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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

In Reply Refer To:
1-3-05-F-0688

MAY 3 1 2007

Mr. Daniel M. Mathis, P.E.
Division Administrator
U.S. Department of Transportation
Federal Highway Administration
Suite 501 Evergreen Plaza
711 South Capitol Way
Olympia, Washington 98501-1284

Dear Mr. Mathis:

This document transmits the U.S. Fish and Wildlife Service's (FWS) Biological Opinion (BO) on the proposed extension of State Route 167 in Pierce County, Washington. This BO addresses the effects of the proposed project on the bull trout (*Salvelinus confluentus*) and designated critical habitat for the bull trout in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Pre-consultation coordination for this project began in 2003. On October 26, 2004, your office submitted a Biological Assessment (BA) and requested formal consultation. This request was withdrawn on December 17, 2004. On September 30, 2005, your office forwarded a revised BA and again requested formal consultation. On October 27, 2005, the FWS sent a letter for FHWA stating that the information necessary to initiate consultation had not been received. Between October 2005 and April 2006 multiple meetings and information exchanges occurred. A collaborative approach began where the National Oceanic and Atmospheric Administration (NOAA) and the FWS (collectively referred to as the Services) assisted the project team in deconstructing the action, completing an exposure analysis and by providing input on various effects analyses. On April 17, 2006, your office submitted a package of information to the Services which included a revised deconstruction of the action, baseline information, action area description, and draft exposure analyses. On October 6, 2006, we received revised exposure analyses from the project team and considered the initiation package complete. Collaborative, pre-consultation meetings and submittal of updated project information continued into February, 2007 when several, new, stormwater infiltration techniques were added to the project. This BO is based on the original BA as well as the collection of subsequent information and revised project descriptions.

TAKE PRIDE® IN AMERICA

The proposed project involves construction of a four-lane freeway with two High Occupancy Vehicle lanes; interchanges with existing SR 167, Interstate-5 (I-5), and SR 509; multiple crossing structures over the Puyallup River, Wapato Creek, Surprise Lake Tributary, and Hylebos Creek; compensatory wetland mitigation; partial relocation of Surprise Lake Tributary and Hylebos Creek; and riparian restoration along Wapato Creek, Surprise Lake Tributary, and Hylebos Creek. The proposed riparian restoration plan (RRP) is intended to provide an alternative approach to traditional stormwater flow control techniques.

As you are aware, the proposed project is at a very early stage of design. Few details regarding stream crossings, stormwater facility design and other important project features are known. As such, the project team requested that this consultation be performance-based. Therefore, the consultation is based on the assumption that some level of ongoing coordination will occur into the future, primarily through our participation in the RRP Technical Assistance Group, as the design progresses and is finalized.

Your effect determinations for the proposed project were "may affect, likely to adversely affect" for the both the bull trout and designated critical habitat for the bull trout; and "may affect, not likely to adversely affect" the bald eagle (*Haliaeetus leucocephalus*).

Based on the information provided in the BA, we concur with your "may affect, not likely to adversely affect" determination for the bald eagle. Our concurrence is based on information in the BA stating that bald eagles do not nest within the action area and the closest nest is approximately 1.6 miles away. While the action area provides some foraging habitat, it does not support known concentrations of bald eagles. Due the existing high levels of disturbance, long-term operation of the proposed project is not expected to result in any significant changes in foraging behavior by eagles. Therefore, potential impacts associated with disturbance during the proposed construction and operation of the proposed project are likely to be discountable.

The enclosed BO addresses the adverse effects associated with the proposed project to bull trout and the potential for adverse modification to designated critical habitat for bull trout.

If you have any comments or questions regarding the BO, please contact Emily Teachout at (360) 753-9583 or John Grettenberger at (360) 753-6044.

Sincerely,

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

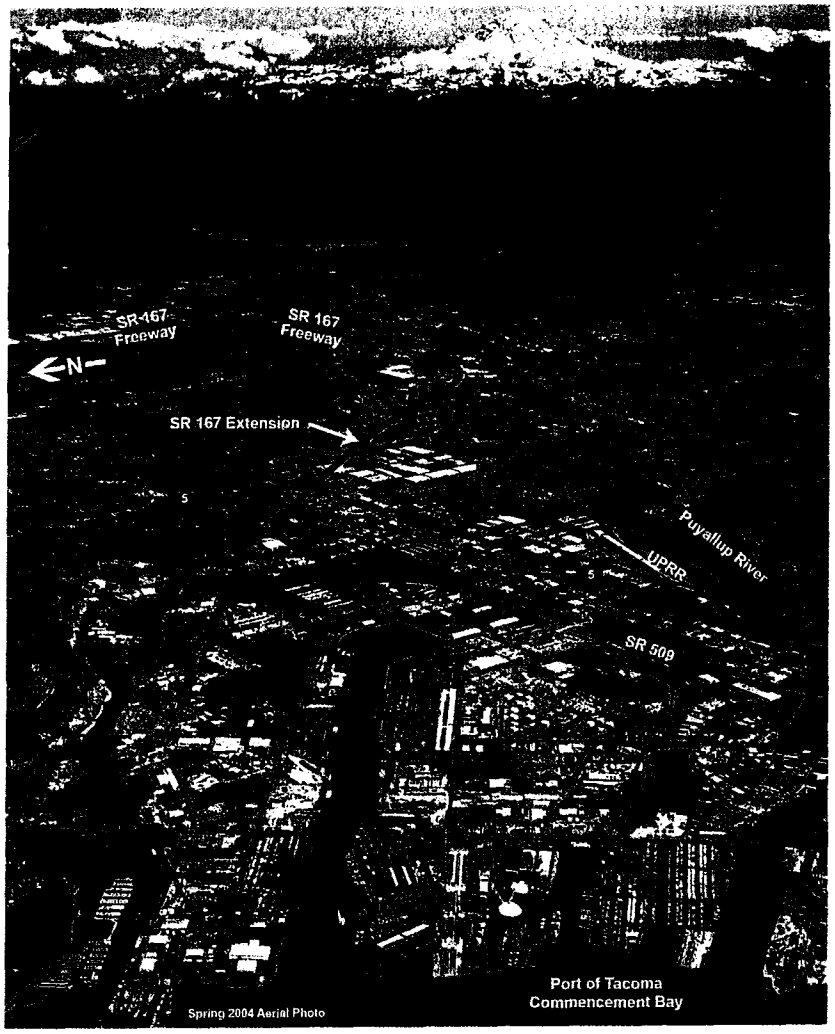
cc:
NOAA-Fisheries, Lacey (Rickard)
WSDOT-ESO, Olympia (White)
WSDOT-Olympic Region, Olympia (Fuchs)

Endangered Species Act – Section 7 Consultation

Biological Opinion

USFWS Reference 1-3-05-F-0688

State Route 167 Extension Project



Action Agency: Federal Highway Administration

Consultation Conducted By:
U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office

May 31, 2007

Ken S. Berg

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CONSULTATION HISTORY

The Washington State Department of Transportation (WSDOT) is proposing to use funding from the Federal Highway Administration (FHWA) to extend State Route (SR) 167 between SR 161 in north Puyallup and the SR 509 freeway in Tacoma, within Pierce County, Washington. The project will involve construction of a four-lane freeway with two High Occupancy Vehicle lanes; interchanges with existing SR 167, Interstate-5 (I-5), and SR 509; multiple crossing structures over the Puyallup River, Wapato Creek, Surprise Lake Tributary, and Hylebos Creek; compensatory wetland mitigation; partial relocation of Surprise Lake Tributary and Hylebos Creek; and riparian restoration along Wapato Creek, Surprise Lake Tributary, and Hylebos Creek.

Pre-consultation coordination for this project began in 2003 with meetings between the FHWA, WSDOT, National Oceanic and Atmospheric Administration (NOAA) and the US Fish and Wildlife Service (FWS) (collectively referred to as the Services). On October 26, 2004, the FHWA submitted a Biological Assessment (BA) and requested formal consultation. This request was rescinded on December 17, 2004, when FHWA withdrew the consultation because a preferred option had not been identified. Pre-consultation meetings began again and the Services provided technical assistance on topics such as conducting the exposure analysis and deconstructing the action. On September 30, 2005, the FHWA forwarded a revised BA and requested formal consultation. On October 27, 2005, the FWS sent a letter for FHWA stating that the information necessary to initiate consultation had not been received. Between October 2005 and April 2006 multiple meetings and information exchanges occurred. A collaborative approach to conducting the consultation was begun which included the Services assisting the WSDOT and FHWA in deconstructing the action, completing an exposure analysis and providing input of various effects analyses. On April 17, 2006, FHWA submitted a package of information to the Services which included a final deconstruction of the action, baseline information, action area description, and draft exposure analyses. Collaborative, pre-consultation meetings continued where the Services provided guidance and input on topics such as development of stormwater flow control approaches, bull trout critical habitat analyses and completion of the exposure analyses. On October 6, 2006, we received revised exposure analyses from the project team and considered the initiation package complete. Revised project descriptions and effect analyses continued to be submitted by WSDOT and FHWA and included revised pollutant modeling results, updated in-water work plans, and responses to various questions throughout the remainder of the consultation. On January 29, 2007, a meeting was held between the Services, FHWA and WSDOT to discuss draft Terms and Conditions that had been provided by NOAA. This meeting led to a formal elevation of particular issues by WSDOT and FHWA. Several meetings and information exchanges occurred at that point. On February 27, 2007, WSDOT provided a revised analysis of the hydrologic impacts of new impervious surface in the Puyallup River sub-basin. This analysis factored in the addition of several, new, stormwater infiltration techniques and is summarized in the "Effects of the Action" section of this Biological Opinion. A complete record of this consultation is on file at the Western Washington Fish and Wildlife Office.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The proposed project is to extend the existing SR 167 by constructing a new highway from SR 161 in north Puyallup to SR 509 in Tacoma, within Pierce County (Figure 1). The project is intended to relieve congestion and will consist of two lanes in each direction, plus inside High Occupancy Vehicle lanes that will be constructed in the future. The project includes freeway-to-freeway connections with SR 509 and I-5, new local access interchanges at 54th Avenue East and Valley Avenue, and completion of the SR 161 interchange. Weigh stations and park-and-ride facilities are included for each direction of travel.

The project will create approximately 221 acres of impervious surface. Of that, 70 acres will be in the Puyallup sub-basin, 115 acres will be in the Hylebos sub-basin, and 36 acres will be in the Wapato sub-basin. The anticipated Average Daily Traffic (ADT) level on the new freeway in the year 2015 is 50,000 to 70,000 vehicles per day and in 2030, it will be 75,000 to 95,000 vehicles per day.

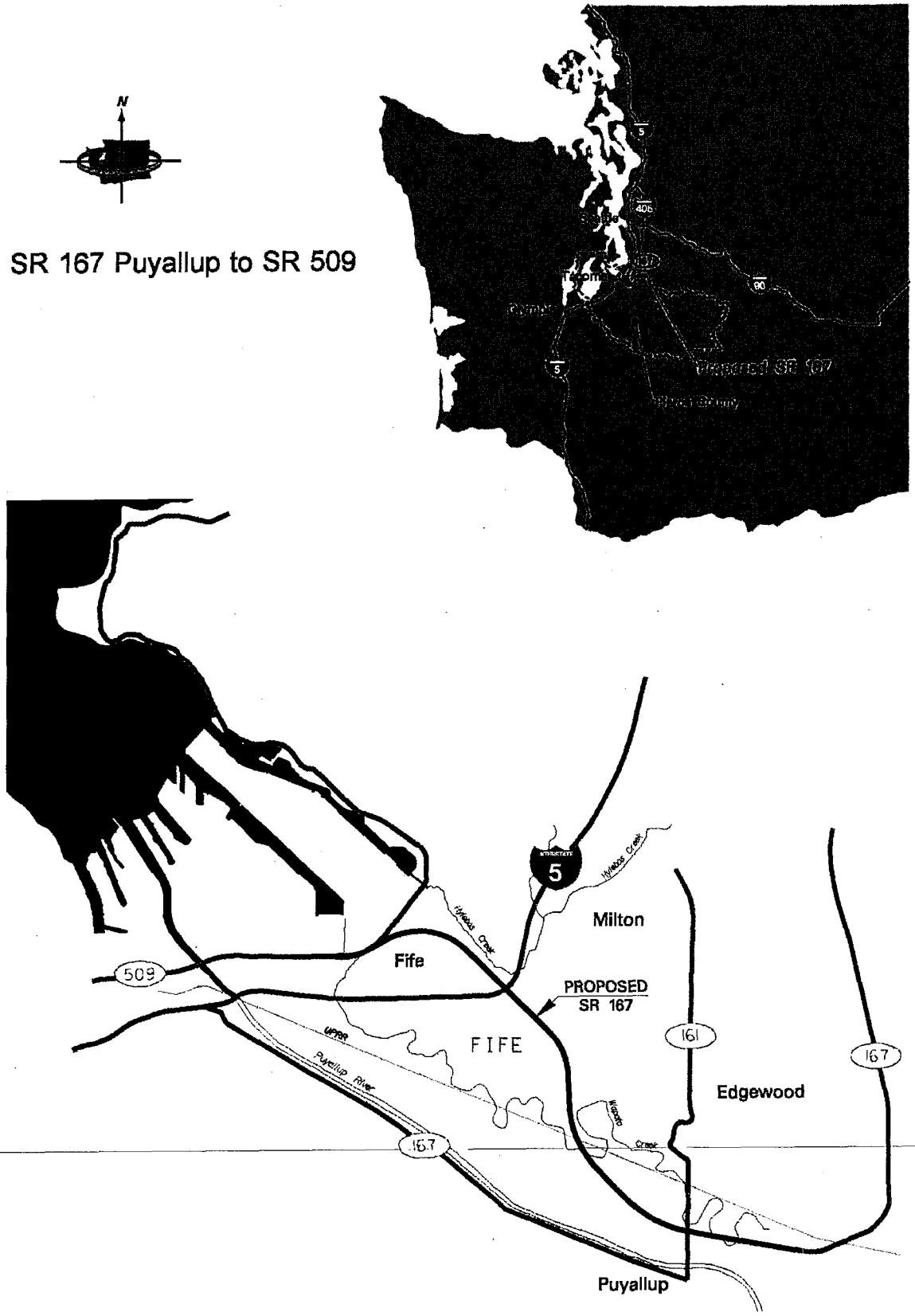


Figure 1. Vicinity Map

Deconstruction of the Proposed Action

At the time of this consultation, design of the proposed project was still in the early stages. For this reason, little specific information exists regarding project design and many of the construction details have been left for the contractor to determine. As such, the analysis relies on attainment of performance standards in some instances and on worst case assumptions in others. To determine the effects of the proposed action, WSDOT, in collaboration with the Services, deconstructed the action into over 100 individual components. These elements were detailed, in matrix form, to the extent possible. This represents a complete description of the proposed action and is included in Appendix A. The following section includes a description of the most significant portions of the action and some individual components have been lumped into larger categories for clarity.

Vegetation Removal and Fill Placement

The project corridor is approximately 6 miles long and will range in width from 250 ft at its narrowest location to 800 ft at the widest point (where riparian restoration is proposed). Existing vegetation will be permanently cleared and grubbed from a maximum of 217.6 acres within the footprint of cut fill slopes: 76.3 acres are within the Puyallup sub-basin, 81.9 acres are within the Hylebos sub-basin, and 59.4 acres are within the Wapato sub-basin. Woody vegetation, where practical, will remain on site and be used to create habitat. Where practical, topsoil will be stripped from the areas of the new embankment during the drier months of the year and will be stockpiled for future use within the project area. Most of the highway will be constructed above existing ground elevation on a maximum of approximately 3.7 million cubic yards of imported fill material, 8 to 35-ft deep, approximately 1.0 million cubic yards in the Puyallup sub-basin, approximately 2.3 million cubic yards in the Hylebos sub-basin, and approximately 0.45 million cubic yards in the Wapato sub-basin. Fill will come from among 50 approved aggregate sources within Pierce and King Counties. Cut and fill slopes will be reseeded and stabilized. Existing vegetation will be temporarily removed from a maximum of 280.2 acres within the area proposed for riparian restoration, and the equipment staging and material stockpiling areas. 17.5 acres will be removed within the Puyallup sub-basin, 171.3 acres within the Hylebos sub-basin, and 91.4 acres within the Wapato sub-basin.

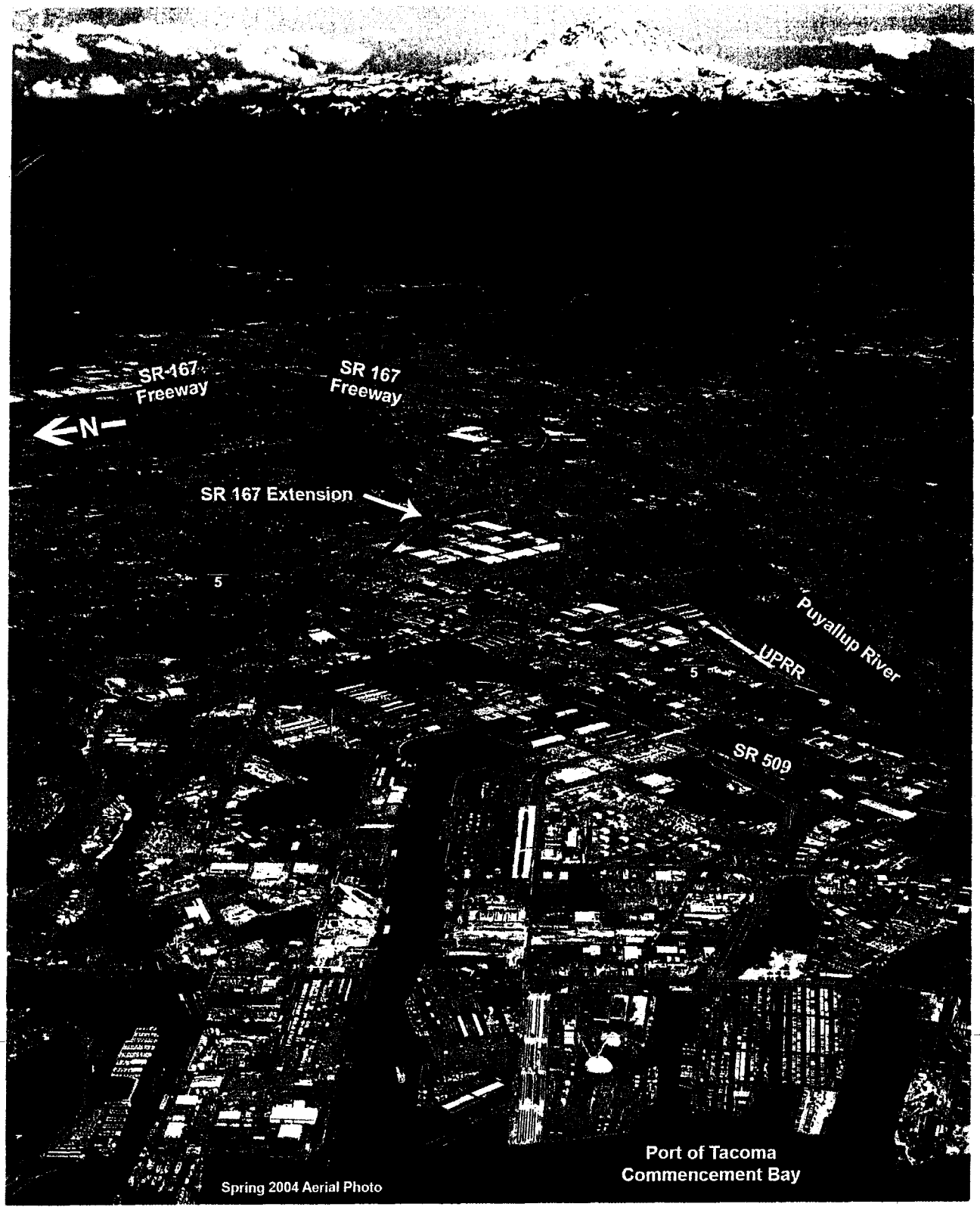


Figure 2: Overview of proposed project area.

Construction of New Roadway and Other Transportation Facilities

The proposed project will construct a new roadway, widen existing roadways, realign existing roadways, and construct interchanges, roundabouts, a cul de sac, weigh stations, and a park and ride lot. This will result in the addition of 70 acres of new impervious surface in the Puyallup sub-basin, 115 acres of new impervious surface in the Hylebos sub-basin and 36 acres of new impervious surface in the Wapato sub-basin. Temporary access roads will be constructed in Hylebos and Wapato sub-basins. Construction of temporary access roads includes grading, installation of cross-drain culverts, dust control, and revegetation. Existing roads and travel paths will be used whenever possible. The number of stream crossings will be minimized and will be perpendicular to the main channel whenever possible. Culverts will be sized to maintain hydraulic capacity.

Figure 3: Design visualization of the proposed SR 167 interchange with the existing Interstate-5.

Stream Diversion and Relocation

In order to accommodate SR 167/I-5 interchange on- and off-ramps, approximately 0.5 acre of existing Hylebos Creek will be permanently filled. For a period of up to 3 years while the relocated permanent channel is being constructed, Hylebos Creek will be diverted into a 950-ft long by 18-ft wide channel installed with habitat features. The channel will be excavated in the dry and large woody debris (LWD) will be installed. Dams will then isolate the existing stream section, fish handling will remove trapped fish, the area will be dewatered, and the flow will be diverted to the temporary channel. Fish handling will be conducted based on the protocol in Appendix B. Dam installation will either be by hand or by equipment operated from the banks, overhead bridges, or outside the wetted perimeter.

Once interchange construction has progressed such that the locations of permanently relocated Hylebos Creek and Surprise Lake Tributary will not be disturbed by further construction, the new approximately 4,000-ft long by 20-ft wide, Hylebos Creek channel and the new, 5,300-ft long by 4-ft wide, Surprise Lake Tributary channel will be constructed. Approximately 0.14

acres of the Surprise Lake Tributary channel will be filled as part of the relocation. Hylebos Creek will be relocated to the reed canary-grass wetland east of I-5. Surprise Lake Tributary will be relocated to agricultural fields east of the new SR 167 mainline and restored to a more natural alignment. Design of the stream channels is only conceptual at this stage of project development, but the created stream channels will be designed to support channel forming processes, floodplain functions, and habitat connectivity. They will be sinuous, meandering channels with habitat features such as LWD (both Hylebos and Surprise Lake Tributary) and side channels (Hylebos only).

To maintain enough velocity to transport sediment, berms will be constructed along relocated Hylebos Creek. The berms will be constructed from native material excavated from the channel and are intended to focus the energy of floodwaters to the center of the channel. The berms will have openings to allow for flood attenuation. Floodwater will be able to disperse onto the floodplain and then recede into the channel. The top of the berms will be at the 1-year flood elevation, and range between 1 to 3 ft above the existing ground. The berms will be approximately 16 ft wide, depending on how much material is excavated from the channel. The berms are intended to fail over time so that they do not limit eventual connectivity with the floodplain.

During in-water construction of the relocated stream channels, dams will be used to isolate work areas. The dams will divert water from the isolated area and fish will be removed as the site is dewatered. Fish removal will occur based on the protocol in Appendix B. The dams will then be removed and the abandoned channels filled. Most of channels can be constructed in the dry season away from the existing location of the creeks until the two ends of each channel are ready to be connected.

Stormwater Management

Temporary and permanent stormwater Best Management Practices (BMPs) will be constructed for water quality treatment and flow control consistent with the most recent version of the WSDOT Highway Runoff Manual. In accordance with the implementing agreement the water quality mixing zones will not exceed 300 ft in the Puyallup River, 200 ft in Hylebos and Wapato Creeks, and 100 ft in Surprise Lake Tributary.

Water Quality Treatment

The WSDOT is proposing water quality treatment for all 221 acres of new Pollution Generating Impervious Surface (PGIS). In the Hylebos sub-basin, 88 acres of PGIS in four threshold discharge areas (TDAs) will discharge through 11 outfalls which discharge above the ordinary high water mark (OHWM) of Hylebos Creek or Surprise Lake Tributary and then into an area intended to provide flow control (see description of the "RRP", below). Depending on the type of water quality BMP that precedes discharge, treated stormwater may sheetflow from BMPs such as vegetated filter strips or it may be collected and conveyed from BMPs such as constructed wetlands. Twenty-seven acres of PGIS in two TDAs within the Hylebos sub-basin will discharge through six outfalls to non-listed fish-bearing Fife Ditch, discharging approximately 1 mile downstream into

Hylebos Creek and then into the Hylebos Waterway. In the non-listed fish-bearing Wapato sub-basin, 3 acres of PGIS in one TDA will discharge into Erdahl Ditch and 9 acres of PGIS in one TDA will discharge into lower Wapato Creek, both will discharge approximately 1 mile downstream into the Port Industrial Waterway. Twenty four acres of PGIS in the Wapato sub-basin will discharge between river mile (RM) 7 and 8. In the Puyallup sub-basin, 70 acres of PGIS in two TDAs will discharge through three outfalls, two of which discharge into the Puyallup River, via the approximately 2,300-ft long Old Oxbow Ditch and lake system and one of which discharges directly into the River. The WSDOT will also retrofit approximately 24 acres of existing PGIS along northbound I-5.

Table 1: Proposed Project Stormwater Facilities BMPs by TDA.

Project Segment	Proposed Treatment[1]	Proposed BMPs[2]	Receiving Water	New PGIS
West terminus - Station 82 to 100	Basic*; no flow control	BS; P; CW	Erdahl Ditch	3 acres
SR 509 Connection - Station 100 to 140	Enhanced; no flow control	CAS; BS; P; CW; EE	Wapato Creek	9 acres
North & South Frontage Roads - Alexander to Taylor	Enhanced; no flow control	CAS; BS; P; CW; EE	Hylebos Creek	3 acres
SR 167 Mainline & 54th Interchange - Station 140 to 165	Enhanced; no flow control	CAS; BS; P; CW; Ditches	Fife Ditch	7 acres
SR 167 Mainline - Station 165 to 210	Enhanced; flow control is RRP	CAS; BS; CW; Ditches	Hylebos Creek	25 acres
I-5 west of 167	Enhanced; no flow control	BS; CW; P; EE	Fife Ditch	20 acres
I-5 east of 167	Enhanced; flow control is RRP	BS; CW; P; EE	Hylebos Creek	24 acres
SR 167 Mainline - Station 210 to 285	Enhanced; flow control is RRP	CAS; BS; CW; Ditches; DFI; P	Surprise Lake Trib./Groundwater	36 acres
Valley Avenue Interchange Valley Ave. Widening	Enhanced; flow control is RRP and WDOE Flow Duration Standard	BS; P; CW; EE; CAS	Wapato Creek	24 acres
SR 167 Mainline - Station 320 to 365	Enhanced; flow control is WDOE Flow Duration	CAS; DFI	Old Oxbow Lake Ditch/Groundwater	18 acres

Project Segment	Proposed Treatment[1]	Proposed BMPs[2]	Receiving Water	New PGIS
Station 365 to SR 161/ SR 512 junction SR 161 Interchange	Standard Enhanced; no flow control (exempt)	DFI; P; Bioswales CW; EE	Puyallup River/Ground water	52 acres

[1] Where noted with an asterisk, WSDOTs intent is to provide enhanced treatment if feasible.
[2] CAS = compost-amended soils; BS = Biofiltration swale; P = detention ponds; CW = constructed wetlands; EE = ecology embankments; DFI = deep fill infiltration; RRP = Riparian Restoration Proposal

Enhanced treatment via compost amended soils, biofiltration swales, detention ponds, constructed wetlands, ecology embankments, or deep fill infiltration is proposed for nine of the TDAs; the exception being the 3 acre TDA discharging into the Erdahl Ditch where basic treatment is proposed if enhanced treatment is not feasible. Infiltration is a preferred enhanced treatment method for stormwater, according to the Washington State Department of Ecology (WDOE 2005a). The predominant soil of the project area is an organic silt loam, which exhibits moderately slow permeability (WSDOT 2002). Due to the poor infiltration capacity of the onsite soils, high ground water elevation, and the relative absence of forested lands, there are few opportunities for employing infiltration. However, the WSDOT is proposing to infiltrate in the road fill, where possible, using compost amended soils and deep fill infiltration. This method has the potential to provide both runoff treatment and flow control (SCA 2001).

The WSDOT will ensure that the BMPs will meet the following Performance Standards:

- Basic Treatment = At least 80 percent removal of Total Suspended Solids (TSS)
- Enhanced Treatment = Basic Treatment plus effluent concentrations not to exceed the following values 90 percent of the time at the point of discharge:
  - Total Copper (Cu) 12 Micrograms per Liter (µg/L)
  - Dissolved Cu 7.8 µg/L
  - Total Zinc (Zn) 67 µg/L
  - Dissolved Zn 44.8 µg/L

Flow Control and Riparian Restoration

No flow control management is proposed for PGIS in a 3 acre TDA discharging to lower Hylebos Creek, nor for a total of 30 acres of PGIS in three TDAs discharging to non-fish bearing Erdahl and Fife Ditches. These ditches are simple conveyance channels that discharge to Port Industrial Waterway and Hylebos Waterway respectively, through tide gates and pumps (FHWA 2006). No flow control is proposed for 9 acres of PGIS in one 9 acre TDA discharging to lower Wapato Creek, which then discharges into the Port Industrial Waterway. In addition, no flow control management is proposed for 52 acres of PGIS in one TDA discharging directly to the Puyallup River. Subject to certain

restrictions, the Puyallup River downstream of the Carbon River is exempt from flow control requirements to address effects on the quantity of water in the river (WDOE 2005a). However, if discharge from this TDA ties into existing stormdrain systems that are already at maximum capacity, flow control BMPs would be designed to match existing flows using single event Santa Barbara Urban Hydrograph methodology so as not to exceed the highway's current contribution to the existing storm drain system (FHWA 2006).

The WDOE Flow Duration Standard (FDS) will be used to design facilities for 18 acres of PGIS in an 18 acre TDA that discharges into Oxbow Lake Ditch, a 2,300 plus foot-long ditch and lake system, prior to discharging into the Puyallup River. Compost amended filter strips for detention and deep fill infiltration, considered experimental in the most recent version of the Highway Runoff Manual, are proposed for use in this TDA. Experimental BMPs would require approval from Washington Department of Ecology (WDOE) and may require monitoring. The most current Flow Duration Standard required by WDOE will be implemented at the time of design (FHWA 2006).

The WSDOT is proposing riparian restoration in the Hylebos sub-basin as an alternative to the construction of large stormwater detention facilities that would be required for control flow from three TDAs totaling 85 acres of PGIS. The Riparian Restoration Proposal (RRP) will be applied to 87 acres of riparian area adjacent to 4,000 ft of existing and the newly relocated Hylebos Creek, and 29 acres of riparian area surrounding relocated Surprise Lake Tributary. The RRP will also be applied to 73 acres of riparian area adjacent to 9,000 ft of Wapato Creek in combination with conventional flow control BMPs at the Valley Avenue Interchange (Figure 4).

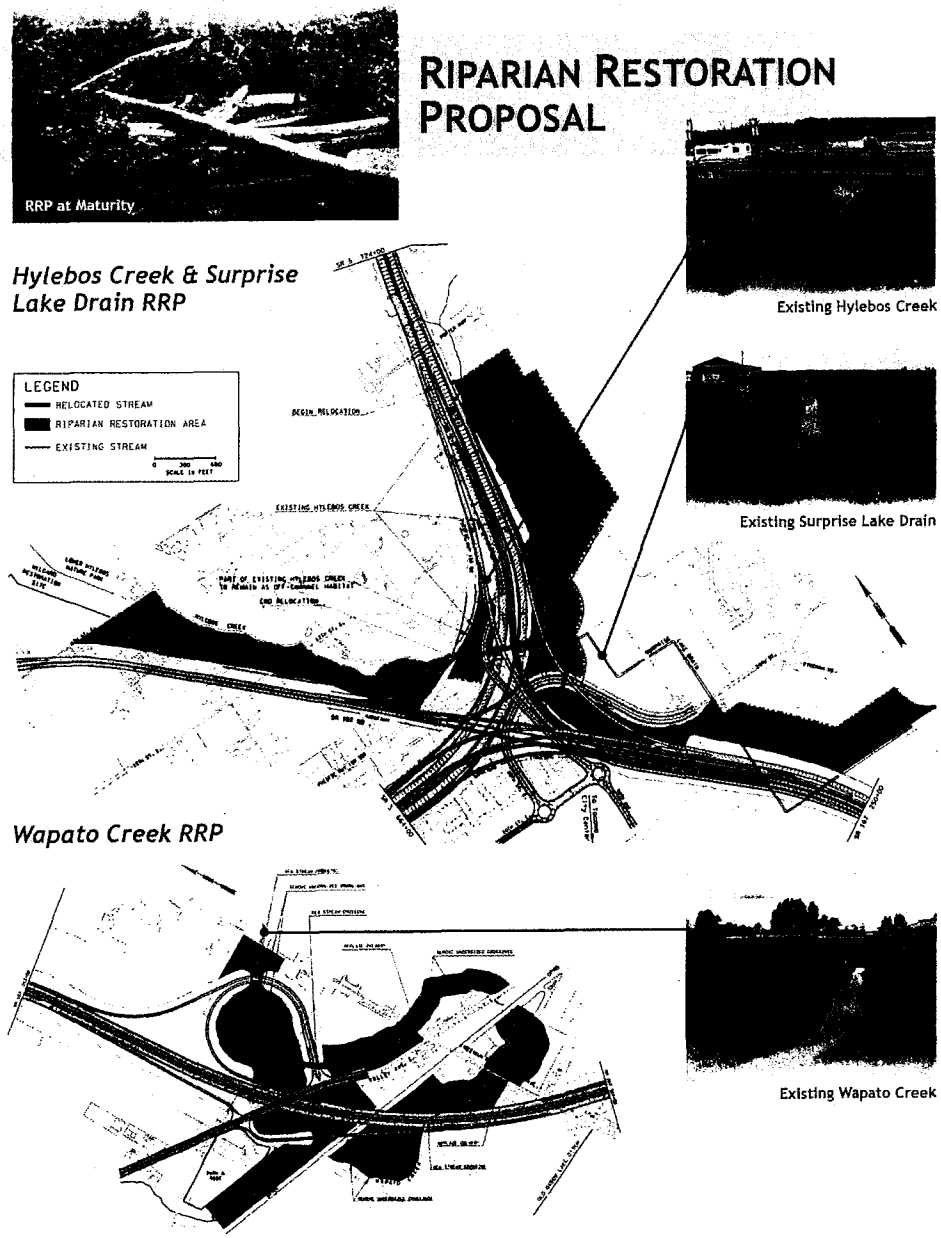


Figure 4: Riparian Restoration Proposal

The primary purpose of the RRP is to provide a creative, alternative approach to flow control. As such, the RRP minimizes the area needed for conventional flow control ponds. For instance, in Wapato Creek sub-basin, 23.6 acres would be required to accommodate conventional flow control ponds, compared to 2.2 acres under the RRP (EnviroVision 2005). The RRP will also reduce the number of inlet structures and amount of drainage piping required to maintain flow control, while at the same time increasing the channel migration area of Wapato Creek, Hylebos Creek, and Surprise Lake Tributary. The three goals of conventional flow control BMPs include reducing streambank erosion, controlling flooding, and maintaining the biological integrity of the stream. The RRP will:

- Prevent increased streambank erosion by directly stabilizing denuded streambanks with native riparian vegetation.
- Provide shading and potentially reduce localized stream temperatures.
- Reduce flood impacts in the Hylebos Basin.
- Increase the biological integrity of the streams by improving in-stream habitat.
- Restore and preserve approximately 218 acres of riparian and wetland habitat.
- Establish forested buffers along 4.4 miles of streams within the project area.
- Improve approximately 63 acres of existing wetlands and create an undetermined amount of wetlands by restoring hydrology and stabilizing streambanks.

Construction of the RRP will include vegetation removal, fill placement, access, staging areas, stockpile areas, grading, revegetation, and removal of invasive plant species. Buildings, roads, culverts, and other infrastructure will also be removed, and the land use will be converted back to a riparian forest and planted with native vegetation. Approximately 30 acres of existing PGIS will be removed within the RRPs. A bench cut will be constructed to lower the flood levels of Hylebos Creek. It will be a depressed floodplain along the southern bank. The gradual slope of the bench cut will allow the water to drain back to the creek and prevent fish stranding. The terrace would be inundated when flow in the creek exceeds half of the 2-year storm event flow.

The current design is conceptual at this stage of project development. A Technical Advisory Group representing local, State, and Federal regulatory agencies, the Puyallup Tribe, and interested non-governmental and environmental organizations was formed by the WSDOT in 2005 to establish the goals and objectives of the RRP. This group will be reconvened following completion of National Environmental Policy Act (NEPA) compliance to make recommendations on the design of the RRPs, their maintenance, and necessary monitoring.

Wetland Impact and Mitigation

A maximum of 32.9 acres of wetlands will be permanently impacted by the project. Approximately 6.6 acres of temporary wetland impacts will also occur. A conceptual mitigation plan has been developed and involves mitigation activities at up to 10 potential sites throughout the action area (Figure 6; Table 2).

Wetland Impact

Permanent wetland impacts occur in all three affected sub-basins Figure 5): Hylebos (23.7 acres; 72 percent), Wapato (1.6 acres; 5 percent) and Lower Puyallup (7.6 acres; 23 percent).

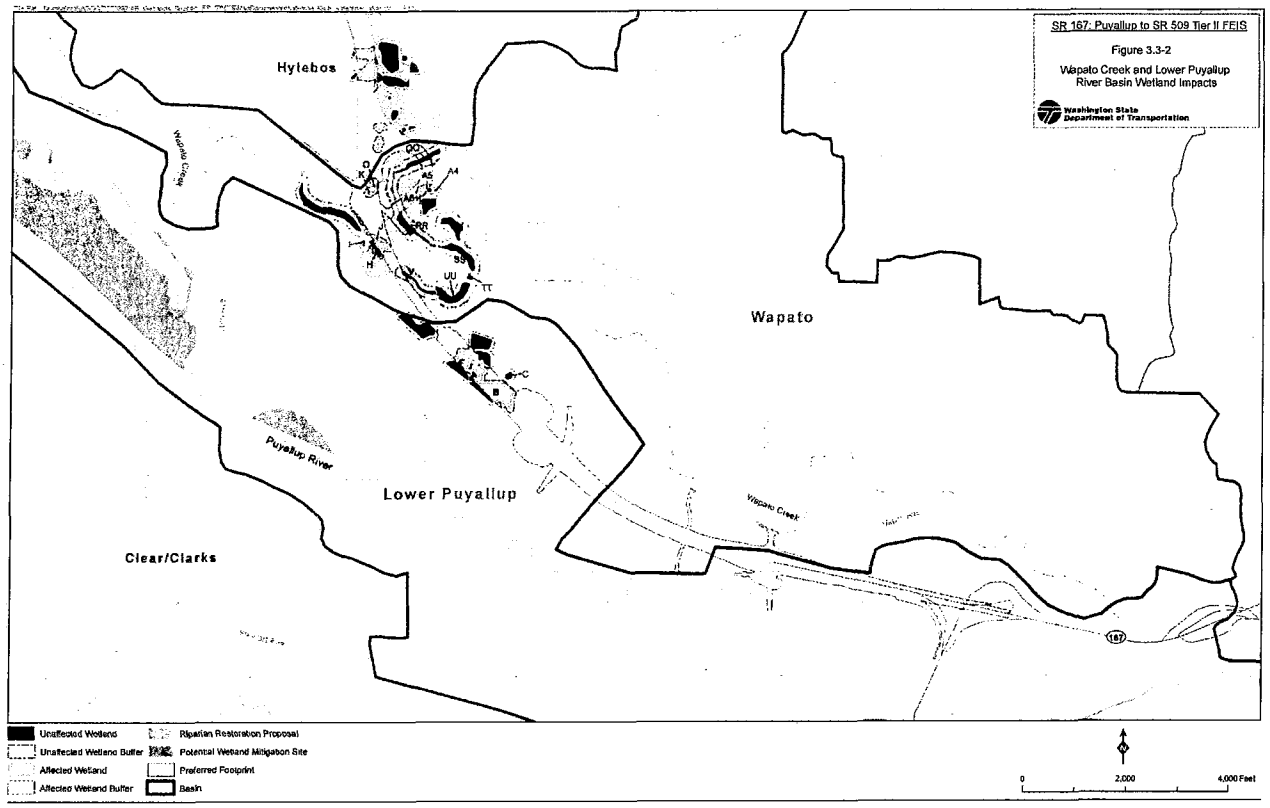


Figure 5: Wetland impact by sub-basin.

The wetlands that will be impacted by the project are primarily disturbed, hydrologically isolated, emergent and farmed wetlands with a large component of non-native plants. Less than 10 percent of impacted wetlands are forested and scrub-shrub wetlands. Additionally, there will be approximately 6.6 acres of temporary wetland impact.

Functions that may be impacted include flood flow alteration, erosion control, shoreline stabilization, sediment and heavy metals retention, and nutrient and toxicant removal. Three wetlands were classified as forested (two occur in a hybrid black cottonwood plantation) and these may also provide some level of general habitat and native plant richness functions (Hill and Montgomery Water Group 2005).

Wetland Mitigation

Ten potential wetland mitigation sites have been identified (Figure 6; Table 2). One or more of these sites may be needed to fulfill wetland mitigation requirements that will be determined by the U.S. Army Corps of Engineers and the WDOE during permitting. Wetland mitigation activities will include some combination of creation, restoration, enhancement, or preservation.

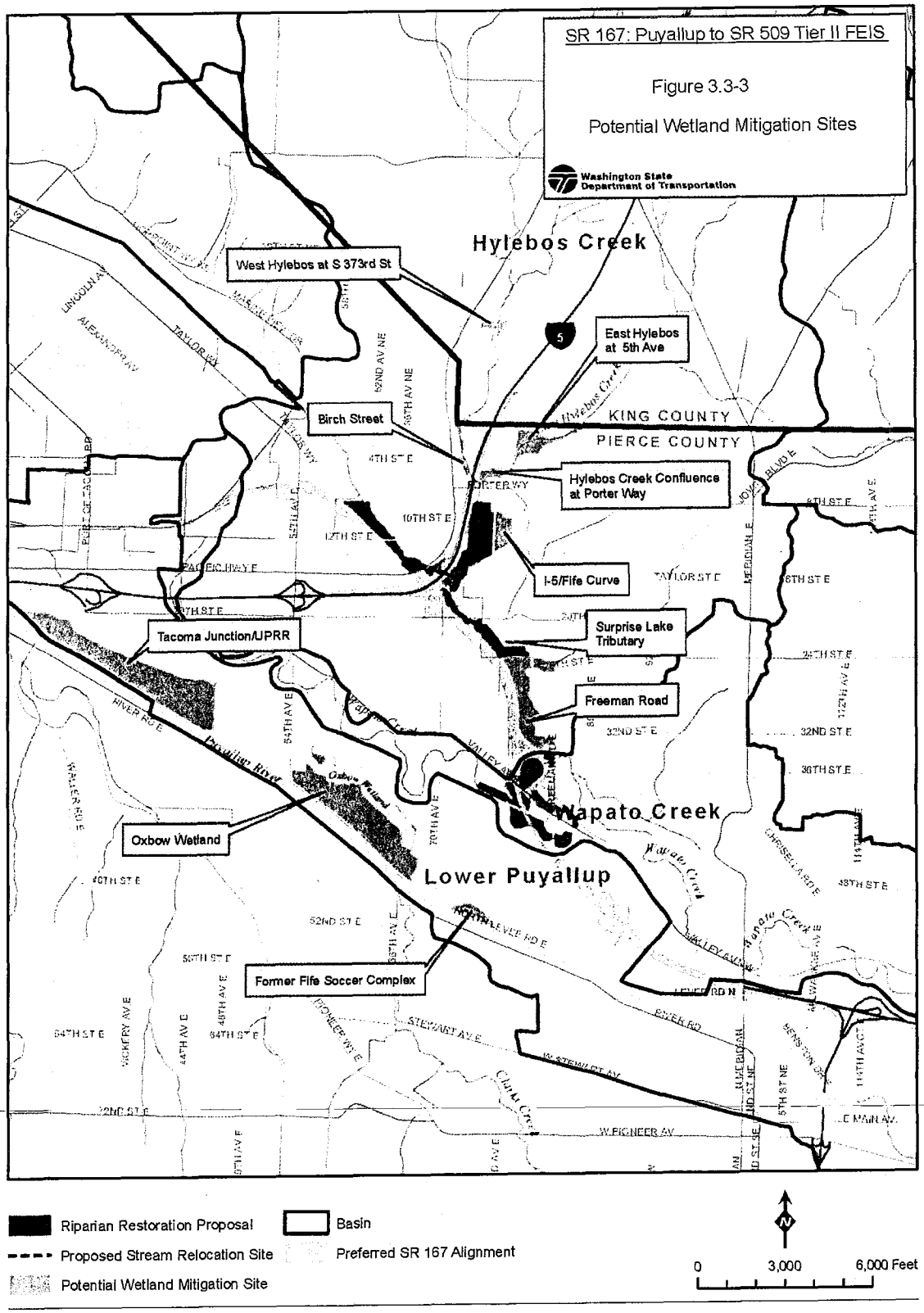


Figure 6: Proposed wetland mitigation sites.

Three potential wetland mitigations sites were identified within the Puyallup sub-basin and seven were identified within the Hylebos sub-basin. The sites adjacent to the Puyallup River could include in-water work such as breaching the existing dike. Areas for breaching will be isolated with sheet pile cofferdams. The flow of water back into the mitigation site after construction will be regulated through slow removal of cofferdams.

The WSDOT is designing the wetland mitigation to result in no net loss of wetland function or area based on 2006 estimates of 32.9 acres of wetland impacts. Replacement ratios will be determined by the U.S. Army Corps of Engineers and WDOE and will depend on whether creation or enhancement is required, and what category of wetland is being impacted. Where practicable, wetland mitigation will occur within the impacted sub-basins. Work at each of the sites will probably involve some level of long-term vegetation maintenance that will involve application of herbicides. Table 2 contains a brief description of each of the 10 sites and the mitigation activities that may take place.

Table 2: Potential Wetland Mitigation Sites.

Site Name	Sub-basin	Acres	Existing Conditions	Proposed Activity
Freeman Road	Hylebos	50	Farmland, surrounded by farmland and quarry. Flat topography; historic floodplain. Includes network of drainage ditches. Perennial stormwater pond treats surface flow; excellent sources of surface water and groundwater hydrology; poor drainage. Lacking vegetation. Low function, disturbed wetlands, likely low water quality	40 acres of wetland creation/restoration and 10 acres of wetland enhancement. Exposure of shallow groundwater table, plug ditches, remove structures, and fill and revegetate. Potential connectivity for wildlife with other sites.
Surprise Lake Tributary (Mortenson Farm)	Hylebos	9	Pasture and residence, surrounded by natural areas and farmlands. Alluvial fan and floodplain. Ditched perennial stream. Lacks vegetation.	5 acres of wetland enhancement, 2.5 acres of creation/restoration, relocation/restoration of stream. Removal of structures and fill, exposure of shallow groundwater table, revegetation. Fish and wildlife habitat connectivity to other restoration areas.

Site Name	Sub-basin	Acres	Existing Conditions	Proposed Activity
West Hylebos Creek at S. 373rd Street	Hylebos	8	Pasture surrounded by rural residential, and farming. Flat floodplain. Hylebos Creek bisects site. Vegetation predominantly native but woody vegetation is lacking. Livestock have access to stream. Includes salmonid spawning habitat.	7 acres of wetland enhancement and up to 1 acre of creation/restoration. Revegetation. Fish and wildlife habitat connectivity to sites both upstream and downstream.
Former Fife Soccer Complex	Lower Puyallup	15	Farmland surrounded by residential development. Flat to sloping floodplain, with a terrace feature. Lacking woody vegetation. Several buildings adjacent to site.	12 acres of wetland creation/restoration; setback levee along terrace feature; excavation to create wetlands; construct connection to Puyallup River via a culvert. Revegetation.
Tacoma Junction (UPRR)	Lower Puyallup	150	Farmland and natural area surrounded by roads, railroad, commercial development. Flat to gently sloping floodplain, with an existing levee. Ditch on northern site boundary. Vegetation mostly row crop and weedy species; possible contamination from agricultural use.	75 acres of wetland creation/restoration and 75 acres of enhancement. Construction of setback levee; grading for soil saturation/inundation; construct connection to the Puyallup River to allow access to side channel habitat; excavate for seasonal inundation/saturation; revegetation. Fish and wildlife habitat connectivity in Puyallup River.
Oxbow Wetland	Lower Puyallup	189	Farmland surrounded by residential development. Flat to gently sloping floodplain, terrace feature, oxbow on-site. Vegetation is mostly weedy species and row crops, with existing emergent, scrub-shrub, and mature forested wetlands in the oxbow. Numerous residential and commercial buildings, and a sewer line and pump station run on-site.	100 acres of wetland creation/restoration, 15 acres of enhancement and 30 acres of preservation of existing wetlands. Construction of setback levee; excavation [8-12 ft] to support wetlands; construct culverts to connect to Puyallup River; revegetation and removal of structures.

