	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; CR demo: 9/2019 – 3/2021; NPH: ~9/2015 – 3/2017 Figures 6-16, 17	3,058 – 20,166 m	24 hrs/day CR con: ~1015 days; CR demo: ~550 days; NPH ~334 days	7 days/week	No injury. Potential harassment. Brief, temporary behavioral disturbance to adult/subadult transiting individuals.	None.	LAA – harassment only
Noise above 120 dB RMS underwater disturbance threshold (continuous noise)	Vibratory driving of sheet pile for cofferdams (3.5.2.4, 3.6.2.1)	CR: 1. PC 2 2. PC 7 3. demo existing piers	1. 12/2013 –3/2014 2. 12-2/2014 3. 03/2020 – 03/2021 (demo) Figures 6-16, 17	6,962 m	24 hrs/day CR con: ~1015 days; CR demo: ~550 days; NPH: ~334 days	7 days/week	No injury. Potential harassment. Brief, temporary behavioral disturbance to adult/subadult transiting individuals.	None.	LAA – harassment only
Noise above 100 dB airborne disturbance threshold	Impact pile driving (3.5.2.4, 3.5.3.1)	Adjacent to CR, NPH	9/15 – 4/15 ~2013 – 2017 Figures 6-16, 17	195 – 274 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	No injury. Potential harassment. Brief, temporary behavioral disturbance to adult/subadult transiting individuals.	Limit impact driving to proofing only. Daily 12-hr rest period.	LAA – harassment only
Noise from underwater debris removal	Debris removal (3.5.3.2)	NPH	Between 11/1 and 2/28	541 m	~ 12 hours/ day, 7 days total	Once.	No injury. Brief, temporary behavioral disturbance to adult/subadult transiting individuals.	None.	NLAA
Vessel noise	Barge use (3.5.2.4, 3.5.3.1, 3.6.2.1)	CR, NPH	Year-round CR con: ~ 1/2013 - ~8/2017; CR demo: 9/2019 – 3/2021; NPH: ~9/2015 – 03/2017	Varies.	24 hrs/day CR con: ~1,400 days CR demo: ~550 days NPH: ~ 640 days	7 days/week	Tolerance, habituation, avoidance, attraction.	None.	NLAA
Physical disturbance	Barge use, in-water and overwater structures (3.5.2.4, 3.5.3.1, 3.6.2, 3.6.2.1).	CR, NPH	Year-round CR con: ~ 1/2013 - ~8/2017; CR demo: 9/2019 – 3/2021: NPH: ~9/2015 – 3/2017	Varies. See Figures 6-30, 31, 35, 42, 43	24 hrs/day CR con: ~1,400 days CR demo: ~550 days NPH: ~ 640 days	7 days/week	Brief sporadic behavioral disturbance. No effect to migration.	None.	NLAA
Prey Quality - Turbidity	Installation and removal of piles and cofferdams, drilled shafts, operation of barges in shallow water, demolition (3.5.2.4, 5; 3.5.3.1, 2; 3.6.2, 3; 3.6.2.1)	CR, NPH	Varies. CR con: ~9/2013 – 5/2017; CR demo: ~9/2019 – 3/2021 NPH: ~9/2015 – 3/2017 See Table 6-14.	0 – 300 feet See Table 6-14.	Varies. CR con: up to ~1,400 days. CR demo: ~550 days NPH: up to ~640 days. See Table 6-14.	Varies. See Table 6-14.	Not likely to cause mortality in prey. Effects to prey limited to temporary avoidance of discrete areas of turbidity over restricted duration. Therefore, effects to prey base are insignificant.	Comply with state water quality standards (mixing zones, duration of plume).	NLAA

Pathway/Stressor	Activity[a] (Section Reference)	Location[b]	Timing	Extent (Distance or Area)	Duration	Frequency	Potential Response	Minimization Measure	Effect Determination[c]
Prey Quality – Chemical contamination	In-water, over-water, and/or near-water work, including removal of treated timber piles. Accidental spills.	CR, NPH	Year-round CR con: ~1/2013 – 8/2017; CR demo: ~9/2020 – 3/2021 NPH: ~12/2013 – 10/2016	Minimal.	Brief to none.	Infrequent or none.	None anticipated. Exposure to prey fish will be none or extremely limited due to use of BMPs.	Standard containment BMPs such as erosion control and spill prevention. Comply with conditions of numerous regulatory permits, including: WDFW HPA, DEQ and Ecology Water Quality Cert., and USACE Section 404 Removal/Fill Permit.	NLAA
Prey Quality –Contaminated sediments	Installation and removal of piles and cofferdams, drilled shafts, operation of barges in shallow water, demolition (3.5.2.4, 5; 3.5.3.1, 2; 3.6.2, 3; 3.6.2.1)	CR, NPH	Year-round CR con: ~ 9/2013 - ~5/2017; demo: 9/2019 – 3/2021; NPH: ~9/2015 – 03/2017	Minimal to none due to avoidance and/or containment of contaminated sediments.	Brief to none.	Infrequent or none.	None anticipated. Exposure will be none or extremely limited due to use of BMPs.	Phase I and (if necessary) Phase II Environmental Site Assessments. Avoid work in areas of contaminated sediments and/or clean up contaminated areas before work begins. Comply with regulatory criteria (DEQ, Ecology).	NLAA
Prey Quantity	Impact pile driving (3.5.2.4, 3.5.3.1)	CR, NPH	9/15 – 4/15 ~2013 – 2017	5 – 446 m	40 mins/day CR: 138 days NPH: 134 days	CR: 5/7 work days NPH: 3 to 5/7 work days	Impact pile driving is likely to cause mortality in an extremely small proportion of the prey base.	Noise attenuation device. Limit impact driving to proofing only. Unattenuated strikes ≤ 300/wk. Daily 12-hr rest period. Biological and acoustical monitoring.	NLAA

[a] **Activity Abbreviations**
Con – construction; Demo – demolition

[b] **Location Abbreviations**
CR – Columbia River; NPH – North Portland Harbor; PC – Pier Complex

[c] **Effect Determinations**
NLAA – Not likely to adversely affect; LAA – Likely to adversely affect