Site Name	Sub-basin	Acres	Existing Conditions	Proposed Activity
Birch Street	Hylebos	11	Natural area, previously farming/pasture. Surrounded by residential and commercial development, and roads. Narrow floodplain with steep valley slopes. Predominantly forest, patches of dense reed canarygrass.	11 acres of wetland enhancement. Treatment of reed canarygrass; revegetation. Habitat connectivity for fish and wildlife with the Hylebos Creek RRP.
East Hylebos Creek east of 5th Ave	Hylebos	25	Natural area, previously farming/pasture, surrounded by residential development. Predominantly forest, patches of dense reed canarygrass.	25 acres of wetland enhancement. Treatment of reed canarygrass; revegetation. Habitat connectivity for fish and wildlife with the West Milton Nature Preserve.

Water Crossing Structures

The project entails construction, widening, removal, or replacement of 57 temporary and permanent bridges and culverts: Twenty Six crossing Hylebos Creek, 1 crossing the Fife Ditch, 11 crossing Surprise Lake Tributary, 14 crossing Wapato Creek, and 5 crossing the Puyallup River. Twenty four of these are permanent structures that will be constructed across the Hylebos, Surprise Lake, and Wapato RRPs. With consideration of site specific design constraints and practicability, the following stream crossing Performance Standard will be applied: "Sizing and location of stream crossings will complement the functions of the RRP by supporting channel forming processes and floodplain functions, and habitat connectivity in the RRP." The known specifics of the water crossing structures to be constructed are described as follows.

Puyallup Sub-basin

Bridge replacement and widening will occur over the Puyallup River at SR 167/North Meridian (Figure 7). The existing crossing consists of two bridges, one steel and one concrete. The existing steel bridge will be replaced and the existing concrete bridge will be widened. To conduct the bridge replacement and widening, two temporary work trestles and one temporary detour bridge are expected to be necessary. A barge may also be used as a work platform for up to two construction seasons.

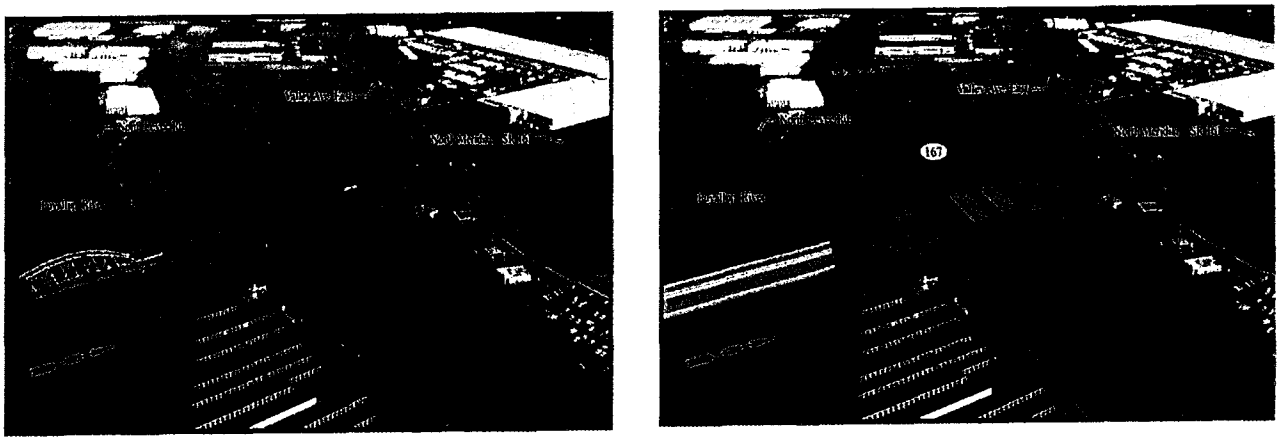


Figure 7: Design visualization of the Puyallup River Bridge replacement.

Installation of Temporary Work Trestles and Detour Bridge

The temporary trestles and the detour bridge will be constructed on hollow steel piling, with steel caps and stringers and a deck of untreated wood beams to accommodate large equipment and traffic. The piles will be a maximum of 24 inches in diameter. Approximately 150 piles are expected to be necessary (50 piles per structure). Installation will occur with a vibratory hammer and then the piles will be proofed with an impact hammer. If the substrates prevent vibratory installation or obstructions are encountered, installation could occur with an impact hammer. Impact pile installation will be limited to daylight hours. It is possible that pile installation for each structure could happen concurrently. Some pile installation may be conducted with a barge-mounted pile driver.

Both temporary work trestles and the detour bridge will be constructed during the first in-water construction window. One temporary trestle could be in place during two construction seasons and the other trestle and the detour bridge could be in place during three construction seasons.

Steel pile installation results in elevated underwater sound pressure levels that are high enough to kill, injure, and or disrupt the normal behavior of aquatic organisms. In order to minimize the potential effect of underwater sound pressure levels from pile installation, the following Performance Standard was proposed by the WSDOT:

- Limit noise levels to 180 to 185 Decibels (dB) at a reference pressure of one micro-Pascal (dB re: 1μPa) measured at mid-depth 10 meters from the piling, utilizing sound attenuation.

Replacement of the Steel Truss Bridge

The steel truss bridge spanning the Puyallup River will be replaced. The bridge contains lead-based paint and will be cut and removed in sections to keep the majority of the paint intact. Demolition will comply with conditions specified in the WSDOTs National Pollution Discharge Elimination System (NPDES) permit for "Washing and Pressure Washing of Bridges and Ferry

Terminals". Conditions listed in the permit specify work restrictions that minimize pollutants entering the water and the disturbance of vegetation. Notable requirements include the following:

- Dry-clean (scrape, sweep, or vacuum) bridge before washing. This includes flaking paint. Residual grease must be removed with degreaser on absorbent-material. Areas of the bridge that cannot be safely dry cleaned should be flushed).
- Use the minimum pressure that will clean the bridge and prevent paint chips from entering the Puyallup River. Avoid flaking paint and lower the pressure if needed to prevent the removal of bonded paint.
- Plug bridge drains before washing.
- Use clean wash water with no detergents or other additives.

Sawcut water will kept out of surface water. The piers and abutments will then be removed. These structures are within the OHWM but are outside the wetted perimeter of the low-flow channel. Holes left when the piers and abutments are removed will be backfilled with rock or new abutments.

The replacement bridge will be approximately 75 ft wide and will be steel or concrete. Drilled shafts are expected to be used for the foundation. Shafts will be placed to a depth adequate to prevent future scour. A maximum of two piers will be placed within the OHWM. Each pier will have a maximum of three 10-ft diameter columns for a total of six columns. The columns will displace approximately 472 ft^2 of benthic habitat.

To minimize noise and lighting disturbance, work will only occur during daylight hours. The work area will not be lit at night or lighting will not be directed at the water.

Widening of the Existing Concrete Bridge

The existing concrete bridge will be widened from 35 ft to approximately 42 ft. Currently, one bridge pier is within the OHWM of the Puyallup River. As part of the widening, the existing footings will be widened and require seismic upgrades. To accommodate the widening, the existing rail and overhang will be removed. This will likely be achieved with the use of a hoe ram (hydraulic cruncher on a backhoe). Debris will be contained. The work will be conducted primarily from the existing bridge; however, a temporary work trestle may be required to access the bridge from underneath the deck.

Bridge Column Construction (Includes Dewatering and Fish Handling)

To construct the new steel bridge, six 14-ft diameter cofferdams will be installed around each new column and will result in a dewatered area totaling approximately 924 ft^2. To widen the concrete bridge a 58-ft by 47-ft cofferdam will be constructed around the footing that is within the channel, resulting in a dewatered area of 2726 ft^2. Cofferdams for the new bridge will be installed during the in-water work window of the second construction season. The cofferdam for

the widened concrete bridge will be installed during the in-water work window of the first construction season. A vibratory hammer will be used to install sheet piles for the cofferdams. The sheet piles and cofferdams will be placed using machines that are kept outside of the wetted perimeter. Fish handling will be necessary to remove any fish trapped inside the area to be dewatered inside the cofferdams. Fish will be removed using the protocol in Appendix B. Cofferdams will remain in place for one construction season per structure. Any waste water withdrawn from cofferdams will be contained and disposed of in an upland location where it will not enter surface waters. Sheet piles for the cofferdams will be removed with either vibratory techniques or by direct pulling. In the event that a sheet pile cannot be completely removed, it may be cut off below the ground level.

Removal of Temporary Work Trestles and Detour Bridge

Following demolition, widening, and replacement of existing structures, the work trestles and traffic detour bridge will be removed. Pile removal techniques could include pulling, vibratory removal, or cutting piles off 2 ft below the existing ground level. Holes left from piling removal will be filled with clean native substrate that matches the surrounding substrate when feasible. Removal of the work trestle and detour bridge will occur during the in-water work window of the third construction season.

Hylebos Sub-basin

Within the Hylebos Sub-basin, two stream crossings will require work area isolation, diversion of water, fish handling, dewatering, channel excavation, and installation of structures. Fish will be removed using the protocol in Appendix B. A temporary culvert will be removed following the Hylebos Creek relocation. The bridge will be a clear-span bridge with no abutments or piers within the OHWM, so no in-water work for the bridge construction is required. The Porter Way Bridge over Hylebos Creek will be demolished and replaced by a new structure with 4 to 6 piers, that will clear-span the creek with neither abutments nor piers within the OHWM. The 54 piles in the Hylebos wetlands will be direct pulled, vibrated out, or cut off 2 ft below existing ground. Bridge demolition is expected to take up to 4 weeks.

Eleven new bridges will clear-span Hylebos Creek, having neither abutments nor piers within the OHWM. Two temporary structures to access the Hylebos RRP and work area will be designed to span the creek channel; there will be no in-water work. These structures could be in place for up to 2 years. Three temporary structures may be needed as work trestles and temporary bridges at the SR 167/I-5 interchange. The structures may have up to six hollow steel piles, no larger than 24 inches diameter, within the OHWM of Hylebos Creek. Two days of piling driving within the OHWM per structure is expected. The bridges will be in place for one construction season each. When they are removed, the piles will be pulled, vibrated out, or cut off 2 ft below existing ground.

One bridge will be permanently widened, with piers and abutments placed outside the OHWM where practicable. Two widened bridges will be in place for up to 3 years. Once both bridges are removed, following the relocation of Hylebos Creek, they will be replaced with fill material.

It is anticipated that one bridge will require removal of accumulated sediment and debris from Hylebos Creek which will take 1 day. Removal of three crossings over Hylebos Creek will require temporary isolation of the work area, diversion of water, fish handling, dewatering, and then removal of the structures. Fish handling will occur based on the protocol in Appendix B.

Surprise Lake Tributary Crossings

A new three-sided box culvert will require an isolated work area, water diversion, fish handling, and dewatering. Fish handling will occur based on the protocol in Appendix B. The abutments will span the OHWM of Surprise Lake Tributary. One temporary structure to access the Surprise Lake RRP and work area will span the creek channel, so there will be no in-water work. The temporary structure could be in place for up to 2 years.

Seven new bridges will clear-span Surprise Lake Tributary, having neither abutments nor piers within the OHWM. Two culverts will be abandoned after Surprise Lake Tributary is relocated.

Fife Ditch Crossing

One new culvert will be installed on Fife Ditch.

Wapato Sub-basin

Four new bridges will be constructed in the Wapato sub-basin. Each of the four bridges will span Wapato Creek, with no abutments or piers within the OHWM. Installation of three new and/or replacement culverts will require temporary isolation of the work area, diversion of water, fish handling, dewatering, channel excavation, removal and/or installation of the structures, and return of flow to the work area. Fish handling will occur based on the protocol in Appendix B. The removal of seven privately-owned culverts will require temporary work area isolation, fish handling, dewatering, channel excavation, removal of the structures, and return of flow to the work area. Fish will be removed using the protocol in Appendix B. In addition, a temporary concrete structure over Wapato Creek may be needed to access riparian areas. No piers are anticipated.

Corridor Wide Construction Elements

The location of staging areas and stockpile sites, which includes the storage of construction materials, equipment and temporary office facilities, will be determined by the contractor and will be subject to WSDOT review and approval. The location of retaining walls is currently unknown; however, they will likely be needed in order to provide shoring for footing excavation at all the major interchange locations. These retaining walls will be placed in upland areas. An impact pile driver could be used for retaining wall installations. Detours will likely occur at proposed interchange locations and the Puyallup River Bridge.

Invasive plant removal will occur within the RRP and the wetland mitigation sites. Removal will take place during summer months during dry conditions and will be required for up to 10 years until desired vegetation is established. Methods will likely include manual removal, mechanical

removal (e.g., mowing), or application of the herbicide glyphosate with the surfactants Agri-Dex or LI 700. Glyphosate will be applied in accordance with label requirements to avoid over application and drift by wicking instead of broadcast spraying. The herbicide will only be applied during dry conditions, and wicking vs. broadcast spray will be used. Either Agri-Dex (preferred) or LI700 will be used as surfactants.

A temporary erosion and sediment control plan will be developed and implemented before ground-disturbing activities are begun. The plan is intended to prevent sediment from leaving the construction site and entering streams and/or wetlands. Erosion and sediment control BMPs to be implemented will include, but are not limited to compost berm/blankets, filter fences, seeding, fertilizing, mulching, and vegetation preservation. As an interim measure before the re-establishment of vegetation and during construction, filter fences will be installed where appropriate, such as at the toe of slopes and the perimeter of exposed soils to minimize sediment from entering streams and/or wetlands. The WSDOT has an implementing agreement with the WDOE regarding compliance with state water quality standards. In accordance with the agreement the water quality mixing zones will not exceed 300 ft in Puyallup River, 200 ft in Hylebos and Wapato Creeks, and 100 ft in Surprise Lake Tributary. Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge (when dewatering work area). The project will implement Standard Specification 8-01.3(1) General - (limits exposure of erodible soils). Controlling pollution, erosion, runoff, and related damage requires the Contractor to perform temporary work items including but not limited to:

- Providing ditches, berms, culverts, and other measures to control surface water.
- Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows.
- Controlling underground water found during construction.
- Covering or otherwise protecting slopes until permanent erosion-control measures are working.

The Contractor will coordinate this temporary work with the construction of permanent drainage and erosion control work. The WSDOT may require additional temporary control measures if it appears pollution or erosion may result from weather, the nature of the materials, or progress on the work. Staging and or material stock pile areas will not be established within 300 ft of any streams, rivers, or wetlands; unless site specific review completed by the project biologist indicates that no impacts to the sensitive resource areas will occur due to topography or other factors.

A spill prevention control and countermeasures (SPCC) plan will be developed and implemented to address activities such as waste disposal methods and locations, control of oil, gasoline, and solvents used in the operation and maintenance of vehicles and machinery; emergency spill control and containment measures; material storage; and waste accumulation. The spill prevention control and countermeasures plan will detail how pollution from these activities will be prevented from entering waters of the State. As necessary, the contractor will be responsible

for revising the plans to conform to their actual operations and unanticipated activities as construction progresses.

Conservation Measures

Conservation measures proposed by the WSDOT are considered part of the project and are incorporated in the above project description. A complete list of the conservation measures is included in Appendix C.

Project Schedule

Construction of the project is expected to occur in multiple phases over a 13-year period. Temporary and permanent removal of vegetation is expected to take 2 years per sub-basin followed by stabilization for an additional year. Placement of fill is expected to take 2 years per sub-basin followed by vegetative stabilization for an additional year. Construction of the RRPs staging will occur over several years in order to accommodate the timing of various phases of the project. Construction of the Hylebos Creek RRP is expected to take two construction seasons and one year for the Surprise Lake Tributary RRP. Vegetation establishment is expected to take up to 10 years. Mitigation site creation is expected to take one construction season per selected site, and vegetation establishment may take up to ten years. In-water work required for many of the bridges and culverts, stream diversion and relocation is expected to take place between July 15 and August 31.

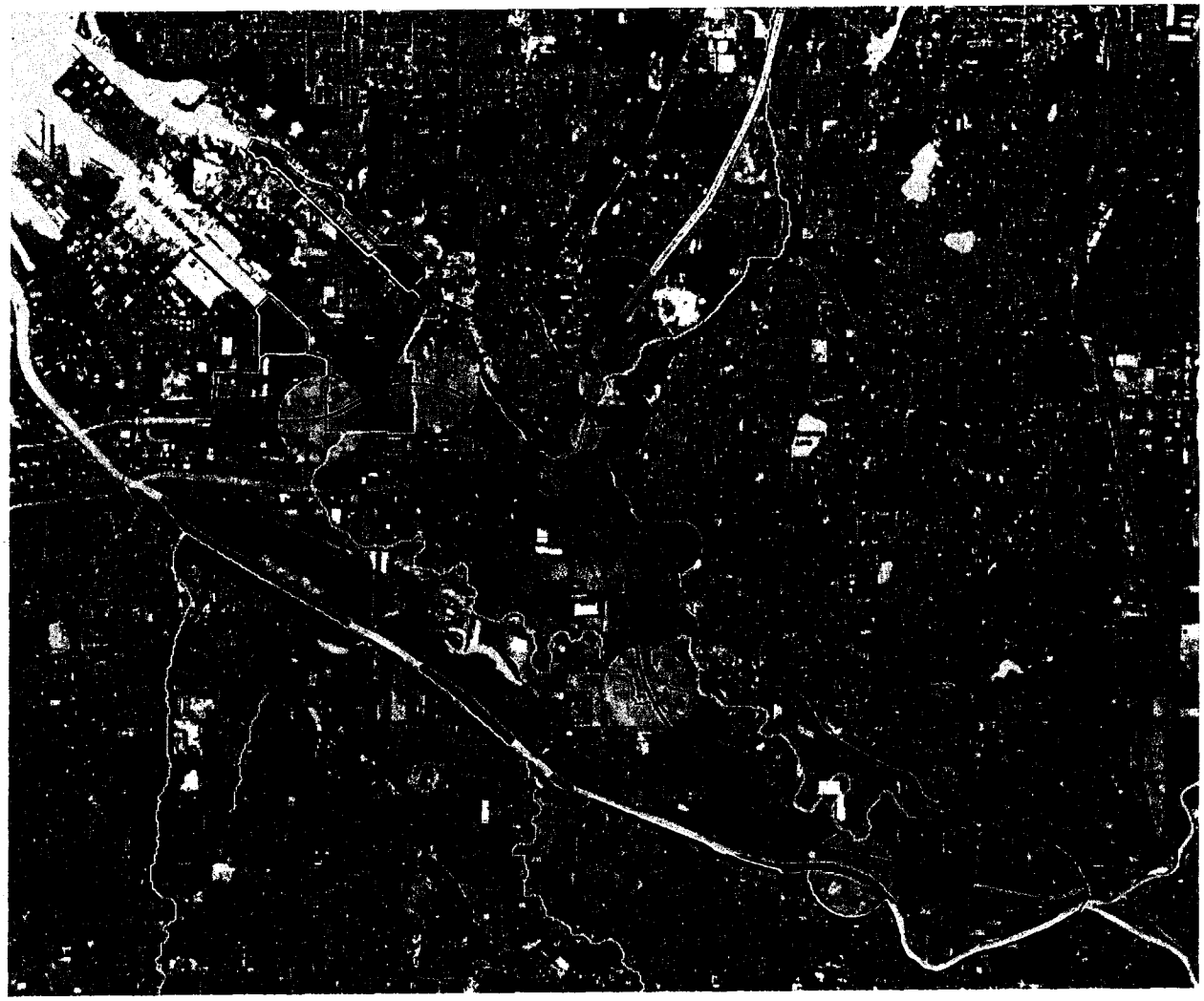
Action Area

'Action area' means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For purposes of this consultation, the action area includes the proposed alignment and area surrounding the alignment where airborne noise levels are expected to exceed ambient levels. It includes in-water areas upstream and downstream of the Puyallup River and Hylebos Creek bridges, between landforms, where underwater sound from construction will exceed ambient levels. It also includes the three areas comprising the RRP and the ten potential wetland mitigation sites. It includes the in-water areas where stormwater pollutants generated by PGIS exceed background levels.

In addition, the project is designed to increase passenger and freight mobility, increase safety, and reduce congestion. As a result, the project may affect the rate, timing, and location of land use changes associated with growth and development. Currently undeveloped areas within and adjacent to the project area are zoned commercial/industrial and are rapidly converting to these uses. The project will result in fragmentation of agricultural lands, making them less viable, and potentially increasing the rate at which they convert to commercial/industrial use. The proposed intersection upgrades may result in changes to local arterial traffic and traffic on existing highways. Based on current zoning and land use in the lower Puyallup valley and the zone of traffic influence as identified in the project Traffic Discipline Report (WSDOT 2001) project effects may extend to the existing SR5/SR 167 interchange to the west, the SR 5/SR 18 interchange to the north, the SR 167/SR 410 interchange to the southeast, and the SR 509/Port of Tacoma Road to the northwest (Figure 8). These points represent project effects to traffic primarily on the highways and I-5.

Surface street traffic effects are estimated to extend to the Puyallup River to the southwest and along the steep slope area to the northeast, and to the Port of Tacoma to the northwest.

Based on these various factors, we defined the action area is bounded to the west by the existing I-5/SR 167 interchange near the I-5 crossing of the Puyallup River (approximately RM 3, to the northwest by the existing SR 509/Port of Tacoma Road intersection near the head of the Hylebos Waterway, to the north by the I-5/SR 18 interchange, and to the southeast by the SR 167/SR 410 interchange near the confluence of the White and Puyallup Rivers (Figure 8). Dilution modeling of pollutants generated by the new PGIS established that the action area includes 7,000 ft of the Hylebos Waterway and 2,000 ft of the Blair Waterway.



SR 167 Proposed Alignment

Zone of Traffic Influence

Total Action Area

Project Area Footprint Including Potential Wetland Mitigation Sites

300-foot Buffer from Project

Noise Buffer from Bridges and Interchanges

Aquatic Effects

Streams

Water Bodies

Figure 8: SR 167 Action Area

The action area contains foraging, migrating, and overwintering habitat for bull trout in the lower Puyallup River and Blair and Hylebos waterways. Hylebos Creek, Wapato Creek and Lower Surprise Lake Tributary are waterbodies within the action area that provide a prey base for bull trout.

STATUS OF THE SPECIES- Bull Trout (rangewide and/or recovery unit)

Bull Trout Status in the Action Area

This section provides a tiered review of the status of bull trout within the action area. It provides a general summary of the status of bull trout within the Puyallup core area, and then a more specific status of bull trout and foraging, migration, and overwintering (FMO) habitat within the area of the lower Puyallup River and the adjoining FMO habitat in estuarine/marine areas within Commencement Bay. Status within the lower Puyallup River and Commencement Bay FMO habitat describes the changes that have taken place over time and the current habitat conditions for bull trout. The effects of the proposed action are largely restricted to the bull trout populations within the Puyallup River system; however, there is a remote potential for bull trout from other core areas to utilize these areas and thus be affected by this proposed action.

Puyallup Core Area

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (USFWS 2004b). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004b).

Number and Distribution of Local Populations

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, because bull trout are known to use this river and it appears to provide suitable spawning habitat, but bull trout reproduction has not yet been documented there (USFWS 2004b).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). Known spawning areas within the above five local populations are few in number and not widespread. The majority of known spawning sites are located in streams within Mount Rainier National Park, with two exceptions: Silver Creek and Silver Springs (Marks et al. 2002; Ladley 2007, Puyallup Tribe, Tacoma, Washington, in litt) which are tributaries to the Upper White River.

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater FMO habitat for migratory bull trout within this core area (USFWS 2004b).

With fewer than 10 local populations, the Puyallup core area is considered by the FWS to be at an intermediate risk of extirpation caused by adverse effects from random naturally occurring events (USFWS 2004b). The factors influencing the number and distribution of bull trout local populations in this core area are discussed below under "Threats".

Adult Abundance

Bull trout abundance estimates based on adequate sampling are generally not available for local populations in the Puyallup core area. Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap (USFWS 2004b). Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate that few anadromous bull trout and mainstem fluvial bull trout return to local populations in the White River system. Based on available information, the bull trout population in the Puyallup core area is considered to be at increased risk of extirpation caused by adverse effects from random naturally occurring events (USFWS 2004b). The factors influencing bull trout abundance in this core area are discussed below under "Threats".

Productivity

No long-term, comprehensive trend data are available on bull trout productivity in the Puyallup core area. Given low known population sizes, productivity is probably low. The factors influencing bull trout productivity in this core area are discussed below under "Threats".

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area based on habitat availability and observed life history forms. However, although connectivity between the Upper Puyallup River and Mowich River local populations and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is considered by the FWS to be at an intermediate risk of extirpation from habitat isolation and fragmentation (USFWS 2004b).

Changes in Environmental Conditions and Population Status within the Action Area

Since the bull trout was listed, the FWS has issued Biological Opinions that exempted incidental take of the bull trout in the Puyallup core area. These incidental take exemptions were in the form of harm and harassment, primarily from hydrologic impacts associated with increased impervious surface, temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Biological Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003, the FWS issued a Biological Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts, as well as cumulative impacts within the action area included urbanization of approximately 600 acres of land. In the above Biological Opinion, we concluded that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for the bull trout and its prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. Incidental take of fluvial, adfluvial, and anadromous bull trout in the form of harassment due to thermal stress and the disruption of migrating and foraging behaviors was exempted for this project. These adverse effects were expected to continue in perpetuity.

Section 10(a)(1)(B) permits have also been issued for Habitat Conservation Plans (HCPs) that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species.

Additionally, capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected some individual bull trout in this core area. In the last decade, 15 to 49 (average 37) adult bull trout have been annually captured and handled at the fish trap and haul facility at Buckley Diversion while being passed upstream of Mud Mountain Dam. In 2004 and 2005, a total of six adult mortalities where associated with a radio telemetry project to track bull trout movements on the White River. During fish recovery operations at the Electron Dam forebay on the Puyallup River, a total of five adult bull trout were captured and released in 2005, while none were encountered in 2006. The Puyallup Tribe have annually collected and released up to six juvenile and two adult bull trout over the past 3 years (2004-2006) at the Electron forebay smolt bypass trap.

Several non-Federal projects are ongoing within the action area as the region is developing rapidly. The development of one project, in particular, came to light during the review of the proposed action and is referred to as the "Riverside Industrial Park". Through right-of-way development of the SR 167 project, WSDOT bought a parcel of land adjacent to the proposed "Riverfront Industrial Park". WSDOT granted the City of Puyallup an easement so that the developer could cross WSDOT property with utilities necessary for development of the parcel (Fuchs 2006a). The parcel includes warehouse style buildings and associated parking and driveways and is estimated to total approximately 42.5 acres. Since the parcel could not be developed without utility access, which was being granted by WSDOT, there is a causal relationship between the two projects. The City was, however, pursuing alternative connection plans. At the time of this writing the project was already under construction. This project will result in additional PGIS in the action area.

Threats to Bull Trout in the Puyallup Core Area

Threats to bull trout in the Puyallup core area include:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect FMO habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or

precluding adult and juvenile migration and degrading FMO habitats in the mainstem. Despite improvements to these facilities, passage-related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout in many parts of the Puyallup core area and their potential to increase in distribution, including into Mount Rainer National Park waters, are considered significant threats to bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich Rivers local populations are of great concern.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (Puget Sound Action Team 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

- In November 2006, an 18,000 gallon spill of diesel fuel in the head waters of Spring Creek (Hebert 2006, in litt), a bull trout spawning area of the Upper White River local population, likely impacted the available instream spawning habitat. The duration of ongoing contamination of instream habitats by residual diesel fuel is unknown.

STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

Legal Status

The FWS published a final critical habitat designation for the coterminous United States population of the bull trout on September 26, 2005 (70 FR 56212); the rule became effective on October 26, 2005. The scope of the designation involved the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units). Rangewide, the FWS designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat (Table 3).

Table 3. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	**294**	**474**	**50,627**	**20,488**
Montana	**1,058**	**1,703**	**31,916**	**12,916**
Oregon	**939**	**1,511**	**27,322**	**11,057**
Oregon/Idaho	**17**	**27**		
Washington	**1,519**	**2,445**	**33,353**	**13,497**
Washington (marine)	**985**	**1,585**		

Although critical habitat has been designated across a wide area, some critical habitat segments were excluded in the final designation based on a careful balancing of the benefits of inclusion versus the benefits of exclusion (see Section 3(5)(A) and Exclusions under Section 4(b)(2) in the final rule). This balancing process resulted in all proposed critical habitat being excluded in 9 proposed critical habitat units: Unit 7 (Odell Lake), Unit 8 (John Day River Basin), Unit 15 (Clearwater River Basin), Unit 16 (Salmon River Basin), Unit 17 (Southwest Idaho River Basins), Unit 18 (Little Lost River), Unit 21 (Upper Columbia River), Unit 24 (Columbia River), and Unit 26 (Jarbidge River Basin). The remaining 20 proposed critical habitat units were designated in the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation.

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Critical habitat units generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support core areas which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993; MBTSG 1998); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993; Hard 1995; Healey 1995; MBTSG 1998); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993; Hard 1995; MBTSG 1998; Rieman and Allendorf 2001).

The Olympic Peninsula and Puget Sound Critical Habitat Units are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound bull trout population. These critical habitat units contain nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain Primary Constituent Elements (PCEs) that are critical to adult and subadult foraging, overwintering, and migration.

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Note that only PCEs 1, 6, 7, and 8 apply to marine nearshore waters identified as critical habitat; and all except PCE 3 apply to FMO habitat identified as critical habitat.

The PCEs are as follows:

1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.

3) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.

4) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

5) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

6) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

7) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

8) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

In freshwater habitat, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. For designated lakes, the lateral extent of critical habitat is defined by the perimeter of the water body as mapped on standard 1:24,000 scale topographic maps.

In marine habitat, critical habitat includes the inshore extent of marine nearshore areas between mean lower low-water (MLLW) and minus 10 meters (m) mean higher high-water (MHHW), including tidally influenced freshwater heads of estuaries. This refers to the area between the average of all lower low-water heights and all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore areas is based on the extent of

the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) relative to the MLLW.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212, {FWS 2004}. The FWSs evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule {USFWS and NMFS 1998}. Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments.

Current Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat.

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Rieman and McIntyre 1993; Dunham and Rieman 1999); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989; MBTSG 1998); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993; Rieman et al. 2006); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Conservation Role of Critical Habitat Unit 28 (Puget Sound)

Critical Habitat has been designated for bull trout within the Coastal-Puget Sound interim recovery unit (70 FR 56212 [September 26, 2005]). The action area is located in Critical Habitat Unit 28, Puget Sound River Basins. The Puget Sound Critical Habitat Unit provides habitat conditions that are essential for diverse life history forms of bull trout; however, one of the unique conservation roles of the unit is that it supports amphidromous bull trout. Therefore, it is one of only two Critical Habitat Units, throughout the range of the species that support the amphidromous life history form. This critical habitat unit contains nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult overwintering, migration, and foraging.

Status of Bull Trout Critical Habitat in the Action Area: Current Condition of Critical Habitat Unit 28

The urban rivers of Puget Sound are impacted from past logging and logging roads in the upper reaches, and agriculture and urban development in the lower floodplains. Intensive channelization to protect urban development and agricultural areas has resulted in permanent loss of floodplain functions in most of the lower rivers. The loss of riparian vegetation, increasing discharge of municipal and industrial wastewater and urban stormwater runoff, has resulted in degraded water quality. The WDOE has placed a large number of waterways throughout Puget Sound on the 303(d) list of impaired waters. In addition to affecting water quality through flow alterations, hydroelectric dams block migration and have isolated bull trout populations in several core areas while water-control structures in the floodplains have effectively eliminated most of the estuaries and wetlands that historically provided rearing and foraging areas. All PCEs within the designated critical habitat have likely been degraded, although the severity of degradation varies on a site specific basis.

ENVIRONMENTAL BASELINE (in the action area)

The 'environmental baseline' includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The SR 167 project will affect areas within the lower valley portion of the Puyallup-White Basin (WRIA 10). The primary waterways associated with this area include the Puyallup River, Commencement Bay, Hylebos Creek, and Surprise Lake Tributary, and Wapato Creek. The Erdahl Ditch and the Fife Ditch are non-fish bearing waterbodies that drain into the Blair Waterway and lower Hylebos Creek.

Lower Puyallup River and Commencement Bay FMO Habitat for the Bull Trout

Bull trout expressing an anadromous life history must use these areas of the lower Puyallup River system. Fluvial migrants would typically limit their most downstream use to the lower Puyallup River (USFWS 2004b). However, due to the plasticity of life history forms, a fluvial individual has a high likelihood of expressing anadromy in the future (Brenkman et al. 2007). Not all fluvial migrants use this reach; some limit their migration to the mainstem White, Carbon or Puyallup rivers upstream of the White River confluence. However, all anadromous individuals natal to the Puyallup River system must use the FMO habitat in the lower Puyallup River mainstem during their movements to (i.e., as subadults and post-spawn adults) and from (i.e., as first-time or repeat spawners) marine waters. This habitat is crucial for completing their anadromous life history.

Use and Abundance

The first description of bull trout in Puget Sound was by Suckley (1860), who reported, "As early as the first of June this beautiful fish is found running up the Nisqually, Duwamish, and other rivers emptying into Puget Sound. They are taken sparingly from these waters until October, when they enter the mouths of the rivers in vast numbers, and are taken by hook and line, nets, traps, etc., until near Christmas". Suckley (1874, as cited in Goetz et al. 2004) additionally reported bull trout to be, "found in the fresh waters from April til near Christmas, but are caught most abundantly during the months of October and November. The Puyallup, Duwamish, and Lemma Rivers, during three months, afford good fishing near their mouths".

It is believed that limited numbers of anadromous individuals are present today within the system, based on the low returns observed at Buckley Diversion, and the fact that upstream passage at Electron Dam was only recently restored. Only the Carbon River local population has maintained full connectivity for the anadromous form, allowing relatively uninterrupted movement between spawning and rearing habitats in the upper Carbon River and downstream FMO habitats in the lower Puyallup River and Commencement Bay. In the past 20 years, few anadromous bull trout have been actually observed within Commencement Bay (PIE 1999) leading some to speculate that the anadromous form may not persist within the system. However, recent acoustical telemetry documented that bull trout in the Puyallup River system continue to migrate to and from Commencement Bay (Jeanes 2006b, R2 Resource Consultants, Kirkland, WA, in litt).

Since identification and enumeration began (in the 1990's) at the Buckley Diversion trap, fewer than 50 anadromous bull trout have been counted annually. No counts of anadromous adults are available for the Carbon or the upper Puyallup Rivers, although occasionally individuals presumed to be anadromous have been incidentally captured by anglers during the steelhead fishery near the confluence of these two rivers (Reynolds K. 2003, USFWS, Lacey, WA, pers. comm.). In addition, migratory individuals are periodically captured in the terminus forebay of the Electron Dam's diversion flume/canal (Fransen 2005, NOAA, Lacey, WA, in litt), indicating that some individuals from this part of the system still express fluvial and perhaps anadromous life histories.

The number of fluvial bull trout migrating downstream as far as the lower mainstem Puyallup River is likely similar in magnitude to the number of anadromous individuals present within the system. Because both anadromous and fluvial adults natal to the White River local populations would have to be passed upstream at Buckley Diversion trap, the number of fluvial individuals would be a subset of the total number (<50) passed upstream at the facility. As with anadromous migrants, until recently, the Electron Dam had also limited fluvial migrants from completing their life cycle for almost 100 years.

Location, Distribution, and Condition of Habitat

Lower Puyallup River

The lower Puyallup River is the key migratory corridor for anadromous bull trout entering and leaving the Puyallup core area. This section of the river is formed by the merging of three major watersheds (the White, Carbon, and upper Puyallup rivers) which support the local populations within the core area. The lower Puyallup River in conjunction with the mainstem White, Carbon, and Puyallup rivers, represent the primary freshwater FMO habitat supporting migratory bull trout in the system. Based on past observations and recent telemetry work (Deming 2006, Habitat Technologies, pers. comm., Jeanes 2006a, in litt), bull trout that are using the lower mainstem often key in on areas near the outlets of tributary streams (e.g., Clarks, Swan, and Clear Creeks), as foraging sites or thermal refugia. Given the degraded nature of the lower Puyallup River, such areas may provide critical stepping-stones during their migration to upstream habitat. Radio-tagged bull trout were found residing at the mouth of Clear Creek into early August before moving upstream (Jeanes 2006a, in litt). The perennial stream flow in Clear Creek is supported by groundwater, and its water temperatures are lower than commonly found in lowland Puget Sound streams (Pierce County Public Works 2006).

Prior to human alteration, in large undeveloped floodplain rivers such as the Puyallup, habitat variability (i.e., complexity) has been described as "the most defining and key attribute" (WCC 1999). The lower Puyallup River watershed has been substantially altered, especially throughout its lower most reaches within the action area from about RM 2.5 to RM 8.5. The primary factors that have created and continue to influence the current habitat conditions in this area include extensive urban growth, heavy industry, dredging, agriculture, and miles of revetments and levees. An extensive infrastructure that includes both roads and railroads has further impacted these lower reaches by maintaining channel constraints, facilitating development, and contributing to contaminant inputs.

The lower mainstem Puyallup River, from approximately RM 28 to the mouth of Commencement Bay, has been confined and straightened by channelization (WCC 1999). It is currently separated from its floodplain by a series of dikes, revetments, and levees along both banks severing or interrupting historic surface water connections. This has significantly simplified the historic river channel complex, eliminating both off-channel and side-channel habitats, as well as complex pools and associated LWD that were important components of bull trout and salmonid habitat in the lower Puyallup River. Dredging of the lower river channel began in the early 1900s with permanent channelization and flood control efforts (e.g., dikes, levees) following soon afterward (WCC 1999). These channel simplifications have also changed

the natural hydrology within these river reaches, further reducing or eliminating the suitability of remaining instream habitat for rearing juvenile salmon. Because bull trout use these lower mainstem river reaches to migrate and forage, they have also been indirectly impacted by this loss and degradation of juvenile salmon rearing habitat.

Past and ongoing urbanization has increased the level of impervious surface and reduced floodplain storage capacity within this part of the basin. This has resulted in increased peak flows and reduced base flows for the lower Puyallup River and associated tributaries. Between 1973 and 1993, U.S. Geological Survey (USGS) gages showed that low flows had dropped, even though the same period of time had above average precipitation. This decrease was attributed to increased demand for ground water withdrawal at unregulated wells and increases in impervious surfaces that led to a decline in groundwater and base surface water flows (WCC 1999). In addition, mature forested riparian areas have largely been eliminated along the lower Puyallup River. Less than 5 percent of the lower reaches of the mainstem Puyallup River retain what is characterized as high quality riparian habitat, much of which is fragmented(WCC 1999).

The lower Puyallup River is currently listed on the 2004 303(d) list of impaired waterways for fecal coliform and mercury violations (WDOE 2005b). However, low levels of dissolved oxygen (DO), elevated levels of copper (Cu), lead (Pb), and turbidity, and elevated temperatures were also identified as concerns. Glacial turbidity is a characteristic of the lower Puyallup River due to the glacial runoff from Mount Rainier, with highest turbidity levels typically occurring between July and September. Sediment from other land use practices has been identified as contributing to the overall turbidity, being largely responsible for the levels observed during periods of the year when glacial melt is lowest.

Commencement Bay FMO Habitat

Bull trout typically utilize the shallow nearshore band of the photic zone (< 10m) when occupying estuarine/marine waters (Goetz et al. 2004; Reisenbichler et al. 2006, USGS, Seattle, WA, in litt). Contemporary observations of bull trout within Commencement Bay have typically been in the area between Brown's Point and the mouth of Hylebos Waterway on the north side of the bay. These observations likely do not represent the full extent of bull trout use in Commencement Bay due to the sampling limitations in these marine areas and the difficulty in detecting use given the depressed abundance of the anadromous life history form within the Puyallup core area.

Commencement Bay is a natural deep water embayment that historically consisted of extensive intertidal mudflats and emergent marsh habitat. Starting in the late 19th century, the bay has been substantially altered through the development of extensive areas of heavy, medium and light industry, and commercial and residential influences. Less than 10 percent and 2 percent of the historic intertidal mudflat and salt marsh, respectively, remain today.

Dredging and filling of mudflats have converted much of the shallow nearshore within Commencement Bay into deep industrial waterways and open-water habitats (WCC 1999). In addition, shorelines of Commencement Bay have been significantly altered from a variety of shoreline protection measures (e.g., vertical bulkheads, riprap, and rubble). Substantial

bulkheads alone cover approximately 6 percent of the length of shoreline from Brown's Point to Ruston (WCC 1999). An additional 71 percent of the shoreline is armored by other protection measures. In addition, the extensive system of piers and docks to support commercial and industrial uses has further structurally modified the historic nearshore habitat throughout the bay. Functional estuarine and nearshore habitats are critical to anadromous bull trout for foraging and migration {WDFW et al. 1997}, and to their prey species (e.g., herring, surf smelt, sandlance) for spawning, rearing, and migration (BMSL (Battelle Marine Sciences Laboratory) et al. 2001). Essentially no forage fish spawning areas remain within Commencement Bay {WDFW 2000}.

As a result of the past and present industrial uses, Commencement Bay has a long history of chemical and metal contamination of its estuarine waters. The bay was listed as a federal Superfund site in 1981 (WCC 1999). Many of these contaminants are toxic to marine life and fish. Although the implications for bull trout are uncertain, some life stages of bull trout appear to have greater sensitivity than other salmonids to some contaminants (Guiney et al. 1996, EPA, Duluth, MN, in litt, Cook et al. 1999), and anadromous bull trout may be exposed numerous times to these contaminants due to their life history and migratory behaviors. Bull trout may also bioaccumulate some contaminants more readily because of their ecological role as an apex predator.

Efforts to restore nearshore habitat structure and riparian areas of Commencement Bay have occurred throughout the bay. Efforts on the north side of the bay and areas near the mouth of the Puyallup River are likely the most important for improving bull trout and forage fish habitat based on the available, although limited, information on bull trout use in the bay. Efforts have been ongoing to address sediment contamination source control and cleanup in upland and waterway sites. Upland cleanup has been completed at 63 of the 70 sites confirmed has having ongoing sources of problem chemicals. The Hylebos, Middle, and Thea Foss waterways remain Superfund sites and have ongoing cleanup actions.

Only the upper parts of Hylebos and Blair Waterways of Commencement Bay are included in the action area. These are described further below.

Blair and Hylebos Waterways

The Blair Waterway is approximately 13,600 ft long, with the outlets of the Erdahl Ditch and Wapato Creek located at its head. The Hylebos Waterway is approximately 16,200 ft long with the mouth of Hylebos Creek located at its head. Land use within this estuarine portion of the action area consists primarily of commercial industrial activities, buildings, or paved surfaces. Terrestrial vegetation is limited, consisting of small pockets of weedy grass and nonnative herbaceous species or planted ornamentals occurring in narrow strips adjacent to the waterway. Historically, this area comprised part of the estuarine delta of the Puyallup River. With the growth and development of Tacoma, the Port of Tacoma, and the surrounding region, the delta, including these two waterways, has been subjected to dramatic environmental changes, primarily from dredging and filling. It has been estimated that of the original 2,100 acres of historical intertidal mudflat, approximately 180 acres remain today (COE et al. 1993). Eight acres are located in the Blair Waterway near the mouths of Wapato Creek and Erdahl Ditch (PIE 2001).

The shorelines of the Blair Waterway have been highly altered by the use of riprap and other materials to provide bank protection. Blair Waterway has seven percent of the total of bulkheads that cover 71 percent of the length of Commencement Bay shoreline. Between 1993 and 1995, the entire Blair Waterway navigation channel, including the turning basin, was dredged as part of the Sitcum Waterway Remediation Project. Contaminated sediments were removed and capped in the Milwaukee Waterway nearshore confined disposal site. After the completion of the dredging, the Environmental Protection Act (EPA) removed the Blair Waterway and all lands that drain to the Blair Waterway from the National Priorities List (PIE 2001). Approximately 940,000 cubic yards of dredging in subtidal and intertidal habitat, debris removal, and 11 acres of sediment capping with sand along the shoreline was initiated in the Hylebos Waterway as part of remediation activities. EPA expects to complete the intertidal cleanup and begin long-term monitoring by the end of 2006 (EPA 2005).

Currently natural aquatic habitats are highly fragmented and dispersed across the delta and bay with few natural corridors linking them. At present, salmonid habitat within Commencement Bay shorelines is gradually increasing in acreage because of habitat restoration projects and natural processes. Approximately 50 acres of intertidal and shallow subtidal habitat have been created through previous restoration actions, including the Fairliner Marina Habitat Area, Gog-le-hi-te Wetland, the Rhone-Poulenc Habitat Area, and the Slip 5 Habitat Area. All provide rocky or gravel beaches and/or tidal mudflats and intertidal areas with native vegetation plantings. Habitat benefits for salmon include increased complexity for juvenile rearing, feeding, and refuge.

Water quality in the action area portion of the Blair Waterway improved measurably following remediation activities (WDOE 1999). Cleanups and source controls are now in place for all known metal sources including log sort yards and a variety of industrial facilities. All metals concentrations were well within state and the EPA water quality criteria for marine life, in most cases by a factor of five or better (WDOE 1999). Comparison with the historical data available on the Blair and the Hylebos Waterways shows that cleanups have resulted in an order of magnitude decrease in arsenic and zinc contamination and similar improvements are likely for copper and lead. The median dissolved copper concentration measured in the Blair Waterway was 0.81 μg/L and 1.6 μg/L for Hylebos Waterway. For dissolved zinc, the median was 3.7 μg/L for the Blair Waterway and 11.6 μg/L for the Hylebos Waterway. Arsenic was 1.3 μg/L for the Blair Waterway and 2.1 μg/L for the Hylebos Waterway (WDOE 1999). These concentrations are below the above-referenced olfactory inhibition and behavioral effects/modification thresholds, with the exception of dissolved zinc in the Hylebos Waterway. Compared to Hylebos and Thea Foss Waterways, the Blair Waterway had the lowest metals concentrations, with the exception of arsenic, where concentrations in the Thea Foss Waterway were slightly lower.

Threats Identified in Project Area

Threats to bull trout in the Project Area include the following, in order of their judged priority based on the current best available information:

1. The ongoing effects of urbanization and development within the floodplain continue to degrade habitat conditions in the lower Puyallup River and associated tributaries, which represent the key migratory corridor for anadromous bull trout. These reaches are also important to a portion of the fluvial population to complete their life history. The impacts include water quality degradation, reduction in hyporheic function, loss of thermal refugia, temperature increases, and habitat simplification.

2. The near complete loss of historic nearshore habitat within Commencement Bay has significantly reduced the productivity of the estuary and amount of high quality habitat for salmonids. The loss of essentially all forage fish spawning habitat within Commencement Bay has greatly reduced the overall prey base key to supporting and recovering anadromous bull trout natal to the Puyallup River system.

3. The effects of river channelization and flood control structures continue to prevent the reestablishment of complex river habitats and functional riparian areas within the reaches of the lower Puyallup River.

4. The ongoing effects of contaminated waters and sediments within the lower Puyallup River and Commencement Bay continue to pose a risk to bull trout fitness, especially the anadromous life history form.

Hylebos Creek

Hylebos Creek within the action area includes approximately RM 0.1 to 5.5 of the mainstem (referred to as the East Fork above RM 5.1) and approximately RM 0 to 1 of the west fork. Existing habitat conditions in Hylebos Creek are highly degraded. Bull trout are not known to occur in Hylebos Creek; however, the system does provide a forage base for bull trout in Commencement Bay.

Habitat complexity in Hylebos Creek is greatly reduced with little side channel, off-channel, and quality pool habitat available. Armored banks occur throughout the project area and the stream is isolated from its floodplain. A lack of LWD, mature riparian vegetation, and streambed gravels, likely limits the abundance and diversity of macroinvertebrates, a food source for salmonids. Stream temperatures can support migration and rearing, but may limit salmonid spawning in the action area. Levels of dissolved Cu reached 2.47 μg/L, within a range sufficient to cause olfactory inhibition in salmonids. Additionally, fecal coliform levels have exceeded State standards.

Several restoration projects that are completed, in process, or planned, are expected to improve habitat conditions over time. Restoration work has included off channel habitat creation, invasive species removal, revegetation, fish passage improvement, wetland restoration and livestock exclusion.

Notably, near the location of the proposed RRP there is a contaminated site referred to as the B & L Woodwaste Site. The site is adjacent to a reed canarygrass-dominated wetland, through which Hylebos Creek is proposed for relocation. Ditches drain west from the wetland to

Hylebos Creek. The woodwaste site was used as an industrial landfill beginning in the mid-70s. Wood chips, sand, rock and Asarco slag, most of which came from log sorting yards in the Commencement Bay tideflats, were dumped at the site. Over time the site has released arsenic and other contaminants into Hylebos Creek.

A complete discussion of the site's history, and specifics of the known extent of the contamination is contained in NOAA (NOAA 2007). In summary, the WDOE issued an enforcement order in 1992, which resulted in consolidation and capping of the site. While this reduced the escape of metals from the site, groundwater in the area has since become contaminated. Continued monitoring revealed arsenic in groundwater in and near the wetland (Snider 2006). The arsenic concentrations in groundwater appear to be decreasing. However, the arsenic appears to not be sorbing to soil, and is therefore mobile (Snider 2006). In Hylebos Creek, arsenic attributable to the B & L Site was detected and it appears that it is migrating from the landfill into Hylebos Waterway (LaPorte 2000).

Surprise Lake Tributary

The action area includes approximately RM 0 to 1.5 of Surprise Lake Tributary. Bull trout are not known to occur in Surprise Lake Tributary but the system does drain to Hylebos Creek which contributes to the bull trout prey base. Surprise Lake Tributary conveys runoff from residential areas in the City of Edgewood, south to the valley below. In the valley it drains agricultural and residential runoff from the City of Fife from a series of linear ditches. These ditches drain to Lower Hylebos Creek (WSDOT 2002). Surprise Lake Tributary lacks mature riparian vegetation, LWD, and other habitat features such as side channels and pools. Substrate material is dominated by silt.

Wapato Creek

Wapato Creek is an approximately 14-mile long independent tributary to Puget Sound that enters the Port Industrial Waterway (also known as the Blair Waterway) in Commencement Bay. Wapato Creek from the mouth to RM 9.0 is within the action area. Wapato Creek has been severely degraded by land use practices and there are fish passage barriers both upstream and downstream of the project area. It also receives a substantial amount of runoff directly from adjacent agricultural, residential, commercial, and industrial areas in the cities of Puyallup and Fife. Within the action area, Wapato Creek lacks riparian habitat and LWD, and has poor water quality. Additionally, water in this system has been over-allocated, leading to flow problems during at least part of the year (WCC 1999). Bull trout are not known to occur in Wapato Creek. The creek does support limited spawning habitat for coho salmon. There is also some use of the creek by chum salmon, steelhead, and coastal cutthroat trout (FHWA and WSDOT 2006). As a fish-bearing stream that drains to marine foraging habitat the system probably contributes to the bull trout forage base in Commencement Bay, but use of the stream itself by bull trout is not expected.

Wapato Creek is on the 2004 303(d) list due to fecal coliform and reduced DO. Water quality monitoring data from the Puyallup Tribe on Wapato Creek indicate that DO, pH and temperature do not meet water quality standards during late summer, when the stream is its lowest, and that

turbidity levels and nitrate/nitrite and phosphorus concentrations were elevated as well (WSDOT 2002). In 1999, the B-IBI score for Wapato Creek was 18, indicating impaired biological processes (Reinelt 2006, Pierce County, pers. comm.).

Wapato Creek is channelized and entrenched in the project area and little to no off-channel habitat remains. Wapato Creek has capacity limitations and much of its flood flows are diverted to the Puyallup River. This diversion of peak flows helps to minimize flooding in the Wapato Creek basin; however, it exacerbates chronic summer low flows in Wapato Creek (WSDOT 2002, citing Nauer, pers. comm. 2002). Only small pockets of riparian habitat consisting of both shrub and tree components occur in the project area (DEA 2004). Non-native shrubs dominate the riparian areas, and where trees occur, they are primarily deciduous. The lack of LWD, mature riparian vegetation, and streambed gravels, likely limits the abundance and diversity of macroinvertebrates, a food source for salmonids. The loss of floodplain connectivity has altered base and flood flows, further affecting temperature regimes and creating extreme summer low flows.

Status of Bull Trout Critical Habitat in the Action Area

The action area includes three distinctly different areas of designated critical habitat: The Puyallup River, from approximately RM 2.5 to RM 8.5; the nearshore (-10 MHHW) of Blair Waterway, including tidally influenced waters in Wapato Creek and Erdahl Ditch; and the nearshore of Hylebos Waterway, including tidally influenced waters in Hylebos Creek. These three areas are discussed separately below.

Puyallup River (Freshwater)

The action area encompasses the mainstem Puyallup River, approximately RM 2.5 to RM 8.5. The baseline conditions of the lower Puyallup River are discussed in the "Environmental Baseline (in the action area) – Puyallup River" section. The baseline is described below in terms of each PCE. Seven of the eight PCEs are present within this section of the lower Puyallup River, including PCE #1, water temperatures that support bull trout use; PCE #2, complex stream channels; PCE #4, a natural hydrograph; PCE #5, cold water sources; PCE #6, migratory corridors with minimal physical, biological, or water quality impediments; PCE #7, an abundant food base; and PCE #8, permanent water of sufficient quantity and quality.

1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

The WDOE recorded water temperatures at Station No. 10A070, near the Meridian Street Bridge in the project area (WDOE 2006b). Water temperature data for water year 2005 are not presented in the 7-day average maximum format, but mean temperatures for 3-month increments are available. The mean temperature for October through December was 10.3 °C, January

through March was 6.8 °C, April through June was 11.8 °C, and July through September was 14.0 °C. The WDOE (2006a) also reported that the six-year maximum temperature recorded at Station Number 10A070 was 16.5 °C. During July through October 2002 the City of Puyallup measured temperatures near the wastewater treatment plant outfall in the Puyallup River that ranged from 9.0 °C to 15.5 °C (Lange 2006, pers. comm.). Temperatures recorded in the lower Puyallup River are currently within ranges that support bull trout use, but are at the high end of the range at which bull trout are found most frequently (2 to 15 °C).

Bull trout utilize the lower Puyallup River year-round for foraging, migrating, and overwintering. Juvenile, subadult, and adult bull trout are known to utilize areas of localized groundwater input, such as the mouth of Clear Creek (see "Environmental Baseline (in the action area) – Status of Bull Trout in the Action Area) as refugia from high temperatures in the Puyallup. Temperatures in Clear Creek are lower than commonly found in lowland Puget Sound streams and are an indicator of subsurface flow (Pierce County Public Works 2006).

2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.

Channelization has straightened, confined and simplified the river channel within the lower Puyallup River. The channelization and levees have also reduced river processes that form pools, side channels, and other habitat features that add complexity to the habitat. The lower reaches of the mainstem Puyallup River are also lacking in the coniferous riparian habitat that was present historically. Less than 5 percent of this section of the mainstem Puyallup has what can be considered high quality riparian habitat and that habitat is fragmented into small segments often separated by distances of over a mile. The lack of riparian habitat has precluded the recruitment of small and large wood from areas most likely to contribute this material (WCC 1999). Within the project area (between RM 7.5 and 8.5), minimal LWD is present, no pools are present, and only narrow (less than 100 ft wide) riparian corridors exist (DEA 2004).

3) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation

The instream minimum flows established at the lower Puyallup River gauge are 1,000 cubic ft per second. For the 14-year time period from 1980 to 1993 inclusive, instream flows were not met at the lower Puyallup River gauge an average of 35 days annually. Generally, these flow violations were in late fall. Low flow averages for the Puyallup River have continually declined even though correlating time periods have had above average precipitation. Increases in impervious surface in the lower Puyallup River sub-basin and reduced floodplain storage has resulted in increased peak flows, quicker peak flows, and reduced base flows (WCC 1999).

4) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

The lower Puyallup River is assumed to contain springs, seeps, groundwater sources, and/or subsurface flow, all providing cold water to the river. Temperatures in Clear Creek (see "Effects of Increased Impervious Surface"), a tributary of the lower Puyallup River within the action area, are lower than commonly found in lowland Puget Sound streams and are an indicator of subsurface flow (Pierce County Public Works 2006).

Increased development and groundwater withdrawal through unregulated wells within the lower Puyallup River sub-basin have lead to a reduction in base flows. Most of the tributaries of the lower Puyallup River also suffer from the effects of development (WCC 1999). These changes have likely contributed to loss of cold water sources within the lower Puyallup River.

Bull trout utilize the lower Puyallup River year-round for foraging, migrating, and overwintering. Juvenile, subadult, and adult bull trout are known to utilize areas of localized groundwater input, such as the mouth of Clear Creek (see "Status of Bull Trout in the Action Area) as refugia from high temperatures in the Puyallup. Cold water refugia in this FMO habitat provides critical "stepping stones" to upstream spawning grounds.

5) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

The Puyallup River provides an essential migratory corridor for bull trout (70 FR 56212 [September 26, 2005]). No physical, biological, or water quality impediments to migratory corridors occur within the aquatic action area. However, summer maximum water temperatures could impede or delay bull trout attempting to move through the aquatic action area.

6) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

The Puyallup River from its mouth at Puget Sound upstream approximately 46.2 mi to the confluence of the North and South Puyallup Rivers provides FMO habitat for the Puyallup core area (70 FR 56212 [September 26, 2005]) . The construction of the revetments and levees and their maintenance has decreased the contribution of prey organisms to the river by precluding functioning riparian vegetation habitats. The lack of suitably sized gravel may also limit the production of aquatic macroinvertebrates. The aquatic action area contains forage fish (e.g. juvenile salmonids) for subadult and adult bull trout. However, limited spawning and rearing habitat for these prey species remains in the lower Puyallup River (WCC 1999).

7) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

The lower Puyallup River is listed on the EPA 303(d) 1996 approved list for flow and fecal coliform violations (also fecal coliform violations in November 2003 at 270/100 ml and again in September 2005 at 120/100 ml). The instream minimum flows established at the lower Puyallup River gauge by WDOE are 1,000 cfs. For the 14 year time period from 1980 to 1993, instream

flows were not met an average of 35 days annually (WDOE 1995). In September 2005, flows were measured at 929 cfs (WDOE 2007).

Low flow averages for the Puyallup River have continually declined even though correlating time periods have had above average precipitation. Increases in impervious surface in the lower Puyallup sub-basin and reduced floodplain storage have resulted in increased peak flows, quicker peak flows, and reduced base flows (WCC 1999).

Blair Waterway and Hylebos Waterway (Marine Water)

Due to potential water quality impacts, approximately 2,000 ft of Blair Waterway, starting at the Erdahl Ditch and Wapato Creek outlets, and approximately 7,000 ft of Hylebos Waterway from the mouth of Hylebos Creek are included in the action area (Ludwa 2006a; Ludwa 2006b). Marine nearshore areas provide foraging and migration habitat for amphidromous bull trout outside of freshwater core areas. Critical habitat has been designated for nearshore marine habitat (-10 MHHW).

The nearshore of Blair Waterway, including tidally influenced waters of Wapato Creek and Erdahl Ditch, and the nearshore of Hylebos Waterway, including tidally influenced waters of Hylebos Creek, are designated bull trout critical habitat within the action area. The baseline conditions of Blair Waterway, Wapato Creek, Erdahl Ditch, Hylebos Waterway, and Hylebos Creek are discussed in the "Environmental Baseline (in the action area)" section. The baseline is described below in terms of each PCE present in the marine action area. Four of the eight PCEs are present within marine waters, including PCE #1, water temperatures that support bull trout use; PCE #6, migratory corridors with minimal physical, biological, or water quality impediments; PCE #7, an abundant food base; and PCE #8, permanent water of sufficient quantity and quality.

1) *Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.*

   Water temperatures measured in Commencement Bay at Brown's Point [UTM 10, 541622E, 5237519N (NAD83)] in 2005 (at a depth of 10 meters) ranged from 8.88 °C in April to 13.52 °C in August (WDOE 2007). It is assumed that temperatures within the Waterways are slightly warmer due to freshwater inflow, stormwater runoff, and limited circulation and flushing with Commencement Bay and Puget Sound; possibly to an extent that discourage extended use by bull trout.

2) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

Blair and Hylebos Waterways provide limited foraging habitat for bull trout. Intertidal wetlands have been dredged or filled and very little native vegetation or natural plant communities remain. Anthropogenic features such as modified floodplains, hardened banks, and urbanization have eliminated or decreased access to historical bull trout foraging areas. Blair Waterway contains seven percent of the total of bulkheads that cover 71 percent of the length of Commencement Bay shoreline.

Eight acres of intertidal mudflats remain in Blair Waterway at the mouth of Wapato Creek and Erdahl Ditch (PIE 2001). These mudflats may support bull trout prey. Low numbers of coho, Chinook, and pink salmon have been documented in Blair and Hylebos Waterways; however, warm water temperatures during summer months may preclude bull trout use. A bull trout was documented within Hylebos Waterway in 1981.

3) *An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

Environmental baseline conditions in Hylebos and Blair Waterways meet few of the biological requirements of forage fish. Intertidal wetlands have been dredged or filled and very little native vegetation or natural plant communities remain. Anthropogenic features such as modified floodplains, hardened banks, and urbanization have eliminated or decreased access to historical bull trout foraging areas.

Eight acres of intertidal mudflats remain in Blair Waterway at the mouth of Wapato Creek and Erdahl Ditch (PIE 2001). These mudflats may support bull trout prey. Low numbers of coho, Chinook, and pink salmon have been documented in Blair Waterway. However, warm water temperatures during summer months may preclude bull trout use.

A majority of the nearshore within Hylebos Waterway contains limited vegetation supportive of bull trout prey species. Observations have indicated that there is a very small Chinook population within the Hylebos watershed (WDFW 2003). However, an emergent marsh wetland (a restoration site within the intertidal estuary) is located in Hylebos Waterway and provides quality habitat for prey species (GeoEngineers, Inc 2006).

4) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

Water quality in the Blair Waterway improved measurably following recent remediation activities (WDOE 1999). Cleanups and source controls are now in place for all known metal sources including log sort yards and a variety of industrial facilities. All metal concentrations are well within State and EPA water quality criteria for marine life (WDOE 1999), but may still be at levels that impact salmonid reproduction, growth, and survival.

Hylebos Waterway is still part of the Commencement Bay/Nearshore Tideflats Superfund site. EPA placed the site on the Superfund List or National Priorities List in 1983. Pesticides, Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs),

and metals have been detected in the Waterway at levels that can affect salmonid reproduction, growth, and survival. The Waterway is a 303(d) Category 5 assessed water for tissue samples (Chlorinated Pesticides, DDT, PAHs, and PCBs). Cleanup of contaminated sediments within the three-mile long Hylebos Waterway is currently being conducted.

Environmental Baseline Summary

Various anthropogenic features such as modified floodplains, hardened banks and levees, disruption of hydrological processes, and eliminated or decreased access to spawning and rearing areas resulting from the construction of dams, as well as agricultural and forest practices and urbanization have degraded conditions in the action area.

EFFECTS OF THE ACTION

This section addresses the effects related to construction of the proposed project, mitigation activities that are currently proposed, and operation of the new highway and associated facilities. Bull trout utilize portions of the action area year-round and are likely to be in the action area during construction and for the duration of operation of the proposed highway (in perpetuity). We assume that affected bull trout are from the lower Puyallup core area although there is a remote chance of bull trout from another core area migrating into the action area.

In- and near-stream construction activities and long-term discharge of stormwater are anticipated to adversely affect bull trout or bull trout critical habitat through the following stressors:

- Increased sedimentation
- Elevated underwater sound pressure levels
- Fish handling
- Exposure to stormwater-related pollutants
- Reduction in groundwater recharge and subsurface water exchange with the Puyallup River
- Reduced prey base

Insignificant and Discountable Effects

As noted previously, the proposed project is in a very early stage of design and few details are available on exactly how the new highway and its associated features will be constructed. A large and complex project such as this has numerous effects. To determine which of the effects were insignificant or discountable we developed an exposure matrix framework, and completed several (one for each affected listed, species and one for each designated critical habitat unit) in collaboration with the WSDOT (Appendix A). This analytical approach begins with deconstructing the action into separate components, or "actions". Once deconstructed, we determined potential exposure of bull trout and/or their critical habitat to the effects of that component by estimating the timing, duration, and frequency of the action and comparing that to what life history form (or PCE) was expected to be present. If exposure was expected, the effect was determined. Then, any applicable minimization measures proposed as part of the project were considered. In some cases, performance standards were necessary to refine the scope of the

action to a point where we could determine effects. The final column of the matrix documented what we expected to be the resulting effect, after all minimization measures and performance standards were applied.

This approach allowed us to identify those effects that were insignificant and/or discountable in a structured and transparent manner. Upon completion of the matrices for bull trout and their designated critical habitat, effects that were determined to be insignificant or discountable included vegetation removal and placement of fill in Hylebos and Wapato Creek sub-basins, construction of new impervious surface in the Wapato Creek sub-basin, fish handling and de-watering in Hylebos Creek, installation of multiple bridges in the Wapato Creek, Hylebos Creek, and Surprise Lake Tributary sub-basins, site development for implementation of the RRPs, removal of invasive vegetation in the RRPs, construction of temporary access roads, demolition of structures, utility relocation, construction of water quality facilities and outfalls in Hylebos and Wapato Creek sub-basins, stormwater quantity and quality impacts in Hylebos and Wapato Creek sub-basins, stormwater quantity impacts in the lower Puyallup River sub-basin, and placement and widening of bridges over the Puyallup River.

While the exposure matrices provided the initial structure for the effects analysis, the analysis continued to evolve after the matrices were completed as new information became available. Therefore, some of the conclusions in the matrices may differ from the effect analysis included below. Refer to Appendix A for final drafts of the matrices.

Direct Effects of the Action to Bull Trout

Construction-related effects to bull trout will occur over 13 years. Clearing, grading, and filling within the lower Puyallup sub basin will impact subsurface water flow. Wetland mitigation site development in the Puyallup sub-basin will involve in-water work, levee breaching, and long-term vegetation management (e.g. herbicide application). Bridge construction will involve placement of permanent and temporary structures that will result in habitat loss and noise disturbance. Road construction will result in increased impervious surface which will alter hydrologic patterns and increase pollutant discharge to the Puyallup.

Operational and long-term effects of the proposed project include a reduction in bull trout prey base produced in Hylebos and Wapato Creeks, and Surprise Lake Tributary resulting from the increase in impervious surface and stormwater runoff.

Direct Effects of Increased Impervious Surface to Bull Trout

Increased impervious surface will cause additional stormwater runoff, decreased groundwater recharge, and other hydrologic impacts. Because both the direct and indirect effects of the project involve increased impervious surface, additional analysis of these potential effects is contained in the "Indirect Effects" section of this Biological Opinion.

Effects of Increased Impervious Surface

A direct effect of the proposed project is conversion of approximately 220 acres of currently vacant/undeveloped (~105 acres) and agricultural land (~112 acres) to impervious surface (WSDOT 2004). This will involve placement of approximately 3,715,041 cubic yards of fill to develop the highway, weigh stations and park and ride lot. Approximately 214 acres of vegetation will be permanently removed. These quantities are broken out by affected sub-basin below:

Puyallup Sub basin
- 1,010,118 cubic yards of fill
- 70 acres of new impervious surface
- 73 acres of permanent vegetation removal

Hylebos Sub basin
- 2,257,067 cubic yards of fill
- 115 acres of new impervious surface
- 81.9 acres of permanent vegetation removal

Wapato Sub basin
- 447,856 cubic yards of fill
- 36 acres of new impervious surface
- 59.4 acres of permanent vegetation removal

The proposed conversion of land to impervious surface, placement of fill, and vegetation removal are expected to negatively affect the hydrograph of waterbodies within the action area. We expect that groundwater recharge and subsurface water exchange with the streams and rivers in the action area will be reduced. These impacts could result in reduced baseflows (in the Hylebos and Wapato sub-basins) and increased temperatures (all sub-basins). Overall, this will degrade conditions for bull trout that use the action area for foraging and migrating. These effects will be most significant for bull trout in the lower Puyallup River and will negatively impact their prey base in the other waterbodies of the action area.

Impervious surface is the major contributor to changes in watershed hydrology and drives many of the physical changes affecting urban streams (May et al. 1997). Conversion of land to impervious surface alters the duration and frequency of runoff, and decreases evapotranspiration and groundwater infiltration (May et al. 1997; Beyerlein 1999; Angermeier et al. 2004). Reduction in infiltration negatively affects hyporheic function, groundwater recharge, and subsurface water flow. For this analysis we distinguish between hyporheic flow, groundwater, and subsurface water and expect the majority of the effects to fall into the broader category of subsurface water.

Hyporheic Flow vs. Subsurface Water

A major feature typical of large alluvial floodplains is that they include a dynamic combination of stream channels and wetlands that are fed by hyporheic flow (Stanford and Ward 1993). In

alluvial rivers the physical extent of the hyporheic zone is determined by soil porosity and relative volume of water either infiltrating into groundwater from the channel, or into the channel from an aquifer (Stanford and Ward 1993). Definitions of "hyporheic zone" vary widely. Broadly, it is the ecotone where ground and surface water are linked (Baxter and Hauer 2000). The boundaries of this zone vary temporally as well as spatially (Stanford and Ward 1993; Baxter and Hauer 2000) due to hydrographic fluctuation. Some studies describe hyporheic zones as being spatially limited to no more than a few meters from the channel, while others argue that they extend laterally for kilometers (Stanford and Ward 1988). One evaluation defined the extent of the hyporheic zone by the presence of subterranean fauna, which were present up to 3 km from the channel (Stanford and Ward 1988). More recently, Fernald et al. (2001) describe the hyporheic zone as where there is movement of water from the river into the bed and banks to emerge downstream.

Some of the anticipated impacts from the proposed project may fit into a particular definition of "hyporheic", but there is overlap with what can more generally be described as "subsurface water" which can encompass groundwater, subsurface flow and hyporheic flow. Frissell (1999) proposes a method for delineating a "groundwater influence zone" by mapping specific areas defined as hyporheic channel segments, ponds and other wetlands connected to groundwater tables, depositional valley fill, convex toeslopes adjacent to channels, and concave slope features. This approach could potentially apply to the action area, but the data for this type of modeling were not available. As such, the emphasis of our analysis is on the effects to "subsurface water exchange". Each category is described in more detail below.

Effect of Increased Impervious Surface to Hyporheic Function in the Lower Puyallup River

The hyporheic zone is a transition zone between terrestrial and aquatic systems and provides habitat for a wide variety of organisms (Dahm and Valett 1996; Bolton and Shellberg 2001). Where hyporheic zones upwell into stream and river systems, thermal refugia and areas of high productivity are created (Bolton and Shellberg 2001).

In channelized river systems the effects of anthropogenic modification on hyporheic function is not well researched (Boulton et al. 1997). Simplification of streams and rivers reduces the connectivity of surface waters with the floodplain and hyporheic zone (Stanford and Ward 1993; Frissell 1999). Whether human modifications completely truncate hyporheic function or partially suppress it is poorly understood (Bolton and Shellberg 2001). In the Rhone River, France, despite intense human modification over hundreds of years, a diverse hyporheic fauna remains (Stanley and Boulton 1993). The Willamette River in Oregon has undergone impacts similar to those occurring in the lower Puyallup River (i.e., diking, forest removal, etc.). Hyporheic exchange was determined to be degraded, but still present despite these impacts (Fernald et al. 2001). It is probable that some hyporheic function remains in the lower Puyallup River despite its degraded state.

In the BA and supplemental information, FHWA and WSDOT conclude that there will be little or no impact to hyporheic function in the Puyallup River due to the degraded nature of the system and the particular soil types (Mooney 2002; FHWA and WSDOT 2006). In a technical memo to the WSDOT project team, Mooney (Mooney 2002) predicts that only "minor" impacts

to ground water regimes will result from consolidation of soils during construction of the roadway in the form of reduced horizontal and vertical hydraulic conductivity. Using consolidation test data from a nearby site, Mooney (Mooney 2002) estimated that vertical hydraulic conductivity of sands and silts will be decreased by $\leq 10\%$ and in elastic silts it will be decreased by $\geq 40\%$. However, no information was provided on how much of the project area is underlain by elastic silts and "minor" impacts are not further defined. The FEIS for the project provides some additional analysis of the effect of land use changes on hyporheic function and groundwater, but it is focused on the Hylebos and Wapato sub-basins and no modeling was done for the Puyallup Basin (FHWA and WSDOT 2006).

In a memo to the FWS addressing the potential impacts of land use conversion associated with the project, WSDOT states that, compared to historic impacts in the lower watershed (i.e., floodplain decoupling), the impacts to hyporheic function from the project will be negligible and little hyporheic function remains (2006). However, no data or rationale were provided to allow for the determination of whether, or to what extent, hyporheic function remains. Frissell (1999) states that in general, surficial simplification of floodplains for activities such as agriculture, transportation systems, and commercial structures could result in a proportional reduction of groundwater exchange and upwelling and loss of thermal refugia.

There is not enough information available to determine the extent or condition of remaining hyporheic function in the action area. However, the hydrogeomorphic setting of the lower Puyallup River, and the case studies from other rivers with severe anthropogenic modification (described above), indicate that it is likely that some level of hyporheic function remains in the action area.

Effects of Increased Impervious Surface on Subsurface Water Exchange and Groundwater Recharge

The Puyallup-White watershed is one of the fastest urbanizing watersheds in the Puget Sound region. Between 1991 and 2001 impervious surface increased 12.3 percent (Puget Sound Action Team 2007). In urban areas of the Pacific Northwest, shifting from subsurface flow to overland flow has had profound impacts to streams (Morley and Karr 2002; Wheeler et al. 2005).

Large quantities of fill are necessary for development of this project. Fill placement can compress the substrates that overlay the shallow groundwater table in the project area. The substrates in the project area are susceptible to compression which could retard subsurface water flow (FHWA and WSDOT 2006). In the project area, these subsurface flows are important to maintaining summer flows (FHWA and WSDOT 2006).

Increased impervious surface can result in lower base flows (Angermeier et al. 2004; Wheeler et al. 2005) and land use-related impacts to baseflow have been documented in the lower Puyallup (WCC 1999). Between 1973-1993 low flows in the river decreased, despite above-average precipitation during that time. This decline in flows was attributed, in part, to increases in impervious surface that have reduced groundwater input to baseflows (WCC 1999). While these effects are less pronounced when agricultural lands areas are converted to impervious surface than when forested areas are converted, detectable effects in the form of temperature increases

can occur. LeBlanc et al. (1997) modeled a watershed with a 10 km^2 catchment and found that when areas in either meadow or row crop land uses went from 0 percent to 70 percent impervious, water temperatures increased by 0.10 and 0.04°C, respectively.

In temperate climates such as ours, upwelling water is usually cooler in the summer and warmer in the winter (Baxter and Hauer 2000). These localized areas may provide thermal refuge for stenothermic (tolerant of a narrow range of temperatures) species (Frissell 1999; Baxter and Hauer 2000; Poole et al. 2001), such as bull trout. Groundwater discharge is one the most influential variables when predicting the effect of land use change on stream temperature (LeBlanc et al. 1997). Additionally, impervious surfaces increase stream temperature by collecting and heating runoff (Wheeler et al. 2005). For example, with every 1 percent increase in impervious surface, maximum daily water temperatures of streams evaluated in Wisconsin and Minnesota increased by 0.25°C (Wheeler et al. 2005).

In addition, groundwater that intersects with surface water may have a distinct chemical signature (Brinckman 2000). These chemical signatures in groundwater may guide homing behavior in bull trout (Baxter and Hauer 2000) as they do in other salmonids (Baxter and Hauer 2000; Brinckman 2000).

In 1999 the USGS studied groundwater hydrology in the Tacoma/Puyallup area. The study area was adjacent to the action area but sheds some light on hydrologic function in the Puyallup River valley in general. The floor of the Puyallup River valley is composed of coarse- to fine-grained materials that include alluvial, marine, and mudflow deposits. In general, groundwater moves towards Puget Sound and the Puyallup River. Precipitation in the study area averages 38 inches per year, and of this, 14 inches enters the ground-water system as recharge. Patterns of recharge reflected the combined effects of precipitation, surficial geology, land use, and type of sewage disposal. The lowest amounts of recharge corresponded with the geographic distribution of urbanization and sewer systems. Groundwater runoff in the study area was estimated to range from 0 to greater than 25 inches/year with an average of 14.1 inches/year. Groundwater that is not captured for domestic and public-supply use generally discharges into one of the creeks, the Puyallup River, Commencement Bay, and Puget Sound at a rate of 11 inches per year. Another 4.5 inches per year is withdrawn from wells (Jones et al. 2006).

Our conclusion, based on our review of the literature, is that although there are no longer any tributaries draining directly to the Puyallup River on the north bank, it is likely that there are subsurface groundwater discharges to the Puyallup River and that there is groundwater exchange in wetlands along the north bank of the river such as the Oxbow Wetland. Impacts from impervious surface to groundwater recharge and exchange within the action would result in reduced subsurface water exchange and groundwater recharge in the lower Puyallup River and other waterbodies in the action area.

Determining the Effect of the Proposed Project on Subsurface Flow and Groundwater Recharge

We evaluated the amount of subsurface flow and groundwater recharge that may be affected by the proposed project in the lower Puyallup sub-basin where no stormwater flow control proposed. Using data in Beyerlein (1999) we compared a baseline condition consisting primarily

of agricultural lands to that of the estimated amount of impervious surface resulting from the direct and indirect effects of the proposed project. In Beyerlein's framework, precipitation that falls onto land is divided into surface runoff, subsurface flow, groundwater recharge, or evapotranspiration (Table 4). The framework assumes 40.7 inches (3.39 ft) of rain per year (from data taken at SeaTac airport), which is very close to that which occurs in the action area.

Table 4. Division of Average Annual Precipitation in Inches Based on SeaTac Airport Precipitation Records (1945-1996) (Beyerlein 1999).

Land Use	Surface Runoff	Subsurface Flow	Groundwater	Evapotranspiration
Forest	**0.09**	**8.46**	**13.4**	**18.79**
Pasture	**0.29**	**13.26**	**10.15**	**17.02**
Lawn	**0.61**	**16.72**	**8.89**	**14.48**
Suburban residential	**9.3**	**12.37**	**6.58**	**12.44**
Commercial	**29.37**	**2.34**	**1.24**	**7.74**
Impervious	**34.05**	**0**	**0**	**6.64**

Table 4 illustrates the loss in subsurface flow and groundwater recharge that occurs with conversion of pervious surface (e.g., forest and pasture) to impervious surface and how that is converted to surface runoff. Based on the above, we determined that the addition of 70 acres of new impervious surface (3,049,200 s.f. x 3.394 inches of precipitation) will affect 10,348,985 cubic ft of water.

We then calculated change in volumes associated with the different hydrologic functions (i.e., surface flow, subsurface flow, groundwater and evapotranspiration) resulting from the direct effects of the proposed project (Table 5).

Table 5. Volumes (c.f.) Associated with Conversion of Pasture to Impervious Surface as a Result of the Direct Effects.

Land Use	Surface Runoff	Subsurface Flow	Groundwater	Evapotranspiration
Pasture (Baseline) (70 acres)	**73,478**	**3,369,630**	**2,580,002**	**4,325,876**
Impervious (Direct) (70 acres)	**8,660,030**	**0.00**	**0.00**	**1,688,954**
Annual Net Change	**8,586,553**	**-3,369,630**	**-2,580,002**	**-2,636,921**

To reduce these effects, WSDOT added several compost-amended vegetated filter strips (CAVFS) and flow dispersion BMPs to the Puyallup River sub-basin and then provided us with a revised analysis of the hydrologic impacts. In their revised analysis they incorporated the water budget data from Beyerlein and modeled existing and post-project conditions using a Hydrological Simulation Program-Fortran. The modeling results concludes that the annual infiltration volume is approximately equivalent before and after the project (Fuchs 2007).

The revised WSDOT analysis differs from our original analysis in four primary ways: 1) the WSDOT method uses an analysis area of 170.8 acres to address the project footprint, which includes lands which would be replanted with vegetation (vs. 70 acres of impervious surface); 2) it lumps interflow with surface runoff, 2) it modified the land use category that Beyerlein uses called "pasture" to "tilled farmland", and 3) it factors in the addition of the CAVFS with a very high assumed effectiveness rating (i.e., more than twice the infiltration to deep groundwater and less than half the interflow + runoff of a forested condition).

While the addition of CAVFS will improve infiltration over what was originally proposed for the Puyallup River sub-basin (see "Project Description"), and we support their use, we do not expect that this approach will completely offset impacts to groundwater recharge, runoff rates, and subsurface flow exchange. Because CAVFS are new there is a lack of actual monitoring data documenting their effectiveness. Effectiveness is calculated by subtracting computed stormflow and computed evapotranspiration. However, we are not aware of any calibration of streamflow measurements to indicate how much of the disrupted surface runoff actually goes into interflow versus deep infiltration. CAVFS are assumed to provide deep infiltration. However, deep infiltration is facilitated by an organic-enriched soil mantle containing live roots and animal-generated pores like that found in a mature forest. These conditions are not created by CAVFS. Additionally, since the CAVFS will accumulate fine sediment and pollutants from runoff it appears that regular maintenance will be needed to ensure that the predicted amount of infiltration can continue over time. Based on the above, we expect that the WSDOT model overestimates the effectiveness of the CAVFS at recovering deep infiltration capacity.

Although CAVFS are designed, in part, to mimic natural forest conditions by reducing runoff and interflow, there are important differences in the timing of discharge. The CAVFS are expected to discharge shortly after a storm (during the wet season) whereas forests can retain water into the summer low flow period when it supports important ecological functions.

We expect that the new impervious surface resulting from the direct effects of the proposed project will intercept and convey precipitation that is currently infiltrated. As a result, subsurface water exchange with the lower Puyallup River will be reduced. By comparing annual runoff volumes associated with tilled farmland and impervious land use, we anticipate that the direct effects will reduce subsurface water exchange with the lower Puyallup River.

Effects of Increased Impervious Surface on Bull Trout

Impervious surface results in physical and chemical changes that influence aquatic systems (Angermeier et al. 2004; Wheeler et al. 2005) to the extent that the relationship between urbanization and decreased fish abundance is well documented (Angermeier et al. 2004).

Urbanized watersheds typically have low species diversity because their biota must be able to tolerate more extreme variation in water flow, increased temperatures, and decreased food availability (Angermeier et al. 2004). As urbanization alters aquatic thermal regimes the health and distribution of fish populations are affected (Poole et al. 2001). This is of concern for migratory bull trout as they are particularly dependent on thermal refugia maintained by surface and groundwater exchanges (Frissell 1999).

Bull trout utilize the lower Puyallup River year-round for foraging, migrating, and overwintering. Recent radio-telemetry work has documented that bull trout spend more time in the lower Puyallup than previously thought (weeks rather than days). Radio-tagged bull trout were found at the mouth of Clear Creek (see "Status of Bull Trout in the Action Area), a tributary to the Puyallup River at RM 2.9 within the action area. These fish stayed near the mouth of the creek into early August before moving upstream (Jeanes 2006b, in litt). Clear Creek is supported by groundwater and temperatures are lower than commonly found in lowland Puget Sound streams (Pierce County Public Works 2006). In August and September of 2001 instream temperatures ranged from 9.5 °C to 12.5 °C (Pierce County Public Works 2006). In contrast, the mean temperature in the mainstem Puyallup at the bridge site from July through September, 2005, was 14.0 °C and the 6-year maximum temperature recorded at that site was 16.5 °C (WDOE 2006b).

Salmonid survival requires a variety of cold water temperatures that are well-distributed over space and time (Poole et al. 2001). Constant temperatures above 16 °C are intolerable for bull trout (Poole et al. 2001). For migratory corridors, bull trout typically prefer water temperatures ranging between 10 ° and 12 °C (McPhail and Murray 1979; Buchanan and Gregory 1997). Bull trout will migrate through higher temperatures by utilizing areas of thermal refuge such as a confluence with a cold water tributary (Swanberg 1997), deep pools, or locations with surface and groundwater exchanges. Swanberg (1997) observed bull trout holding for extended periods during summer in coldwater refugia at the mouths of tributary streams. These areas are regarded as necessary for bull trout survival (Frissell 1999). Even small, isolated pockets of groundwater are of local importance for the persistence of bull trout (Frissell 1999; Poole et al. 2001). As such, maintenance of thermal refugia is a key component to habitat access for bull trout. In disturbed systems, these localized areas of refugia may be widely separated (Frissell 1999) as appears to be the case in the lower Puyallup River. As habitat conditions in surface water deteriorate (i.e., through summer warming), increasing dependence on groundwater-influenced habitats is a predictable response (Buchanan and Gregory 1997).

Bull trout may utilize areas such as the mouth of Clear Creek, as well as other areas of localized groundwater input, as refugia from high temperatures in the Puyallup. Given the degraded nature of the baseline in the lower Puyallup River, such areas provide critical "stepping stones" to upstream habitat. As these "stepping stones" are degraded and/or eliminated, the ability of the river to support migratory bull trout, especially the anadromous life history form, is further reduced. Ultimately, this could lead to reduced survivorship during periods of temperature extremes (Poole et al. 2001), increased isolation of bull trout from the upper watershed, and increased risk of local population extinction (Fahrig and Merriam 1994; Poole et al. 2001). Additionally, these effects could reduce foraging habitat for other Puget Sound bull trout populations that utilize the lower Puyallup River since anadromous bull trout commonly migrate

and forage outside of their natal basins and this behavior has been documented in other parts of Puget Sound (Goetz et al. 2004).

Reduction in groundwater recharge and subsurface water exchange will be proportional to the amount of added impervious surface resulting from the project. This is expected to reduce baseflows in the Hylebos and Wapato sub-basins; degrade thermal refugia in the lower Puyallup River; and increase water temperatures in the lower Puyallup, Hylebos and Wapato sub-basins.

Adult and sub-adult bull trout would be exposed to these effects in the lower Puyallup River and their prey base would be affected in all other surface water bodies in the action area. Effects are expected over two general time scales. The effect of a reduction in subsurface water exchange is expected to occur in a timeframe of days to weeks following the placement of fill and conversion to impervious surface. The effect of a reduction in groundwater recharge is expected to occur on a time scale of years after the initial impact. Both of these effects are expected to continue in perpetuity. These reductions in subsurface flow are expected to degrade areas of thermal refugia along the north bank of the Puyallup River in the action area. Such coldwater patches are used to some extent by migratory juvenile bull trout (age 1-4 years), but are more widely used by migratory subadult and adult bull trout (Frissell 1999).

Temporally small-scale (weekly or daily) variability in temperature can have important effects on chronic or acute thermal stress and behaviors such as migration and habitat selection (Poole et al. 2001). Spatially, thermal refuges may be found at a fine scale (e.g., pockets of cold water from localized ground water upwelling) to coarse scale (e.g., thermal variation between tributaries and mainstem rivers) (Poole et al. 2001). As water moves downstream through urbanized watersheds (such as the lower Puyallup) heat accumulates unless there are downstream conditions (e.g., riparian vegetation, geomorphology, etc.) present to allow the accumulated heat to dissipate out of the system (Poole et al. 2001).

Degraded thermal refugia and increased water temperatures will result in exposure of bull trout to sub-optimal temperatures. Temperature acts synergistically with other stressors, negatively affecting the ability of individual fish to survive and reproduce (Poole et al. 2001). Very high temperatures can cause direct mortality; however, temperatures in the range of causing sublethal effects are more widespread (Poole et al. 2001).

Salmonid life stages that are critically affected by temperature include smoltification, migration, and pre-spawn holding (Poole et al. 2001). Bull trout will utilize the action area during these life stages and may be exposed to increased temperatures. When adult fish hold in warm stream reaches they are subjected to bioenergetic stress that can impair spawning success by decreasing gamete viability (Poole et al. 2001). Prolonged holding under higher than optimum temperatures can result in death from multiple stressors such as concurrent thermal stress, disease, and energy depletion (Poole et al. 2001). High temperatures can create a thermal barrier to adult migration (Poole et al. 2001). If enough fish are affected, population-level effects may be seen (Poole et al. 2001). Small increases in temperature (e.g., 2-3 °C) above optimal ranges have been shown to reduce salmonid fitness (Poole et al. 2001).

Similar effects to those described above are expected to occur in fish species that comprise the prey base for bull trout in the lower Puyallup River. In their biological opinion on the proposed project, NOAA (2007) determined that the effects of increased impervious surface would adversely affect Chinook salmon. Adverse effects to fish that comprise the prey base for bull trout could result in reduced foraging efficiency and increased energetic costs for bull trout in the lower Puyallup River.

Conclusion

Bull trout foraging, migrating, and overwintering habitat will be permanently degraded as a result of increased impervious surface. The loss of vegetation, placement of fill, and conversion to impervious surface will negatively impact the hydrologic function of the lower Puyallup River. Over time, the proposed project will reduce the quality of thermal refugia, reduce the foraging effectiveness of bull trout in the action area, and result in increased energetic costs for bull trout. These effects are expected to occur incrementally over time, in perpetuity. The loss of vegetation, placement of fill, and conversion to impervious surface will negatively impact the hydrologic function of the Wapato and Hylebos sub-basins. Impacts in those basins will be at least partially offset through implementation of the RRP. We expect that exposure to the combined effects of increased temperatures, loss of thermal refugia, and a smaller prey base will reduce bull trout numbers in the action area and result in reduced fitness of spawners.

Direct Effects of Stormwater Discharge on Bull Trout

Highways collect a variety of pollutants from traffic and are disproportionate contributors to overall pollutant loads in waterbodies (Wheeler et al. 2005). Pollutants are mobilized by runoff water and are transported to streams and rivers. Traffic residue contains several metals including iron, zinc, lead, cadmium, nickel, copper, and chromium (Wheeler et al. 2005). These metals come off disintegrating tires, brake pads, and other vehicle parts and accumulate in roadside dust and soil (Wheeler et al. 2005).

Stormwater-Related Pollutants

The proposed project will create new PGIS where none currently exists and will accommodate new traffic. Even with treatment, the new PGIS and the attendant traffic will result in the delivery of additional pollutants to waterbodies within the action area. Stormwater effluent within the action area will change the concentrations and loading of pollutants to the Puyallup River, Hylebos Creek, Surprise Lake Drain, and the Blair and the Hylebos Waterway portions of Commencement Bay. To help minimize the effects of these pollutants, the following performance standard was proposed as part of the project for all water quality BMPs:

- Basic Treatment = At least 80 percent removal of TSS
- Enhanced Treatment = Basic Treatment plus effluent concentrations not to exceed the following values 90 percent of the time at the point of discharge:
    - Total copper: 12 μg/L
    - Dissolved copper: 7.8 μg/L

- Total zinc: 67 μg/L
- Dissolved zinc: 44.8 μg/L

However, these concentrations exceed thresholds of effects to listed fish as described below. Stormwater runoff from roads conveys pollutants, sometimes at concentrations that are toxic to fish (Spence et al. 1996). The relative success of removing pollutants from stormwater runoff depends upon the treatment technology used, and maintenance of treatment facilities. Studies indicate variability among different treatment applications (Schueler 1987; Hayes et al. 1996; Young et al. 1996).

Stormwater-delivered pollutants can affect the physiology and/or behavior of salmonids in ways that reduce growth, migratory success, reproduction, and cause death. The likelihood and extent of effects on bull trout from the discharge of roadway pollutants to surface waters can vary spatially and temporally. Effects are influenced by background water quality conditions, life stage of the fish, duration of exposure, concentration and relative toxicity of the pollutants, and concurrent discharges and/or background levels of other contaminants.

The main pollutants of concern in this consultation are heavy metals from vehicle sources (EPA 1980). Additionally PAHs from urbanized areas (Van Metre et al. 2000; Kayhanian et al. 2003) can have long-term deleterious effects on salmonids (Peterson et al. 2003). Finally, roads can also deliver pesticides to surface waters, although levels of these pollutants obviously do not correlate with ADT or road drainage area (Kayhanian et al. 2003).

Exposure of Bull Trout to Pollutants

In addition to upstream migrating adults, sub-adult and adult bull trout may be in the action area year-round and are known to hold downstream of the Puyallup River Bridge during the warm summer months. The level of exposure of bull trout to pollutants, and the lifestage that is exposed will vary, depending on time of year. Most migratory bull trout in the lower Puyallup River will encounter project-related stormwater outfall mixing zones at some point in their lives since they may pass through the area 20 or more times over a 10-year life span. The risk from exposure is greatest during low flow periods. Although adults that are migrating upstream to spawn during June and July usually pass through lower rivers in a matter of a few days (Goetz et al. 2004), exposure during this time of year will occur when water quality is poor, temperatures are high, and the fish are producing gametes. However, stormwater discharge is least likely during this time of year.

We rely on toxicity data for other salmonids when specific information on toxicity to bull trout isnot available. Fish species in the Salmonidae family are considered more suitable as surrogates for bull trout than non-salmonids (due to their taxonomic similarity), although Hansen et al. (2002b) demonstrated that even though other salmonids may be taxonomically similar to bull trout, the sensitivities to chemicals and/or chemical mixtures may differ. In general, however, we anticipate that other salmonids will react in a more similar manner to chemical exposure than non-salmonid species. Therefore, if no specific information is available regarding bull trout, we have assumed that those species which are most closely related to bull trout share similar

sensitivities. We have relied on toxicity data for species in the following preferential order: species (bull trout) > genus (*Salvelinus*) > family (Salmonidae). Rainbow trout are the primary species used by EPA to develop toxicity data for regulatory purposes; hence, the majority of data generated are based on rainbow trout, which are in the family Salmonidae.

The most commonly reported end points in the toxicity literature are for concentration levels at which 50 percent of the organisms died (LC50). This indicates that lethal concentrations which affect a smaller (i.e. LC10) percentage of the test population may occur at lower/untested concentrations. A sublethal and/or lethal effect to only one bull trout would be considered an adverse effect to the species.

Toxicity of many compounds to aquatic organisms varies with water hardness, alkalinity, the type and life stage of organisms, presence of organic matter, presence of other toxicants, and the duration of exposure. In addition, mixtures of compounds with the same toxic mechanism of action can have a combined effect on the test species, increasing or decreasing overall toxicity. Yet, chemical mixtures are rarely tested due to the complexity of responses to combinations of individual chemicals.

There are three known physiological pathways of metal exposure and uptake within salmonids: 1) gill surfaces can uptake metal ions which are then rapidly delivered to biological proteins (Niyogi et al. 2004), 2) olfaction (sense of smell) receptor neurons (Baldwin et al. 2003), and 3) dietary uptake. Of these three pathways, the mechanism of dietary uptake of metals is least understood. For dissolved metals, the most direct pathway to aquatic organisms is through the gills (WCC 1999).

Measurement of total recoverable metals concentrations include a fraction of metal that is bound to suspended solids, and/or is complexed with organic matter or other ligands and therefore is not available to bind to gill receptor sites. As such, most metal toxicity studies are based on the dissolved fraction of the metal because it approximates the most immediately bio-available fraction and toxicity. Metals bound to sediment remain biologically relevant because they may be incidentally ingested by water column organisms or be accumulated by benthic organisms that are in turn prey sources for salmonids. Relative toxicity of metals can be altered by hardness, water temperature, pH, organic content, phosphate concentration, suspended solids, and presence of other metals. Water hardness affects the bio-available fraction of metals from gill surfaces, as hardness increases; metals become less bio-available and therefore less toxic (WCC 1999; Hansen et al. 2002b; Niyogi et al. 2004). However, Baldwin et al. (2003) did not find any influence of water hardness on the inhibiting effect of copper on salmon olfactory functions. Olfactory inhibition can decrease the ability of salmonids to recognize predators and navigate back to natal streams for spawning (Baldwin et al. 2003).

Types and Concentrations of Metals to Which Bull Trout will be Exposed

To predict the concentrations of pollutants generated by existing untreated PGIS as well as new and retrofitted PGIS, the WSDOT used the "FHWA method" referenced in WSDOTs Environmental Procedure Manual (WSDOT 2003a). The FHWA method "...was developed specifically for assessment of impacts from roadway projects, and as a consequence may be the

most appropriate model…" (WSDOT 2003a). This method uses estimates of average pollutant concentrations that are based on a limited data set to provide a general estimate of plausible stormwater pollutant concentrations at the TDA scale.

Stormwater from existing PGIS within the action area already contains concentration of copper, zinc, cadmium, and chromium. These levels will change with the addition of new PGIS. Table 6 presents a modeling analysis by the WSDOT of pre- (existing PGIS) and post-project (existing, retrofitted, removed, and new PGIS) stormwater pollutant concentrations at the point of discharge throughout the action area by TDA. In the Fife Ditch, Hylebos Creek, and Puyallup River TDAs, and within all waterbodies combined, the retrofit of approximately 24 acres of existing PGIS is expected to decrease the concentrations of TSS, and total and dissolved copper and zinc down to the performance standard. In the remainder of the TDAs where new PGIS will be installed, and there is no existing PGIS to retrofit, concentrations of pollutants are expected to meet the project's performance standards

Table 6. Pre- and Post-Project Pollutant Concentrations on Zinc (Zn) and Copper (Cu) and Net Change by TDA.

TDA		**Pollutant Concentration (µg/L)[4]**				
		TSS[5]	**Tot. Zn**	**Diss. Zn**	**Tot. Cu**	**Diss. Cu**
Erdahl Ditch	Pre-project					
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**14.00**	**67.00**	**44.80**	**12.00**	**7.80**
Wapato Creek[1]	Pre-project					
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**14.00**	**67.00**	**44.80**	**12.00**	**7.80**
Fife Ditch[2]	Pre-project	192.00	350.00	110.00	59.00	14.00
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**-178.00**	**-283.00**	**-65.20**	**-47.00**	**-6.20**
Hylebos Creek[3]	Pre-project	192.00	350.00	110.00	59.00	14.00
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**-178.00**	**-283.00**	**-65.20**	**-47.00**	**-6.20**
Surprise Lake Trib.	Pre-project					
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**14.00**	**67.00**	**44.80**	**12.00**	**7.80**
Oxbow Lake Ditch	Pre-project					
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**14.00**	**67.00**	**44.80**	**12.00**	**7.80**
Puyallup River	Pre-project	192.00	350.00	110.00	59.00	14.00
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**-178.00**	**-283.00**	**-65.20**	**-47.00**	**-6.20**
All Waterbodies	Pre-project	192.00	350.00	110.00	59.00	14.00
	Post-Project	14.00	67.00	44.80	12.00	7.80
	Net Change	**-178.00**	**-283.00**	**-65.20**	**-47.00**	**-6.20**

[1] Combines PGIS from two non-listed Fish bearing TDAs. Pollutant loading from at least the downstream TDA will likely affect PS Chinook salmon inhabiting the Blair Waterway and Commencement Bay.
[2] Combines PGIS from two non-listed Fish bearing TDAs.
[3] Combines PGIS from three listed fish-bearing TDAs.
[4] The pollutant concentrations were derived from data on influent and effluent concentrations for multiple stormwater quality BMPs contained in the 2005 WSDOT NPDES Report (2005)
[5] Total Suspended Solids

Copper

Copper is acutely toxic to fish, even at low concentrations. Typical effects of copper exposure include 1) impaired disease resistance, 2) disrupted migration (via avoidance behavior of copper-contaminated areas, 3) hyperactivity, 4) impaired respiration, 5) disrupted osmoregulation, 6) pathology of kidneys, liver, and gills, 7) impaired function of olfactory organs and brain, 8) altered blood chemistry, and 9) enzyme activity that has been documented in fish exposed to copper (Eisler 1998).

Baldwin et al. (2003) demonstrated that short pulses of dissolved copper at concentrations as low as 2 μg/L reduced olfactory sensory responsiveness by approximately 10 percent within 10 minutes and by 25 percent within 30 minutes. At 10 μg/L (a concentration that could occur in outfall effluent), responsiveness was reduced by 67 percent within 30 minutes, an exposure time that is less than is typical of discharge times for BMP outfalls. The effects of short-term copper exposure persist for hours and possibly longer. Although salmonids will actively avoid copper, if they are unable to do so, olfactory function will be impaired within minutes of exposure. The study identified a copper concentration neurotoxic threshold of an increase of 2.3 to 3.0 μg/L, when background levels are 3.0 μg/L or less, as sufficient to cause olfactory inhibition. They also referenced three studies that reported copper exposures of over 4 hours that resulted in cell death of olfactory receptor neurons in rainbow trout, and Atlantic and Chinook salmon. Baldwin et al. (2003) determined that water hardness did not influence the toxicity of copper to coho salmon sensory neurons.

The avoidance of a chemical plume can cause a fish to leave refugia and to occupy less suitable habitat, increasing the chances of predation and decreasing their ability to find prey. Folmar (1976) observed avoidance responses in rainbow trout fry when exposed to a Lowest Observed Effect Concentration of 0.1 μg/L of dissolved copper (hardness of 90 mg/L). The EPA (1980) also documented avoidance by rainbow trout fry of dissolved copper concentrations as low as 0.1 μg/L during a 1 hour exposure, as well as a LC_{10} for smolts exposed to 7.0 μg/L for 200 hours, and a LC_{10} for juveniles in the swim-up stage exposed to 9.0 μg/L for 200 hours.

Sprague (1964) and Sprague and Ramsay (1965) reported the Incipient Lethal Level for dissolved copper to be 48 μg/L and 32 μg/L at water hardness of 20 and 14 mg/L, respectively. The Incipient Lethal Level is that concentration which is required to kill half of the fish tested within 1 week of exposure. Their experiment did not account for fish that are able to survive 1 week, but subsequently die due to exposure. Sprague and Ramsay (1965) found that higher concentrations of copper killed juvenile salmon much more rapidly than lower concentrations at 14 mg/L hardness.

The WDOE (2006a) reported ambient dissolved copper concentrations in the Puyallup River as high as 0.95 μg/L , which is below the 3.0 μg/L background level limit where the 2.3-3.0 μg/L neurotoxic threshold sufficient to cause olfactory inhibition is observed (Baldwin et al. 2003). The WSDOTs pollutant concentration modeling, which is based on their NPDES monitoring data, estimated pre-project concentrations of dissolved copper of up to 14.0 μg/L and post-project concentrations of 7.8 μg/L. Under the proposed action, stormwater BMP effluent concentrations of 7.8 μg/L 90 percent of the time at the point of discharge, will be 3.4 times the lower limit of the above neurotoxic effects threshold. These levels would be exceeded in the mixing zones (300 ft downstream) at the two outfalls in the Puyallup River (see description of mixing zone in "Relevance of Water Quality Standards" section below). Exposures to these concentrations for durations as short as 10 minutes are sufficient to significantly decrease the ability of juvenile Chinook to recognize and avoid predators and navigate back to natal streams as adults to spawn, resulting in lower spawning and increased predation on them. These concentrations exceed the LC_{10} concentration for smolt stage rainbow trout; however the duration of the exposure would likely be too short to result in mortality.

The WDOE (1999) reported median ambient dissolved copper concentrations in the surface waters of the Blair Waterway of 0.81 μg/L and 1.6 μg/L in the Hylebos Waterway, again below the background levels attendant to the neurotoxic threshold sufficient to cause olfactory inhibition. In an effort to estimate the concentrations of dissolved copper that would be added to this estuarine environmental baseline following receiving water dilution, the WSDOT modeled pollutant concentrations using the WDOEs RIVPLUM and TSDCALC spreadsheets which predict dilution and pollutant concentrations in mixing zones (Ludwa 2006a). The WDOEs spreadsheets do not account for pollutant mixtures or the synergistic effects of multiple pollutants. Modeled pollutant concentrations do not reflect a worst case scenario for listed fish and are likely too low, as the WSDOT maximized dilution by employing the 2-year discharge in the receiving water body and the 10-year discharge off the project's PGIS. The WSDOTs dilution modeling analyses indicated that concentrations of dissolved copper in the upper reaches of both the Blair and the Hylebos Waterway, at background levels below the 3.0 μg/L limit, would exceed the lower limit of the neurotoxic effects threshold (Ludwa 2006a). However, concentrations will likely be diluted below the 2.3 μg/L effects threshold to bull trout and other salmonids within a short distance from entering the waterways, owing to the large volume of water and significant daily tidal exchange within the waterways.

We have no data to predict whether adult bull trout would be more or less sensitive to copper than juvenile fish. However, it is likely that juvenile or subadult bull trout and juvenile salmon (prey species) that are exposed to the mixing zone may incur harm from cell damage and/or may experience an increased risk of predation due to inhibited predator avoidance behavior. Bull trout that avoid the mixing zone will be precluded from a portion of the channel, reducing foraging opportunities, increasing the risk of predation, and/or creating thermal stress during warmer weather. Compromising bull trout use of a portion of the river is anticipated to significantly impair normal behaviors. Furthermore, effects of copper on juvenile salmon may adversely affect bull trout by reducing prey resources.

Zinc

Zinc occurs naturally in the environment and is an essential trace element for most organisms. Toxicity of zinc to aquatic organisms is dependent on water hardness, pH, dissolved oxygen, presence of mixtures, and trophic level (Eisler 1993). Toxicity of zinc can be altered by a number of factors including temperature, pH, organic matter, phosphate, suspended solid concentration, the presence of mixtures, and duration of exposure (Eisler 1993). Bioavailability of zinc is increased under conditions of high dissolved oxygen, low salinity, low pH, and high levels of inorganic oxides and humic substances (Eisler 1993). Most of the zinc introduced into aquatic environments is eventually partitioned into sediments (Eisler 1993).

Zinc exposure has resulted in the destruction of gill epithelium, consequent tissue hypoxia, and potential lethality (Eisler 1993). In fish, sublethal effects of zinc have been associated with the following: altered behavior, blood and serum chemistry, and liver enzyme activity (Hilmy et al. 1987a; Hilmy et al. 1987b); interference with gall bladder and gill metabolism (Eisler 1993), and altered immune response (Ghanmi et al. 1989). Zinc has also resulted in reduced growth, altered avoidance behavior, impaired reproduction, increased respiration, decreased swimming ability, increased jaw and branchial abnormalities, hyperactivity, hyperglycemia, and reduced survival in freshwater fish (Eisler 1993).

Hansen et al. (2002b) measured the 120-day lethal concentrations of zinc to bull trout and rainbow trout fry. Multiple pairs of zinc tests were performed with a nominal pH of 7.5, hardness of 30 mg/L, and a temperature of 8 °C. The bull trout LC50 values under these conditions ranged from 35.6 to 80 µg/L with an average of 56.1 µg/L. These tests determined that rainbow trout fry were more sensitive to zinc (lower LC50) than bull trout fry. They also determined that older, more active juvenile bull trout were more sensitive than younger, more docile juvenile bull trout based on observed changes in behavior at the juvenile life stage. The authors concluded that the timing of zinc (and cadmium) exposure with the activity level of the fish is germane to predicting toxicity in the field. Since active feeding and increased metabolic activity are apparently related to sensitivity, we assume that adult and subadult bull trout will also be sensitive to zinc toxicity. However, it is unknown if there is a difference in sensitivity to zinc between adult, subadult, and juvenile bull trout. Activity level may be a better indicator of sensitivity than age.

The mode of action for zinc toxicity relates to net loss of calcium. Zinc appears to reduce calcium uptake, although this effect is reversible once the fish is placed in clean water. The apparent difference in sensitivity between rainbow trout and bull trout may be due to the lesser susceptibility of bull trout to calcium loss. Hansen et al. (Hansen et al. 2002b) state that differences in sensitivity between these two salmonids may relate to different physiological strategies for calcium regulation. These strategies may include structurally different gills, differences in calcium uptake mechanisms, or resistance to calcium loss.

Sublethal endpoints have been evaluated in toxicity tests with rainbow trout, but not with bull trout. These sublethal data are available for both juvenile and adult rainbow trout (EPA 1980, EPA 1987, Spear 1981, all cited in Eisler 1993). When comparing toxicity test results between juvenile and adult rainbow trout, it is apparent that juveniles are more sensitive. When making

general comparisons between lethal and sublethal endpoints tested on juvenile rainbow trout, the sublethal effects occur at concentrations approximately 75 percent less (5.6 μg/L) than lethal effects (24 μg/L) (Eisler 1993; Hansen et al. 2002b).

The lowest sublethal zinc concentration (5.6 μg/L) resulted in avoidance of the plume. Hansen et al. (Hansen et al. 2002b) identified the sensitivity ranges for bull trout and rainbow trout from 25 to 55 percent. Given this difference in sensitivity, one might expect bull trout to avoid a zinc plume if the zinc concentration ranged between 6.7 to 8.7 μg/L. However, because stormwater effluent contains of a mixture of chemicals, some of which are known to affect the olfactory system (e.g. copper), we cannot assume that bull trout will be able to detect and potentially avoid the mixing zone.

Ambient dissolved zinc concentrations in the Puyallup River can be as high as 4.1 μg/L (WDOE 2006b), which is between the 3.0 μg/L and 13.0 μg/L background level limit related to the behavioral avoidance threshold in rainbow trout (5.6 μg/L). This is likely an accurate characterization of the environmental baseline for dissolved zinc in the project area since WDOEs sampling location is just downstream of the existing terminus of SR 167. The WSDOTs pollutant concentration modeling, based on NPDES monitoring data, estimated pre-project concentrations of dissolved zinc of up to 110.0 μg/L and post-project concentrations of 44.8 μg/L. Under the proposed action, stormwater BMP effluent concentrations of 44.8 μg/L 90 percent of the time at the point of discharge will be eight times above the behavioral avoidance concentration in rainbow trout (5.6 μg/L). These concentrations exceed the LC_{50} concentration for juvenile bull and rainbow trout; with applicable pHs, hardness and temperatures, although the expected duration of exposure would likely be too short to result in mortality.

The WDOE reported median dissolved zinc concentrations in surface waters of the Blair Waterway of 3.7 μg/L and 11.6 μg/L in the Hylebos Waterway, which are between the 3.0 μg/L and 13.0 μg/L background level limit attendant to the behavioral avoidance concentration for rainbow trout. Using the dilution modeling method described above, the WSDOT again indicated that concentrations of dissolved zinc in the upper reaches of the Blair and the Hylebos Waterway, at background levels between the 3.0 μg/L an 13.0 μg/L limit,, would exceed the behavioral avoidance concentration (Ludwa 2006a; Ludwa 2006b).

Subadult and juvenile bull trout reside in the action area during the summer months when warmer temperatures increase the risk of effects from exposure to zinc in the effluent plume. We anticipate that those bull trout exposed to zinc in the mixing zone for several days may experience impaired calcium uptake. Other bull trout that avoid the mixing zone will be precluded from a portion of the channel, reducing foraging opportunities, increasing the risk of predation, and/or creating thermal stress to bull trout during warmer weather. Compromising bull trout use of a portion of the river, especially during low flow periods, is anticipated to significantly impair normal behaviors.

Cadmium and Chromium in Highway Runoff

Traffic residue contains multiple metals including iron, zinc, lead, cadmium, nickel, copper, and chromium. There is currently more information regarding the presence of zinc and copper in

highway runoff, and therefore the potential effect of these metals on fish. However, there is some general information on the effects of cadmium and chromium on fish and aquatic organisms.

Cadmium is considered one of the most toxic of metals to fish (Sorensen 1991). Typical effects of cadmium toxicity to freshwater organisms include spinal deformities, inhibited respiration, immune response, temporary immobility, decreased growth, inhibited reproduction, decreased survival, and population alterations (Sorensen 1991; Brent and Herricks 1998; Sanchez-Dardon et al. 1999). Hansen et al. (2002a) investigated sublethal effects from cadmium exposure on bull trout. They determined that exposure to 0.786 μg/L cadmium caused a 37 percent increase in mortality and a 28 percent reduction in weight in test fish. The 120-hour lethal LC50 for cadmium in juvenile bull trout in a mixture was 0.83 μg/L (Hansen et al. 2002a). Cicmanec and Jackson (2001) reviewed long-term, sub-lethal tests conducted with rainbow and brown trout. The No Observed Effect Concentrations (NOECs) ranged from 3.4 to 9.3 μg/L.

At high concentrations, chromium is a mutagen, teratogen, and carcinogen (Eisler 1986). Chromium toxicity to aquatic biota is significantly influenced by abiotic variables such as water hardness, temperature, pH, salinity, and species, life stage, and presence of mixtures (Eisler 1986). Sensitivity to chromium varies widely, even among closely related species. Effects of chromium toxicity to freshwater organisms include reduced survival in freshwater invertebrates (including molluscs), reduced growth and disease resistance, behavioral modifications, disrupted feeding, cell damage in the gills, osmoregulatory upset in outmigrating smolts, and reduced reproduction and survival in freshwater fish (Eisler 1986).

Stevens and Chapman (1984) conducted early life stage tests with rainbow trout to evaluate lethal and sub-lethal effects from exposure to Chromium+3 (the less toxic of the two forms of Chromium that can be found in stormwater). Reductions in survival were observed during chronic exposures of 89 and 157μg/L. The authors concluded that the chronic toxicity threshold was bounded by a 30μg/L No Observed Adverse Affect Level and an unacceptable toxic concentration of 157μg/L.

These studies indicate that measurable impacts to growth, survival, reproduction, and/or metabolism may occur for bull trout from stormwater effluent containing cadmium and chromium. Unknowns remaining for the proposed project include what baseline concentrations of cadmium and chromium are for the lower Puyallup River and what the project's contribution will be when stormwater is discharged post-treatment. Stormwater treatment techniques may be somewhat effective at removing cadmium from highway runoff. The WSDOT monitored a suite of BMPs and found that the reduction in total cadmium ranged from 36 to 86 percent and reduction in dissolved cadmium ranged from increasing to a decrease of 62 percent. The WSDOT concluded that "with treatment" 98 percent of their samples met State standards for dissolved cadmium (FHWA and WSDOT 2006). In this case, "treatment" refers to basic treatment levels. The proposed project will involve both basic and enhanced treatment so it is expected to attain a higher rate of removal of dissolved metals (FHWA and WSDOT 2006).

Estimates of the Extent of Exposure

To predict annual pollutant loads under the proposed action, WSDOT used the "FHWA method" (WSDOT 2003a). This method uses estimates of storm pollutant export per acre, based on a limited data set, to provide a general estimate of pollutant loading at the TDA scale.

Existing PGIS within the action area currently contributes pollutant loads of copper, zinc, cadmium, and chromium. These pollutant loads will change with the addition of new PGIS. Table 7 presents the results of an analysis by WSDOT of pre- and post-project annual pollutant loading for copper and zinc throughout the action area by TDA.

Table 7. Pre- and Post-Project Annual Pollutant Loading of Zinc (Zn) and Copper (Cu) and Net Change by TDA.

TDA		**Annual Pollutant Loading (lbs/yr)**				
		TSS	**Tot. Zn**	**Diss. Zn**	**Tot. Cu**	**Diss. Cu**
Erdahl Ditch	Pre-project	0.00	0.00	0.00	0.00	0.00
	Post-project	135.00	0.84	0.60	0.20	0.11
	Net Change	**135.00**	**0.84**	**0.60**	**0.20**	**0.11**
Wapato Creek[1]	Pre-project	0.00	0.00	0.00	0.00	0.00
	Post-project	1,485.00	9.24	6.60	2.15	1.16
	Net Change	**1,485.00**	**9.24**	**6.60**	**2.15**	**1.16**
Fife Ditch[2]	Pre-project	9,571.10	18.63	6.78	3.39	0.90
	Post-project	1,215.00	7.56	5.40	1.76	0.95
	Net Change	**-8,356.10**	**-11.07**	**-1.38**	**-1.63**	**0.05**
Hylebos Creek[3]	Pre-project	9,571.10	18.63	6.78	3.39	0.90
	Post-project	2,340.00	14.56	10.40	3.38	1.82
	Net Change	**-7,231.10**	**-4.07**	**3.62**	**-0.01**	**0.92**
Surprise Lake Trib.	Pre-project	0.00	0.00	0.00	0.00	0.00
	Post-project	1,620.00	10.08	7.20	2.34	1.26
	Net Change	**1,620.00**	**10.08**	**7.20**	**2.34**	**1.26**
Oxbow Lake Ditch	Pre-project	0.00	0.00	0.00	0.00	0.00
	Post-project	810.00	5.04	3.60	1.17	0.63
	Net Change	**810.00**	**5.04**	**3.60**	**1.17**	**0.63**
Puyallup River	Pre-project	4,152.75	8.09	2.94	1.47	0.39
	Post-project	2,670.75	16.62	11.87	3.86	2.08
	Net Change	**-1,482.00**	**8.53**	**8.93**	**2.39**	**1.69**
All Waterbodies	Pre-project	23,294.95	45.35	16.49	8.25	2.19
	Post-project	10,275.75	63.94	45.67	14.84	7.99
	Net Change	**-13,019.20**	**18.59**	**29.18**	**6.60**	**5.81**

[1] Combines PGIS from two non-listed Fish bearing TDAs. Pollutant loading from at least the downstream TDA will likely affect PS Chinook salmon inhabiting the Blair Waterway and Commencement Bay.
[2] Combines PGIS from two non-listed Fish bearing TDAs.

[3] Combines PGIS from three listed fish-bearing TDAs.
[4] Total Suspended Solids

Total Suspended Solids, as well as total and dissolved copper and zinc, pollutant loading will increase in all TDAs with the following exceptions. Total suspended solids are expected to decrease in the Fife Ditch, Hylebos Creek, and Puyallup River TDAs, as well as in all waterbodies combined. Both total zinc and copper are expected to decrease in the Fife Ditch and Hylebos Creek TDAs. These decreases are a result of the proposed retrofit of existing impervious surface. The loading of dissolved copper and dissolved zinc is expected to increase in all TDAs, as well as the project overall, with the exception of a decrease in dissolved zinc in the Fife Ditch TDA. For example, In the Puyallup sub-basin, the loading of dissolved copper will increase from 0.39 pounds (lbs) per year to 2.71 lbs per year (approximately a sevenfold increase) and the loading of dissolved zinc will increase from 2.94 lbs per year to 15.47 lbs per year (approximately a fivefold increase). The net increases in pollutant loading will measurably degrade the environmental baseline adversely affecting bull trout in the Puyallup River, their prey base in Hylebos Creek and Surprise Lake Drain during periods of high water, and to a limited extent downstream in the Blair and the Hylebos Waterways.

The discharge of stormwater to channel margins exposes fish to metal concentrations that (depending upon duration of exposure, among other factors) may elicit sublethal effects such as avoidance of the plume or repressed olfactory performance and potentially lethal affects.

Discharges of treated stormwater into the Puyallup River will have a less-severe effect bull trout during periods of high flows. Average monthly discharges between May and November varies from a high of 4,410 cfs in June to a low of 1,690 cfs in September (USGS 2006). Average monthly discharge is the highest between February and June (3,220 cfs to 4,410 cfs). However, bull trout utilize the Puyallup River year-round and will also be exposed to stormwater pollutants throughout the year. Low daily discharges occur in early fall, and in some years in February or March. Rainfall events during these periods often generate a "first flush" of stormwater pollutants, increasing the likelihood of adverse effects. The WSDOT did not provide a worst-case scenario dilution modeling of stormwater discharged into the Puyallup River, so we assume on average, that bull trout would be exposed to the above-referenced pollutant concentrations and annual loading at the point of discharge.

Effects of Pollutant Exposure on Bull Trout

Bull trout and their prey base within the Puyallup River, Hylebos Creek and Surprise Lake Drain, during periods of high water, and the Blair Waterway, are already exposed to complex mixtures of metals and other contaminants from runoff resulting from existing roadways, as well as pollution originating from other land uses within each sub-basin. Since adverse effects from these pollutants likely occur in the action area, the effects of the proposed project may be additive, synergistic, and/or antagonistic. Although the concentrations of dissolved copper and zinc are expected to decrease in TDAs where retrofit of existing PGIS is proposed, these and the concentrations in TDAs with only new PGIS will be significantly greater than the neurotoxic threshold sufficient to cause olfactory inhibition and the behavioral avoidance, respectively. In addition, there will be a significant increase in the annual loading of copper and zinc, particularly

in the Puyallup River. As such, bull trout will be exposed to greater levels of stormwater pollutants as a result of the SR 167 Extension project.

Most published literature concerns the acute toxicity of most metals on an individual basis, though in aquatic receiving bodies most metals typically exist in mixtures, and are known to interact with each other (Niyogi et al. 2004). These mixtures interacting at gill (and olfaction) mediums likely result in adverse effects, and the physiological consequence of metal mixtures is a continuing area of study (Niyogi et al. 2004). However, individual metal concentrations, and some mixture concentrations and combinations have been tested with a variety of *Oncorynchus* (i.e. Chinook, coho and rainbow trout), and *Salvelinus* (bull and brook trout) species. Tested endpoints range from lethal to sublethal effects, which include reduced growth, fecundity, avoidance, reduced stamina and neurophysiological, and histological effects on the olfactory system. For example, mixtures containing copper and zinc were found to have greater than additive toxicity to a wide variety of aquatic organisms including freshwater fish (Eisler 1998), and other metal mixtures also yielded greater than additive toxic effects at low dissolved metal concentrations (Playle 2004).

Strong biological evidence of water quality degradation within urbanized watersheds in the Puget Sound has been recently observed. Death of adult coho has been documented in some highly urbanized streams in Seattle and other areas of Puget Sound such as: Longfellow, Thornton, Pipers, and Fauntleroy Creeks. Data summarized in 2002 showed that the adult coho pre-spawn mortality rate was 60 percent for Longfellow Creek; 71 percent for Pipers Creek; 82 percent for Thornton Creek; and approximately 25 percent for Fauntleroy Creek (Longfellow Creek Community 2002).

These observations prompted a pilot study in 2004 by the Northwest Fisheries Science Center, which revealed significant pre-spawn mortality of coho salmon within Longfellow Creek, compared to a relatively non-urbanized stream within the Stillaguamish River Watershed (NMFS 2005a). Mortality in adult coho was observed within hours of their return to the creek, often during, or soon after, rain events. Pollutant mixtures in stormwater are likely a primary contributor to the high level of pre-spawn mortality, though the exact causes have not been fully determined to date (NMFS 2005b).

Recent studies have shown that salmonids that rear and migrate through contaminated waterways bioaccumulate pollutants, and have suppressed immune systems (Arkoosh et al. 1991; Varanasi et al. 1993). These sublethal effects can persist after fish leave the natal streams and enter the ocean (Arkoosh et al. 1998).

Relevance of Water Quality Standards

The Puyallup Tribe has Clean Water Act jurisdiction on surface waters overlaying tribal trust lands; in the Puyallup River from RM 1.0 to approximately RM 7.3 and the marine conservancy area in the Hylebos Waterway (Naylor 2007, Puyallup Tribe, pers. comm.). Therefore, actions taken within surface waters overlaying tribal trust lands, or having downstream effects to surface waters overlaying tribal trust lands, need to comply with the Tribe's water quality standards, including the anti-degradation standard. Compliance with Tribe's water quality standards is

therefore necessary for discharges to the Puyallup River via outfalls for the SR 161/SR 167 Interchange and the Puyallup River Bridges, as well as discharges to the Puyallup River via the Oxbow Lake Ditch. Discharges from the 18 proposed stormwater outfalls discharging into Hylebos Creek and Surprise Lake Drain either directly or via the RRPs; as well as those discharging into the Fife Ditch are all outside the boundary of Puyallup Tribal trust land but will need to meet Tribe's anti-degradation standard at the head of the Hylebos Waterway.

The Tribe's mixing zone water quality standard for the Puyallup River can be found in the 2002 NPDES permit for the City of Puyallup Wastewater Treatment Plant, (EPA and Puyallup Tribe 2002). Per this NPDES permit, the chronic mixing zone may not exceed 300 ft plus the horizontal length of the diffuser downstream, 100 ft upstream, and 25 percent of the width of the river during the 7Q10 discharge (the 7 day average low flow that has a 10 percent chance of occurring in any given year). The permit indicates that that this discharge is equivalent to 757 cfs. The acute mixing zone may not exceed the same width and may not exceed 10 percent of the above-referenced length.

Discharges from the 24 proposed stormwater outfalls discharging into Hylebos and Wapato Creeks and Surprise Lake Drain either directly or via the RRPs; as well as those discharging into the Fife and Erdahl Ditches are all outside the boundary of Puyallup Tribal trust land and are therefore covered by Washington State Water Quality Standards under the Washington State Administrative Code (173-201A WAC). The mixing zone under State water quality standards is identical to the Tribes' mixing zone. Information regarding the 7Q10 discharges for Hylebos and Wapato Creeks, and Surprise Lake Drain, as well as for the Fife, Erdahl, and Oxbow Lake Ditches was not available.

Water Quantity

Construction of the proposed project will include the placement of 221 acres of PGIS and will result in the permanent loss of approximately 218 acres of vegetation. Additionally, approximately 280 acres of vegetation will be temporarily removed, 189 acres of which will be replanted with native woody species within the Hylebos, Surprise Lake, and Wapato RRPs. Equipment staging and material storage areas, occupying another approximately 90 acres, will also be replanted. While replanting will eventually reduce the effects of vegetation removal, permanent removal of vegetation will negatively affect existing watershed hydrologic function and the habitat-forming processes that rely on that function. The effects of impervious and compacted surfaces on watershed hydrology and habitat quality include increased frequency and duration of peak flows, diminished base flows, reduced subsurface flow, groundwater recharge and hyporheic flow, and mobilization and deposition of sediment/bedload. The effects are described in the "Effects of Impervious Surface" section.

Puyallup River Sub-basin

Stormwater from the completed project in Puyallup River TDA will contribute to increased peak flows in the lower Puyallup River. However, this contribution is expected to be insignificant compared to flow alterations upstream of the action area (e.g. flood control and hydroelectric generation discharge regimes from the three upstream Puyallup

River system dams). As such, effects on the flow regime of the Puyallup River are expected to be discountable.

Hylebos and Wapato Sub-basins

If traditional flow control BMPs were implemented in the Hylebos and Wapato sub-basins, new impervious areas would also increase the frequency and duration of peak flows, diminish base flows, reduce subsurface flow, groundwater recharge and hyporheic flow. Soils in the action area consist of glacial till, marine silt from tidal influences, alluvial and volcanic mudflow deposits, or glacial outwash from melt water (MGS 2004) which are not conducive to infiltration. Additionally, much of the project area is within frequently-flooded areas. Therefore, riparian restoration is proposed along Hylebos and Wapato Creeks and Surprise Lake Drain in lieu of traditional flow control. The riparian restoration approach includes obtaining land to allow the removal of roadways, buildings, floodplain fill, and culverts from riparian areas. Land currently in agricultural production will be allowed to revert back to natural wetland conditions. Non-native plants will be removed from riparian areas and native trees and shrubs will be planted. This approach is expected to more effectively control stormwater flow control (over traditional BMPs) and have the added benefit of increasing habitat functions.

The RRPs will establish approximately 75- to 300-foot-wide riparian buffers along each side of approximately 4 miles of stream (EnviroVision 2005). Within this area, wetlands will be restored and channel meanders will be allowed to develop. These improvements will minimize the effects of increased runoff rates, increased flow duration, base and peak flow alteration, and possibly subsurface flow alteration. The restoration plan is designed to reduce channel erosion, increase channel capacities, increase contaminant filtration, improve floodplain storage in some areas, and provide infiltration (WSDOT 2003b).

Returning developed lands to a forested condition will reduce surface runoff, and increase infiltration and aquifer recharge. Forested areas generate the least amount of surface runoff of any land use. Forested areas intercept rainfall and, through evapotranspiration, they prevent precipitation from entering the surface water. The remaining water is then slowly released to streams through subsurface flow and groundwater exchange, with a fraction entering via surface runoff. On glacial till soils forest root systems reduce soil compaction, allowing for better infiltration. The benefits associated with restoration of forested areas will increase as the trees mature.

Within the RRPs approximately 63 acres of existing wetland will be improved, resulting in better floodwater storage and water quality. An undetermined amount of additional wetland will also be created from streambank stabilization and restored hydrology in the riparian areas. Floodplain storage capacity will vary over time, because the channels would once again be allowed to migrate. As new channels are created during flood events and old channels abandoned, riparian wetlands and backwater channels could form. According to WSDOTs hydraulic analysis, the RRPs are expected to reduce the 100-year floodplain elevation relative to pre-project conditions (MGS 2004).

The project's proposed flow control (via the RRPs) is expected to maintain or improve stream channel stability, reduce flood levels and inundation area, enhance degraded stream channel segments, and expand and enhance riparian habitat. However, the RRPs will not be fully functional until a mature riparian zone is established. It is expected that the RRPs will be functioning as effective flow control after 10 years from completion assuming that monitoring and maintenance requirements are met. Functions related to physical habitat conditions (contribution of LWD, etc.) will take longer to develop. During development of the RRPs, prey species for bull trout will experience temporally decreasing effects to in-stream and riparian habitat functions. As a result we expect that the prey base for bull trout will be decreased for approximately 10 years, after which time they should rebound to baseline conditions. Past that point, we expect that prey species will respond positively to expected improvements in habitat conditions and increase in abundance.

Conclusion

The proposed project will result in the discharge of stormwater with concentrations of dissolved copper (7.8 μg/L above background), and dissolved zinc (44.8 μg/L above background), that exceed the thresholds for adverse effects to olfaction and behavior in juvenile salmonids. Exposure to these as well as other project-related pollutants such as chromium and cadmium will continue at the point of discharge in perpetuity. This exposure could affect the ability of bull trout to recognize and avoid predators in the Puyallup River and Commencement Bay and could affect the ability of adults to migrate back to these natal streams to spawn.

Mortality of bull trout could result if the exposure is of sufficient duration. However, we do not anticipate mortality because levels of pollutants are not expected to reach lethal levels and because it is unlikely that bull trout will remain in close proximity to outfall pipes (i.e., the acute mixing zone).

The substantial flows in the Puyallup River and Commencement Bay will reduce the magnitude of the adverse effects. To account for dilution of these pollutants at the point of discharge, a mixing zone was established for all of the outfalls discharging to streams that bear listed fish, consistent with Puyallup Tribe and Washington State water quality standards. Adverse effects are expected to occur only within the mixing zones associated with the two outfalls in the Puyallup River.

Direct Effects of Bridge Construction in the Puyallup River

Construction-Related Turbidity

The severity of the effect on bull trout from turbidity depends on numerous factors including the proximity of the work to surface water, amount of ground-disturbing activity, slope, amount of vegetation removed, and weather. Effects of suspended sediment on fish are well documented (Bash et al. 2001). Suspended sediment can affect fish behavior and physiology and result in stress and reduced survival. Temperature acts synergistically to increase the effect of suspended sediment. The severity of effect of suspended sediment increases as a function of the

concentration and exposure time (e.g., dose) (Newcombe and Jensen 1996; Bash et al. 2001). Suspended sediment can cause sublethal effects such as elevated blood sugar levels and cough rates (Servizi and Martens 1991), physiological stress, and reduced growth rates. Turbidity can reduce the ability of salmonids to detect prey, cause gill damage (Sigler et al. 1984; Lloyd et al. 1987; Bash et al. 2001), and cause juvenile fish to leave rearing areas (Sigler et al. 1984). Additionally, short-term pulses of suspended sediment has influenced territorial, gill-flaring, and feeding behavior of salmon in the laboratory (Berg and Northcote 1985).

Settling of fine sediment can impact food production. When fine sediment settles on gravel and cobble, benthic diversity and density may drop significantly (Cordone and Pennoyer 1960; Herbert et al. 1961; Bullard, Jr. 1965; Reed and Elliot 1972; Nuttall and Bilby 1973; Bjornn et al. 1974; Cederholm et al. 1978). The resulting reduction in prey could negatively impact fish growth.

As sediment is suspended during construction, enters the lower Puyallup River, and moves downstream, concentrations will be diluted and heavier sediments will settle. To assess the levels at which adverse effects will occur and to determine the downstream extent of sediment impacts for this project, the FWS used the analytical framework attached in Appendix D. This framework uses the findings in Newcombe and Jensen (1996) on the impacts to fish from suspended sediment to determine project-related impacts on bull trout.

Increases in suspended sediment may affect salmonid behavior in several ways. Fish may avoid high concentrations of suspended sediment altogether (Hicks et al. 1991). Slight elevations in suspended sediment may reduce feeding efficiency of some salmonids. At lower concentrations fish may decrease feeding, and at higher concentrations they may cease feeding completely (Sigler et al. 1984). In addition, social behavior patterns may be altered by suspended sediment (Berg and Northcote 1985). Not only can feeding efficiency be affected, but high concentrations of suspended sediment can also affect survival, growth, and behavior of stream biota on which salmonids feed (Harvey and Lisle 1998). Suspended sediment may alter food supply by decreasing abundance and availability of aquatic insects; however, the precise thresholds of fine sediment in suspension or in deposits that result in harmful effects to benthic invertebrates is difficult to characterize (Chapman and McLeod 1987).

The proposed project will temporarily increase turbidity levels in the action area, and cause adverse effects to bull trout. The types of adverse effects experienced by bull trout exposed to increased turbidity are summarized in Table 8.

Table 8. Summary of adverse effects to bull trout resulting from elevated sediment levels.

Sediment Impacts	Adverse Effects Related to Sediment Impacts
Gill trauma	Clogs gills which impedes circulation of water over the gills and interferes with respiration.
Prey base	Disrupts both habitat for and reproductive success of macroinvertebrates and other salmonids that spawn and rear downstream of the construction activities.
Feeding efficiency	Reduces visibility and impacts feeding rates and prey selection.
Habitat	Fills pools, simplifies and reduces suitable habitat.
Physiological	Increases stress, resulting in decreased immunological competence, growth and reproductive success.
Behavioral	Results in avoidance and abandonment of preferred habitat.

The analysis requires a measurement of the existing suspended sediment concentration levels (mg/l) and duration of time that sediment impacts would occur. We used data available from WDOE (2006b) to determine the ratio of turbidity (NTU) to suspended solids (mg/l) in the lower Puyallup during the proposed months of construction (1:2, for July and August). Twenty-six years of data were used to determine the ratio (1978-2005, incomplete data for 1985).

To evaluate the length of time that sediment impacts would occur, we estimated that in-water work would occur during business hours, 10 hours a day, for a total of 35 days for the first construction season, 14 days for the second construction season, and 16 days for the third construction season. Using these measurements, the FWS determined adverse affects to bull trout will occur in the following circumstances:

1) When background NTU levels are exceeded by 74 NTUs at any point in time.
2) When background NTU levels are exceeded by 28 NTUs for more than 1 hour.
3) When background NTU levels are exceeded by 28 NTUs for more than 3 hours, cumulatively over a 10-hour workday.

The installation and removal of the temporary piles for the detour bridge and the work platforms, and the installation and removal of the sheet piles for the cofferdams, could cause turbidity above background levels. To assess the potential downstream extent of these effects, we relied on limited monitoring data from past projects (Widener and Associates 2005){Pascoe 2006} (Pascoe Environmental Consulting 2006). These reports show that turbidity from pile installation and removal did not reach 28 NTU's over background. Therefore we expect that pile installation and removal will not generate turbidity at levels significant enough to adversely effect bull trout.

Effects of Elevated Underwater Sound Pressure Levels from Impact Pile Driving

The proposed project includes installation of up to 150, 24-inch diameter hollow steel pilings; 50 pilings each to support the two temporary work bridges and the temporary detour bridge. Pile installation for all three temporary structures is expected to occur over 35 days within one in-water work window and may involve the operation of more than one pile driver at a time. In order to reduce the likelihood and extent of exposure to elevated underwater Sound Pressure Levels (SPLs), installation is limited to the period between July 15 through August 31. This timing window allows in-water work to occur when the numbers of listed fish in the action area are at their lowest, and the life stages of listed fish are less vulnerable (i.e. larger) to the potential effects. To further reduce potential effects, the project will use a vibratory hammer to install the piles, limiting the use of an impact hammer to that needed for proofing. The proposed project includes a performance standard that an attenuation system will be used to ensure that SPLs will not exceed 185 dB_{peak} at 10 m from the pile being installed. In order to gain baseline hydroacoustic monitoring data, some impact proofing will need to occur without sound attenuation.

In 2005, WSDOT monitored SPLs generated by installation of 24-inch piles in Friday Harbor, Washington, and found that the highest recorded level was 217 dB_{peak} and average rms levels were 195-178 dB_{rms} (Laughlin 2005). Other monitoring efforts in Washington have documented maximum levels above 200 dB_{peak} and 190 dB_{rms} for 24-inch piles (Anderson 2004; MacGillivray and Racca 2005). Based on these data, we expect that source level SPLs from impact proofing of steel piles could reach 217 $_{peak}$ and 190 dB_{rms}.

High underwater SPLs are known to have negative physiological and neurological effects on a wide variety of vertebrate species {Yelverton, 1973 7567 /id;Yelverton, 1981 7569 /id;Steevens, 1999 7391 /id;Fothergill, 2001 6845 /id;U.S.Department of Defense, 2002 7448 /id;Cudahy, 2002 6758 /id}. High underwater SPLs are known to injure and/or kill fishes, as well as causing temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny et al. 1994; Popper 2003; Hastings and Popper 2005). Risk of injury appears related to the effect of rapid pressure changes, especially on gas-filled spaces in the bodies of exposed organisms (Turnpenny et al. 1994).

High underwater SPLs can also cause a variety of behavioral responses that have not been thoroughly studied. Broadly, the effects of elevated underwater SPLs on organisms range from no effect to death. Over this continuum of effect, there is no easily identifiable point at which behavioral responses transition to physical effects. For the purposes of this analysis we attempt to group the effects into these two categories as they are roughly correlated with the Endangered Species Act definition of harm (those causing mortality and/or injury) and harassment (those causing significant behavioral changes). General literature and information on each category are described first, with the potential effects to bull trout described in subsequent sections.

Effects from Impact Installation of Steel Piles Expected to Result in Mortality or Injury

Injury and mortality in fishes has been attributed to impact pile driving (Stotz and Colby 2001; Stadler 2002; Fordjour 2003; Abbott et al. 2005; Hastings and Popper 2005). The injuries

associated with exposure to high SPLs are referred to as barotraumas, and include hemorrhage and rupture of internal organs, hemorrhaged eyes, and temporary stunning (Yelverton et al. 1973; Yelverton et al. 1975; Yelverton and Richmond 1981; Turnpenny and Nedwell 1994; Hastings and Popper 2005). Death from barotrauma can be instantaneous, occurring within minutes after exposure, or can occur several days later (Abbott et al. 2002).

The most noticeable and well-documented effects of pile driving have been fish kills. However, it is important to note that not all fish killed by pile driving float to the surface and they are therefore likely to go undetected (Teleki and Chamberlain 1978; WSDOT 2003c). With few exceptions, fish-kills are reported only when dead and injured fishes are observed at the surface. Thus, the frequency and magnitude of such kills are likely underestimated.

Physical injury to aquatic organisms may not result in immediate mortality. If an animal is injured, death may occur several hours or days later, or injuries may be sublethal. Necropsy results from Sacramento blackfish (*Othodon microlepidotus*) exposed to high SPLs showed fish with extensive internal bleeding and a ruptured heart chamber were still capable of swimming for several hours before death (Abbott et al. 2002). Sublethal injuries can interfere with the ability to carry out essential life functions such as feeding and predator avoidance (Popper 2003).

The potential for injury and/or mortality of any aquatic organism from pile driving depends on the type and intensity of the sounds produced. These are greatly influenced by a variety of factors, including the type of hammer, the type of substrate, and the depth of the water. Firmer substrates require more energy for pile driving, and produce more intense sound pressures. Biologically, key variables that factor into the degree to which an animal is affected include size, anatomical variation and location in the water column (Gisiner et al. 1998). Any gas-filled structure inside an animal is particularly susceptible to the effects of underwater sound (Gisiner et al. 1998). Examples of gas-filled structures in vertebrate species are swimbladders, bowel, sinuses, lungs, etc. As a sound travels from a fluid medium into these gas-filled structures, there is a dramatic drop in pressure, which can cause rupture of the hollow organs (Gisiner et al. 1998).

Sound energy from an underwater source readily enters the bodies of animals because the acoustic impedance of animal tissue nearly matches that of water (Hastings 2002). This has been demonstrated in fishes with swimbladders (such as salmonids). As a sound pressure wave passes through a fish, the swimbladder is rapidly compressed due to the high pressure and then rapidly expanded by the underpressure. Exposure to this type of pneumatic pounding can cause rupture of capillaries in the internal organs, as observed in fishes with blood in the abdominal cavity, and maceration of kidney tissues (Abbott et al. 2002; Stadler 2002).

Yelverton and Richmond (1981) and Yelverton and others (1973) exposed many fish species, various birds, and terrestrial mammals to underwater explosions. Common to all the species that were exposed to underwater blasts were injuries to air and gas-filled organs, as well as eardrums. These studies identified injury thresholds in relation to the size of the charge, the distance at which the charge was detonated, and the mass of the animal exposed. Yelverton and others (1973) and Yelverton and Richmond (1981) found that the greater the fish's mass, the greater

impulse level needed to cause an injury. Conversely, a fish with smaller mass would sustain injury from a smaller impulse.

At Bremerton, Washington, approximately 100 surfperch (*Cymatogaster aggregata, Brachyistius frenatus* and *Embiotoca lateralis*) were killed during impact driving of 30-inch diameter steel pilings (Stadler 2002). The size of these fish ranged from 70 mm to 175-mm fork length. Dissections revealed that the swimbladders of the smallest of the fishes (80 mm fork length) were completely destroyed, while those of the largest individual (170 mm fork length) were nearly intact. Damage to the swimbladder of *C. aggregata* was more severe than to similar-sized *B. frenatus*. These results are suggestive of size and species-specific differences and are consistent with those of Yelverton and others (1975) who found size and/or species differences in injury from underwater explosions.

Another mechanism of injury and death resulting from high SPLs is "rectified diffusion", or the formation and growth of bubbles in tissue. Rectified diffusion can cause inflammation and cellular damage because of increased stress and strain (Vlahakis and Hubmayr 2000; Stroetz et al. 2001) and blockage or rupture of capillaries, arteries, and veins (Crum and Mao 1996). Crum and Mao (1996) analyzed bubble growth underwater by rectified diffusion caused by sound signals at low frequencies (less than 5,000 Hz), long pulse widths, and atmospheric pressure. Their analysis indicated that SPLs exceeding 190 dB_{peak} could cause bubble growth.

Due to differences between species and from variation in exposure type and duration, uncertainty remains as to the degree of potential adverse effects from SPLs between 180 and 190 dB_{peak}. Turnpenny and others (1994) exposed brown trout (*Salmo trutta*) to SPLs greater than 170 dB with pure tone bursts for a duration of 90 seconds. This resulted in a mortality rate of 57 percent after 24 hours in brown trout and 50 percent mortality occurring at 176 dB (95 Hz) in bass (*Dicentrarchus labrax*) and whiting (*Merlangius merlangus*). The authors suggest that the threshold for continuous sounds was lower than for pulsed sounds such as seismic airgun blasts. Sounds from pile driving are more similar to that of airguns than to pure tone bursts. As such, we conclude that the 170 dB threshold for injury to brown trout identified by Turnpenny is likely lower than the injury threshold level anticipated for pile driving from this project.

Based on the above, we anticipate the potential for barotrauma to occur in aquatic organisms, including bull trout, at SPLs of $\geq$190 dB_{peak}. We anticipate other types of potential physical injury to occur above 180 dB_{peak}, based on the studies of both aquatic and terrestrial species discussed above. The 180 dB_{peak} threshold is probably at least somewhat conservative because most studies described evaluated transmitted signals of longer duration that what is anticipated to result from pile driving. The specific adverse effects anticipated for bull trout are described in more detail below.

Effects of Impact Installation of Steel Piles Expected to Result in Significant Alteration of Normal Behavior

No experimental data specific to bull trout response to underwater sound from pile driving are available. In fact, there is much uncertainty regarding the behavioral response of organisms to underwater sound in general. Further confounding the issue is the fact that most of the

information on the behavioral effects of underwater sound is from studies using pure tone sounds. Sounds generated by pile driving, however, are impulsive sounds and are made up of multiple frequencies/tones, making comparisons with existing data difficult.

Exposure to elevated SPLs can result in temporary hearing damage referred to as Temporary Threshold Shift (TTS). Most bioacoustic specialists consider TTS to be physiological fatigue, and not injury (Popper et al 2006c). However, an organism that is experiencing TTS may suffer consequences of not being able to detect biologically relevant sounds such as approaching predators or prey, and/or mates attempting to communicate. Mesa (1994) examined predator avoidance ability and physiological response of Chinook salmon subjected to various stressors. The test fish were agitated to cause disorientation and injury. When equal numbers of stressed and unstressed fish were exposed to predators, there was significantly more predation of stressed fish.

Shin (1995) reports that pile driving may result in "agitation" of fish manifested in a change of swimming behavior. Turnpenny and others (1994) attempted to determine a level of underwater sound that would elicit behavioral responses in brown trout, bass, sole, and whiting. With brown trout an avoidance reaction occurred above 150 dB_{rms} and other reactions (e.g., a momentary startle), were noted at 170-175 dB_{rms}. The report references Hastings' "safe limit" recommendation of 150 dB_{rms} and concludes that the Hastings' "safe limit" provides a reasonable margin below the lowest levels where fish injury was observed. In an associated literature review, Turnpenny and Nedwell (1994) also state that the Hastings' 150 dB_{rms} limit did not appear overly stringent and that its application seemed justifiable. Additionally, observations by Feist and others (1992) suggest that sound levels in this range may also disrupt normal migratory behavior of juvenile salmon.

More recently, Fewtrell (2003) held fish in cages in marine waters and exposed them to seismic airgun impulses. The study detected significant increases in behavioral responses when sound pressure levels exceeded 158-163 dB_{rms}. Responses included alarm responses, faster swimming speeds, and tighter groups and movement toward the lower portion of the cage. It is difficult to discern the significance of these behavioral responses. The study also evaluated physiological stress response by measuring plasma cortisol and glucose levels and found no statistically significant changes. Conversely, Santulli and others (1999) found evidence of increased stress hormones after exposing caged European bass to seismic survey noise.

Clearly, there is a substantial gap in scientific knowledge on this topic. The most recent study by Fewtrell presents, at least, some experimental data on behavioral responses of fishes to impulsive sounds above 158 dB_{rms}. Given the large amount of uncertainty, however, that lies not only in extrapolating from experimental data to the field, but also between sound sources (airguns vs. pile driving), and also from one species to another, we believe it is appropriate to utilize the most conservative known threshold. As such, for the purposes of this analysis, the FWS will anticipate that SPLs in excess of 150 dBrms will cause significant behavioral changes in bull trout.

Methods to Reduce Underwater Sound Pressure Levels

Air bubbles can be used to attenuate underwater sound (Gisiner et al. 1998). Air bubbles are most effective at moderate to high frequencies but are also useful for low frequency sounds and have been known to reduce sound pressure levels at some frequencies by as much as 30 dB (Gisiner et al. 1998). During demolition of a dam on the Mississippi River, Keevin and others (1997) found a significant reduction in mortality of caged bluegill (*Lepomis macrochirus)* with use of a bubble curtain. Bubble curtains can also reduce particle velocity levels (MacGillivray and Racca 2005).

In recent years, bubble curtains have been required and used on an increasing number of pile installation projects, primarily on the west coast. Designs have varied and are largely experimental. Effectiveness has also varied widely and is likely to be influenced by factors such as design, site conditions, and the ability for construction contractors to correctly implement the system. Improper installation and operation can decrease effectiveness. Problems with implementation have been observed on a number of projects (Laughlin 2005; Pommerenck 2006).

Impact installation of large (2.4 m diameter) piles with an isolation casing combined with an air bubble curtain resulted in significant sound pressure attenuation on a project in California. During impact pile driving in the San Joaquin River an attenuation system consisting of an isolation casing with a bubble curtain on the inside achieved much less attenuation (between 6-9 dB) (Pommerenck 2006). However, this project had problems correctly implementing the system. During impact installation of steel piles in an embayment on the Columbia River a bubble curtain built according using the Longmuir and Lively (2001) design achieved a maximum reduction of 17 dB, although the results were variable (Laughlin 2006). A test of bubble curtain effectiveness in Friday Harbor, Washington, found improvements were seen after the original design was modified on site to improve contact with the substrate. After modification, the bubble curtain was achieving a 12 dB reduction which equates to an 85 percent reduction in peak overpressure (Laughlin 2005). Use of a bubble curtain while installing 24-inch steel piles at a marina in Washington resulted in reductions of 10-15 dB (Houghton and Smith 2005). These examples illustrate the high degree of variability seen with use of air bubble attenuation systems and the influence of design, site conditions, and contractor implementation. When correctly implemented, however, bubble curtains significantly reduce the extent of potential adverse effects.

As the current velocities in the lower Puyallup River during the in-water work window are ~~expected to be in excess of 1.7 knots, the recommended attenuation system is one that is~~ "confined" (e.g. by a fabric, plastic, or metal sleeve) such that air bubbles surround 100 percent of the piling perimeter for the full depth of the water column. The performance standard included as part of this project indicates that attenuated SPLs will not exceed 185 dB_{peak}. Based on the monitoring information from impact pile driving of 24-inch pilings at two Washington State Ferries facilities, the corresponding rms SPL should be approximately 12 dB lower, or 173 dB.

Estimating the Extent of Effect

To estimate the geographic area in which effects to bull trout are expected, the distance at which transmission loss (TL) attenuates the pressures to below the thresholds must be estimated. Calculating TL is extremely complicated, and is likely to be site-specific. In the past, the FWS has relied on a cylindrical spreading model [TL = 10*Log (R), where R = range or distance from the source] or spherical spreading model [TL = 20*Log(R)] to estimate TL. However, (Reyff 2003) provided hydroacoustic monitoring data which suggest that the actual spreading loss may be intermediate between cylindrical and spherical spreading. Therefore, a practical spreading model, as described by (Davidson 2004) [TL = 15*Log(R)] is more appropriate. The practical spreading model is used to estimate the distances at which injury and behavioral disruption are expected. This model assumes that SPLs decrease at a rate of 4.5 dB per doubling distance.

Effects to Bull Trout from Impact Installation of Steel Piles

The performance standard proposed by the project proponent that ensures that SPLs will not exceed 185 dB_{peak} will substantially reduce the extent of the potential impacts from pile installation to bull trout, but will not eliminate them entirely. Additionally, a limited amount of proofing will need to occur without any attenuation in order to obtain baseline hydroacoustic data. The FWS expects that bull trout will be exposed to elevated underwater SPLs from impact pile installation during construction at levels that could result in mortality, injury, and/or significant alteration of normal behavior.

To reduce overall exposure and minimize the potential effects on migration to listed fish, the WSDOT has agreed to limit the extent of injurious SPLs to a specific portion of the river to allow for some passage through the action area without probable injury. The Services, in collaboration with WSDOT determined that provision of a "corridor" representing approximately 25 percent of the river width could allow for safe passage of fish through the action area. The width of the river, where pile driving will occur, is approximately 210 ft. To protect 25 percent of that width, SPLs above 180 dB_{peak} cannot not extend beyond either a 79-ft radius from each pile, or 158 ft of the 210 ft- width of the river. This would leave approximately 52 ft of the river's wetted perimeter width as a passage corridor. Compliance with the attenuation performance standard would actually result in a larger passage corridor (31 percent of the width of the river).

Effects to Bull Trout from Impact Installation of Steel Piles Expected to Result in Mortality or Injury

The FWS uses SPLs measured as peak pressure to define the onset of injury (USFWS 2003; USFWS 2004a). In 2004, the California Department of Transportation (Caltrans) and the FHWA convened a group of experts in the field of underwater acoustics (referred to as the Fisheries Hydroacoustic Working Group) with the intent of evaluating, and potentially refining this criteria. This effort included an extensive literature review which was the basis for report on the topic (Hastings and Popper 2005) and a white paper proposing interim criteria (Popper et al. 2006). The Hastings and Popper (2005) report indicates that a metric of Sound Exposure Level (SEL) may be more appropriate for correlating injury to fishes from pile installation. The basis

for this is, in part, because the use of SEL allows for the summing of energy over multiple pile driving pulses, which cannot be accomplished when using peak pressure. However, no empirical data are available to develop a method for calculating the accumulation of energy from multiple pile strikes and the resultant effect on fishes. Therefore, the FWS continues to use a peak SPL metric to define the onset of expected injury in this analysis.

Based on the preceding information, we anticipate the potential for injury to occur at SPLs greater than or equal to 180 dB_{peak}. The 180 dB_{peak} threshold is conservative because most of the studies described evaluated transmitted signals of longer duration than is anticipated to result from pile driving.

Pile installation will be completed within one in-water work period. During impact proofing, SPLs are expected to reach levels that can result in injury or mortality to bull trout. Foraging, and migrating adult and sub-adult bull trout are expected in the action area during the in-water work period. These subadult and adult bull trout would be exposed to elevated SPLs from impact pile installation for the amount of time they are in the action area. Due to their size, adult fish can likely tolerate higher SPLs (Hubbs and Rechnitzer 1952; Yelverton et al. 1975), and injury rates are expected to be less than those of juvenile fish.

Conclusion

As stated above, the FWS expects that, with the proposed performance standard, impact proofing of 24-inch piles will result in SPLs up to 185 dBpeak and 173 dB_{rms}, when measured 10 meters from the pile. A limited amount of impact proofing without attenuation will also need to occur during data collection.

Using the practical spreading model, described above, we have determined that SPLs above 180 dBpeak would occur as far as a radius of 22 meters from each pile and cause injury or mortality. The affected area (diameter around each pile) totals 44 meters, or approximately 69 percent of the 64 meter (210 ft) wetted width of the river. All subadult and adult bull trout within a 22 meters radius of each pile are expected to be exposed to injurious SPLs for the duration of impact proofing between July 15 and August 31. When impact proofing is done without attenuation for the purposes of baseline data collection, we expect that all subadult and adult bull trout within a 215 meter radius will be exposed to injurious SPLs for the duration of the baseline data collection.

<u>Effects to Bull Trout from Impact Installation of Steel Piles Expected to Result in Significant Alteration of Normal Behavior</u>

As described above, there are significant gaps in scientific understanding of the behavioral effects of impulsive underwater sound on aquatic organisms. The following summarizes those literature sources that the FWS feels are most pertinent for anticipating potential effects to bull trout.

Popper (2003) suggests that behavioral response of fishes to loud sounds may include swimming away from the sound source, thereby decreasing potential exposure to the sound, or "freezing" (staying in place), thereby becoming vulnerable to possible injury.

Alternatively, responses to sound could affect behavior more extensively and result in the fish leaving a feeding ground (Engas et al. 1996) or an area in which it would normally reproduce or in some other way affect long-term behavior and subsequent survival and reproduction. The effect of these avoidance responses may range from insignificant, to permanent long-term effects if feeding or reproduction is impeded.

Feist et al. (1992) found that impact pile driving of concrete piles affected juvenile pink and chum salmon distribution, school size, and schooling behavior. In general, on days when pile driving was not occurring, the fish exhibited a more polarized schooling behavior (moving in a definite pattern). When pile driving was occurring, the fish exhibited an active milling schooling behavior (moving in an eddying mass). Fish appeared to change their distributions about the site, orienting and moving towards an acoustically-isolated cove side of the site on pile driving days more than on non-pile driving days.

Knudsen et al. (1992) studied spontaneous awareness reactions (consisting of reduced heart beat frequency and opercular movements[1]), and avoidance responses to sound in juvenile Atlantic salmon. This study evaluated the responses of these fish to frequencies ranging from 5 to 150 Hz. With increasing frequencies, the difference between the threshold for spontaneous awareness reaction and the estimated hearing threshold also increased. At 5, 60 and 150 Hz, the signal had to exceed the hearing thresholds by 25, 43 and 73 dB, respectively, to elicit the reactions.

Most of the sound energy of impact hammers is concentrated at frequencies between 100 and 800 Hz. Salmonids can detect sounds at frequencies between 10 Hz (Knudsen et al. 1997) and 600 Hz (Mueller et al. 1998). Optimal salmonid hearing is thought to be at frequencies of 150 Hz (Hawkins and Johnstone 1978). Therefore, impact pile installation produces sounds within the range of salmonid hearing.

Pile installation will occur between July 15 and August 31. During that time, SPLs are expected to reach levels that can significantly alter the normal behavior patterns of bull trout.

Bull trout have been documented in the action area and suitable FMO habitat is present. Anadromous adult and sub-adult bull trout are expected to use the action area for foraging, and migration during the in-water work period. Subadult and adult bull trout would be exposed to elevated SPLs from pile installation for the amount of time they are in the action area.

Conclusion

Sound pressure levels in excess of 150 dB_{rms} are expected to cause temporary behavioral changes. They are not expected to cause injury. The FWS expects that SPLs exceeding 150

[1] Knudsen and others (1992) assumed that stimuli that evoke these awareness reactions are adverse to fish.

dB_{rms} could result in significant disruption of foraging, and migrating behavior in bull trout within the action area. Should SPLs cause bull trout to avoid the area, or alter their migration timing, it will result in a significant disruption in foraging and migratory behavior.

The FWS expects that after application of the attenuation performance standard, impact proofing of 24-inch piles will result in SPLs up to 173 dB_{rms}, at 10 meters. Using 173 dB_{rms} as a source level in applying the practical spreading model, we have determined that SPLs above 150 dB_{rms} will occur as far as 341 meters from each pile and result in significant disruption of normal behaviors. All subadult and adult bull trout within 341 meters of each pile will be exposed to SPLs above 150 dB_{rms} during impact proofing between July 15 and August 31. When impact proofing is done without attenuation for the purposes of baseline data collection, we expect that all subadult and adult bull trout within a 3,415 meter radius will be exposed to SPLs above 150 dB_{rms} for the duration of the baseline data collection.

Effect of Elevated Underwater Sound Pressure Levels from Pile and Cofferdam Removal

Sheet pile cofferdams and steel piles installed for the temporary work trestles and detour bridge will be removed when construction is complete. Removal techniques have not been specified but they will most likely be either vibratory removal or direct pulling. There is a slight possibility that piles will have to be cut off if they cannot be completely removed. Direct pulling of piles is not expected to produce significant elevated underwater sound levels. Vibratory hammers produce underwater peak pressures that are approximately 17 dB lower than those generated by impact hammers (Nedwell and Edwards 2002). Not only are these sounds different in intensity, but also in frequency and impulse energy (total energy content of the pressure wave) which may account for the fact that no fish kills have been associated with use of vibratory hammers. Most of the sound energy of impact hammers is concentrated between 100 and 800 Hz, the frequencies thought to be most harmful to aquatic animals, while the sound energy from the vibratory hammer is concentrated around 20 to 30 Hz. Additionally, during the strike from an impact hammer, the sound pressure rises much more rapidly than during the use of a vibratory hammer (Carlson et al. 2001; Nedwell and Edwards 2002).

Just as these two sounds are different, so are the observed behavioral responses of fishes to them. Most of the energy in the sounds produced by vibratory hammers is at around 20 to 30 Hz, near the range of infrasound (less than 20 Hz). Fish have been shown to avoid infrasound (Knudsen et al. 1997). However, depending on the location of the vibratory installation, sound pressure levels may not exceed ambient sound levels. Vibratory installation of steel piles in a river in California resulted in sound pressure levels that were not measurable above the background noise created by the current (Reyff 2006). The bridge replacement site is in a large river system and the rapid currents are expected to generate significant levels of underwater sound. Thus, we expect that the ambient sound levels will be high and will significantly reduce the extent to which the sound from vibratory pile removal is detectable.

In conclusion, we do not anticipate significant adverse effects to bull trout in the form of physical injury or mortality, or behavioral disruption from pile removal based on the differences, discussed above, in the underwater sounds produced by removal of piles.

Habitat Loss from Bridge Construction

Temporary habitat loss in the Puyallup River will occur from installation of cofferdams, and temporary bridges. Permanent habitat loss will occur from the addition of columns from the new bridge.

Cofferdams

Placement of seven cofferdams will eliminate approximately 3,650 ft^2 of riverbed habitat for one in-water construction season, or 1.5 months. This will eliminate invertebrate production until recolonization can occur. Drift of invertebrates from upstream is expected to rapidly recolonize the affected area once the cofferdams are removed (Barton 1977; Chisholm and Downs 1978; Waters 1995). Cofferdam placement will temporarily obstruct a portion of the wetted perimeter of the river. This could potentially affect migration of bull trout during construction.

Impacts to prey base, foraging behavior, and migratory behavior from cofferdam placement are not expected to significantly effect bull trout. The life stage of bull trout expected to utilize the action area (sub-adult and adult) preys primarily on other fish as prey opposed to invertebrates. Additionally, recolonization of the affected area is expected to occur rapidly. Migratory behavior is not expected to be significantly affected because the channel will not be completely obstructed and bull trout will still be able to move through the project area.

Temporary Bridges

Installation of up to 50 pilings, for the first work trestle will eliminate a maximum of approximately 158 ft^2 of riverbed habitat for up to 13.5 months. Installation of up to 100 pilings for the second work trestle and the detour bridge will eliminate a maximum of approximately 316 ft^2 of riverbed habitat during construction. Removal of the pilings, either completely or to the streambed level with gravel fill will take up to 2 months.

Placement of temporary pilings for up to 1.5 months at a time during inwater work periods, and over a 27 month time period, will temporarily obstruct a portion of the wetted perimeter of the river. This could result in delayed migration during construction.

Temporary piling placement is not expected to significantly affect bull trout. Sub-adult and adult bull trout prey primarily on other fish as opposed to invertebrates and recolonization of the affected area is expected to occur rapidly. Migratory behavior is not expected to be significantly effected because the channel will not be completely obstructed and bull trout will still be able to move through the project area.

Permanent Bridge

The six 10-foot-diameter columns that will support the new bridge will permanently eliminate 472 ft^2 of invertebrate production. Scour on the downstream sides of the columns may create deep pools; which in conjunction with decreased velocity could provide holding/resting habitat

for bull trout. Loss of invertebrate habitat from the permanent bridge is not expected to significantly affect bull trout. Sub-adult and adult bull trout prey primarily on other fish as opposed to invertebrates.

Riparian Vegetation Removal

Replacement and widening of the Puyallup River Bridge will require removal of approximately 0.5 acres of riparian vegetation. The bridge is located between two existing levees with very little woody vegetation. The vegetation on the site primarily consists of non-native grasses and other herbaceous vegetation. There are a few deciduous trees and some will be removed for equipment access. Removal of this amount of vegetation is not expected to have a measurable effect on bull trout.

Fish Handling During Dewatering for Bridge Construction

Installation of up to seven cofferdams is necessary to isolate work areas needed to replace and widen the Puyallup River Bridge. Isolation of work areas within the cofferdams will involve fish removal. Removal of fish is intended reduce the likelihood of injury or mortality of fish that get trapped within the cofferdam. However, handling fish to remove them can also cause mortality and injury. The proposed project has incorporated measures to reduce the potential negative effects of fish handling. Timing of cofferdam installation will be restricted to July 15 through August 31. Cofferdam installation for the widened bridge is expected to occur in the first construction season and cofferdam installation for the new bridge is expected to occur in the second construction season. Sub-adult and adult bull trout may be in the project area during this timeframe.

Handling stresses fish, increasing plasma levels of cortisol and glucose (Hemre and Krogdahl 1996; Frisch and Anderson 2000). Electrofishing could kill juvenile and adult fish, or cause physical injuries including internal hemorrhaging, spinal misalignment, or fractured vertebrae. However, between 95 percent and 98 percent, or more, of fish captured and handled are expected to survive with no long-term effects, and 1 percent to 5 percent are expected to be injured or killed, including delayed mortality because of injury (NMFS 2003). The variability is in part a function of fish removal staff experience and site-specific conditions.

Capture and handling of fish, including bull trout, may result in their injury or death. Mortality may be immediate or delayed. Handling stress, trauma from seines and dip nets, impingement on block nets, and electroshocking may result in some injury and death. Injury and death due to handling stress when using seines and dip nets is uncommon. Adverse impacts from stranding, block nets and electroshocking are more likely to occur. The actual numbers of fish impacted by capture and handling is difficult to anticipate. While it is possible that no impacts may occur due to the low numbers of bull trout in the system, bull trout are known to be present the action area during the in-water work window and could be handled. Because up to seven cofferdams will be needed, the likelihood of impacts are capturing and handling bull trout is increased.

Direct Effects of Wetland Mitigation Site Development

Ten potential wetland mitigation sites have been proposed throughout the project area (Figure 6; Table 2). One or more sites may be needed to meet the wetland mitigation needs of the project. Of the ten sites, three are adjacent to the Puyallup River. Seven sites are located throughout the Wapato and Hylebos sub-basins. Wetland mitigation activities outside of the lower Puyallup sub-basin are not expected to have a measurable effect on bull trout, their prey base, or designated critical habitat for bull trout. Wetland mitigation activity adjacent to the lower Puyallup River has the potential to affect bull trout that utilize the Puyallup River for foraging, migrating, and overwintering.

There are currently no designs for any of the conceptual wetland mitigation sites. The three sites along the Puyallup River could all involve breaching of the levees to allow some fish access to off-channel habitat.

Levee Breaching

According to WSDOT, the assumption is that each of the three sites along the Puyallup River will have the levees breached in two places; one as an inlet and one as an outlet (Ward 2007, pers. comm.). Levee breaching is necessary to allow fish access and may be combined with some degree of off-channel habitat creation. Levee breaching will be conducted during the first season of construction and will involve the use of sheet pile cofferdams at each breach location. Use of cofferdams will potentially expose bull trout to noise, turbidity and fish handling. The effects of noise from sheet pile installation and removal are addressed under the Effects of Underwater Sound section above.

Turbidity

The effects of turbidity from sheet pile installation and removal for the levee breaching would be the same as for the sheet pile installation and removal for the bridge construction described above in the Direct Effects of Bridge Construction section. From the analysis above, the FWS determined adverse affects to bull trout will occur in the following circumstances:

1) When background NTU levels are exceeded by 74 NTUs at any point in time.
2) When background NTU levels are exceeded by 28 NTUs for more than 1 hour.
3) When background NTU levels are exceeded by 28 NTUs for more than 3 hours, cumulatively over a 10-hour workday.

Again, based on past monitoring reports and the analysis in the Direct Effects of Bridge Construction section, the FWS does not expect the sheet pile work to generate turbidity levels that would adversely affect bull trout.

Elevated turbidity levels could occur when the river or tidal flow is introduced to the mitigation site(s). There are very limited data on the initial effects of levee breaching on turbidity levels. All three of the proposed mitigation sites along the lower Puyallup River would involve substantial earthwork prior to exposing the areas to river and tidal flows. Since the mitigation

activities have not been designed, we assume that the hydrologic connections with the river could occur at any location within each site. Therefore, the FWS anticipates that the flow over the disturbed soil will generate turbidity levels that will cause sublethal adverse affects (as described in the "Direct Effects of Bridge Construction" section and in Appendix A) to any adult or subadult bull trout from the upstream extent of each site to within 600 ft downstream each site (Figure 9). The FWS anticipates the high turbidity levels will occur during all of the out-going tides for 2 days following the exposure of the sites to river and tidal flow.

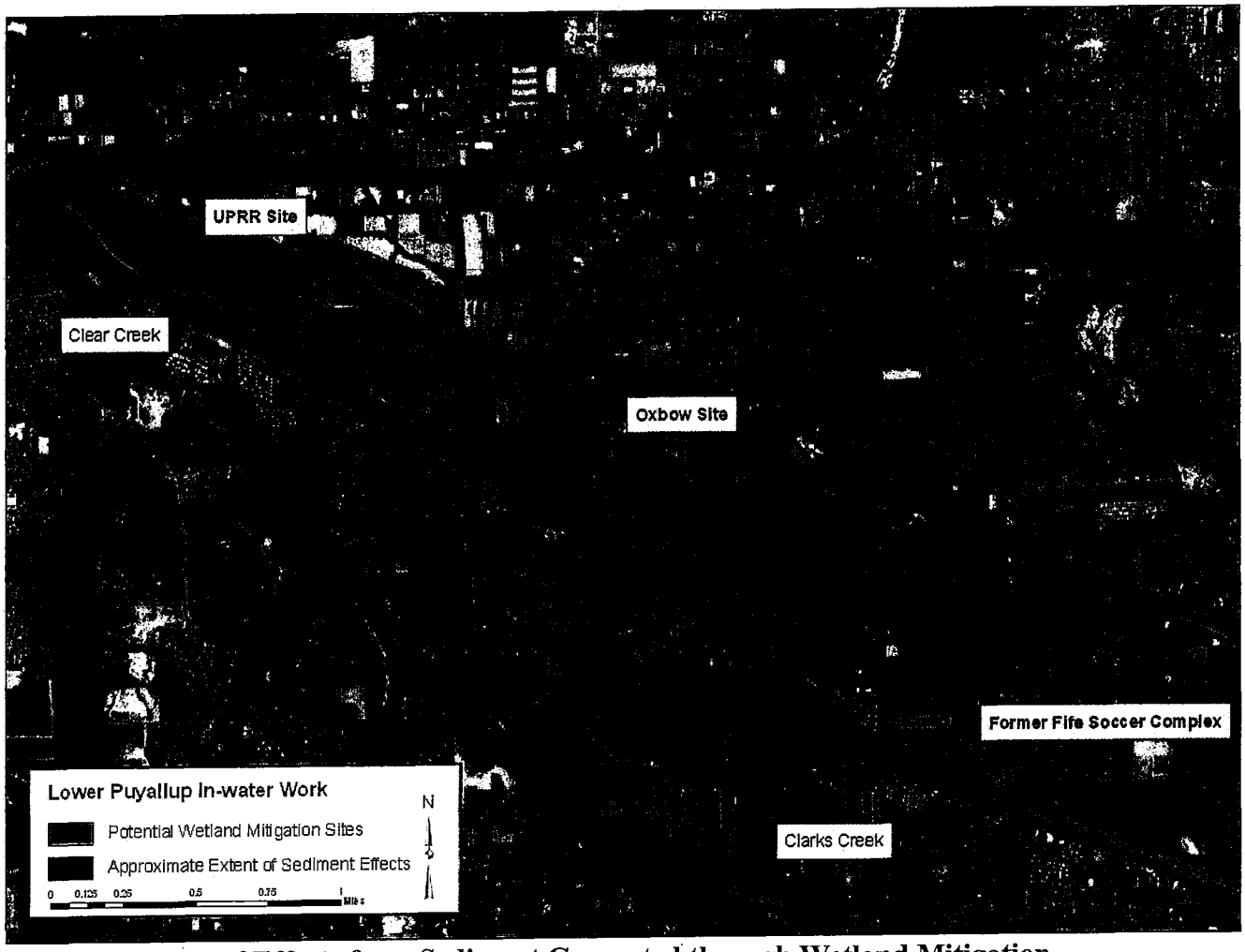


Figure 9: Extent of Effects from Sediment Generated through Wetland Mitigation Activities

Fish Handling during Dewatering for Mitigation Site Levee Breaching

Installation of up to six cofferdams is necessary to isolate work areas needed to construct the wetland mitigation sites. Isolation of work areas within the cofferdams will involve fish removal. Removal of fish is intended reduce the likelihood of injury or mortality of fish that get trapped within the cofferdam. However, handling fish to remove them can also cause mortality and injury. The effects associated with fish handling are described above (see "Fish Handling During Dewatering for Bridge Construction").

The proposed project has incorporated measures to reduce the potential negative effects of fish handling. Timing of cofferdam installation will be restricted to July 15 through August 31. Cofferdam installation is expected to occur in the first construction season. Sub-adult and adult bull trout may be in the project area during this timeframe. The actual numbers of fish impacted by capture and handling is difficult to anticipate. While it is possible that no impacts may occur due to the low numbers of bull trout in the system bull trout are known to be present the action area during the in-water work window. Because up to six cofferdams will be needed, the likelihood of impacts are capturing and handling bull trout is increased.

Herbicide Application

Bull trout could be exposed to herbicide because development of the wetland mitigation sites along the Puyallup River could involve the application of herbicides to allow for the establishment of native vegetation. Herbicide use would take place during summer months during dry conditions and would continue for up to 10 years until desired vegetation is established. The application would consist of a product containing only glyphosate as the active ingredient and the surfactants Agri-Dex (preferred) or LI 700. The glyphosate product will be applied directly to plant foliage (by wicking) to inhibit the production of a growth enzyme. It is not applied to the soil or water. The proposed invasive plant management strategy also relies on manual and mechanical removal (e.g., mowing). Mowing will reduce herbicide use and make herbicide treatment more effective and efficient.

Due to the application method (wicking), the soil is not directly exposed to the products except when drift/drips occur. Decomposing vegetation (dead vegetation from herbicide treatment) at the site may also contain glyphosate. Due to glyphosate's high affinity for soil particles, it is not likely to become part of runoff except with sedimentation. Even during flood events, glyphosate is expected to adsorb to soil particles and not be present within the water column, except under turbid conditions. Microbial degradation is the primary method of breakdown of glyphosate. "Glyphosate is strongly adsorbed by soil, with little potential for leaching to ground water. Microbes in the soil readily and completely degrade it even under low temperature conditions" (EPA 2002).

The toxicity of the active ingredient glyphosate is generally considered to be low. The EPA (1993) classifies the acute toxicity of glyphosate as ranging from "slightly toxic to practically non-toxic to both cold and warm water fish". The application of glyphosate combined with a surfactant increases its toxicity. The surfactant used in the Roundup® formulation is considered to be more toxic to fish than many other surfactants. Monsanto (in Kubena 1998) calculated Rodeo® LC_{50} estimates of invertebrates for R-11®, X-77®, and LI 700® at 19 ppm, 1 ppm, and 130 ppm, respectively. While R-11® and X-77® (used for emergent weed control) are both more toxic than LI 700®, EPA (1993) reports that under the typical application rates (0.12 – 0.5 gallons per 100 gallons of spray solution), the resulting concentration of surfactant in the receiving water body would not likely exceed the acute toxicity thresholds.

In a laboratory study of the effects of Rodeo® on juvenile rainbow trout, Kubena (1998) concluded that most concentrations of glyphosate and surfactants tested did not have a detectable

effect on growth and survival or vitellogenin production. Tests conducted using "high" concentrations of Rodeo®/R-11® resulted in a number of fish jumping from their tanks. McGinness-Kubena characterized this behavior as an avoidance response, which suggested that if Rodeo® is applied at high enough concentrations in or adjacent to salmonid habitat, salmonids could be forced to relocate due to undesirable conditions. Rainbow trout avoided Rodeo® contaminated water at the highest test concentrations (surfactant = 3,000 ppb; glyphosate = 30,000 ppb), but not at the lower test concentrations (surfactant = 300 ppb; glyphosate = 3,000 ppb). This lower concentration is approximately 1,000 times greater than the chemical concentrations documented in field samples following operational application of Rodeo® (Kubena 1998).

Laboratory tests using 100-1,000 times the concentrations of glyphosate and surfactants than documented in field applications did not disrupt the endocrine systems of juvenile rainbow trout. Therefore, in-water concentrations of glyphosate and surfactants (Rodeo®) following application are unlikely to disrupt the normal endocrine processes of juvenile salmonids (Kubena 1998). However, the same study documented a reduction in growth of fish exposed to the higher concentrations of Rodeo®/R-11® compared to the control group, but no effects on growth were detectable at lower concentrations tested. Field studies evaluating the effect of Rodeo® in Willapa Bay revealed no significant short- or long-term effects on the estuarine invertebrates studied (Simenstad and Feist 1996). Likewise, no significant effects to freshwater invertebrates from Rodeo® were detected by Henry (1992), Henry et al. (1994), and Gardner and Grue (Zedler 1996).

Seawater adaptation was not impaired for coho salmon that were exposed to concentrations of Roundup® of up to 2.78 ppm (comparable to the highest environmental concentration measured) in freshwater for 10 days, and were then transferred to seawater (Heydens 1991).

Glyphosate is not expected to bioconcentrate in aquatic organisms due to its water solubility (EPA 2002). A laboratory study using glyphosate concentrations 3- to 4-times the recommended levels over 10- to 14-day exposure periods documented bioconcentration factors at no more than 0.3 percent the level of what is usually regarded as significant (Brandt 1984).

The chemical glyphosate has a very low potential to adversely impact animals, including fish and aquatic invertebrates. The surfactants (X-77, R-11, LI 700) used in the application of glyphosate are slightly more toxic to these organisms than is glyphosate. However, the surfactants are used at comparably low concentrations (typically 0.12 – 0.5 gallons per 100 gallons of spray solution), which reduces the probability of measurable effects on aquatic organisms.

Past studies support the conclusion that, if applied in accordance with label requirements, Rodeo® (formulated glyphosate with an added surfactant) is not likely to result in measurable effects to salmonids or their habitat. This is due primarily to the low toxicity level of the products used in Rodeo®, the strong soil-binding characteristics of glyphosate which renders it inactive soon after application, and its tendency to not bioconcentrate in aquatic organisms due to its water solubility.

Past studies support that exposure to glyphosate and surfactant concentrations at rates considerably higher than what is experienced during typical applications, are likely to result in sub-lethal behavioral effects such as habitat avoidance. Sub-lethal physiological effects such as decreased growth rates and reduced reproduction rates are also possible as a result of high levels of exposure. Mortality of fish and invertebrates could result from exposure to even higher concentrations. However, none of these effects are likely to result from applications of Rodeo® made per the label requirements in and near aquatic habitats.

The proposed application methods will significantly limit the likelihood of exposure of bull trout to herbicide. Wicking, as opposed to spraying, will limit the amount of chemical that contacts the water and timing of application during the dry season will limit the amount of chemical that is washed off of leaves or soil. Of the possible surfactants WSDOT is proposing to use the least toxic options. Based on the application method, timing, and relatively low expected toxicity of the chemical, we do not anticipate a measurable effect on bull trout from the application of herbicide associated with mitigation site development for the proposed project.

Direct Effect of Reduction in Prey Base

The proposed project is expected to adversely effect the prey base of bull trout through the direct effects of construction and the long-term effects of operation. The action area includes areas designated as Essential Fish Habitat per the Magnuson-Stevens Fishery Conservation and Management Act and provides habitat for 46 species of groundfish, four species of coastal pelagics, and three species of Pacific salmon (NOAA 2007). In their analysis of the proposed project, NOAA anticipated that the proposed project would adversely affect these species through by degradation of habitat as a result of construction and operation; elevated SPLs from impact proofing of steel piles; and water quantity and quality impacts from construction and operation.

Both Hylebos and Wapato Creeks are fish-bearing and the proposed project is expected to adversely affect the production of prey species in these systems. Existing habitat in both creeks is highly degraded although substantial restoration efforts have occurred in the Hylebos system. The development of the RRP will benefit habitat conditions in both systems. However, in the Hylebos system, the construction of the RRP could create a new pathway for exposure to arsenic contamination from the nearby B&L Woodwaste site. The sublethal, and potential lethal effects from stormwater discharge and arsenic exposure may preclude production of juvenile fall-run Chinook in the creek (NOAA 2007). Similar effects from stormwater are expected to occur to other, non-listed fish species in both the Wapato and Hylebos systems. These impacts will reduce the prey base for anadromous bull trout that forage in Commencement Bay.

Due to previous impacts, essentially no forage fish spawning areas remain in Commencement Bay. Since forage fish limited, the loss of salmonid production from tributaries to Commencement Bay could significantly affect bull trout utilizing the marine waters. Reductions in prey base could negatively impact fitness of sub-adult and adult anadromous bull trout. However, in marine waters the principal forage for bull trout is surf smelt and other small schooling fish (e.g., sandlance and herring) (USFWS 2004a) which are not expected to be affected by the proposed project and for which spawning areas remain in lower Puget Sound.

Indirect Effects

The regulations implementing the Act define "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline". Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur (50 CFR 402.02). The regulations further note that "indirect effects" which can be expected to result must be considered under section 7 of the Act per the finding of National Wildlife Federation v. Coleman, 529 F.2d 359 (5th Circuit 1976). In that case the court enjoined completion of a highway because the WSDOT failed to consider the effects of future private development that would result from the construction of the highway. The regulations specify that our approach to an analysis of indirect effects must be consistent with that case.

We conducted a multi-step analysis of potential indirect effects for the proposed project. The BA contained an initial indirect effect analysis prepared by the WSDOT which was drawn, in part from the land use, traffic, and indirect/cumulative effects discipline reports prepared as part of the project's evaluation for NEPA. This analysis raised a number of questions which we posed to WSDOT and FHWA. Their response to these questions established a position that the area would develop similarly, with or without, the proposed project with some relatively minor exceptions. With this collective information as a starting point, we reviewed applicable local planning documents such as the City of Fife's Transportation Planning Element and their 6-year transportation plan, contacted planning officials at local governments, and searched local jurisdiction websites for associated information. From these sources we compiled a list of actions within the action area which we divided into the categories of interrelated/interdependent actions, indirect effects and cumulative effects based on the definitions in the Act (16 U.S.C. 1531 *et seq.*) and its implementing regulations (50 CFR 402.02).

Through right-of-way development of the SR 167 project, WSDOT bought a parcel of land adjacent to the proposed "Riverfront Industrial Park". WSDOT granted the City of Puyallup a franchise easement so that the developer could cross WSDOT property with utilities necessary for development of the parcel (Fuchs 2006b, pers. comm.). Since the parcel could not be developed without utility access, which was being granted through a WSDOT easement, there is a causal relationship between the two projects. The City was, however, pursuing alternative connection plans. At the time this consultation was being finalized, the project was already under construction. Therefore, the action is included in the Environmental Baseline section, above.

Additional transportation projects and land use changes expected to occur in the action area that are not causally linked to the proposed project are addressed under the Cumulative Effects section.

Development of transportation infrastructure can lead to the conversion of agricultural areas to commercial or residential development (Wheeler et al. 2005), a pattern apparent in the action area. While these land use decisions are ultimately made at the local level, transportation

infrastructure can provide an impetus for this type of urban development (Wheeler et al. 2005). This is, in part, because reduced travel time to cities encourages the establishment of commerce in previously undeveloped areas (Wheeler et al. 2005). As such, watershed urbanization is a predictable indirect effect of highway construction (Wheeler et al. 2005). This pattern is expected to hold true for the proposed project.

In a supplement to the BA addressing indirect effects, the FHWA (2005) noted the much of the currently undeveloped land in the vicinity has development projects planned and that of the remaining farm land in the project area, 421 acres is currently on the market or was sold to commercial developers. The FHWA estimated that within 0.75 mile to 1.0 mile of the project footprint lands are zoned for development and that the proposed project may accelerate the rate at which these areas develop, especially in the vicinity of the interchanges.

Effects of Impervious Surface Resulting from the Indirect Effects of the Proposed Project

The indirect effects of the project involve increased impervious surface in each of the sub-basins that the project corridor crosses. Increasing impervious surface will alter the existing hydrograph in each sub-basin. These effects are described in detail, as they apply to the lower Puyallup River sub-basin in the "Effects of the Action" section above. In general, increased impervious surface will cause additional stormwater runoff, decreased groundwater recharge, and other hydrologic impacts in each sub-basin. The use of the RRPs will reduce the magnitude of these impacts in the Hylebos and Wapato sub-basins but not in the lower Puyallup River sub-basin. These impacts are expected to result in localized temperature increases and degraded foraging and migrating habitat. Bull trout could be exposed to these effects in the lower Puyallup sub-basin and their prey base will be exposed in the Hylebos and Wapato sub-basins.

Effects of Increased Impervious Surface Resulting from the Indirect Effects to Bull Trout

For the lower Puyallup sub-basin the way in which increased impervious surface affects bull trout and their habitat is detailed in the "Direct Effects of the Action" section, above. Due to the implementation of the RRPs, similar, but less significant, effects to the existing hydrograph are expected in the Hylebos and Wapato sub-basins. Increased runoff and reduction in groundwater recharge and subsurface water exchange, proportional to the amount of added impervious surface and land use conversion associated with the project, is expected. Within the Puyallup River sub-basin this is expected to affect bull trout by reducing thermal refugia, and creating localized temperature increases. These effects are also expected in the Hylebos and Wapato sub-basins and will affect prey species for bull trout, negatively impacting prey availability for anadromous bull trout in Commencement Bay.

Conclusion

The indirect effects of the proposed project include land use changes that will result in increased impervious surface. Increased impervious surface will alter the existing hydrograph of each sub-basin and bull trout foraging, migrating, and overwintering habitat will be permanently degraded as a result. Over time, the proposed project will degrade the quality of thermal refugia, and reduce foraging effectiveness by bull trout in the action area. These effects are expected to occur

incrementally over time, and will continue in perpetuity. We expect that exposure to the combined effects of increased temperatures, loss of thermal refugia, and a smaller prey base will reduce bull trout numbers in the action area by reducing fitness of sub-adult and adult (potential spawners) bull trout.

Effects to Bull Trout Critical Habitat

The presence of PCEs within the action area has been documented; however, the exact location of the PCEs is not known. Therefore, impacts to PCEs can only be assumed where critical habitat overlaps with the effects of the action. The information below describes effects on the applicable PCEs and how the effects will influence the function and conservation role of the CHU.

Puyallup River (Freshwater)

1) *Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.*

   Project components such as the removal of upland vegetation, loss of riparian vegetation, and addition of new impervious surface are known to increase runoff and decrease infiltration. Reduced infiltration inhibits groundwater recharge, subsurface water exchange, and results in decreased baseflows. Reductions in baseflow, loss of shade from riparian vegetation, and reduced groundwater recharge and subsurface flows (as cold water sources) can lead to warming of the surface water (the lower Puyallup River). Also, as water moves downstream through urbanized watersheds heat accumulates unless there are downstream conditions (i.e. riparian vegetation) present to allow the accumulated heat to dissipate out of the system (Poole and Berman 2001). Project impacts in the lower Puyallup River are likely to lead to slight localized temperature increases in the lower Puyallup River during timeframes that bull trout are present (see "Indirect Effects of the Proposed Action").

   Temperatures in the lower Puyallup River are at the high end of the range that bull trout are found most frequently. The loss of vegetation, placement of fill, and conversion of undeveloped lands to impervious surface will negatively impact the hydrologic function of the lower Puyallup River and over time, cause warming of the lower Puyallup River. Adverse effects to PCE #1 are expected in the action area (lower Puyallup River).

2) *Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.*

   The proposed project may install a maximum of three bridge piers (unknown design) below the OHWM of the lower Puyallup River. It is unlikely that the construction of three piers

within the stream channel would affect opportunities for natural creation of channel complexity in the future. The in-stream piers could result in alteration to large wood transport to reaches downstream or to the Puget Sound. If there is large wood moving downstream and it is trapped by the piers, the response would likely be to pull it out, not allowing it to settle there and not allowing it to continue downstream. However, considering that LWD is a limiting factor in the lower Puyallup River, this is unlikely to occur.

The added piers to the wetted channel may also promote local bed scour, which may result in local downstream bar development. This could possibly add to habitat complexity by improving the availability of mid-channel velocity gradients and bed material sorting. However, if the design is inadequate to control scour and/or deposition, or is poorly implemented, maintenance would be required on a regular basis to implement protective measures such as more armoring or dredging, which would contribute to habitat degradation and instability. With proper design and implementation of the added piers, which we assume will occur; impacts to PCE #2 are not expected to be measurable.

The proposed wetland mitigation (depending on the site selected) is expected to have long-term beneficial effects to PCE #2 by improving features that contribute to stream complexity (riparian vegetation, pools, side-channels, etc.).

4) *A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.*

Project components such as removal of vegetation and addition of new impervious surface are known to increase runoff and decrease infiltration. Increased runoff results in increased peak flows of surface water, and reduced infiltration inhibits groundwater recharge and subsurface flow with the river, and consequently decreases base flow. Puyallup River flow is currently impaired due to significant development within the basin. Additional significant increases of impervious surface within the sub-basin from this project are likely to have measurable negative impacts on peak and base flows of the lower Puyallup River (see "Effects of Increased Impervious Surface"). Project components are expected to have adverse effects on PCE #4 in the lower Puyallup River.

The proposed wetland mitigation is expected to have long-term beneficial effects to PCE #4 in the lower Puyallup River by improving floodplain connectivity and in return controlling peak flows.

5) *Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.*

Constant temperatures above 16°C are intolerable for bull trout (Poole and Berman 2001) but bull trout will migrate through higher temperatures by utilizing areas of thermal refuge, such as a confluence with a cold water tributary, deep pools, or locations with surface and

groundwater exchanges (see "Effects of Increased Impervious Surface to Bull Trout"). Temperatures in the lower Puyallup River are at the high end of the range that bull trout are found most frequently.

It is well understood that impervious surface and vegetation removal decreases infiltration, resulting in decreased groundwater recharge and loss of subsurface flow from the river. Given the degraded nature of the baseline in the lower Puyallup River, the existing cold water sources provide critical "stepping stones" to upstream habitat. As these "stepping stones" are degraded the ability of the river to support migratory bull trout is reduced.

The loss of vegetation and placement of fill will negatively impact the hydrologic function of the lower Puyallup River. The significant increases in impervious surface within the sub-basin from the project (70 acres) is expected to result in additional decreases in groundwater recharge and loss of subsurface flow (see "Effects of Increased Impervious Surface to Bull Trout") to an extent that may result in degradation of cold water refugia for foraging and migrating bull trout. These changes will likely result in alterations of how the habitat will be used. Project components are expected to have adverse effects on PCE #5 in the lower Puyallup River.

Depending on the mitigation site chosen, the proposed wetland mitigation could have long-term beneficial effects to PCE #5 by improving floodplain connectivity and restoring subsurface water exchange, thereby acting as a cold water source.

6) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

No physical impediments are expected to result from construction of the project. However, degradation of cold water refugia for foraging and migrating bull trout and increases in water temperature are expected and would be considered an impediment to use of a migratory corridor. (64 FR 58910 [November 1, 1999]) documented steady and substantial declines in abundance in stream reaches where water temperature ranged from 15 to 20 °C. Temperatures in the lower Puyallup River are already at the high end of the range that bull trout are found most frequently.

Project components such as removal of upland vegetation, loss of riparian vegetation, and addition of new impervious surface increase runoff and decrease infiltration. Reduced infiltration inhibits groundwater recharge and results in decreased baseflows. Low baseflows, loss of shade from riparian vegetation, and reduced groundwater recharge (as a cold water source) can lead to warming of the surface water (the lower Puyallup River). Project impacts in the lower Puyallup River are likely to lead to slight localized temperature increases in the lower Puyallup River during timeframes that bull trout are present. Adverse effects to PCE #6 are expected in the action area (lower Puyallup River) due to temperature increases that prevent use of previously existing habitat.

The new bridge piers (maximum of three piers) that may be installed below the OHWM of the lower Puyallup River result in temporary, but significant increases in turbidity; however, the impacts are not expected to significantly impair migratory corridor functions. The installation of a maximum of three bridge piers in the lower Puyallup River is likely an insignificant effect on PCE #6.

7) *An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

Prey species, particularly salmonids, will also be affected by impacts to subsurface flow and stream temperatures. Project components such as new impervious surface and vegetation removal increase runoff and decrease infiltration, resulting in decreased groundwater recharge and loss of subsurface flow from the river (see "Effects of Increased Impervious Surface on Bull Trout" section, above). This will result in a reduced prey base.

The new bridge piers (maximum of three piers) that may be installed below OHWM of the lower Puyallup River may result in temporary, but significant increases in turbidity, which will temporarily degrade foraging habitat. However, this activity will not result in the permanent loss of this foraging habitat and the activities are expected to occur when bull trout are least likely to be present. The new piers may also result in the loss of benthic habitat and benthos species simply due to their presence within the stream channel. This impact is not likely to be measurable and is therefore, insignificant. Project effects to PCE #7 from the new bridge piers within the lower Puyallup River are insignificant.

8) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

Increased runoff from new impervious surface is expected to further degrade the water quality of the lower Puyallup River. The water quality impacts to the lower Puyallup River from stormwater constituents are likely to be significant; primarily at the site of the mixing zone where stormwater discharge occurs. Temperature increases from the loss of hyporheic function is likely to occur. Adverse effects from degraded water quality are expected to PCE #8 within the lower Puyallup River.

Blair and Hylebos Waterways (Marine Water)

PCE 1 - Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

Stormwater from new impervious surface is expected to discharge to creeks within Blair and Hylebos sub-basins. However, temperature impacts to Blair and Hylebos Waterways from

additional stormwater runoff are not expected to be measurable and are, therefore, insignificant.

PCE 6 - Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

Stormwater discharge from new impervious surface is expected to contain contaminants such as copper, zinc, other metals, and sediment. Water quality impacts are expected to occur within Blair and Hylebos Waterways as a result (see "Direct Effects of Stormwater Discharge on Bull Trout" section, above). However, these effects are not expected to preclude migratory movements or use by bull trout, therefore effects to PCE #6 within Hylebos and Blair Waterways are considered insignificant.

PCE 7 - An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Significant water quality impacts are expected to occur to bull trout prey species in Hylebos and Blair Waterways due to stormwater discharge from the proposed project (see "Direct Effects of Stormwater Discharge on Bull Trout" section, above). These impacts are expected to further reduce the use of the waterways as foraging habitat. Adverse effects are expected to PCE #7 in Hylebos and Blair Waterways.

PCE 8 - Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Water quality impacts are expected to occur within Blair and Hylebos Waterways due to stormwater discharge within Wapato and Hylebos Creek sub-basins (see "Direct Effects of Stormwater Discharge on Bull Trout") which could inhibit normal reproduction, growth, and survival. Adverse effects from degraded water quality are expected to PCE #8 within Blair and Hylebos Waterways.

Conclusion

The proposed project will adversely affected designated critical habitat in the Puyallup River and the marine waters of Commencement Bay. In the lower Puyallup River, permanent impacts to the following PCEs will occur: PCE #1 (water temperature), PCE #4 (natural hydrograph), PCE #5 (groundwater sources and subsurface water), PCE #6 (migratory corridors), PCE #7 (abundant food base), PCE #8 (permanent water of sufficient quantity and quality). In the Blair and Hylebos Waterways, permanent impacts to the following PCEs will occur: PCE #7 (abundant food base), PCE #8 (permanent water of sufficient quantity and quality).

Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions have no independent utility apart from the action under consideration. No interrelated or interdependent actions were identified.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Cumulative effects include the effects of future State, Tribal, local, or private actions (non-federal) that are reasonably certain to occur in the action area considered in this Biological Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Land use in the action area is either currently industrial or commercial or is rapidly converting to such (FHWA 2005). The proposed project is expected to support growth as it is planned and envisioned by the local and regional jurisdictions (FHWA 2005). This is evidenced by the fact that the project has been promoted by both the City of Fife and the City of Puyallup in their Comprehensive and Transportation Plans (FHWA 2005). Properties adjacent to the proposed project are expected to increase in value due to their proximity to the Port of Tacoma and freeway access (WSDOT 2004) and placement of a new highway in this location is expected to increase pressure for development in the region (WSDOT 2004).

The geographic scope of the cumulative effect analysis was influenced by traffic analyses conducted by WSDOT for NEPA documentation (WSDOT 2001) and summarized in an indirect effect analysis that supplemented the original BA (FHWA 2005); and by the FWS after identifying cumulative effects associated with expansion of the Port of Tacoma. Traffic analyses conducted by the WSDOT identify the proposed project's zone of traffic influence as the area bounded by the existing SR5/SR167 interchange to the west, the SR5/SR18 interchange to the north, the SR167/SR410 interchange to the southeast, and the SR509 and the Port of Tacoma Road to the northwest (WSDOT 2001). For surface street traffic, traffic influence was considered to extend to the Puyallup River to the southwest, the Port of Tacoma to the northwest, and the steep bluff area to the northeast (FHWA and WSDOT 2005).

The data needed to quantify the amount of land use changes and development that will occur as cumulative effects were requested by the FWS from FHWA/WSDOT but were not provided and were not readily available. The FWS expects that areas within the action area that are currently undeveloped will continue to develop consistent with the zoning designations and in a fashion similar to what has been seen in recent years. In general terms, this will involve conversion of agricultural and vacant land to light industrial developments.

Despite the lack of quantitative data on land use changes expected in the action area, we were able to identify the following actions as cumulative effects via local jurisdiction planning documents and conversations with local planners (Figure 10; Table 9):

- Fife land use conversion – South of I-5 to the city limits (Freeman Road) the city has annexed land, removed the agricultural designation, and has designated the majority of the land as industrial/commercial. This land use conversion is currently occurring and is expected to continue as planned in the City's comprehensive plan. The City has designated 1,571 acres for industrial development, approximately 47 percent of the entire City (WSDOT 2006).

- Kelsey Lane Residential Development – This planned development of 49-single-family lots is on 12.39 acres at a density of 4 units/acre. It is located in the City of Fife adjacent to the Puyallup River. The developer is required to construct an access roadbed to accommodate future widening of Levee Road (City of Fife 2006a).

- City of Puyallup Urban Growth Area Development – The urban growth area and incorporated land north of the Puyallup River has been designated as Light Manufacturing (industrial/commercial) land use. "In portions of the UGA, agricultural lands provide a base for needed industrial development…" (Puyallup Comprehensive Plan 2005 update). (WSDOT 2006)

- City of Milton Urban Growth Area Development – The urban growth area south and west of Milton, adjacent to the Fife city limits along SR 99/Pacific Highway, is expected to be developed for residential and commercial uses (WSDOT 2006).

- Union Pacific Railyard Expansion – The Union Pacific Railroad (UPRR) plans to expand its railyard to the south and the City of Fife intends to develop warehousing adjacent to this expansion. The railyard and warehousing projects are anticipated to occur regardless of the construction of SR 167. The UPRR property location is south of the south terminus of SR 167, and traffic between the UPRR site and the Port of Tacoma is not anticipated to use SR 167 (WSDOT 2006).

- City of Fife Transportation Plan Improvements – The City of Fife's 6-year transportation plan identifies numerous transportation projects that are likely to happen in the action area (City of Fife 2006b). For this analysis we excluded those that currently have Federal funding assigned as these will undergo separate section 7 consultations. The remaining projects are considered cumulative effects because they are likely to happen in the future and at this point are non-Federal actions. Along with miscellaneous improvements and intersection signalizations these projects include:

    - Widen Valley Avenue E
    - Extend 59th Ave. E
    - Widen I-5 Ramp off Port of Tacoma Rd.
    - Pedestrian Bridge across Wapato Creek
    - Construct new road at 52nd Ave. E

- Realign 58th Ave. E. at Valley Ave. E
- Construct New Ramps from I-5 to Pacific Highway and Port of Tacoma Rd
- Reconstruct 34th Ave. E
- Reconstruct 12th St. E to Port of Tacoma Rd
- Extend Frank Albert Rd.
- Reconstruct Levee Rd. – West, East, and Central Segments
- 70th Ave. Bridge – New bridge across the Puyallup River
- Widen 20th St. E
- Reconstruct Freeman Rd – North and South Segments
- Construct Railroad Overpass at 70th Ave. E
- Widen 70th Ave. E
- Construct Bicycle/Pedestrian Trail
- Construct Puyallup River Trail
- Widen 48th St.
- Reconstruct 12th Ave. E
- Reconstruct 62nd Ave. E
- Construct new road at 32nd St. E
- Construct 54th Ave. Grade Separation to re-open street at Union Pacific Railroad
- Construct new road at 74th Ave. E
- Extend 58th Ave. E
- Construct Pedestrian Overpass of Union Pacific Railroad at 54th Ave. E

- Port of Tacoma Expansion – The Port of Tacoma encompasses land east of the Thea Foss Waterway to Marine View Drive, and north of the city limits of Fife. The Port has 2,400 acres that are used for shipping terminal activity, warehousing, distribution, and manufacturing. The Port of Tacoma is currently expanding. Expansion plans include new wharf construction, wharf extensions, terminal expansions, new terminal construction, new container yards, and expansion of intermodal facilities (FHWA 2005). The proposed project is recommended as part of a growth management strategy for the Port of Tacoma's expansion (FHWA 2005). Additionally, the Port is expanding its industrial development capabilities. Between 1964 and 1981 the Port of Tacoma bought land in Frederickson and developed a 553 acre industrial development area. This site is Puget Sound's largest industrial site zoned for heavy manufacturing. The site currently has 24 industrial users including The Boeing Company. The Port is actively marketing remaining parcels and point to features such as its proximity to the Port (13 miles), rail access and improved access to Interstate 5 via the planned Cross-base Highway as attributes (Port of Tacoma 2006b). The Port of Tacoma also owns properties in South Prairie (423 acres utilized by "Cascadia"), Fife (23 acres utilized by the Fife Business Park; 33 acres utilized by Rainier Corporate Park East; 88 acres utilized by TransPacific Industrial Park), Sumner (150 acres utilized by the Greenwater Corporate Park; 20 acres utilized by the Valley South Corporate Park), Lakewood (170 acres utilized by the Lakewood Industrial Park), and Puyallup (79 acres utilized by the Puyallup Industrial Park) (Port of Tacoma 2000). A major focus of the Port's Five-Year Capital Improvement Plan (2005-2009) is emphasizing strategic land acquisition to increase the land base for future business opportunities (Port of Tacoma 2006a). According to the City of Puyallup, economic

- growth attributable to the expansion of the Port of Tacoma is resulting in a population shift into Puyallup's South Hill area from Tacoma, Seattle and King County (City of Puyallup 2006).

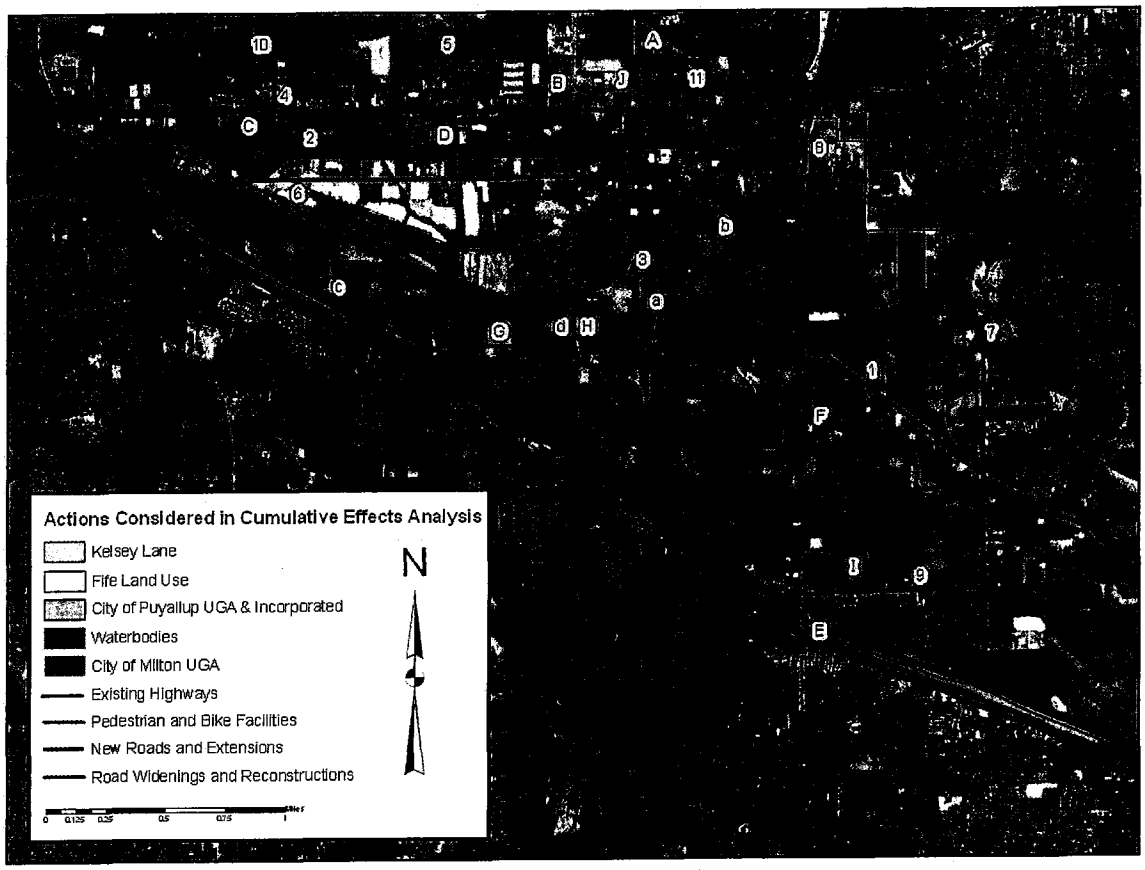


Figure 10: SR 167 Extension Cumulative Effects

Table 9: Categorization of actions shown in Figure 10.

ID in Figure 10	Category	Action
1	Road widening and reconstructions	**Widen Valley Avenue East**
2		**Widen I-5 Ramp off Port of Tacoma Rd.**
3		**Realign 58th Ave. E. at Valley Ave. E.**
4		**Reconstruct 34th Ave. E.**
5		**Reconstruct 12th St. E. to Port of Tacoma Road**
6		**Widen 20th St. E.**
7		**Reconstruct Freeman Road – North and South Segments**
8		**Widen 70th Ave. E.**
9		**Widen 48th St.**
10		**Reconstruct 12th Ave. E.**
11		**Reconstruct 62nd Ave. E.**
A	New Roads and Extensions	**Extend 59th Ave. E**
B		**Construct new road at 52nd Ave. E.**
C		**Construct New Ramps from I-5 to Pacific Highway and Port of Tacoma Road**
D		**Extend Frank Albert Rd.**
E		**70th Ave. Bridge – New bridge across the Puyallup River**
F		**Construct Railroad Overpass at 70th Ave. E.**
G		**Construct new road at 32nd St. East**
H		**Construct 54th Ave. Grade Separation to re-open street at Union Pacific Railroad.**
I		**Construct new road at 74th Ave. E.**
J		**Extend 58th Ave. East**
a	Pedestrian and Bicycle Facilities	**Pedestrian Bridge across Wapato Creek**
b		**Construct Bicycle/Pedestrian Trail**
c		**Construct Puyallup River Trail**
d		**Construct Pedestrian Overpass of Union Pacific Railroad at 54th Ave. E.**

Between 1991 and 2001 population in the watershed increased by 25 percent and the population of Pierce County is expected to grow 34 percent by 2025 (Puget Sound Action Team 2007). Due to rapidly increasing population increases and urbanization, Pierce County has reached the limits of their surface-water supply and are relying more on groundwater supplies (USGS 1999). Groundwater recharge may be reduced by current land development that impedes precipitation from infiltrating downward into the ground, thus increasing surface runoff (USGS 1999). This pattern will continue as impervious surface increases from conversion of agricultural land to light industrial development.

The continued urbanization is expected to further degrade the aquatic ecosystems of Hylebos Creek, Wapato Creek, Surprise Lake Drain and the lower Puyallup River and adversely affect bull trout. It is anticipated that Critical Areas Ordinances within the associated jurisdictions will reduce some of these adverse effects but will not eliminate them. Increases in occurrence and duration of peak flow and water temperatures, decreases in baseflows, degradation of water quality and a reduction of bull trout prey are expected. The impacts to bull trout associated with a reduction in vegetative cover and an increase in impervious surface are discussed in detail in the **Effects of Impervious Surface** and **Indirect Effects** sections above.

These effects are expected to further degrade the aquatic environment for bull trout and bull trout critical habitat in the Puyallup River Basin.

Integration and Synthesis

The above analysis forms the foundation for our jeopardy analysis, which is intended to determine whether we would reasonably expect threatened or endangered species to experience reductions in reproduction, numbers, or distribution that would appreciably reduce the species' likelihood of surviving and recovering in the wild and/or the destruction or adverse modification of designated critical habitat. We identify reductions in the bull trout's likelihood of surviving and recovering in the wild by qualitatively analyzing the probable effect of changes in reproduction, numbers, and distribution based on the probability of the species to persistence over time, at the scale of the coterminous range. While modeling efforts can be helpful in analyzing these relationships, in this case, the lack of abundance, demographic, and fecundity data for bull trout in this core area, coupled with the fact that the majority of the expected effects are sublethal, made this impracticable. Below, we describe how the expected effects of the project will relate to the survival and recovery of bull trout at the project, local population, core area, and interim recovery unit scales.

Effect of the Proposed Project on Individual Bull Trout and Their Designated Critical Habitat

The proposed project will adversely affect sub-adult and adult bull trout and their designated critical habitat within the lower Puyallup core area. The action area contains foraging, migrating, and overwintering habitat that is used by an unknown number of fluvial, and all anadromous bull trout natal to the Puyallup core area. The habitat in the action area is essential to the anadromous form of bull trout for their movements to and from marine waters.

The effects of the proposed project can be grouped into two categories: the temporary effects from construction (e.g., exposure to elevated underwater SPLs, turbidity, and fish-handling); and the long-term effects from operation (e.g., exposure to increased pollutants, reduced prey base, and reduced thermal refugia). The temporary effects will occur over two in-water work seasons and could include injury and mortality of individual bull trout. Since bull trout occur in the action area in low numbers, we expect that few fish will be affected by these actions. Impacts to these individuals will temporarily reduce the number of bull trout in the Puyallup core area: however, we expect that these impacts will be indiscernible at the population level.

Exposure to the project's long-term effects presents a greater risk to bull trout since the stormwater and impervious surface-related effects will continue in perpetuity. Additionally, since bull trout are iteroparous, individual bull trout could be repeatedly exposed to the long-term effects. These effects, combined with significant alterations of normal foraging and migrating behavior are expected to result in the reduced fitness of all sub-adult and adult bull trout using the action area. The severity of this reduction in fitness will vary depending on an individual's condition and the duration and timing of exposure making the ultimate result difficult to estimate. We expect that these effects will be sub-lethal and that the anticipated reduction in fitness could manifest itself through reduced fecundity.

The proposed project is expected to adversely affect PCEs 1 (water temperature), 4 (natural hydrograph), 5 (water quality and quantity for a cold water source), 6 (migratory corridors), 7 (abundant prey base), and 8 (water quality). Similar to the effects of individual bull trout, the construction-related effects to critical habitat are expected to be temporary while the long-term, operational, effects will continue in perpetuity. While effects to these PCEs are expected to degrade their condition, we anticipate that each of the PCEs will still be able to serve their intended conservation role for bull trout. In general, the conservation role of bull trout critical habitat units is to support viable core area populations (USFWS 2004b).

Coastal-Puget Sound Interim Recovery Unit

The bull trout was initially listed as three separate DPSs. The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under Section 7 of the Act relative to this species (64 FR 58910). It explains that the DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Under this approach, the proposed project is within the Coastal-Puget Sound interim recovery unit.

Within the Coastal-Puget Sound interim recovery unit, abundance has declined, especially in the southeastern portion (the vicinity of the proposed project). The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area. We do not expect the proposed project will result in significant, long-term, impacts to any of these three conservation needs, for the reasons described below.

Puyallup Core Area

The Puyallup core area is one of 14 in the interim recovery unit. It contains the southernmost, anadromous bull trout population in Puget Sound (USFWS 2004b) and is critical to maintaining the overall distribution of migratory bull. Within the core area some local extirpations have occurred and many remaining populations are isolated or fragmented.

The status of a core area is based on four elements: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity. The proposed project is expected to negatively impact adult abundance (#2) for 2 years, and productivity (#3) over the long-term; but will not affect the number and distribution of local populations or connectivity. We expect bull trout returning to spawn to be in poorer condition (reduced fitness) which could manifest itself in reduced fecundity and productivity. The condition of individual bull trout will be a function of its exposure to project effects, and will vary depending on how an individual uses the action area.

Local Populations within the Puyallup Core Area

Five local populations of the bull trout occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River (USFWS 2004b). Each of these local populations is estimated to contain approximately 100 adult bull trout. It is unknown what proportion of these fish are anadromous, and it is possible that fish from each of these populations could utilize the action area. Because there are fewer than 10 local populations in the core area it is considered to have an intermediate risk of extirpation. Little is known about the productivity of the core area and it is considered at an increased risk of extirpation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap.

Reliable abundance estimates for these local populations are not available. The Buckley Diversion fish trap encounters fish from 3 of the 5 local populations (in the White River portion of the core area) and has never trapped more than 50 bull trout. Numbers for the remaining two local populations (in the Upper Puyallup portion of the core area) are not known. Based on the number of fish detected at Buckley, and assuming that the remaining two local populations do not produce higher numbers of anadromous fish, we expect that no more than 100 individual anadromous bull trout would be exposed to the effects of the proposed project. We further assume that it will be a random mix of individuals from each local population that are effected.

There are also no long-term, comprehensive trend data for bull trout productivity in these local populations. Given low known population sizes, we assume that productivity is low. Since the long-term effects of the project are expected to be sub-lethal, affected fish are still expected to have some level of productivity (albeit reduced to an unknown degree). Due to limited data on abundance and productivity of these local populations, it is impossible to predict, with any reasonable precision, the degree to which productivity will be reduced. This, in turn, makes it difficult to estimate the potential for population-level effects. However, given that some productivity will continue and because impacts will be distributed over five local populations we conclude that these sublethal effects will not result in a discernable effect to numbers and reproduction at the core area scale.

CONCLUSION

We have reviewed the current status of the Coastal-Puget Sound bull trout, the environmental baseline for the action area and the direct and indirect effects of the proposed SR 167 Extension Project. We have also evaluated effects to the PCEs of designated critical habitat.

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed project and the cumulative effects, it is the U.S. Fish and Wildlife Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout for the following reasons:

- Potential injury and/or mortality associated with the temporary (construction-related) effects of the proposed project are expected to impact so few individual bull trout that the effects will not be measurable at the scale of the Puyallup core area.

- The long-term, sub-lethal effects, are not expected to measurably reduce productivity at the scale of the Puyallup core area.

- Because effects will not be discernable at a core area scale, we do not expect that the effects of the proposed project will reduce the species' likelihood of survival and recovery in the wild.

After reviewing the current status of bull trout critical habitat, the environmental baseline for the action area, the effects of the proposed project and the cumulative effects, it is the U.S. Fish and Wildlife Service's biological opinion that the action, as proposed, is not likely to destroy or adversely modify designated critical habitat for the following reasons:

- Although several PCEs will be degraded, each of the PCEs will still be able to serve their intended conservation role for bull trout.

- Significant loss of prey species input to Commencement Bay will degrade PCE 7 (abundant prey base), but will not prevent fulfillment of the conservation role of this PCE because additional forage base sources remain in lower Puget Sound and will continue to provide prey for anadromous bull trout in Commencement Bay.

- Water quality impacts associated with discharge of stormwater are expected to be localized and will not preclude use by bull trout of designated critical habitat throughout the action area.

- Water quantity and temperature-related impacts associated with the increase in impervious surface are expected to be localized and will not preclude use by bull trout of designated critical habitat within the action area.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR § 17.3). *Harass* in the definition of "take" in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR § 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the FHWA so that they become binding conditions of any grant or permit issued to the WSDOT, as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this incidental take statement. If the FHWA 1) fails to assume and implement the terms and conditions or 2) fails to require the WSDOT to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the WSDOT must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The FWS anticipates that take of bull trout from the Puyallup Core population is likely to result from the proposed action.

The FWS anticipates that incidental take of individual bull trout will be difficult to detect or quantify because of the sublethal nature of the take and the low likelihood of finding the affected juveniles or adults. Using post project habitat conditions as a surrogate indicator of take, the FWS anticipates that the following forms of take will occur as a result of the activities associated with the project.

Degradation of Thermal Refugia in the Lower Puyallup River Sub-basin from Increased Impervious Surface

Incidental take of bull trout in the form of ***harassment*** through significant disruption of normal foraging and migratory behavior resulting from the direct effects of degraded thermal refugia and water temperatures in the lower Puyallup sub-basin.

- All sub-adult and adult bull trout utilizing the lower Puyallup River portion of the action area (approximately RM 2.5 to RM 9) from completion of construction and continuing in perpetuity.

Discharge of Project-related Stormwater

Discharge of stormwater into waterbodies throughout the action area will result in incidental take of bull trout in the form of *harm* and *harassment*.

- Incidental take of bull trout in the form of ***harm*** of all adult and subadult bull trout exposed to the effluent plume at each stormwater outfall in the Puyallup River as a result of sub-lethal physical injury (or the likelihood of such injury) caused by exposure to various pollutants when the concentration of dissolved copper exceeds 2.3 µg/L over background levels not exceeding 3.0 µg/L and the concentration of dissolved zinc exceeds 5.6 µg/L over background levels between 3.0 µg/L and 13.0 µg/L. Because bull trout are long-lived and reside in or must pass through the action area several times over their lifetimes, the FWS anticipates that individual bull trout are likely to be exposed to pollutants at concentrations that will result in injury or impairment of essential behavior. The area in which sub-lethal harm of all bull trout is likely to occur in the Puyallup River is at the mouth of the Oxbow Lake Ditch and in the mixing zones (300 ft long downstream by 25 percent of the width of the river during the 7Q10 discharge) of each outfall. The duration of this incidental take is in perpetuity.

- Incidental take of bull trout in the form of ***harassment*** of all adult and subadult bull trout through significant disruption of normal foraging and migrating behavior from discharge of stormwater effluent in the lower Puyallup River. Disruption of normal foraging and migrating behavior is expected to occur when bull trout avoid the mixing zones associated with stormwater outfalls in the Puyallup River. One outfall is located at the bridge (approximately RM 9) and the second outfall is considered to be the downstream end of the Oxbow Lake Ditch (approximately RM 5). The duration of behavior disruption may be as little as a few days for adults that are migrating through the action area or indefinitely for individuals that are foraging or overwintering in the lower river and are precluded from a portion of the river on a continual basis.

Pile Installation in the Puyallup River

Incidental take of bull trout in the form of *harm* through physical injury from the direct effects of elevated underwater SPLs resulting from impact installation of 150 steel piles in the Puyallup River between July 15 and August 31 of the first construction season.

- All sub-adult and adult bull trout within a 44-meter diameter around each steel pile installed and/or proofed with an impact hammer, are expected to be incidentally ***harmed.*** The total area where harm to bull trout would occur is expected to equal approximately 69 percent of the wetted width of the river.
- All sub-adult and adult bull trout exposed to impact pile installation without sound attenuation as necessary to determine baseline SPLs, are expected to be incidentally ***harmed.*** This area where bull trout will be harmed is a 215-meter radius from each pile being installed with an impact hammer without sound attenuation measures.

Incidental take of bull trout in the form of ***harassment*** through significant disruption of normal foraging and migratory behavior resulting from elevated underwater sound pressure levels generated by impact installation of steel piles in the Puyallup River between July 15 and August 31 of the first construction season.

- All bull trout within a 341 meter radius from each steel pile being installed and/or proofed with an impact hammer are expected to be ***harassed.*** The area affected in the form of harassment includes the entire estimated 210-ft wetted width of the Puyallup River up to 0.21 miles up- or down-stream of the pile driver.
- All sub-adult and adult bull trout exposed to impact pile installation without sound attenuation as necessary to determine baseline SPLs hydroacoustic monitoring, are expected to be incidentally ***harassed.*** This area will consist of a 3,415 meter radius from each pile being installed with an impact hammer without sound attenuation measures.

Fish Handling Related to Cofferdam Use in the Puyallup River

Incidental take of bull trout in the form of *harm* through physical injury and/or mortality from the direct effects of electroshocking and handling resulting from work area isolation for construction of the Puyallup River bridge (7 cofferdams) and construction of the Puyallup River mitigation sites (6 cofferdams) between July 15 and August 31 over 2 construction seasons. The capture and handling of bull trout will result in direct take. Affected bull trout are likely to be fluvial and/or anadromous subadult and adults. Fish handling may still result in injury or mortality but is expected to minimize the risk of injury or mortality of individual bull trout from bridge construction activities. Because bull trout occur in the action area in low numbers, we expect that no more than one bull trout will be harmed during construction of each element. Therefore, we expect that one bull trout may be harmed during construction of the mitigation sites, and one bull trout per season of construction at the bridge site (for a total of 3 bull trout).

Sediment from Wetland Mitigation Levee Breeching

Incidental take of bull trout in the form of harassment will occur through the disruption of normal migratory and foraging behaviors associated with direct impacts resulting from elevated sediment levels. Elevated sediment levels are expected to result from the breeching of the levee at each of three wetland mitigation sites along the Puyallup River. Elevated sediment is expected during outgoing tides during the first 2 days after removal of the coffer dams at each site.

- All sub-adult and adult bull trout from the upstream extent of each site to 600 ft downstream of each site are expected to be harassed during outgoing tides for 2 days between July 15 and August 31.

Reduction in Prey Base

Incidental take of anadromous bull trout in the form of *harassment* as a result of reduced fitness expected to occur through a reduction in prey base. Prey base will be reduced in all affected water bodies. Bull trout foraging in the lower Puyallup River and Commencement Bay are likely to experience reduced fitness because production of forage fish is limited in Commencement Bay. These effects are expected to occur in perpetuity.

EFFECT OF THE TAKE

In the accompanying Biological Opinion, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of bull trout:

BTI. Minimize harm of bull trout within the action area during construction.
BTII. Minimize harassment of bull trout from the addition of new impervious surface in the lower Puyallup sub-basin.
BTIII. Minimize harm and harassment of bull trout from impacts to their prey base from stormwater-related pollutants.
BTIV. Minimize harassment of bull resulting from a loss of prey base throughout the action area.
BTV. Minimize harm and harassment of bull trout resulting from exposure to elevated underwater SPLs.
BTVI. Minimize harassment of bull trout resulting from exposure to elevated sediment levels

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

To implement RPM BTI:

1. Install individual pieces of multiple-piece cofferdams in sequence to discourage fish from entering the project area and to allow any fish that may become trapped to escape through a downstream opening.
2. Conduct cofferdam dewatering in two or three stages, pausing between stages to accommodate fish removal.
3. Screen dewatering pumps in a manner that prevents fish from being entrained in the pumps or impinged on the screens.
4. Do not remove cofferdam materials until turbidity levels within the work area are the same as the river.
5. Document all bull trout encountered during work area isolation and report the result to USFWS within 30 days of work area isolation.

To implement RPM BTII:

1. Restore infiltration capacity in the Puyallup River sub basin to the maximum extent possible. Utilize the sites identified as potential wetland mitigation sites with the objective of maximizing potential to create, restore and enhance infiltration through the use of native woody vegetation. Runoff/interflow is estimated at 250.74 acre-ft and infiltration is 120.1 acre-ft yearly under existing conditions for the 170.8 acre analysis area in the sub basin. An analysis demonstrating how planned restoration activities at the site will minimize the change to runoff/interflow and infiltration volumes listed above shall be provided to the FWS for review prior to finalization of the plan.

To implement RPM BTIII:

1. Ensure that concentrations of dissolved metals from the SR 167 Extension do not exceed 2.3 µg/L dissolved copper over background levels not exceeding 3.0 µg/L or 5.6 µg/L dissolved zinc over background levels between 3.0 µg/L and 13.0 µg/L. The points of compliance will be:

    i. In the Puyallup River and Hylebos Creek, immediately outside the mixing zone (300 ft long downstream by 25 percent of the width of the river during the 7Q10 discharge)

    ii. In the non-listed fish-bearing Oxbow Lake Ditch, Surprise Lake Drain, Fife Ditch, Erdahl Ditch, and Wapato Creek, will be at the

WSDOT stormwater outfalls to each of these water bodies. Hydraulic modeling conducted by the WSDOT indicates that dissolved metal concentrations at the confluence of each of these water bodies with listed fish-bearing waters will meet the thresholds identified above, as long as concentrations at the stormwater outfalls do not exceed the following values 90 percent of the time:

- Dissolved copper: 7.8 ug/L
- Dissolved zinc: 44.8 ug/L

2. Monitor stormwater effluent for a yet to be determined number of years over a 10 year period at a representative set of points of compliance identified in 3c to demonstrate attainment of the concentrations of dissolved copper and zinc identified in 3c. Monitoring parameters shall also include TSS, total copper and zinc, AADT, rainfall, and antecedent dry period. A statistically sound sampling scheme shall be submitted to FWS for approval within 90 days prior to the initial discharge from the stormwater outfalls. The results of monitoring shall be submitted to FWS at the end of the calendar years during which monitoring was conducted.
3. Use a continuous flow model calibrated to forested conditions in sizing duration flow control BMPs.

To implement RPM BTIV:

1. Minimize the project's effects on in-water and riparian habitat in the lower Puyallup River sub-basin by improving riparian habitat at a site within the lower Puyallup River sub-basin. Of the 10 proposed wetland mitigation sites, utilize 1 of the 3 that are in the Puyallup sub-basin when finalizing the wetland mitigation plan. Incorporate fish habitat features to benefit listed fish species in the Puyallup River.
2. Develop and implement a monitoring plan to ensure that the RRPs and the relocated channels provide stormwater flow control, as well as habitat forming processes, floodplain functions, and habitat connectivity; and provide quality rearing and migratory habitat for salmonids. The monitoring plan shall contain contingencies consistent with the above functions and shall be undertaken for 10 years following project completion.
3. Prepare a monitoring Plan to ensure that arsenic and copper contamination in the areas proposed for the temporary Hylebos Creek diversion channel, both relocated Hylebos Creek and Surprise Lake Drain, and the adjacent RRPs do not exceed project baseline water and soil conditions in and adjacent to Hylebos Creek upstream of the area proposed for the Hylebos Creek RRP. This information will be used in conjunction with other studies conducted in the area to determine what steps are necessary by the WSDOT to ensure that arsenic and copper contamination in the above-referenced areas does not occur. This plan will be sent to FWS for review and approval.
4. Monitor arsenic and copper contamination for a yet-to-be-determined number of years over a 10-year period in relocated Hylebos Creek, in relocated Surprise Lake Drain, and in the adjacent RRPs. A statistically sound sampling scheme measuring

groundwater, wetland soil/sediment, and surface water concentrations, shall be submitted to the FWS for approval prior to construction of the relocated streams and RRPs. The results of monitoring shall be submitted to the FWS at the end of the calendar years during which monitoring was conducted.

5. Ensure that relocated Hylebos Creek and Surprise Lake Drain, as well as the 21 new, replacement, or widened, permanent stream crossing structures within the RRPs, shall, where feasible, support channel forming processes, floodplain functions, and aquatic habitat connectivity within the RRPs. The relocated streams shall be designed according to an accepted design methodology. To determine stable dimension, pattern, and profile, the design process shall take the following parameters and considerations into account:

    i. Dimension, pattern, and profile of a western Washington reference stream shall be used in the design.
    ii. The new channel shall accommodate the current flow regime and consider bankfull flows in design.
    iii. The new channel shall be competent in transporting predicted sediment loads.
    iv. The profile of the river shall be proportionate to the pattern and dimensions. The placement and spacing of pools and riffles shall be a function of stream width and gradient.
    v. The new stream channel should be constructed with native material including LWD. The LWD shall be stabilized by burying. LWD shall not be cabled to artificial weights. The stream should not be built or stabilized with large rock, because the native geology does not provide this material.
    vi. Floodplain storage and side channels shall be constructed to minimize stranding of fish during receding waters. Connect depressions to the main channel.
    vii. To allow the new stream channel to laterally migrate the banks of the new stream channel shall not be hardened with rock. Soft bank armoring as outlined in the ISPG may be used to stabilize banks until mature vegetation is established.

To implement RPM BTV:

1. Submit sound attenuation design specifications to FWS for review and comment a minimum of 30 days prior to impact pile driving.
2. Develop and implement a hydroacoustic monitoring plan to document the effectiveness of the approved sound attenuation system. The monitoring plan shall be submitted to FWS for approval a minimum of 30 days prior to impact pile driving. The hydroacoustic monitoring plan must be prepared and implemented by an individual(s) with proven expertise in the field of underwater acoustics, fish biology and behavior, and data collection. The results of monitoring shall be submitted to FWS within 90 days of completing monitoring.

3. If more than one impact pile hammer is used to proof steel piles no more than one shall operate at the same time.
4. Impact installation and/or proofing of steel pilings shall not occur between 1 hour after sunset and 1 hour before sunrise.
5. Contact the FWS within 24 hours if hydroacoustic monitoring indicates that the SPLs will exceed the extent of take exempted in this Biological Opinion. The FHWA shall consult with FWS regarding modifications to the sound attenuation methodology in an effort to reduce the SPLs below the limits of take and shall continue hydroacoustic monitoring.

To Implement BT VI

1. The FHWA shall monitor downstream turbidity levels in the Puyallup River after cofferdam removal at each mitigation site on the outgoing tides for 2 days following the introduction of flow into each of the sites.

a) Monitoring shall occur 300 ft downstream from the outlet culvert of each mitigation site.

b) Monitoring shall occur at three locations to the extent practicable along a transect extending perpendicular to the stream flow.

c) Monitoring will be conducted at 15-minute intervals for the first 2 hours during the first outgoing tide. If turbidity levels do not exceed 10 NTUs over background (water quality standards) during that time, then sampling will occur at a frequency of once every 6 hours during the outgoing tides. Whenever an increase in turbidity is visually observed, an additional sample will be collected. If at anytime a sample exceeds the 10 NTUs over background standard, sampling will continue at 15-minute intervals until turbidity levels are below 10 NTUs above background. To the extent practicable, visual monitoring will occur throughout the outgoing tides. If night monitoring is deemed to be unsafe, the first two daylight tides are to be monitored.

d) If monitoring 300 ft downstream indicates that background sediment levels are exceeded at any time by 28 NTUs (the analysis describing sediment levels at which take will occur is described in the "Direct Effects of Bridge Construction" section), then monitoring will occur 600 ft downstream from the outlet culvert (level at which incidental take would occur) at 15-minute intervals until the exceedance no longer exists.

2. Monitoring to establish background turbidity levels will occur up stream and outside the area of influence. Background turbidity levels will be measured once per day following the introduction of flow into each of the mitigation sites.

3. A monitoring report on the turbidity levels will be submitted by December 31 of the year of the introduction of flow into the mitigation sites and will include, at a minimum:

a) Dates and times of project activities that generated sediment and when the monitoring occurred.

b) Identification of the activities and downstream NTUs associated with those activities.

c) Any corrective actions taken to reduce sediment/turbidity.

d) Any reporting requirements of the 401 State Water Quality Permit issued for this project.

4) The FWS shall be notified in advance of the proposed in-water work so that a biologist can be onsite, if possible, to observe the impacts associated with the project.

5) If project induced sediment levels exceed background by the amounts and durations listed below as measured at 600 ft, then the amount of take authorized by the Incidental Take Statement will have been exceeded, and FHWA must reinitiate consultation. FHWA will contact the FWS at the Western Washington Fish and Wildlife Office in Lacey, Washington.

a) 74 NTUs above background at any time, or

b) 28 NTUs above background for more than 1 hour, cumulatively, over an 8 hour workday, or

c) 28 NTUs above background for more than 3 hours, cumulatively, over an 8 hour workday.

The FWS believes that no more than the following incidental take of bull trout will occur as a result of the proposed project:

- All sub-adult and adult bull trout, in the form of harassment through significant disruption of normal behavior resulting from degradation of thermal refugia and water temperatures between approximately RM 2.5 and RM 9 in the lower Puyallup sub-basin from completion of construction and continuing in perpetuity.

- All sub-adult and adult bull trout, in the form of harm, exposed to stormwater effluent at two outfalls (mouth of the Oxbow Lake Ditch, and at the bridge site) within the Puyallup River when the concentration of dissolved copper exceeds 2.3 μg/L over background levels not exceeding 3.0 μg/L and the concentration of dissolved zinc exceeds 5.6 μg/L over background levels between 3.0 μg/L and 13.0 μg/L in the mixing zone from completion of construction and continuing in perpetuity.

- All sub-adult and adult bull trout, in the form of harassment, through disruption of normal behavior when exposed to stormwater effluent at two outfalls (mouth of the Oxbow Lake Ditch, and at the bridge site) within the Puyallup River in perpetuity.

- All sub-adult and adult bull trout, in the form of harm, within a 44 m diameter around each of 150 steel piles installed and/or proofed with an impact hammer between July 15 and August 31 of the first construction season.

- All sub-adult, and adult bull trout, in the form of harm, within a 215 m radius from each pile installed with an impact hammer without sound attenuation measures for the purpose of collecting hydroacoustic baseline data between July 15 and August 31 of the first construction season.

- All sub-adult and adult bull trout, in the form of harassment, within a 341 m radius from each of 150 steel piles installed and/or proofed with an impact hammer between July 15 and August 31 of the first construction season.

- All sub-adult and adult bull trout, in the form of harassment, within a 3,415 m radius from each pile installed with an impact hammer without sound attenuation measures for the purpose of collecting hydroacoustic baseline data between July 15 and August 31 of the first construction season.

- A total of 3 sub-adult or adult bull trout, in the form of harm, through fish handling during in-water work in the Puyallup River between July 15 and August 31 over 2 construction seasons.

- All sub-adult and adult bull trout, in the form of harassment through disruption of normal behavior due to exposure to elevated sediment levels during construction of the wetland mitigation sites in the Puyallup River from the upstream extent of each site to 600 ft downstream of each site during outgoing tides for 2 days between July 15 and August 31.

- All sub-adult and adult bull trout that utilize Commencement Bay for foraging, in the form of harassment, resulting from reductions in prey base from construction and continuing in perpetuity.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the FWS the need for possible modification of the reasonable and prudent measures.

The FWS is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Western Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

- Develop a strategy for reducing the effects of transportation-related increases in impervious surface throughout the lower Puyallup sub-basin by restoring hydrologic processes that maximize groundwater recharge and best mimic natural systems. Coordinate this effort with the USFWS (Western Washington Fish and Wildlife Office), WSDOTs Highways and Local Programs Office, and Olympic Region Office, and incorporate the cities of Fife, Tacoma, and Puyallup as well as the Puyallup Tribe of Indians.
- When developing transportation improvement projects in the lower Puyallup sub-basin, focus conservation measures on improving foraging, migrating, and overwintering habitat for bull trout in the lower Puyallup River. Consider measures that will protect the existing functions contributing to the presence of thermal refugia in the lower river. Such measures may include preserving existing habitat along important tributaries and/or restoring infiltration capacity to existing impervious areas.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the proposed SR 167 Extension Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions regarding this Biological Opinion, please contact Emily Teachout (360-753-9583) at the Western Washington Fish and Wildlife Office.

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APPENDIX A

Exposure and Response Matrix 10/06/06

Item	Action	Where	Exposure: Stressor	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
1	Vegetation removal - 76.3 acres permanent - 0.5-acre riparian and grading the same acres	Puyallup sub basin.	1. Increased runoff 2.Turbidity 3.Streambank erosion 4.Increased water temperature due to shade reduction 5.Loss of cover due to loss of overhanging vegetation 6.Potential reduced baseflow 7. Reduced benthic abundance and diversity from riparian impact and settling of sediment (covering benthos)	1. During rain events. 2. During rain events 3. Three years - two years for construction, one for vegetation stabilization 4-7. In perpetuity.	1. 24 hours 2. 24 hours 3. Three years - two years for construction, one for vegetation stabilization 4-7. In perpetuity.	1-3. Nine times yearly 4-7. In perpetuity.	1-7. All life history forms (adult, sub-adult- juvenile) for bull trout 1-7. Adult and juvenile Chinook salmon.	1. Delayed foraging/avoidance, 2. Delayed foraging/avoidance, 3. Reduced foraging/avoidance, 4. Reduced foraging/less time and less use of area for bull trout overwintering or Chinook rearing, 5. Reduced foraging/ less time and less use of area for bull trout overwintering/ or rearing by Chinook, 6. Reduced overwintering/rearing by Chinook, 7. Reduced foraging.	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (300 ft mix. zone req. and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to min. disturbance to sensitive areas. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Boundaries will be delineated w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1). 4.& 5. Mark clearing boundaries. 6.& 7. none.	1- 3 None 4,5. Clearing will not exceed marked boundaries. (Environmental lead will monitor/inspect for the project team). 6. None 7.None	1. Reduced foraging efficiency during rain events - during runoff pulse. 2. Reduced foraging efficiency within mixing zone. 3. Insignificant 4.Reduce foraging efficiency and overwintering/rearing habitat. 5. Insignificant - primarily herbaceous and non-native shrub, appx. 2 trees. 6. Reduce foraging efficiency and overwintering/rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted and the prevalence of sediment already in the system.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
2	Vegetation removal - 81.9 acres permanent and grading the same acres	Hylebos sub basin.	1. Increased runoff 2.Turbidity 3.Streambank erosion 4.Increased water temperature due to shade reduction 5.Loss of cover due to loss of overhanging vegetation 6.Potential reduced baseflow 7. Reduced benthic abundance and diversity from riparian impact and settling of sediment (covering benthos)	1. During rain events. 2. During rain events 3. Three years - two years for construction, one for vegetation stabilization 4-7. In perpetuity.	1. 24 hours 2. 24 hours 3. Three years - two years for construction, one for vegetation stabilization 4-7. In perpetuity.	1-3. Nine times yearly 4-7. In perpetuity.	1-7. Adult and juvenile Chinook salmon.	1. Delayed foraging/avoidance, 2. Delayed foraging/avoidance, 3. Reduced foraging/avoidance, 4. Reduced foraging/less time and less use of area for Chinook rearing, 5. Reduced foraging/ less time and less use of area for rearing by Chinook, 6. Reduced rearing, 7. Reduced foraging.	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (200 ft mix. zone req.at Hylebos and 100 ft at Surprise Lake Tributary, and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to disturbance of sensitive areas. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Boundaries will be delineated w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1). 4.& 5. Mark clearing boundaries. 6.& 7. none.	1- 3 None 4,5. Clearing will not exceed marked boundaries. (Environmental lead will monitor/inspect for the project team). 6. None 7.None	1. Reduced foraging efficiency during rain events - during runoff pulse. 2. Reduced foraging efficiency within mixing zone. 3. Insignificant 4.Reduce foraging efficiency and rearing habitat. 5. Insignificant. 6. Reduce foraging efficiency and rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted and the prevalence of sediment already in the system..
3	Vegetation removal - 59.4 acres permanent and grading the same acres	Wapato sub basin.	None due to lack of presence.	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for vegetation removal, will be implemented.	As standard practice, the same performance standards as previously disclosed for vegetation removal, will be implemented.	None due to lack of presence.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
4	Temporary vegetation impact - 17.52 acres temporary agricultural, shrub/grass, forest; "developed" partially vegetated area (landscaping).	Puyallup sub basin.	1. Increased runoff 2. Turbidity 3. Streambank erosion 4. Increased water temperature due to shade reduction 5. Loss of cover due to loss of overhanging vegetation 6. Potential reduced baseflow 7. Reduced benthic abundance and diversity from riparian impact and settling of sediment (covering benthos).	1. During rain events. 2. During rain events 3. Three years - two years for construction, one for vegetation stabilization 4-7. 10 years until veg. establishes.	1. 24 hours 2. 24 hours 3. Three years - two years for construction, one for vegetation stabilization 4-7. Ten years until veg. establishes.	1-3. Nine times yearly 4-7. Ten years until veg. establishes.	1-7 All life history forms (adult, sub-adult- juvenile) for bull trout 1-7 Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance 2. Delayed foraging/avoidance 3 Reduced foraging/avoidance 4. Reduced foraging/less time and less use of area for bull trout overwintering or Chinook rearing. 5.Reduced foraging/ less time and less use of area for bull trout overwintering/ or rearing by Chinook 6.Reduced overwintering 7. Reduced foraging.	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (300 ft mix. zone req. and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to disturbance of sensitive areas. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Delin, boundaries will w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1). 4.& 5. Mark clearing boundaries. 1-7. replant with native vegetation	1- 3 None 4,5. Clearing will not exceed marked boundaries. (Environmental lead will monitor/inspect for the project team). 6. None 7.None .	1. Reduced foraging efficiency during rain events - during runoff pulse. 2. Reduced foraging efficiency within mixing zone. 3. Insignificant 4.Reduce foraging efficiency and overwintering/rearing habitat. 5. Insignificant. 6. Reduce foraging efficiency and overwintering/rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted and the prevalence of sediment already in the system...

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
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5	Temporary vegetation impact - 39.92 acres temporary agricultural, shrub/grass, forest; "developed" partially vegetated area (landscaping) and 131.4 acres riparian.	Hylebos sub basin.	1. Increased runoff 2. Turbidity 3. Streambank erosion, 4. Increased water temperature due to shade reduction 5. Loss of cover due to loss of overhanging vegetation 6. Potential reduced baseflow 7. Reduced benthic abundance and diversity from riparian impact and settling of sediment (covering benthos)..	1. During rain events, 2. During rain events, 3. Three years -two years for construction, one for vegetation stabilization, 4-7. Ten years until veg. establishes.	1. 24 hours 2. 24 hours 3. Three years - two years for construction, one for vegetation stabilization 4-7. Ten years until veg. establishes.	1. - 2. -3 Nine times yearly 4-7 10 years until veg. establishes.	1-7. Adult and juvenile Chinook salmon.	1. Delayed foraging/avoidance, 2. Delayed foraging/avoidance, 3 Reduced foraging/avoidance, 4. Reduced foraging/less time and less use of area for Chinook rearing, 5. Reduced foraging/ less time and less use of area for rearing by Chinook, 6. Reduced rearing, 7. Reduced foraging.	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (200 ft mix. zone req. at Hylebos and 100 ft at Surprise Lake Tributary,and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to disturbance of sensitive areas. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Delin, boundaries will w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1). 4.& 5. Mark clearing boundaries. 1-7. replant with native vegetation	1- 3 None 4,5. Clearing will not exceed marked boundaries. (Environmental lead will monitor/inspect for the project team). 6. None 7.None	1. Reduced foraging efficiency during rain events - during runoff pulse. 2. Reduced foraging efficiency within mixing zone. 3. Insignificant 4.Reduce foraging efficiency and rearing habitat. 5. Insignificant. 6. Reduce foraging efficiency and rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted and the prevalence of sediment already in the system....
6	Temporary vegetation impact - 30.56 acres temporary agricultural, shrub/grass, forest; "developed" partially vegetated area (landscaping) 60.8 acres riparian	Wapato sub basin	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for temporary vegetation removal, will be implemented	As standard practice, the same performance standards as previously disclosed for temporary vegetation removal, will be implemented	None due to lack of presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
7	Place 1,010,118 cubic yards of fill including crushed rock for new, widened, and realigned roadway, cul de sac, roundabout, park and rides, weigh stations, cross connection, grading	Puyallup sub basin.	1. Increased turbidity 2. Changes in hyporheic flow due to compaction (potential reduced base flow)	1. During rain events which occur during the maximum 13-year construction period. 2 .In perpetuity.	1. 24 hours 2. In perpetuity.	1.Nine times yearly 2 In perpetuity	1,2 All life history forms (adult, sub-adult- juvenile) for bull trout 1,2 Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance. 2.Reduced overwintering/rearing	1. Implement TESC and SPCC. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 2. None	None	1. Reduced foraging efficiency within mixing zone. 2. Reduce foraging efficiency and overwintering/rearing habitat.
8	Place 2,257,067 cubic yards of fill including crushed rock for new, widened, and realigned roadway, cul de sac, roundabout, park and rides, weigh stations, cross connection, grading	Hylebos sub basin.	1. Increased turbidity 2. Changes in hyporheic flow due to compaction (potential reduced base flow)	1. During rain events which occur during the maximum 13-year construction period. 2 .In perpetuity.	1. 24 hours 2. In perpetuity.	1.Nine times yearly 2 In perpetuity	1,2 Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance. 2.Reduced rearing	1. Implement TESC and SPCC. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils). 2. Implement stormwater BMPs with infiltration.	None	1. Reduced foraging efficiency within mixing zone. 2. Flow movement will not be significantly affected. Minimization measures will reduce effects to insignificant levels.
9	Place 447,856 cubic yards of fill including crushed rock for new, widened, and realigned roadway, cul de sac, roundabout, park and rides, weigh stations, cross connection, grading	Wapato sub basin.	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for fill placement, will be implemented	None	None due to lack of presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
10	Construct 70 acres of new impervious for roadway, widening, realignment, interchanges, roundabout, cul de sac, weight stations, park and rides, cross connection (includes placing crushed rock, paving, guardrail installation, signing, painting, grading)	Puyallup sub basin.	1. Increased contaminants (pavement materials and heavy equipment) 2. Increased runoff 3. Increased temperature.	1-3. During rain events which occur during the maximum 13-year construction period.	1-3. 24 hours	1.Nine times yearly	Adult, sub-adult, juvenile bull trout; Adult and juvenile Chinook salmon,	1. Reduced foraging, increased predation, displacement. 2. Delayed foraging/avoidance 3. Reduced foraging/less time and less use of area for bull trout overwintering or Chinook rearing.	1. Application of tacifier coat will not occur when rain is forecasted. Tacifier is a petroleum product that is used to bind together layers of asphalt and it would be the expected source of contamination from paving (besides equipment). Implement TESC and SPCC. 2-3.Permanent s/w BMP w/ flow control.	1. All concrete shall cure a minimum of 7 days before contact with waters of the State. 2,3. None	1-3 not measurable
11	Construct 115 acres of new impervious for roadway, widening, realignment, interchanges, roundabout, cul de sac, weight stations, park and rides, cross connection (includes placing crushed rock, paving, guardrail installation, signing, painting, grading)	Hylebos sub basin	1. Increased contaminants (pavement materials and heavy equipment) 2. Increased runoff 3. Increased temperature.	1-3. During rain events which occur during the maximum 13-year construction period.	1-3. 24 hours	1.Nine times yearly	Adult and juvenile Chinook salmon	1. Reduced foraging, increased predation, displacement. 2. Delayed foraging/avoidance 3. Reduced foraging/less time and less use of area for Chinook rearing.	1. Application of tacifier coat will not occur when rain is forecasted. Tacifier is a petroleum product that is used to bind together layers of asphalt and it would be the expected source of contamination from paving (besides equipment). Implement TESC and SPCC. 2-3.Permanent s/w BMP w/ flow control.	1. All concrete shall cure a minimum of 7 days before contact with waters of the State. 2,3. None	1. Insignificant 2. Reduced foraging efficiency during rain events - during runoff pulse. 3.Reduced foraging efficiency and rearing habitat.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
12	Construct 36 acres of new impervious for roadway, widening, realignment, interchanges, roundabout, cul de sac, weight stations, park and rides, cross connection (includes placing crushed rock, paving, guardrail installation, signing, painting, grading)	Wapato sub basin.	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for new impervious surface construction, will be implemented	None	None due to lack of presence
13	Constructing temporary access roads (assumes 20,000 square feet of road in Hylebos Basin) (grading, regrading, cross drain culverts, dust control, rock/hog fuel placement, revegetation)	Hylebos sub basin	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Alterations of hydrodynamics	1-3. During rain events for up to 13 years	1-3. 24 hours	1-3. Nine times yearly	1-3. Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance.2. Reduced foraging, increased predation, displacement. 3.Habitat alteration	1. Implement TESC, materials will be clean, covered when appropriate, and placed in a manner to prevent erosion and siltation that might result from high water or heavy rains. 1,2 Existing roads or travel paths will be used whenever reasonable. 1,2.The number of stream crossings will be minimized and will be perpendicular to the main channel whenever reasonable. 1,2.Stabilized Construction Entrances and wheel washing stations will be used where determined appropriate. 2. Implement SPCC 3. Size culverts to maintain hydraulic capacity.	None	1. Reduced foraging efficiency 2,3 Insignificant

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
14	Constructing temporary access roads (assumes 25,000 square feet of road in Wapato Basin) (grading, regrading, cross drain culverts, dust control, rock/hog fuel placement, revegetation)	Wapato sub basin	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for temporary access roads, will be implemented	None	None due to lack of presence
15	Demolish existing infrastructure (not including bridges over water).	Throughout project area.	1. Increased turbidity 2. Increased contaminants (heavy equipment and dust)	During rain events for up to 13 years	1-2. 24 hours	1,2. Nine times yearly	1,2. Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement.	1,2 Implement TESC and SPCC 1,2 During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters. 1,2 Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. 1,2 Implement dust control	None	Minimization measures are expected to reduce effects on fish to insignificant levels.

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
16	Relocate utilities. Many underground utilities will be relocated to other underground locations and potentially the relocation of the jet fuel line could require drilling under Hylebos Creek and/or Surprise Lake Tributary.	Throughout project area.	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3.Noise and vibration	During rain events for up to 13 years. 3. During direction drilling	1-2. 24 hours 3. Daylight hours	1,2. Nine times yearly 3. One time event	1,2. Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon, 3.Juvenile and adult Chinook salmon	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement. 3. Avoidance, delayed or reduced feeding efficiency, delayed migration.	1,2. Implement TESC and SPCC. Set drilling terminus outside of the OHWM of the channel. 3. Establish 2-foot minimum drill depth below channel.	None	Minimization measures are expected to reduce effects on fish to insignificant levels.
17	Construct interchange	SR 509, 54th Ave East,I-5,Valley Avenue, SR 161, widen I-5, non-motorized path, realign 20th Street E., 70th Ave.	1. Increased turbidity 2. Increased contaminants (heavy equipment)	During rain events for up to 13 years	1-2. 24 hours	1,2. Nine times yearly	1,2. Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement.	Implement TESC and SPCC.	None	Minimization measures are expected to reduce effects on fish to insignificant levels.
18	Construct terrestrial retaining wall	70th Ave East and at interchanges.	1. Increased turbidity 2. Increased contaminants (heavy equipment)	1,2 During rain events for up to 13 years	1-2. 24 hours	1,2. Nine times yearly	1,2. Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement.	Implement TESC and SPCC.	None	Minimization measures are expected to reduce effects on fish to insignificant levels.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
19	Construct temporary and permanent stormwater/erosion control BMPs, also new outfalls and/or outfall relocations, implement SPCC, grading	Puyallup River - 3 outfall locations at the Puyallup River (just one direct outfall likely – from the stormwater treatment facility for the new SR 161 bridge deck – likely located at the south side of the river. A 12-inch diameter pipe is estimated. Other Puyallup River drainage would be via existing outfalls. 2 outfalls at Old Oxbow Lake Ditch.	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Habitat loss 4. Increased temperature 5. Reduced cover 6. Reduced productivity 7. Disturbance	1,2 During rain events for up to 13 years, 3-6 In perpetuity (permanent BMPs) 7.In water work window - July 15-August 31	1-2. 24 hours 3-6 In perpetuity (permanent BMPs) 7. Duration of stormwater outfall construction during daylight hours	1,2.Nine times yearly 3-6 In perpetuity, 7.Two times	1-7. Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement. 3. In perpetuity for habitat loss. 4,5. Reduced foraging/less time and less use of area for bull trout overwintering or Chinook rearing. 6. Reduced foraging 7. Avoidance, delayed or reduced feeding efficiency, delayed migration.	1-7. To the extent possible, the construction of new outfalls will be avoided or minimized by connecting project drainage to existing conveyance systems such as pipes or non fish-bearing ditches or by dispersing flows in uplands or riparian areas. Avoid rock placement by dissipating energy and reducing flow prior to reaching outfall and locate outfalls on already armored banks. Use river rock or cobble for pads where velocity allows. 3-5. Where practicable, use ditches instead of pipes to the outfall. Ditches to the Puyallup River will not be feasible due to the presence of the levy. 3,6. Locate outfalls to allow backwatering and reduced velocities.	None	1-2, 4-6 Minimization measures are expected to reduce effects on fish to insignificant levels. 3-habitat loss, 7 - Harassment

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
19 (cont.)	Additional minimization measures								1-2. Imple. SPCC and TESC in accord. with imple. agreement (300 ft mix. zone req.) and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to min. disturbance to sensitive areas. 3-5. Minimize footprint of dissipater pad and outfall. and locate to minimize habitat impact. 5. Revegetate with native vegetation where possible. 6. None. 7. Rock shall be placed and not end dumped.		
20	Construct temporary and permanent stormwater/erosion control BMPs, also new outfalls and/or outfall relocations, implement SPCC, grading	Hylebos Creek - 7 outfall locations	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Habitat loss 4. Increased temperature 5. Reduced cover 6. Reduced productivity 7. Disturbance	1,2 During rain events for up to 13 years, 3-6 In perpetuity (permanent BMPs) 7.In water work window - July 15-August 31	1-2. 24 hours 3-6 In perpetuity (permanent BMPs) 7. Duration of stormwater outfall construction during daylight hours	1,2.Nine times yearly 3-6 In perpetuity, 7.Three times	Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement. 3. In perpetuity for habitat loss. 4,5. Reduced foraging/less time and less use of area for Chinook rearing. 6. Reduced foraging 7. Avoidance, delayed or reduced feeding efficiency, delayed migration.	See action #19 for numerous minimization measures.	None	1-2, 4-6 Minimization measures are expected to reduce effects on fish to insignificant levels. 3-habitat loss, 7 - Harassment

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
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21	Construct temporary and permanent stormwater/erosion control BMPs, including new outfalls and/or outfall relocations, implement SPCC, grading	Hylebos Creek non fish-bearing tributary (Fife Ditch) - 6 outfall locations)	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	See action #19 for numerous minimization measures.	None	Fife Ditch empties into Hylebos Creek almost one mile downstream of the project. Impacts to Hylebos Creek from this action are not expected.
22	Construct temporary and permanent stormwater/erosion control BMPs, including new outfalls and/or outfall relocations, implement SPCC, grading	Surprise Lake Tributary - 4 outfall locations	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Habitat loss 4. Increased temperature 5. Reduced cover 6. Reduced productivity 7. Disturbance	1,2 During rain events for up to 13 years, 3-6 In perpetuity (permanent BMPs) 7.In water work window - July 15-August 31	1-2. 24 hours 3-6 In perpetuity (permanent BMPs) 7. Duration of stormwater outfall construction during daylight hours	1,2.Nine times yearly 3-6 In perpetuity, 7. 1 time	Juvenile Chinook salmon	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement. 3. In perpetuity for habitat loss. 4,5. Reduced foraging/less time and less use of area for Chinook rearing. 6. Reduced foraging 7. Avoidance, delayed or reduced feeding efficiency, delayed migration.	See action #19 for numerous minimization measures.	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely.
23	Construct temporary and permanent stormwater/erosion control BMPs, also new outfalls and/or outfall relocations, implement SPCC, grading	Wapato Creek - 6 outfall locations	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	See action #19 for numerous minimization measures.	None	None due to lack of presence

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24	Establish and utilize staging and stock pile areas	Throughout project area.	1. Increased turbidity 2. Increased contaminants (heavy equipment)	1,2. During rain events for up to 13 years	1-2. 24 hours	1,2. Nine times yearly	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance. 2. Reduced foraging, increased predation, displacement.	1-2 Imple. SPCC and TESC, staging and or material stock pile areas will not be located within 300 feet of any streams, rivers, or wetlands, unless site specific review completed by the project biologist indicates that no impacts to the sensitive resource areas will occur due to topography or other factors.	None	Minimization measures are expected to reduce effects on fish to insignificant levels.
25	Construct RRP **(pages 25-27 BA)** Vegetation removal, fill placement, access, staging areas, stockpile areas are covered above. This action is addressing grading and revegetation	Hylebos Basin (including Surprise Lake Tributary) 116 acres	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Loss of riparian vegetation	1,2 - During rain events for 1 construction season for Surprise Lake Tributary, 2 construction seasons for Hylebos Creek. 3. 10 years until veg. establishes.	1,2. 24 hours 3. Ten years until veg. establishes.	1,2. Nine times yearly. 3. Ten years until veg. establishes.	Adult and juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement.3.Reduced foraging/less time and less use of area for Chinook rearing.	1,2 Implement TESC and SPCC. 1-3 Construction of the RRP will avoid and minimize impacts to existing desirable habitat. Existing (desirable) riparian vegetation shall be maintained unless the impact is unavoidable.	None	1. Reduced foraging efficiency 2.Minimization measures are expected to reduce effects on fish to insignificant levels. 3-temporal effects of loss vegetation associated with the hydrologic cycle.
26	Construct RRP Vegetation removal, fill placement, access, staging areas, stockpile areas are covered above. This action is addressing grading and revegetation	Wapato Basin 73 acres.	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	As standard practice, the same minimization measures as previously disclosed for RRP construction, will be implemented	None	None due to lack of presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
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27	Implement RRP	Hylebos Basin (including Surprise Lake Tributary)	1. Decreased stream temperatures 2. Increased productivity 3. Increased habitat complexity 4. Improved groundwater recharge 5. Improved floodplain connectivity 6. Improved and increased channel complexity 7. Improved water quality 8. Reduced peak flows 9. Increased cover (riparian) 10. Increased stream system complexity. 11. Increased abundance and diversity of prey and salmonid species.	After 10 years when vegetation establishes	After 10 years when vegetation establishes	In perpetuity	Adult and juvenile Chinook salmon	1-11. healthier fish, more habitat , more food resources, increased productivity, increased fish utilization, increased fish populations, increased survival.	None	Implement the RRP in accordance with the recommendations from the RRP Technical Advisory Group (for design, maintenance, and monitoring).	Long-term improvements in water quality from reestablishment of healthy riparian corridors (increased sediment filtration and shading), establishment of channel migration zones, improved streambank stability, stream habitat complexity, and floodplain connectivity.
28	Implement RRP	Wapato Basin	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	None	As standard practice, the same performance standard as previously disclosed for RRP implementation will be applied.	There may be improvement to listed fish prey resource habitat.

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
29	Wetland mitigation site development - grading and vegetation removal, replanting for approximately 32.9 acres	10 potential sites throughout project area (7 in Hylebos Basin, 3 in Puyallup Basin)	1. Increased turbidity 2. increased contaminants (heavy equipment) 3. Loss of riparian vegetation	1,2 - During rain events for 1 construction season at each location, 3. Ten years until veg. establishes.	1,2. 24 hours 3. Ten years until veg. establishes.	1,2.Nine times yearly. 3.10 years until veg. establishes.	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement. 3. Reduced foraging/less time and less use of area for bull trout overwintering and Chinook rearing.	1 and 3 -avoid and minimize impacts to existing desirable vegetation. Existing (desirable) vegetation shall be maintained unless the impact is unavoidable. 1 and 2 Implement TESC and SPCC.	None	1. Reduced foraging efficiency 2. Minimization measures are expected to reduce effects on fish to insignificant levels. 3. Temporal effects of loss vegetation associated with the hydrologic cycle.
30	Wetland mitigation site development and implementation- in-water work breaching the dike (not veg removal or replanting - covered separately)	Three potential sites adjacent to the Puyallup River.	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Loss of riparian vegetation 4. Underwater sound and vibration (from coffer dam installation) 5. Fish entrapment and stranding. 6. Habitat loss from bank hardening at inlet 7. Disturbance	In water work window - July 15-August 31	4 weeks	Post construction rain events and tidal inundations for up to two seasons.	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement. 3. Reduced foraging/less time and less use of area for bull trout overwintering and Chinook rearing. 4. Harassment and avoidance 5. Injury and death. 6.and 7. see above. .	1 and 3 -avoid and minimize impacts to existing desirable vegetation. Existing (desirable) vegetation shall be maintained unless the impact is unavoidable. 1 and 2 Implement TESC and SPCC. 1. Regulate rate of flow into mitigation site through slow removal of cofferdam. 4- use vibratory hammer to install cofferdam. 5. To ensure streamside wetlands do not strand fish, low-flow connecting channels will be incorporated into the design. This will allow floodwaters to flow back into the channel and preclude standing water. 6. None 7. Limit work to daylight hours.	None	1. Reduced foraging efficiency 2. Minimization measures are expected to reduce effects on fish to insignificant levels. 3. Temporal effects of loss vegetation associated with the hydrologic cycle. 4. Harassment and avoidance; 5. Minimization measures are expected to reduce effects on fish to insignificant levels. 6. Effects on listed fish are expected to be insignificant. 7. Harassment

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
31	Wetland mitigation site development - planting	10 potential sites throughout project area (7 in Hylebos Basin, 3 in Puyallup Basin)	1. Increased turbidity 2. Contaminants (heavy equipment)	1-2. During rain events	1,2. 24 hours for 14 years (4 years of construction; 10 year plant establishment period)	1-2. Nine times yearly	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement.	1. TESC; 2. SPCC	None	1. Temporal effects until vegetation is established, minimization measures are expected to reduce effects on fish to insignificant levels; 2. Minimization measures are expected to reduce effects on fish to insignificant levels.
32	Wetland mitigation site implementation - NOTE: Impacted wetlands are all Ecology class III.	Puyallup Basin	1. Increased productivity 2. Increased habitat complexity 3. Improved groundwater recharge 4. Improved floodplain connectivity. 5. Improved and increased channel complexity. 6. Increased cover (riparian)	After 10 years when vegetation establishes	After 10 years when vegetation establishes	In perpetuity	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon,	1-6. More food resources, increased productivity, increased fish utilization, increased survival, increased habitat.	None	There will be no net loss of wetland function or area from the proposed project based on 2006 estimates of 7.57 acres of wetland impacts. Ratios depend on whether using creation or enhancement and the category of wetland being impacted. Where practicable, wetland mitigation will occur within the impacted sub basins. The project's Final Mitigation Plan will be fully implemented.	1-6. Improved stream habitat complexity, and floodplain connectivity.

Item	Action	Where	Exposure: Stressor	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
33	Wetland mitigation site implementation - NOTE: Impacted wetlands are almost all Ecology class III, less than 1% are class II.	Hylebos Basin	1. Increased productivity (for those sites adjacent to Hylebos Creek) 2. Increased habitat complexity (for those sites adjacent to Hylebos Creek) 3. Improved groundwater recharge 4. Improved floodplain connectivity. 5. Improved and increased channel complexity.(for those sites adjacent to Hylebos Creek) 6. Increased cover (riparian) (for those sites adjacent to Hylebos Creek)	After 10 years when vegetation establishes	After 10 years when vegetation establishes	In perpetuity	Adult and juvenile Chinook salmon,	1-6. more food resources, increased productivity, increased fish utilization, increased survival, increased habitat.	None	There will be no net loss of wetland function or area from the proposed project based on 2006 estimates of 23.7 acres of wetland impacts. Ratios depend on whether using creation or enhancement and the category of wetland being impacted. Where practicable, wetland mitigation will occur within the impacted sub basins. The project's Final Mitigation Plan will be fully implemented.	1-6. Improved stream habitat complexity, and floodplain connectivity.
34	Wetland mitigation site implementation - NOTE: Impacted wetlands are almost all Ecology class III, less than 2% are class II, and less than 1% are class IV.	Wapato Basin	None due to lack of presence	N/A	N/A	N/A	None	None due to lack of presence	None	There will be no net loss of wetland function or area from the proposed project based on 2006 estimates of 1.62 acres of wetland impacts. Ratios depend on whether using creation or enhancement and the category of wetland being impacted. Where practicable, wetland mitigation will occur within the impacted sub basins. The project's Final Mitigation Plan will be fully implemented.	None due to lack of presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
35	Removal of invasive plant species	Within RRP boundaries and wetland mitigation sites.	1. Turbidity 2. Contaminants (herbicides) 3. Increased temperatures 4. Reduction in productivity 5. Reduced cover and loss of non-target riparian plant species	1-2. With rainfall; 3-5. during summer months until desired vegetation is established	24 hours up to 10 years	1-2. Nine times yearly up to 10 years; 3-5. up to 10 years	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Avoidance, decreased growth , reduced reproductive . 3-5. Reduced foraging/less time and less use of area for bull trout overwintering and Chinook rearing, reduced dissolved oxygen levels from introduction of decaying plant materials.	1,2. - Implement TESC and SPCC. 1. Use manual methods where appropriate. 2. Only apply herbicide during dry conditions, use wicking vs. broadcast spray and dense planting of desired veg., use of hummocks to increase survival of shade plants, use either Agri-Dex (preferred) or LI700 as surfactants; do not use glyphosate products identified as "toxic to fish". 2,5. Apply in accordance with label requirements to avoid over application and drift. 3-5. Mark application boundaries and replant with native species.	None	1, 2, 3, 4, and 5 Minimization measures are expected to reduce effects on fish to insignificant levels 2. Glyphosate products do not bioconcentrate in aquatic organisms, it breaks down quickly, and has a high affinity for soil binding, making it unlikely to become part of runoff except with sedimentation which will be reduced through implementation of minimization measures.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
36	Remove existing bridge, including piers and abutments (they are within OHWM)	Puyallup River (P2)	1. Elevated turbidity 2. Contaminants from bridge paint, sawcutting, and equipment operation 3. Noise 4. Disturbance	1.During rainfall; 2-4. In-water work window: July 15-August 31 (and time outside of window for work over and adjacent to water-spring and early summer)	1. 24 hours; 2. Duration of demolition (one construction season) plus one day; 3,4. Duration of demolition (one construction season) during daylight hours	1. Nine times yearly; 2., 3., and 4. Daily during demolition	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Injury; 3, 4. Avoidance, delayed or reduced feeding opportunity	1. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, implement TESC and SPCC. Conditions listed in the NPDES for Washing and Pressure Washing of Bridges and Ferry Terminals (WA#-0039039 or most current version) will be complied with as appropriate; sawcut water will not enter surface water; holes from abutments will be backfilled with rock or new abutments will be placed in existing holes; 2. SPCC and NPDES requirements; 3, 4. Only operate during daylight hours; work area will not be lit at night or lighting will not be directed at the water.	None	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level; 3,4. Avoidance; reduced foraging efficiency
37	Operate heavy equipment from barge (estimated area of shading from barge is 3000 square feet)	Puyallup River **(P1,P2,P3,P4)**	1. Increased shading 2. Substrate impact from anchor 3. Increased contaminants (heavy equipment) 4. Noise and disturbance.	1.Year round, 2. When anchor is initially placed. 3. During rainfall. 4.During daylight hours	1, 2,4,5 - 2 construction seasons, 3. 24 hours. 4. During daylight hours.	1,2 4,5. Daily during demolition 3. Nine times yearly for up to 2 construction seasons. 4. During daylight hours.	Adult, sub-adult, juvenile bull trout; Adult and juvenile Chinook salmon	1. Increased predation on juvenile fish. 2.Low potential for Chinook salmon spawning habitat impact 3,4. Avoidance, injury,	1. None 2. Minimize dragging anchor 3. implement SPCC 4. None	None	1 Effects are not expected to be significant.2,3. Minimization measures expected to reduce effects to insignificant level; 4. Avoidance; reduced foraging efficiency; delayed migration

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
38	Construction of dewatered work area for 4 new piers (2 each for widened concrete bridge and new steel bridge) (approximately 240 square feet of dewatered area per pier)	Puyallup River (P2, P3)	1. Turbidity 2. Contaminants (heavy equipment) 3. Noise 4. Disturbance 5. Loss of benthic habitat and benthos species	In water work window - July 15-August 31	1, 2. In-water work period plus one day; 3,4. In-water work period during daylight hours; 5. Duration of cofferdam placement (1 construction season for new bridge and east side of widened bridge, 1 construction season for west side of widened bridge)	1, 5. Day and night; 2-4. Daylight hours	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement. 3. Injury and avoidance; 4; Avoidance; 5; reduced foraging efficiency	1. None; 2. Implement SPCC; 3,4. Vibratory installation of cofferdam; Minimize size of cofferdams.	None	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level; ; 3. Avoidance; reduced foraging efficiency; delayed migration 4. Avoidance; reduced foraging efficiency 5. Reduced foraging efficiency.
39	Dispose of waste water	Puyallup River (P2, P3)	1.Elevated turbidity 2. Elevated contaminants (waste water and heavy equipment)	During pier construction	1 construction season	Day and night	Adult, sub-adult, juvenile bull trout; adult and juvenile Chinook salmon, Chinook salmon and bull trout critical habitat	1,2. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration.	1,2 - Contain waste water and dispose of in an upland location where it will not enter surface waters.	None	1,2. Minimization measures expected to reduce effects to insignificant level.

Item	Action	Where	Stressor	When	Exposure Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
40	Handle fish	Puyallup River (P2, P3): Four cofferdam locations.	1. Handling 2. Electrofishing	In water work window - July 15-August 31	1/2 day per cofferdam	1 time per cofferdam during daylight hours	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1. Injury and elevated stress; 2. Injury or mortality	1,2. Follow latest version of WSDOT's fish handling protocol; hold fish in aerated buckets; hold fish for min. time necessary; only electrofish when other methods unfeasible, release to suit. habitat nearby, adeq. staff on-site will reduce the number of electrofishing passes necessary, doc. species handled. No electrofishing when turbidity reduces visibility to < 0.5 meters and when water temp. > 18 degrees C or < 4 degrees C. Electrofish only when a bio. w/ at least 100 hours of electrofishing experience is on site to conduct or direct all activities assoc. w/ capture attempts. A max. of 3 passes made while electro. Fish will remain in buckets for a max. of 15 min. during transport to release pt.	None	1,2. Bull trout and Chinook salmon within the area of effect could be injured, harassed and killed

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
41	Construct new bridge piers (2 each below OHWM for both the widened concrete bridge and the new steel bridge, so 4 total) each pier a max. of 3, 6-foot diameter columns (approximately 339 square feet of total habitat displacement)	Puyallup River (P2, P3)	1. Elevated turbidity 2. Elevated contaminants (wet concrete, heavy equipment) 3. Loss of benthic habitat and benthos species	1,2 In water work window - July 15-August 31 3. In perpetuity	1,2 One construction season 3. In perpetuity	1,2 During 16-hour workday 3. In perpetuity	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement; 3. Reduced foraging efficiency	1,2. Use drilled shaft construct. Work in dewatered environment. Imple. TESC and SPCC. 2. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorp.into embankments as approp.,all forms of concrete shall be completely sealed to prevent the possibility of fresh concrete from getting into the river. Water that comes into contact with concrete within the first 7 days of cure shall be contained and discharged to land with no poss. entry to surface waters. Where land is not avail. for treatment, other methods of water treatment shall be utilized as approved by the WSDOT engineer. 3. Minimize area of impact. Place pier shafts to a depth adequate to prevent future scour.	2. All concrete shall cure a minimum of 7 days before contact with waters of the State.	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level. 3. Reduced foraging efficiency.

Item	Action	Where	Stressor	When	Exposure Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
42	Installing or widening permanent bridges over water(15,000 square feet of increased shading for replaced bridge and 4,500 square feet from the widened bridge)	Puyallup River (P2,P3)	1. Increased turbidity 2. Increased contaminants (heavy equipment) 3. Increased shading	1-2 During rain events 3. In perpetuity	1,2 24 hours 3. In perpetuity	1,2. Nine times yearly for two construction seasons each 3. In perpetuity	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1-2. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration.3.Increased predation on juvenile fish.	1.Debris accumulation on bridges and within bridge drains shall be collected and properly disposed of off site. 2. Implement SPCC 3.None	None	1,2. Minimization measures expected to reduce effects to insignificant level. 3. Effects to listed fish are expected to be insignificant
43	Remove existing rail and overhang from concrete bridge with hoe ram	Puyallup River (P3)	1. Elevated turbidity 2. Increased contaminants	During rain events	1,2. 24 hours	1,2. Nine times yearly for one construction season	Adult, sub-adult, juvenile bull trout; Adult and juvenile Chinook salmon	1-2. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration.	1-2. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters. Any waste material will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate.	None	1,2. Minimization measures expected to reduce effects to insignificant level.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
44	Install 150, 24-inch diameter piles for temporary work bridges and detour bridge (50 per structure) (approx. 158 square feet of temp. habitat displacement from piles and 6250 square feet each increased shading for the work trestles and another 1875 for a "finger" off one of the work trestles and 7500 square feet for the detour bridge)	Puyallup River **(P1, P4)**	1. Elevated sound pressure levels 2. Temporary habitat displacement (approx. 158 square feet) and potential loss of invertebrate production 3. Increased shading and 6250 square feet each increased shading for the work trestles and another 1875 for a "finger" off one of the work trestles and 7500 square feet for the detour bridge 4. Change in habitat forming processes 5. Contaminants (from treated wood decking or piles and heavy equipment)	1. In water work window - July 15-August 31 ; 2-4. year-round 5. During rain events while structures are in place	1. During pile installation (35 days per season, one construction season per structure, potentially concurrently);.2-4. during structure installation and use (2 construction seasons per structure) 5. number of rain events	1 During installations 2-4. 2 years while structures in place. 5. Number of rain events during 2-year period.	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1. Avoidance, injury, mortality; 2-4. reduced foraging efficiency; reduced productivity; increased predation; 5. Injury	1. Install piles with a vibratory hammer and limit impact hammer to proofing. Limit noise levels to 180 – 185 SPLs, utilizing bubble curtain attenuation. Install piles with impact pile driver only during daylight hours; 2-4. Keep structures in place for the minimum amount of time necessary. 5. Use untreated wood for decking	1,-5: None	1. Avoidance, reduced foraging efficiency, delayed migration; 2.-4. Reduced productivity, reduced foraging efficiency, increased predation; 5. None

Item	Action	Where	Exposure: Stressor	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
45	Remove temporary detour bridge and 2 temporary work bridges including 150 total piles. Piles will be direct pulled, vibed out, or cut off 2 feet below existing ground.	Puyallup River (P1,P4)	1. Turbidity 2. Contaminants (heavy equipment, bridge materials) 3. Noise 4. Disturbance	In water work window - July 15-August 31	1-4. During pile removals - 2 weeks (detour bridge) 4 weeks (work bridges) during one construction season, potentially concurrently	1-4. Daylight hours	Juvenile, sub-adult and adult bull trout, juvenile Chinook salmon	1. Delayed foraging/avoidance, injury, delayed migration. 2. Reduced foraging, increased predation, displacement.; 3. Injury and avoidance; 4. Avoidance	1. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, a containment boom will be used to contain and collect any floating debris and sheen. 1. Holes left from pilings will be filled with clean native substrate that match surrounding substrate materials when feasible. 2. Creosoted materials if found will be disposed of by the contractor in a landfill according to Ch 173-304 WAC. 3,4. None	None	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level; 3. Avoidance; reduced foraging efficiency; delayed migration 4. Avoidance; reduced foraging efficiency
46	Excavation (including in-water) for temporary diversion channel (approximately 1,000 square feet of excavation) (approx. 950 linear feet)	Hylebos Creek from the existing 70th Ave. crossing to the existing I-5 crossing	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance	1-3: In water work window - July 15-August 31	1 week	Daylight hours	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	Implement TESC and SPCC	None	1. Reduced foraging efficiency within the mixing zone. 2.Minimization measures expected to reduce effects to insignificant level. 3.Avoidance and reduced foraging efficiency.
47	Install habitat features (LWD) in the diversion channel	Hylebos Creek from the existing 70th Ave. crossing to the existing I-5 crossing.	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	1 week	Daylight hours	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	Implement TESC and SPCC, conduct work in dewatered environment	None	1. Reduced foraging efficiency within the mixing zone when water reintroduced to work area. 2,3. Minimization measures expected to reduce effects to insignificant level.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
48	Construct temporary diversion dams for dewatering work area (upstream will occur first, downstream second)	Hylebos Creek (segment between 70th Ave and I-5 for temporary relocation)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	5 days	Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Injury 3. Avoidance	1,2. Dam installation will either be by hand or by equipment operated from the banks, overhead bridges or outside the wetted perimeter. Material placed within the water will be free of sediment and other contaminants. 3. None	None	1,2. Minimization measures expected to reduce effects to insignificant level; 3. Avoidance; reduced foraging efficiency
49	Handle fish	Hylebos Creek (segment between 70th Ave and I-5 for temporary relocation).	1. Handling 2. Electrofishing	In water work window - July 15-August 31	2 days	One time during daylight hours	Juvenile Chinook	1. Injury and elevated stress; 2. Injury or mortality	1, 2. Follow latest WSDOT fish handling protocol; use block nets, start rem. by completing a sweep with a net, hold fish in aerated buckets and for min. time necessary (max 15 min. dur. transport); only electrofish when other methods unfeasible, release to suit. habitat nearby, adeq. staff on-site will reduce # of electro. passes necessary, doc. species handled. No electro. when turbidity reduces visibility to < 0.5 m. and when water temp. > 18 degrees C or < 4 degrees C. Electro. only when a bio. w/ at least 100 hrs of electro. experience is on site to conduct or direct all activities assoc. w/ capture attempts. A max. of 3 passes made while electro.	None	1,2. Chinook salmon within the area of effect could be injured, harassed and killed

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
50	Direct Flow to temporary channel	Hylebos Creek - temporary diversion channel.	1. Elevated turbidity 2. Delay in benthic colonization	1. During rain events and seasonal flush 2. Until colonizing vegetation establishes (up to 3 years) no active planting,	1. 24 hours 2. Until colonizing vegetation establishes (up to 3 years)	1.Nine times yearly; 2.Until colonizing vegetation establishes (up to 3 years)	Juvenile and adult Chinook and Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Reduced foraging oppertunities	1. Implement TESC. Flow will gradually be introduced to the temporary channel over a 24 hour period. 2. None	None	1. Injury, harassment, and migration movements could be temporarily disrupted. 2. Reduced foraging opportunity.
51	Dewater work area	Hylebos Creek (segment between 70th Ave and I-5 for temporary relocation).	1. Turbidity 2. Contaminants (heavy equipment) 3. Noise 4. Disturbance 5. Loss of benthic habitat and benthos species	In water work window - July 15-August 31	1,2. In-water work period plus one day; 3,4. in-water work period during daylight hours; 5. Duration of dewatered area	1, 5. Day and night; 2-4. Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury; 3. Injury and avoidance; 4. Avoidance; 5. Reduced foraging opportunity	1. Removed water would be pumped into tanks or upland area. 2.Implement SPCC. 3,4. None 5. Minimize size of work area.	Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge.	1-5, Minimization measures expected to reduce effects to insignificant level
52	Fill 0.5-acre of Hylebos Creek channel	Hylebos Creek.	Loss of habitat (migration, limited foraging and rearing)	June through September, following flow diversion	In perpetuity	In perpetuity	No fish will be present during filling, indirectly Adult and juvenile Chinook salmon	Reduced productivity and foraging opportunity	1. Create temporary channel that is 950 ft long for 3 years. Create 4,010 linear feet of new permanent channel with habitat features. Fill channel when dewatered, following flow diversion and fish removal	None	There will be no direct exposure to fish during this action, habitat loss will be offset by the temporary and then the permanent new channel creation and associated restoration plantings, LWD placement, side channel construction as part of the RRP. The quality of rearing and migration habitat will be improved in the long term. There will be a minor temporal loss of productivity until the benthic community establishes.

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
53	Use of temporary diversion channel	Hylebos Creek segment between 70th Ave and I-5.	1. Elevated turbidity 2. Reduced foraging opportunity 3. Elevated temperature	1. During rain events and seasonal flush 2, 3. For period of channel use (up to three years)	1. 24 hours 2. and 3. For period of channel use (up to three years)	1. Nine times yearly; 2. and 3. For period of channel use (up to three years)	Juvenile and adult Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. and 3 Reduced foraging / less time and less use of area for rearing.	1-3. Minimize length of time diversion channel is used. 1. Implement TESC. 2. Install habitat features such as LWD.	None	1. Injury, harassment, and migration movements could be temporarily disrupted. 2,3. Reduced foraging efficiency/ overwintering/rearing habitat.
54	Construct new permanent creek channel, including side channel, LWD placement, riparian plantings, bench cut, and stabilization berm (approximately 4,010 linear feet of new channel, channel will be 20 feet wide)	Hylebos Creek, **RH 11, RH12**	None	N/A	N/A	N/A	N/A	N/A	Construct permanent channel in the driest conditions possible before directing water into the channel. Existing water table may not allow for totally dry conditions.	None	There will be no exposure during this action
55	Construct temporary diversion dams for dewatering work area (upstream will occur first, downstream second)	Hylebos Creek (segment between 70th Ave and I-5)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	2 days	Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Injury 3. Avoidance	1,2. Dam installation will either be by hand or by equipment operated from the banks, overhead bridges or outside the wetted perimeter. Material placed within the water will be free of sediment and other contaminants. 3.None	None	1,2. Minimization measures expected to reduce effects to insignificant level; 3.Avoidance; reduced foraging efficiency

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
56	Handle fish	Hylebos Creek (segment between 70th Ave and I-5 temporary channel).	1. Handling 2. Electrofishing	In water work window - July 15-August 31	2 days	One time during daylight hours	Juvenile Chinook	1. Injury and elevated stress; 2. Injury or mortality	1, 2. Follow latest WSDOT fish handling protocol; use block nets, start rem. by completing a sweep with a net, hold fish in aerated buckets and for min. time necessary (max 15 min. dur. transport); only electrofish when other methods unfeasible, release to suit. habitat nearby, adeq. staff on-site will reduce # of electro. passes necessary, doc. species handled. No electro. when turbidity reduces visibility to < 0.5 m. and when water temp. > 18 degrees C or < 4 degrees C. Electro. only when a bio. w/ at least 100 hrs of electro. experience is on site to conduct or direct all activities assoc. w/ capture attempts. A max. of 3 passes made while electro.	None	1,2. Chinook salmon within the area of effect could be injured, harassed and killed
57	Dewater work area	Hylebos Creek (segment between 70th Ave and I-5 temporary channel).	1. Turbidity 2. Contaminants (heavy equipment) 3. Noise 4. Disturbance 5. Loss of benthic habitat and benthos species	In water work window - July 15-August 31	1 and 2 in-water work period plus one day; 3 and 4 in-water work period during daylight hours; 5. Duration of dewatered area	1, 5. Day and night; 2-4. Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury; 3. Injury and avoidance; 4. Avoidance; 5. Reduced foraging opportunity	1. Removed water would be pumped into tanks or upland area. 2.Implement SPCC. 3,4.None 5. Minimize size of work area.	Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge.	1-5. Minimization measures expected to reduce effects to insignificant level

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
58	Direct Flow to new creek channel and use of the channel	Hylebos Creek - relocated channel.	1. Elevated turbidity 2. Delay in benthic colonization	1. During rain events and seasonal flush 2. Until colonizing vegetation establishes (up to 3 years) no active planting,	1. 24 hours 2. Until colonizing vegetation establishes (up to 3 years)	1.Nine times yearly for up to ten years; 2. Until colonizing vegetation establishes (up to 3 years)	Juvenile and adult Chinook and Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Reduced foraging opportunities	1. Implement TESC. Flow will gradually introduced to the new channel over a 24 hour period. 1, 2. Plant native trees and shrubs to increase benthic diversity over the long-term.	None	1. Injury, harassment, and migration movements could be temporarily disrupted. 2. Reduced foraging opportunity.
59	Fill diversion channel and remove dam	Hylebos Creek.	Loss of habitat (migration, limited foraging and rearing)	June through September, following flow diversion to new channel	In perpetuity	In perpetuity	No fish will be present during filling, indirectly Adult and juvenile Chinook salmon	Reduced productivity and foraging opportunity	Create 4,010 linear feet of new channel with habitat features. Fill channel when dry, following flow diversion and fish removal.	None	There will be no exposure to fish during this action, habitat loss will be offset by the new channel creation and associated restoration plantings, LWD placement, side channel construction as part of the RRP. The quality of rearing and migration habitat will be improved in the long term.
60	Construct temporary work area isolation (this is not the same as damming the whole stream) (H9 will have approx. 540 square feet of dewatering area, H14 will have approx. 360 square feet of dewatering area)	Hylebos Creek **(H9 [temporary culvert],H14 [repl. Culvert w/bridge])**	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance 4. Impediment to fish movement (temporary)	In water work window - July 15-August 31	2 days at each location	Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Injury. 3. Avoidance 4. Avoidance, delayed or reduced feeding opportunity, delayed migration, increased predation.	1. Vibratory pile installation for sheet piles, place by hand or machines kept outside the wetted perimeter. Material placed within the water will be free of sediment and other contaminants. 3. None 4. Work will not inhibit passage of juvenile fish throughout the construction period.	None	1,2. Minimization measures expected to reduce effects to insignificant level 3 .Avoidance; reduced foraging efficiency 4. Delay of migration, lack of efficient use of habitat for rearing juveniles.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
61	Divert water around work area	Hylebos Creek (**H9 [temporary culvert],H14 [repl. Culvert w/bridge]**)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance 4. Injury	In water work window - July 15-August 31	I week at each location	Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 2. Injury 3. Avoidance 4. Injury.	1,3. None 2. Implement SPCC 4. Install fish screens on pump intake.	None	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration. 3. Avoidance 2,4. Minimization measures expected to reduce effects to insignificant levels.
62	Handle fish	Hylebos Creek (**H9,H14**)	1. Handling 2. Electrofishing	In water work window - July 15-August 31	2 days	One time during daylight hours	Juvenile Chinook	1. Injury and elevated stress; 2. Injury or mortality	1, 2. Follow latest WSDOT fish handling protocol; use block nets, start rem. by completing a sweep with a net, hold fish in aerated buckets and for min. time necessary (max 15 min. dur. transport); only electrofish when other methods unfeasible, release to suit. habitat nearby, adeq. staff on-site will reduce # of electro. passes necessary, doc. species handled. No electro. when turbidity reduces visibility to < 0.5 m. and when water temp. > 18 degrees C or < 4 degrees C. Electro. only when a bio. w/ at least 100 hrs of electro. experience is on site to conduct or direct all activities assoc. w/ capture attempts. A max. of 3 passes made while electro.	None	1,2. Chinook salmon within the area of effect could be injured, harassed and killed

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
63	Dewater work area	Hylebos Creek (H9,H14)	1. Turbidity 2. Contaminants (heavy equipment) 3. Noise 4. Disturbance 5. Loss of benthic habitat and benthos species	In water work window - July 15-August 31	1, 2. In-water work period plus one day; 3,4. In-water work period during daylight hours; 5. Duration of dewatered area	1, 5. Day and night; 2-4.Daylight hours	Juvenile Chinook salmon	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury; 3. Injury and avoidance; 4. Avoidance; 5. Reduced foraging opportunity	1. Removed water would be pumped into tanks or upland area. 2.Implement SPCC. 3,4. None. Minimize size of work area.	Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge.	1-5. Minimization measures expected to reduce effects to insignificant level
64	Remove culvert and bridge, and excavate in channel (appx. 480 square feet)	Hylebos Creek (H14, H9)	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	1 week	Daylight hours one time	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	1,2. Implement TESC and SPCC 3. Conduct work in dewatered environment	None	1. Reduced foraging efficiency within the mixing zone when water reintroduced to work area. 2,3. Minimization measures expected to reduce effects to insignificant level.
65	Install temporary culvert	Hylebos Creek (H9)	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	1 week	Daylight hours	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	Implement TESC and SPCC. Where stream crossings are essential, the design will take into account reasonably foreseeable risks such as flooding, bedload, and debris in order to prevent stream diversions from leaving the channel in the event of a crossing failure. Exclude fish and dewater work area.	None	1. Reduced foraging efficiency within the mixing zone when water reintroduced to work area. 2,3.Minimization measures expected to reduce effects to insignificant level.

Item	Action	Where	Stressor	When	Exposure Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
66	Construct clear-span bridge (no in-water work) (stream crossing document)	Hylebos Creek (H14)	1. Elevated turbidity 2. Contaminants (heavy equipment and concrete) 3. Loss of channel complexity.	1,2. During rain events. 3. In perpetuity	1,2. 24 hours 3. In perpetuity	1,2. Nine times yearly for 1 construction season 3. In perpetuity	Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury 3. Reduced foraging efficiency; reduced productivity; increased predation	1,2. Implement TESC and SPCC, no in-water work. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. All concrete forms shall be completely sealed to prevent the possibility of fresh concrete from getting into the stream.	1-2, All concrete shall cure a minimum of 7 days before contact with waters of the State. 3. Piers and abutments will be placed outside channel. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP. Place pier shafts to a depth adequate to prevent future scour.	1,2. Minimization measures and performance standards are expected to reduce effects to insignificant level
67	Remove temporary culvert	Hylebos Creek (H9)	None	Following creek relocation	1 day	Daylight hours	None	None	Culvert removal shall occur following stream relocation when there is no flow	None	There will be no measurable effect from this action
68	Install temporary crossing	Hylebos Creek (RH1,RH4)	1. Elevated turbidity 2. Contaminants (heavy equipment)	1,2. During construction	1-2. Three days at each location	1-2. Daylight hours	Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury	1,2. Implement TESC and SPCC, no in-water work. Where stream crossings are essential, the design will take into account reasonably foreseeable risks such as flooding, bedload, and debris in order to prevent stream diversions from leaving the channel in the event of a crossing failure.	1,2. piers and abutments will be placed outside channel	1,2. Minimization measures, ambient turbidity levels, and performance standards are expected to reduce effects to insignificant level.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
69	Operate temporary crossing (400 square feet of shading per structure)	Hylebos Creek (RH1,RH4)	1. Habitat displacement, 2. Increased shading (400 square feet each)	While structures in place - up to two years	Up to two years at each location	Day and night while structures in place	Juvenile and adult Chinook salmon	Reduced foraging efficiency; reduced productivity;2. Increased predation	None	None	1., 2. Effects are not expected to be significant.
70	Remove temporary crossing	Hylebos Creek (RH1,RH4)	1. Elevated turbidity 2. Contaminants (heavy equipment)	During removal	2 days at each location	1 time occurrence per structure, Daylight hours	Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury	1,2 - Implement TESC and SPCC, no in-water work to occur during low flows.	None	1,2 - Minimization measures are expected to reduce effects to insignificant level
71	Remove bridge, includes rem. 54 piles in Hylebos wetland. Piles will be direct pulled, vibrated out, or cut off 2 feet below existing ground.	Hylebos Creek (H5)	1. Turbidity 2. Contaminants (heavy equipment, bridge materials) 3. Noise 4. Disturbance	1-3. In water work window - July 15-August 31 4. During bridge removal	4 weeks	Daylight hours one time for project	Juvenile Chinook salmon (fish presence is not expected in Hylebos Wetland)	1. Reduced foraging within mixing zone; 2. Injury; 3. Injury and avoidance; 4. Avoidance	1,2. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, implement TESC and SPCC. Creosoted materials if found will be disposed of by the contractor in a landfill according to Ch 173-304 WAC. No equipment to enter wetland. Remove piles from existing road. 3. None 1. Fill holes left by piers with suitable materials.	None	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level; 3. Avoidance; reduced foraging efficiency; delayed migration 4.Avoidance; reduced foraging efficiency

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
72	Construct clear-span bridge (no in-water work)	Hylebos Creek (**H3, H5, H8, H10, RH2, RH3, RH5, RH6, RH8, RH9, RH10**)	1. Elevated turbidity 2. Contaminants (heavy equipment and concrete) 3. Loss of channel complexity.	1,2. During rain events. 3. In perpetuity	1,2. 24 hours 3. In perpetuity	1,2. Nine times yearly for 1 construction season per bridge 3. In perpetuity	Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury 3. Reduced foraging efficiency; reduced productivity; increased predation	1,2. Implement TESC and SPCC, no in-water work. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. All concrete forms shall be completely sealed to prevent the possibility of fresh concrete from getting into the stream.	1-2. All concrete shall cure a minimum of 7 days before contact with waters of the State. Piers and abutments will be placed outside channel. .3. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP. Place pier shafts to a depth adequate to prevent future scour.	1,2. Minimization measures and performance standards are expected to reduce effects to insignificant level
73	Use of clear-span bridges (these bridges are not identified as high-spanning so we are assuming there will be shading impacts associated with them)	Hylebos Creek (**H3, H5, RH5, RH6, RH8, RH9**)	Increased shading (total of approximately 3000 square feet permanent shade increase and 270 square feet of temporary at H8)	In perpetuity except at H8 where the stream will be relocated so it will eliminate the crossing point	In perpetuity except at H8 where the stream will be relocated so it will eliminate the crossing point	In perpetuity except at H8 where the stream will be relocated so it will eliminate the crossing point	Juvenile and adult Chinook salmon	Reduced foraging efficiency; reduced productivity; increased predation	None	None	Potential for reduced foraging efficiency; reduced productivity; increased predation.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
74	Construction and operation of pedestrian/bike trail bridge	Hylebos Creek **(H12)**	1. Elevated turbidity 2. Contaminants (heavy equipment and concrete) 3. Shading increase of approximately 300 square feet 4. Loss of channel complexity.	1,2. During rain events. 3,4. In perpetuity	1,2 24 hours 3,4. In perpetuity	1,2. Nine times yearly for one construction season 3,4. In perpetuity	Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury 3,4. Reduced foraging efficiency; reduced productivity; increased predation	1,2. Implement TESC and SPCC, no in-water work. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. All concrete forms shall be completely sealed to prevent the possibility of fresh concrete from getting into the stream. 3. None	1-2. All concrete shall cure a minimum of 7 days before contact with waters of the State. Piers and abutments will be placed outside channel 3. None 4. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP.	1,2. Minimization measures and performance standards are expected to reduce effects to insignificant level. 3.Potential for reduced foraging efficiency; reduced productivity; increased predation.
75	Install temporary work trestle (up to 10, 24-inch piles, 6 within the OHWM per structure)	Hylebos Creek **(H1,H4, RH7)**	1. Elevated sound pressure levels 2.Contaminants (heavy equipment and treated wood decking) 3. Temporary habitat displacement (approx. 6.3 square feet) and potential loss of invertebrate production	1. During pile installation and inwater work window: July 15-August 31; 2. During rain events while structures are in place	1. During pile installation (2 days per structure); 2. 2 days for equipment, one construction season per structure (for wood decking).	1 During installations 2. During construction , Nine times yearly for one construction season.	1. Juvenile Chinook salmon 2. Juvenile and adult Chinook salmon	1. Avoidance, injury, mortality; 2. Injury	1. Install piles with impact hammer only during daylight hours, do not place piles within the channel; 2. Use untreated wood for decking and implement SPCC.	None	1. Avoidance, reduced foraging efficiency, delayed migration; 2. None

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
76	Operation of temporary work trestle (shading increase of 3200 square feet and habitat displacement of 24 square feet)	Hylebos Creek (H1,H4, RH7)	1. Temporary habitat displacement (approx. 24 square feet) and potential loss of invertebrate production 2. Increased shading 3200 square feet 3. Change in habitat forming processes	Year-round	During structure installations and use (1 construction season each)	1 year each while structures in place	Juvenile and adult Chinook salmon	Reduced foraging efficiency; reduced productivity; 2. Increased predation;	Keep structures in place for the minimum amount of time necessary.	None	Reduced productivity, reduced foraging efficiency, increased predation;
77	Remove bridge, includes 10 piles per structure. Piles will be direct pulled, vibrated out, or cut off 2 feet below existing ground.	Hylebos Creek (H1,H4, RH7)	1. Turbidity 2. Contaminants (heavy equipment, bridge materials) 3. Noise 4. Disturbance	In water work window - July 15-August 31	During pile removals - 2 days per structure	Daylight hours one time removal	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Injury and avoidance; 4. Avoidance	1. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, a containment boom will be used to contain and collect any floating debris and sheen if in water piles are removed . 1. Holes left from pilings will be filled with clean native substrate that match surrounding substrate materials when feasible. 2. Creosoted materials if found will be disposed of by the contractor in a landfill according to Ch 173-304 WAC. 3,4. None	None	1. Reduced foraging efficiency within mixing zone. 2. Minimization measures expected to reduce effects to insignificant level; 3. Avoidance; reduced foraging efficiency; delayed migration 4. Avoidance; reduced foraging efficiency
78	Widen bridge. No piles in Hylebos Creek	Hylebos Creek (H2)	1. Increased turbidity 2. Increased contaminants (heavy equipment)	1-2. During rain events	1,2. 24 hours	1,2. Nine times yearly for 1 construction season.	1,2. Adult and juvenile Chinook salmon	1-2. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration.	1.Debris accumulation on bridges and within bridge drains shall be collected and properly disposed of off site. 1. Implement TESC 2. Implement SPCC	1. Piers and abutments will be placed outside channel	1,2. Minimization measures and performance measures are expected to reduce effects to insignificant level.

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
79	Widened bridge operation (400 square feet of shading)	Hylebos Creek (H2)	1. Increased shading	1. In perpetuity	1. In perpetuity	1. In perpetuity	Juvenile Chinook salmon	Increased predation on juvenile fish.	None	None	Effects to listed fish are expected to be insignificant
80	Temporary widen bridge	Hylebos Creek (H7)	1. Increased turbidity 2. Increased contaminants (heavy equipment)	1-2. During rain events	1,2. 24 hours	1,2. Nine times yearly	1,2. Adult and juvenile Chinook salmon	1-2. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration.	1.Debris accumulation on bridges and within bridge drains shall be collected and properly disposed of off site. 2. Implement SPCC	1. Piers and abutments will be placed outside channel	1,2. Minimization measures expected to reduce effects to insignificant level.
81	Widened bridge operation (400 square feet of shading)	Hylebos Creek (H7)	1. Increased shading	1. Up to 3 years	1. Up to 3 years	1. Up to 3 years	Juvenile Chinook salmon	Increased predation on juvenile fish.	None	None	Effects to listed fish are expected to be insignificant
82	Remove bridge, replace with fill material.	Hylebos Creek (H6,H7)	None	Following creek relocation	1 week at each location	Day and night one time occurrence	None	None due to lack of presence	Bridge removal shall occur following stream relocation when there is no flow	None	There will be no measurable effect from this action
83	Remove sediment and debris at existing bridge	Hylebos Creek (H11) Existing SR 99	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance 4. Loss of benthic productivity 5. Alteration of habitat structure	In water work window - July 15-August 31	1 day	Daylight hours; one time	Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance 4. Reduced feeding opportunity. 5.Reduced foraging opportunity and productivity	1-2. Implement TESC and SPCC 3-5. none	None	1. Reduced foraging efficiency within the mixing zone. 2. Minimization measures expected to reduce effects to insignificant level. 3. Avoidance and reduced foraging efficiency. 4, 5. Reduced foraging opportunities, displacement of juveniles.
84	Construct temporary work area isolation (this is not the same as damming the whole stream) **See item #60 for this action's analysis**	Hylebos Creek (H13, H15, H16)									

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
85	Divert water around work area **See item #61 for this action's analysis**	Hylebos Creek **(H13, H15, H16)**									
86	Handle fish **See item #62 for this action's analysis**	Hylebos Creek **(H13, H15, H16)**									
87	Remove undersized bridge	Hylebos Creek **(H13, H15, H16)**	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance	1-3. In water work window - July 15-August 31	1-3. 1 week	1-3. Daylight hours	1-3. Juvenile Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	1. Implement TESC 2. Implement SPCC 3. None	None	1. Reduced foraging efficiency within the mixing zone. 2. Minimization measures expected to reduce effects to insignificant level. 3. Avoidance and reduced foraging efficiency.
88	Restore flow to work area	Hylebos Creek **(H13, H15, H16)**	1. Turbidity 2. Contaminants (heavy equipment) 3. Disturbance 4. Improved habitat forming processes and 1550 square feet of daylighted channel	1-3. In water work window - July 15-August 31 4. Following bridge removals	1-3. One day. 4. Following removals (long-term)	1-3. Daylight hours 4. Following removals (long-term)	1-3. Juvenile Chinook salmon 4. Juvenile and adult Chinook salmon	1. Reduced foraging within mixing zone; 2. Injury; 3. Avoidance	1. Implement TESC 2. Implement SPCC 3,4. None	None	1. Reduced foraging efficiency within the mixing zone. 2. Minimization measures expected to reduce effects to insignificant level. 3. Avoidance and reduced foraging efficiency. 4. Long-term increased foraging efficiency and productivity and improved mobility.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
89	Remove roadway and buildings	Hylebos Creek (**RRP area**)	1. Elevated turbidity 2. Contaminants (from heavy equipment and dust, demolished materials) 3. Increased infiltration 4. Increased habitat forming processes.	During rain events from June through September	24 hours	Nine times yearly for rainfall, once for the project.	Juvenile and adult Chinook salmon.	1. Injury, avoidance, delayed or reduced feeding opportunity, delayed migration; 2. Injury 3,4. Increased base flow .	1,2. Implement TESC and SPCC. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. Implement dust control. 3,4 None	None	Minimization measures are expected to reduce effects to insignificant level and create beneficial effects to baseflow and habitat forming processes.
90	Construct new channel including LWD placement and channel stabilization berm (5340 linear feet of new channel)	Surprise Lake Tributary	None	June through September	3 weeks	Day and night	None	None	Construct channel during the driest possible conditions. Existing water table may not allow for totally dry conditions	None	No measurable effect from this action.
91	Construct temporary diversion dam for dewatering work area	Surprise Lake Tributary (**Portion of channel to be relocated**)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	2 days at each location	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and adult and juvenile Chinook for Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury 3. Avoidance	1,2. Dam installation will either be by hand or by equipment operated from the banks, overhead bridges or outside the wetted perimeter. Material placed within the water will be free of sediment and other contaminants. 3. None	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Turbidity impacts downstream to Hylebos Creek are expected to be insignificant from this action.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
92	Handle fish	Surprise Lake Tributary **(Portion of channel to be relocated)**	1. Handling 2. Electrofishing	In water work window - July 15-August 31	2 days	One time during daylight hours	Juvenile Chinook Salmon	1. Injury and elevated stress. 2. Injury or mortality	1, 2. Follow latest version of WSDOT's fish handling protocol; hold fish in aerated buckets; hold fish for min. time necessary; only electrofish when other methods unfeasible, release to suit. habitat nearby, adeq. staff on-site will reduce the number of electrofishing passes necessary, doc. species handled. No electrofishing when turbidity reduces visibility to < 0.5 meters and when water temp. > 18 degrees C or.< 4 degrees C. Electrofish only when a bio. w/ at least 100 hours of electrofishing experience is on site to conduct or direct all activities assoc. w/ capture attempts. A max. of 3 passes made while electro. Fish will remain in buckets for a max. of 15 min. during transport to release pt.	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. No downstream effects to Hylebos Creek are expected.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
93	Dewater work area (approximately 1800 square feet of dewatered area)	Surprise Lake Tributary **(Portion of channel to be relocated)**	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	2 days each location	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and adult and juvenile Chinook for Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury 3. Avoidance	Implement TESC and SPCC.	Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge.	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Turbidity impacts downstream to Hylebos Creek are expected to be insignificant from this action.
94	Direct Flow to new creek channel and use of the channel	Surprise Lake Tributary RRP	1. Elevated turbidity 2. Delay in benthic colonization	1. During rain events and seasonal flush 2. Until colonizing vegetation establishes (up to 3 years) no active planting,	1. 24 hours 2. Until colonizing vegetation establishes (up to 3 years) no active planting,	1. Nine times yearly for 10 years; 2. Until colonizing vegetation establishes (up to 3 years) no active planting,	Juvenile Chinook salmon for Surprise Lake Tributary and adult and juvenile Chinook for Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Reduced foraging efficiency	1. Implement TESC, SPCC, if using a diversion system with temporary sediment-trapping BMPs, sediments shall be cleaned out and the settled sediment removed before removing the diversion and returning flow to its natural channel. Settled sediment shall be kept from the entering the stream during runoff flows that may occur after work is complete. Flow will gradually be introduced to the channel over a 24 hour period. 1, 2. Plant native trees and shrubs to increase benthic diversity over the long-term.	None	Effects are expected to be insignificant within Surprise Lake Tributary due to implementation of minimization measures and because juvenile Chinook use of Surprise Lake Tributary is limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Turbidity effects could extend downstream to Hylebos Creek and could affect fish, but would be expected to dissipate within 300 feet downstream of the confluence of Surprise Lake Tributary and Hylebos Creek.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
95	Fill 0.14-acre of channel and remove diversion	Surprise Lake Tributary	Loss of habitat and benthos species	June through September, following flow diversion to new channel	In perpetuity	In perpetuity	Juvenile Chinook salmon for Surprise Lake Tributary and adult and juvenile Chinook for Hylebos Creek.	Reduced rearing opportunity	Create new channel, fill channel when dry, following flow diversion and fish removal	None	There will be no direct exposure to fish during this action, habitat loss will be offset by the permanent new channel creation and associated restoration plantings, LWD placement, as part of the RRP. The quality of rearing habitat will be improved in the long term. There will be an insignificant temporal loss of productivity until the benthic community establishes. No downstream effects to Hylebos Creek are expected.
96	Construct recessed floodway (or high flow channel) (max. 3 feet deep, 150 feet wide) and associated low berm for an approximately 2000-foot distance (excavation down to 3 feet deep in a 300,000 sq. ft. maximum area. This area will be planted following excavation.	Surprise Lake Tributary (**RS5**) **Freeman Road to 20th St.**	1. Elevated turbidity 2. Contaminants (heavy equipment)	1. Year round 2.June through September	1. 24 hours, Until vegetation establishes (up to 10 years) no active planting, 2. While equipment is operating (2 weeks).	1. Nine times yearly, Until vegetation establishes (up to 10 years) no active planting,) 2. While equipment is operating (two weeks)	Juvenile Chinook salmon for Surprise Lake Tributary and adult and juvenile Chinook for Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury	1,2. Implement TESC and SPCC. Conduct work during the driest possible conditions. Existing water table may not allow for totally dry conditions. 1. Time planting to maximize plant establishment prior to flood events.	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek from exposed soils, but due to approximately 2000-ft distance to confluence and minimization measures, effects are expected to be insignificant.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
97	Construct temporary work area isolation (this is not the same as damming the whole stream) (1800 square feet of dewatered area)	Surprise Lake Tributary (RS3)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	2 days	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury 3. Avoidance	1,2. Dam installation will either be by hand or by equipment operated from the banks, overhead bridges or outside the wetted perimeter. Material placed within the water will be free of sediment and other contaminants. 3. None	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 500-ft distance to the confluence and minimization measures, effects are expected to be insignificant.
98	Divert water around work area	Surprise Lake Tributary (RS3)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3. Disturbance	In water work window - July 15-August 31	2 days	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek.	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury 3. Avoidance	1. Implement TESC 2. Implement SPCC 3. None 4. Install fish screens on pump intake.	None	No measurable effect from this action as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 500-ft distance to the confluence and limited instream disturbance, effects are expected to be insignificant.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
99	Handle fish **(see item #92 for analysis of this action)**	Surprise Lake Tributary (**RS3**)									
100	Dewater work area **(see item #93 for analysis of this action)**	Surprise Lake Tributary (**RS3**)									
101	Install new box culvert	Surprise Lake Tributary (**RS3**)	1. Elevated turbidity 2. Contaminants (heavy equipment) 3.Loss of channel complexity	1,2.In water window – July 15 – August 31 3. In perpetuity	1,2. 3 days 3. In perpetuity	1,2.Daylight hours one time 3. In perpetuity	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury 3. Reduced foraging efficiency; reduced productivity; increased predation	Implement TESC and SPCC. 1. Construct during the driest possible conditions. Existing water table may not allow for totally dry conditions. Build in conjunction or before new channel.	3. Abutments will be placed outside of channel. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP.	No measurable effect from this action. No downstream effects to Hylebos Creek are expected because of work area isolation.
102	Remove temporary diversion for dewatering work area	Surprise Lake Tributary (**RS3**)	1. Elevated turbidity 2. Contaminants (heavy equipment)	In water work window - July 15-August 31	1 day	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury	1,2. Dam removal will either be by hand or by equipment operated from the banks, overhead bridges or outside the wetted perimeter.	None	No measurable effect from this as juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 500-ft distance to the confluence and minimization

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
											measures, effects are expected to be insignificant.
103	Install temporary crossing	Surprise Lake Tributary (**RS1**)	1. Elevated turbidity 2. Contaminants (heavy equipment)	In water work window - July 15-August 31	3 days for installation	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1. Reduced foraging within mixing zone. 2. Injury	1,2. Implement TESC and SPCC, no in-water work. Where stream crossings are essential, the design will take into account reasonably foreseeable risks such as flooding, bedload, and debris in order to prevent stream diversions from leaving the channel in the event of a crossing failure.	1,2. No piers or abutments will be placed inside the channel.	1,2. Minimization measures, ambient turbidity levels, and performance standards are expected to reduce effects to insignificant level and juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 1600-ft distance to the confluence and minimization measures, effects are expected to be insignificant.
104	Operate temporary crossing (400 square feet of shading)	Surprise Lake Tributary (**RS1**)	1. Habitat displacement, increased shading	While structure in place - up to two years	Up to two years	Day and night while structure in place	Juvenile Chinook salmon	Reduced foraging efficiency; reduced productivity; increased predation	None	None	Effects are not expected to be significant. No downstream effects to Hylebos Creek are expected.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
105	Remove temporary crossing (see RH1)	Surprise Lake Tributary (**RS1**)	1. Elevated turbidity 2. Contaminants (heavy equipment)	In water work window - July 15-August 31	2 days	Daylight hours	Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1. Injury, avoidance, delayed or reduced feeding opportunity. 2. Injury	Implement TESC and SPCC.	None	Minimization measures are expected to reduce effects to insignificant level and juvenile Chinook use of Surprise Lake Tributary is unlikely during in-water work period – use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 1600-ft distance to confluence and minimization measures, effects are expected to be insignificant.

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
106	Installing permanent, high-spanning bridges over water	Surprise Lake Tributary (S1, S3, S7, RS2)	1. Increased turbidity 2. Increased contaminants (heavy equipment and concrete)	1-2. During rain events	1,2. 24 hours	1,2. Nine times yearly for 1 construction season per bridge.	1,2..Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1-2. Injury, avoidance, delayed or reduced feeding opportunity.	Implement SPCC. All concrete forms which are in contact with water shall be completely sealed to prevent the possibility of fresh concrete from getting into the stream. Any water that comes into contact with concrete within the first 7 days of cure shall be contained and discharged to land with no possible entry to surface waters. Where land is not available for treatment, other methods of water treatment shall be utilized as approved by the WSDOT engineer.	All concrete shall be cured a minimum of 7 days before contact with waters of the State. Piers and abutments will be placed outside channel. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP.	Minimization measures are expected to reduce effects to insignificant level and juvenile Chinook use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 1600-ft distance to confluence at RS2, 1000-ft distance at RS1, 800-ft distance at S3, and 400-ft distance at S7; and minimization measures, no effects are expected.

Item	Action	Where	Exposure: Stressor	When	Duration	Frequency	Life History Form	Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
107	Installing permanent, channel-spanning bridges over water	Surprise Lake Tributary (**S4, S5, RS4**)	1. Increased turbidity 2. Increased contaminants (heavy equipment and concrete)	1-2. During rain events	1,2. 24 hours	1,2. Nine times yearly for 1 construction season per bridge.	1,2. Juvenile Chinook salmon for Surprise Lake Tributary and Hylebos Creek	1-2. Injury, avoidance, delayed or reduced feeding opportunity.	Implement SPCC. All concrete forms which are in contact with water shall be completely sealed to prevent the possibility of fresh concrete from getting into the stream. Any water that comes into contact with concrete within the first 7 days of cure shall be contained and discharged to land with no possible entry to surface waters. Where land is not available for treatment, other methods of water treatment shall be utilized as approved by the WSDOT engineer.	All concrete shall be cured a minimum of 7 days before contact with waters of the State. Piers and abutments will be placed outside channel. With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP.	Minimization measures are expected to reduce effects to insignificant level and use limited to high flow/flood events when Hylebos Creek backs up into Surprise Lake Tributary. Potentially some turbidity extending downstream to Hylebos Creek, but due to approximately 700-ft distance to the confluence at S4 and S5 and 400-ft distance at RS4; and minimization measures, effects are expected to be insignificant.
108	Use of permanent, channel-spanning bridges over water	Surprise Lake Tributary (**S4, S5, RS4**)	Increased shading	In perpetuity	In perpetuity	In perpetuity	Juvenile Chinook salmon	Increased predation	None	None	Effects are not expected to be significant. No downstream effects to Hylebos Creek are expected.
109	Abandon culvert	Surprise Lake Tributary (**S2, S6**)	None	N/A	N/A	N/A	No listed fish present	None	Abandon following flow diversion to new channel.	None	No measurable effect from action due to lack of species presence. No downstream effects to Hylebos Creek are expected.
110	Install bridges (4) (bridges will span OHWM)	Wapato Creek (**W1, W9, W13, W15**)	None	N/A	N/A	N/A	No listed fish present	None	None	With consideration of site specific design constraints and practicability, sizing and location of stream crossings will compliment the functions of the RRP by supporting channel forming	No measurable effect from action due to lack of species presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
										processes, floodplain function, and habitat connectivity in the RRP.	
111	Construct temporary work area isolation (this is not the same as damming the whole stream)	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
112	Divert water around work area	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
113	Handle fish	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
114	Dewater work area (W4 will have approx. 2500 square feet of dewatered area, W5 will have approx. 660 square feet of dewatered area, and W8 will have approx. 540 square feet of dewatered area)	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
115	Excavate in channel (W4 will have approx. 2700 square feet of excavation, W5 will have approx. 880 square feet of excavation, and W8 will have approx. 720 square feet of excavation)	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
116	Install culverts	Wapato Creek **(W4, W5, W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	With consideration of site specific design constraints and practicability, sizing and location of	No measurable effect from action due to lack of species presence

Item	Action	Where	Exposure					Response to Stressor	Minimization Measures	Performance Standards	Resulting Effects of the Action
			Stressor	When	Duration	Frequency	Life History Form				
										stream crossings will compliment the functions of the RRP by supporting channel forming processes, floodplain function, and habitat connectivity in the RRP.	
117	Remove temporary diversion dam for dewatering work area	Wapato Creek **(W4,W5,W8)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
118	Remove culvert	Wapato Creek **(W2, W3, W5, W6, W7, W8, W10, W11)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
119	Install temporary crossing (concrete slab)	Wapato Creek **(W12)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
120	Remove temporary crossing	Wapato Creek **(W12)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
121	Remove roadway and buildings	Wapato Creek **(RRP areas)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence
122	Remove invasive plants	Wapato Creek **(RRP areas)**	None	N/A	N/A	N/A	No listed fish present	None	None	None	No measurable effect from action due to lack of species presence

SR 167 Bull Trout Critical Habitat Draft Pathways of Exposure
6/30/06

Item	Action	Where	Exposure: Potential Effect to PCE	When	Duration	Frequency	PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
1	Vegetation removal - 76.3 acres permanent - 0.5-acre riparian, **(pages 14,15 BA)** and grading the same acres.	Puyallup sub basin.	1. Increased runoff **(PCE 4)** 2. Increased turbidity **(6,7)** 3. Erosion **(2&7)** 4. Increased water temperature due to shade reduction **(1,7)** 5. Loss of cover due to loss of overhanging vegetation **(2,7)** 6. Potential reduced baseflow **(4,5)** 7. Reduced benthic abundance and diversity **(7)**	1. During rain events 2. During rain events 3. 3 years - 2 years for construction, 1 for stabilization 4-7. In perpetuity	1. 24 hours 2. 24 hours 3. 3 years - 2 years for construction, 1 for stabilization 4-7. In perpetuity	1-3. 4 times yearly 4-7. In perpetuity	PCEs 1,2,4-8 **(see footer for abbreviated PCE descriptions)**	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (300 ft mix. zone req. and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to min. disturbance to sensitive areas. Implement Standard Spec 8-01.3(1) General - (limits exposure of erodible soils to a max. of 17 acres from May 1 to Sept 30 and max. of 5 acres from October 1 to April 30. 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Boundaries will be delineated w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1) 4.& 5. Mark clearing boundaries 6.& 7. None	1-3. None 4,5. Clearing will not exceed marked boundaries. (Biologist will monitor/inspect or provide acceptance in writing) 6. None 7. None	1. Reduced opportunity for groundwater recharge. 2. May temporarily degrade migration and foraging habitat in affected area. 3. Minimization measures and performance standard will reduce effects to insignificant levels. 4. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat. 5. Insignificant - primarily herbaceous and non-native shrub, appx. 2 trees. 6. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
2	Temporary vegetation impact - 17.52 acres temporary agricultural, shrub/grass, forest; "developed" partially vegetated area (landscaping) (**pages 14,15 BA**).	Puyallup sub basin.	1. Increased runoff (**PCE 4**) 2. Increased turbidity (**6,7**) 3. Erosion (**2&7**) 4. Increased water temperature due to shade reduction (**1,7**) 5. Loss of cover due to loss of overhanging vegetation (**2,7**) 6. Potential reduced baseflow (**4,5**) 7. Reduced benthic abundance and diversity (**7**)	1. During rain events 2. During rain events 3. 3 years - 2 years for construction, 1 for stabilization 4-7. 10 years until veg. establishes	1. 24 hours 2. 24 hours 3. 3 years - 2 years for construction, 1 for stabilization 4-7. 10 years until veg. establishes	1-3. 4 times yearly 4-7. 10 years until veg. establishes	PCEs 1,2,4-8	1. Perm. s/w BMP w/ flow control. 2. Imple. TESC, in accord. with imple. agreement (300 ft mix. zone req. and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to disturbance of sensitive areas. Implement Standard Spec 8-01.3(1) General - limits exposure of erodible soils to a max. of 17 acres from May 1 to Sept 30 and max. of 5 acres from October 1 to April 30. 3. Imple. TESC, veg. impacts, limited to the max. extent poss. Delin, boundaries will w/ construct. fencing prior to clearing/grub. Imple. Standard Spec 8-01.3(1). 4.& 5. Mark clearing boundaries. 1-7. Replant with native vegetation.	1-3. None 4,5. Clearing will not exceed marked boundaries: (Biologist will monitor/inspect or provide acceptance in writing). 6. None 7. None	1. Reduced opportunity for groundwater recharge. 2. May temporarily degrade migration and foraging habitat in affected area. 3. Minimization measures and performance standard will reduce effects to insignificant levels. 4. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat. 5. Insignificant - primarily herbaceous and non-native shrub, appx. 2 trees. 6. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat. 7. Insignificant due to the nature of the riparian habitat impacted.
3	Place 1,010,118 cubic yards of fill including crushed rock for new, widened, and realigned roadway, cul de sac, roundabout, park and rides, weigh stations, cross connection (**pages 15,16 BA**), grading	Puyallup sub basin.	1. Increased turbidity (**6,7**) 2. Changes in hyporheic flow due to compaction (potential reduced base flow) (**PCE 4,5**)	1. During rain events 2. In perpetuity	1. 24 hours 2. In perpetuity	1. 4 times yearly 2. In perpetuity	PCEs 4-7	1. Implement TESC and SPCC. Implement Standard Spec 8-01.3(1) General - which limits exposure of erodible soils to a maximum of 17 acres from May 1 to Sept 30 and a maximum of 5 acres from October 1 to April 30. 2. None	None	1. May temporarily degrade migration and foraging habitat in affected area. 2. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure						Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
			Potential Effect to PCE	When	Duration	Frequency	PCE				
4	Construct 70 acres of new impervious for roadway, widening, realignment, interchanges, roundabout, cul de sac, weight stations, park-and-rides, cross connection (includes placing crushed rock, paving, guardrail installation, signing, painting, grading) **(page 16 BA)**	Puyallup sub basin.	1. Increased contaminants (pavement materials and heavy equipment) **(8)** 2. Increased runoff **(4)** 3. Increased temperature **(1,7)**	1-4. During rain events which occur during the 5- to 13-year construction period	1-4. 24 hours	4 times yearly	PCEs 1,4,7,8		1. Paving will not occur when rain is forecasted. Implement TESC and SPCC. 2-3. Permanent s/w BMP w/ flow control.	1. All concrete shall cure a minimum of 7 days before contact with waters of the State. 2,3. None	Minimization measures and performance standard will reduce effects to insignificant levels.
5	Demolish existing infrastructure (not including bridges over water) **(pages 16,17 BA)**	Throughout project area.	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment and dust) **(8)**	During rain events for up to 13 years	1-2. 24 hours	1,2. 4 times yearly	PCEs 6-8		1,2. Implement TESC and SPCC. 1,2. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters. 1,2. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate. 1,2. Implement dust control.	None	Minimization measures are expected to reduce effects to discountable levels.
6	Relocate utilities **(pages 16,17 BA)**. Many underground utilities will be relocated to other underground locations and potentially the relocation of the jet fuel line could require drilling under Hylebos Creek and/or Surprise Lake Tributary.	Throughout project area.	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment) **(8)** 3. Noise and vibration **(6)**	1,2. During rain events for up to 13 years. 3. During direction drilling	1-2. 24 hours 3. Daylight hours	1,2. 4 times yearly 3. 1 time event	PCEs 6-8		1,2. Implement TESC and SPCC. Set drilling terminus outside of the OHWM of the channel. 3. Establish 2-foot minimum drill depth below channel.	None	Minimization measures are expected to reduce effects to insignificant levels.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
7	Construct interchange (**pages 8,9,11,16 BA**)	SR 509, 54th Ave East, I-5, Valley Avenue, SR 161, widen I-5, non-motorized path, realign 20th Street E., 70th Ave.	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**)	During rain events for up to 13 years	1-2. 24 hours	1,2. 4 times yearly	PCEs 6-8	Implement TESC and SPCC.	None	Minimization measures are expected to reduce effects to discountable levels.
8	Construct terrestrial retaining wall (**page 19 BA**)	70th Ave East and at interchanges.	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**)	1,2. During rain events for up to 13 years	1-2. 24 hours	1,2. 4 times yearly	PCEs 6-8	Implement TESC and SPCC.	None	Minimization measures are expected to reduce effects to discountable levels.
9	Construct temporary and permanent stormwater/erosion control BMPs, also new outfalls and/or outfall relocations, implement SPCC, grading (**pages 12,13 BA**)	Puyallup River - 3 outfall locations at the Puyallup River and 2 at Old Oxbow Lake Ditch.	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**) 3. Habitat loss (foraging/benthic) (**7**) 4. Increased temperature (**1,7**) 5. Reduced cover (**2,7**)	1,2. During rain events for up to 13 years 3-6. In perpetuity (permanent BMPs) 7. In water work window - July 15 to August 31	1-2. 24 hours 3-6. In perpetuity (permanent BMPs) 7. Duration of stormwater outfall construction during daylight hours	1,2. Four times yearly 3-6. In perpetuity 7. 2 times	PCEs 1,2,6-8	1-7. To the extent possible, the construction of new outfalls will be avoided or minimized by connecting project drainage to existing conveyance systems such as pipes or non fish-bearing ditches or by dispersing flows in uplands or riparian areas. Avoid rock placement by dissipating energy and reducing flow prior to reaching outfall and locate outfalls on already armored banks. Use river rock or cobble for pads where velocity allows. 3. Create fish alcoves (low velocity recess near outfall). 3-5. Use ditches instead of pipes to the outfall. 3,6. Locate outfalls to allow backwatering and reduced velocities.	None	1-2, 4,5. Minimization measures are expected to reduce effects to insignificant levels. 3. Habitat loss

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	When	Duration	Frequency	PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
9 (cont.)	Additional minimization measures							1-2. Imple. SPCC and TESC in accord. with imple. agreement (300 ft mix. zone req.) and veg. impact, shall be limited to max. extent possible. Boundaries will be delineated w/construct. fencing prior to clearing/grubbing, to min. disturbance to sensitive areas. 3-5. Minimize footprint of dissipater pad and outfall, and locate to minimize habitat impact. 5. Revegetate with native vegetation where possible. 6. None. 7. Rock shall be placed and not end dumped.		
10	Establish and utilize staging and stock pile areas **(page 14 BA)**	Throughout project area.	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment) **(8)**	1,2. During rain events for up to 13 years	1-2. 24 hours	1,2. 4 times yearly	PCEs 6-8	1-2. Imple. SPCC and TESC, staging and or material stock pile areas will not be located within 300 feet of any streams, rivers, or wetlands, unless site specific review completed by the project biologist indicates that no impacts to the sensitive resource areas will occur due to topography or other factors.	None	Minimization measures are expected to reduce effects to discountable levels.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	Exposure: When	Exposure: Duration	Exposure: Frequency	Exposure: PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
11	Wetland mitigation site development - grading and vegetation removal, replanting for approximately 32.9 acres (**pages 21,22 BA**)	10 potential sites throughout project area (7 in Hylebos Basin, 3 in Puyallup Basin)	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**) 3. Loss of riparian vegetation (**1,2,7**)	1,2. During rain events for 1 construction season at each location 3. 10 years until veg. establishes.	1,2. 24 hours 3. 10 years until veg. establishes.	1,2. 4 times yearly. 3. 10 years until veg. establishes.	PCEs 1,2,6-8	1,3. Avoid and minimize impacts to existing desirable vegetation. Existing (desirable) vegetation shall be maintained unless the impact is unavoidable. 1,2. Implement TESC and SPCC.	None	1. May temporarily degrade migration and foraging habitat in affected area. 2. Minimization measures are expected to reduce effects to discountable levels. 3. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat.
12	Wetland mitigation site development and implementation, in-water work (**pages 21,22 BA**) breaching the dike (not veg removal or replanting - covered separately)	3 potential sites adjacent to the Puyallup River.	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**) 3. Loss of riparian vegetation (**1,2,7**) 4. Underwater sound and vibration (from coffer dam installation) (**6,7**) 5. Habitat loss from bank hardening at inlet (**7**)	In-water work window - July 15-August 31	4 weeks	Post construction rain events and tidal inundations for up to 2 seasons.	PCEs 1,2,6-8	1. Meter rate of flow into mitigation site thorough slow removal of cofferdam. 1,2. Implement TESC and SPCC. 1,3. Avoid and minimize impacts to existing desirable vegetation. Existing (desirable) vegetation shall be maintained unless the impact is unavoidable. 4. Use vibratory hammer to install cofferdam. 5. None	None	1,4. May temporarily degrade migration and foraging habitat in affected area. 2. Minimization measures are expected to reduce effects to discountable levels. 3. Increased temperatures may result in a reduction of suitable foraging, overwintering/rearing habitat. 5. Effects are expected to be insignificant based on existing conditions of banks (armored).
13	Wetland mitigation site development - planting (**pages 21,22 BA**)	10 potential sites throughout project area (7 in Hylebos Basin, 3 in Puyallup Basin)	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment) (**8**)	1-2. During rain events	1,2. 24 hours for 14 years (4 years of construction; 10 year plant establishment period)	1-2. 4 times yearly	PCEs 6-8	1. Implement TESC 2. Implement SPCC	None	1. May temporarily degrade migration and foraging habitat until vegetation is established; minimization measures are expected to reduce effects to discountable levels. 2. Minimization measures are expected to reduce effects to discountable levels.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure					Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
			Potential Effect to PCE	When	Duration	Frequency	PCE			
14	Wetland mitigation site implementation - NOTE: Impacted wetlands are all Ecology class III.	Puyallup Basin	1. Increased benthic abundance and diversity (7) 2. Increased habitat complexity (2) 3. Improved groundwater recharge (4,5) 4. Improved floodplain connectivity (4) 5. Improved and increased channel complexity (2) 6. Increased riparian cover (1,7)	After 10 years when vegetation establishes	After 10 years when vegetation establishes	In perpetuity	PCEs 2,4,5,7	None	There will be no net loss of wetland function or area from the proposed project based on 2006 estimates of 7.57 acres of wetland impacts. Ratios depend on whether using creation or enhancement and the category of wetland being impacted. Wetland mitigation will occur within the impacted sub basins and the project's Final Mitigation Plan will be fully implemented.	1-6. Improved stream habitat complexity, and floodplain connectivity.
15	Removal of invasive plant species (pages 26,27 BA)	Within RRP boundaries and wetland mitigation sites.	1. Increased turbidity (6,7) 2. Contaminants (herbicides) (8) 3. Increased temperature (1,7) 4. Reduction in benthic abundance and diversity (7) 5. Reduced cover and loss of non-target riparian plant species (1,2,7)	1-2. With rainfall 3-5. During summer months until desired vegetation is established	24 hours up to 10 years	1-2. 4 times yearly up to 10 years 3-5. Up to 10 years	PCEs 1,2,6-8	1,2. Implement TESC and SPCC. 1. Use manual methods. 2. Only apply herbicide during dry conditions, use wicking vs. broadcast spray and dense planting of desired veg., use of hummocks to increase survival of shade plants, use either Agri-Dex (preferred) or LI700 as surfactants; do not use glyphosate products identified as "toxic to fish." 2,5. Apply in accordance with label requirements to avoid over application and drift. 3-5. Mark application boundaries and replant with native species.	None	1,2,3,4,5. Minimization measures are expected to reduce effects to discountable levels 2. Glyphosate products break down quickly, and have a high affinity for soil binding, making them unlikely to become part of runoff except with sedimentation which will be reduced through implementation of minimization measures.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	When	Duration	Frequency	PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
16	Remove existing steel bridge, including piers and abutments (they are within OHWM) **(pages 18,19 BA; stream crossing document)**	Puyallup River (P2)	1. Increased turbidity (6,7) 2. Contaminants from bridge paint, sawcutting, and equipment operation (8) 3. Noise (6,7)	1.During rainfall 2-4. In-water work window: July 15-August 31 (and time outside of window for work over and adjacent to water spring and early summer)	1. 24 hours 2. Duration of demolition plus 1 day 3,4. Duration of demolition during daylight hours	1. 4 times yearly 2,3,4. Daily during demolition	PCEs 6-8	1. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, implement TESC and SPCC. Conditions listed in the NPDES for Washing and Pressure Washing of Bridges and Ferry Terminals (WA#-0039039 or most current version) will be completed with as appropriate; sawcut water will not enter surface water; holes from abutments will be backfilled with rock or new abutments will be placed in existing holes 2. SPCC and NPDES requirements 3. Only operate during daylight hours; work area will not be lit at night or lighting will not be directed at the water.	None	1,3. May temporarily degrade migration and foraging habitat in affected area. 2. Minimization measures are expected to reduce effects to discountable levels.
17	Operate heavy equipment from barge **(page 18 BA)** (estimated area of shading from barge is 3000 square feet)	Puyallup River **(P1,P2,P3,P4)**	1. Increased shading (7) 2. Substrate impact from anchor (7) 3. Increased contaminants (heavy equipment) (8) 4. Noise (6,7)	1.Year round 2. When anchor is initially placed 3. During rainfall 4. During daylight hours	1,2,4,5. 2 construction seasons 3. 24 hours 4. During daylight hours	1,2,4,5. Daily during demolition 3. 4 times yearly 4. During daylight hours	PCEs 6-8	1. None 2. Minimize dragging anchor 3. implement SPCC 4. None	None	1. Effects are not expected to be significant 2,3. Minimization measures expected to reduce effects to insignificant level 4. May temporarily degrade migration and foraging habitat in affected area.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure					Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
			Potential Effect to PCE	When	Duration	Frequency	PCE			
18	Construction of dewatered work area for 4 new piers (2 each for widened concrete bridge and new steel bridge) **(page 18 BA)** (approximately 240 square feet of dewatered area per pier)	Puyallup River **(P2, P3)**	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment) **(8)** 3. Noise **(6,7)** 4. Loss of benthic habitat and benthos species **(7)**	In water work window - July 15-August 31	1,2. In-water work period plus 1 day 3,4. In-water work period during daylight hours 5. Duration of cofferdam placement (1 construction season for each bridge, non-concurrent)	1,5. Day and night 2-4. Daylight hours	PCEs 6-8	1. None 2. Implement SPCC 3,4. Vibratory installation of cofferdam; work restricted to daylight hours 5. Minimize size of cofferdams.	None	1,3. May temporarily degrade migration and foraging habitat in affected area 2. Minimization measures expected to reduce effects to insignificant level 4. May temporarily degrade foraging habitat in affected area.
19	Dispose of waste water	Puyallup River **(P2, P3)**	1. Increased turbidity **(6,7)** 2. Elevated contaminants (waste water and heavy equipment) **(8)**	During pier construction	1 construction season	Day and night	PCEs 6-8	1,2. Contain waste water and dispose of in an upland location where it will not enter surface waters.	None	1,2. Minimization measures expected to reduce effects to insignificant level.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Potential Effect to PCE	Exposure: When	Duration	Frequency	PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
20	Construct new bridge piers (2 each below OHWM for both the widened concrete bridge and the new steel bridge, so 4 total) each pier a max. of 3, 6-foot diameter columns **(pages 19,20 BA; stream crossing document)** (approximately 339 square feet of total habitat displacement)	Puyallup River **(P2, P3)**	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment) **(8)** 3. Loss of benthic habitat and benthos species **(7)** 4. Change in habitat forming processes **(2)**	1,2. In-water work window - July 15-August 31 3. In perpetuity	1,2. One construction season 3. In perpetuity	1,2. During daylight hours 3. In perpetuity	PCEs 6-8	1,2. Use drilled shaft construct., imple. TESC and SPCC. 2. Any waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorp. into embankments as approp.;all forms of concrete shall be completely sealed to prevent the possibility of fresh concrete from getting into the river. Water that comes into contact with concrete within the first 7 days of cure shall be contained and discharged to land with no poss. entry to surface waters. Where land is not avail. for treatment, other methods of water treatment shall be utilized as approved by the WSDOT engineer. 3. Minimize area of impact	2. All concrete shall cure a minimum of 7 days before contact with waters of the State.	1. May temporarily degrade migration and foraging habitat in affected area 2. Minimization measures and performance standard are expected to reduce effects to insignificant level 3. May degrade foraging habitat in affected area 4. May degrade habitat complexity in affected area.
21	Installing or widening permanent bridges over water **(pages 19,20 BA)** (15,000 square feet of increased shading for replaced bridge and 4,500 square feet from the widened bridge)	Puyallup River **(P2,P3)**	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment) **(8)** 3. Increased shading (7)	1,2. During rain events 3. In perpetuity	1,2. 24 hours 3. In perpetuity	1,2. 4 times yearly 3. In perpetuity	PCEs 6-8	1. Debris accumulation on bridges and within bridge drains shall be collected and properly disposed of off site. 2. Implement SPCC 3.None	None	1,2. Minimization measures expected to reduce effects to insignificant level. 3. Effects are expected to be insignificant.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure: Potential Effect to PCE	Exposure: When	Exposure: Duration	Exposure: Frequency	PCE	Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
22	Remove existing rail and overhang from concrete bridge with hoe ram **(page 20 BA)**	Puyallup River **(P3)**	1. Increased turbidity **(6,7)** 2. Increased contaminants (heavy equipment and bridge materials) **(8)**	During rain events	1,2. 24 hours	1,2. 4 times yearly	PCEs 6-8	1,2. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters. Any waste material will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate.	None	1,2. Minimization measures expected to reduce effects to insignificant level.
23	Install 450, 12-inch diameter piles for temporary work bridges and detour bridge (150 per structure) **(pages 17,18 BA; stream crossing document)** (approx. 353 square feet of temp. habitat displacement from piles and 12,000 square feet each increased shading for the work trestles and 16,800 square feet for the detour bridge)	Puyallup River **(P1, P4)**	1. Elevated sound pressure levels **(6,7)** 2. Temporary habitat displacement (approx. 353 square feet) and potential loss of benthos species production **(7)** 3. Increased shading 12000 square feet each for the work trestles and 16800 square feet for the detour bridge **(7)** 4. Change in habitat forming processes **(2)** 5. Contaminants (from treated wood decking or piles and heavy equipment) **(8)**	1. In-water work window - July 15-August 31 2-4. Year-round 5. During rain events while structures are in place	1. During pile installation (35 days per season) 2-4. During structure installation and use (2 construction seasons per structure) 5. Number of rain events	1. During installations 2-4. 2 years while structures in place 5. Number of rain events during 2-year period.	PCEs 2, 6-8	1. Use only concrete or untreated wood piles, installed with a vibratory hammer and limit impact hammer to proofing; install piles only during daylight hours 2-4. Keep structures in place for the minimum amount of time necessary 5. Use untreated wood for piles and decking.	1. Performance standard discussions are on-going 2-5. None	1. May temporarily degrade migration and foraging habitat in affected area 2,3. May temporarily degrade foraging habitat in affected area 4. May temporarily degrade habitat complexity in affected area 5. None

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

Item	Action	Where	Exposure					Minimization Measures	Performance Standards	Resulting Effects of the Action on Critical Habitat
			Potential Effect to PCE	When	Duration	Frequency	PCE			
24	Remove temporary detour bridge and 2 temporary work bridges, including 450 total piles (**page 18 BA; stream crossings document**). Piles will be direct pulled, vibed out, or cut off 2 feet below existing ground.	Puyallup River (**P1,P4**)	1. Increased turbidity (**6,7**) 2. Increased contaminants (heavy equipment and bridge materials) (**8**) 3. Noise (**6,7**)	In-water work window - July 15-August 31	1-4. During pile removals - 2 weeks (detour bridge), 4 weeks (work bridges)	1-4. Daylight hours	PCEs 6-8	1. During demolition, materials shall not be stored where upland runoff can cause the materials or leachate to enter into surface waters, a containment boom will be used to contain and collect any floating debris and sheen. 1. Holes left from pilings will be filled with clean native substrate that match surrounding substrate materials when feasible. 2. Creosoted materials if found will be disposed of by the contractor in a landfill according to Ch 173-304 WAC. 3,4. None	None	1,3. May temporarily degrade migration and foraging habitat in affected area 2. Minimization measures expected to reduce effects to insignificant level.

1=water temp., 2=complex stream channels, 3=substrate, 4=nat. hydrograph, 5=cool water sources, 6=migration corridors, 7=food base, 8=perm. water

APPENDIX B

Appendix B – Fish Exclusion Protocols and Standards

Prior to dewatering, all fish and other vertebrate aquatic life will be removed from sites that will be dewatered. For projects where in-water work is limited to a specific area and dewatering will not occur, fish will be excluded from the area to the maximum extent feasible within an isolated work area.

The sequence for fish exclusion is as follows:

- Isolation of the work area.
- Removal of as many fish as possible.
- Gradual dewatering of the work area (if the work area is to be dewatered).
- Removal of remaining fish.
- Record fish exclusion activities and notify Services as required.

Isolation of the work area, fish removal and release shall be conducted or directed by a biologist who possesses the competence to ensure the safe handling of all Endangered Species Act (ESA) listed fish, and who is also experienced with work area isolation. This protocol may not apply or may be modified in emergency situations or in certain areas that have unique site-specific characteristics.

Isolation of the Work Area

Installation of block nets will occur at predetermined locations, based on site characteristics, to prevent fish and other aquatic wildlife from moving into the work area. Sites will be selected based on desirable attributes such as slower flows and suitable locations for stake and/or gravel bag placement. Areas with heavy vegetation, undercut banks, deep pools, etc. will be avoided due to the difficulty of sealing nets. The downstream block net will be angled across the stream if possible to prevent impingement of fish on the net. Additionally, a "mini-pool" may be constructed at the downstream block net to provide a lower velocity area for fish to maneuver away from the net. Whenever conditions allow, the upstream block net shall be placed first. The downstream block net shall then be used as a seine to herd fish from the upstream block net location downstream to the point selected for the downstream block net installation. If feasible, this action will potentially move significant numbers of fish downstream, out of the impact area prior to other removal methods.

Block net mesh size, length, type of material, and depth will vary based on site conditions. The directing biologist on site will base the design of block nets on specific site characteristics such as water depth, velocity and channel width. Typical block net material is 9.5 millimeter stretched mesh. Block nets shall remain in place until in-water work is completed. Block nets will require frequent leaf and debris removal. An individual will be assigned the responsibility of frequently checking the nets to maintain their effectiveness and integrity. The frequency of such checks will

be determined on a case-by-case basis, dependent upon the system, season and weather conditions. Block nets need to be secured along both banks and in-channel to prevent failure during unforeseen rain events or debris accumulation. Some locations may require additional block net support (examples include galvanized hardware cloth and metal fence posts).

Fish Removal and Dewatering

If the site is dewatered, dewatering and the placement of cofferdams or diversions will be in accordance with any provisions contained in the HPA permit from WDFW.

Pumps used to temporarily bypass water around a work site, or to dewater residual pools within a dewatered site, shall be fitted with mesh screens to prevent aquatic life from entering the intake hose of the pump. The screens will also prevent aquatic life from entering the intake hose if a block net should fail. Screens shall be placed approximately 2-4 feet from the end of the intake hose to assure fish are not pinned upon the screen. Screening techniques must utilize the specifications in the HPA and be in compliance with Washington State Laws RCW 77.55.320, RCW 77.55.040 and RCW 77.55.070.

The site will be dewatered slowly enough to allow the efficient removal of all fish species and avoid strandings. The site will be rewatered slowly enough to prevent the loss of surface water downstream as the streambed absorbs water and to minimize or avoid a sudden increase in stream turbidity. During rewatering, the site will be monitored to prevent stranding of aquatic organisms below the construction site.

Removal Methods:

Methods for exclusion or removal of fish from the area between the block nets are described below. These methods are given in order of preference and for many locations a combination of methods will need to be applied. The use of visual observation techniques (e.g. snorkeling, surveying with polarized glasses or Plexiglas bottomed buckets) should be considered for evaluation of removal method effectiveness and to identify specific locations of fish concentrations prior to removal attempts.

- **Seining** shall be the preferred method. The remaining methods shall be used when seining is not possible or to enhance the effectiveness of removal through seining. Seines made from 9.5 mm stretched nylon mesh shall be used to remove fish from the isolated stream reach. Seine design will be dependent upon site-specific characteristics. The on-site biologist will plan seining procedures based on an evaluation of site characteristics. Seines, once pursed, will remain partially in the water while aquatic life is removed. Aquatic life will be captured by personnel in water or on shore using hand held nets.

- **Baited minnow traps** (typically used in conjunction with seining) may be left in overnight, but will be checked at least three times daily to minimize predation within the trap. Traps will be checked more frequently if temperatures are in excess of 15°C.

- **Dip Nets and Hand Removal** will be used in conjunction with seining and as a site is slowly dewatered. This usually occurs after other methods.

- **Connecting rod snakes** will be used to help move fish out of stream crossing structures. The connecting rod snake is made of wood sections approximately three feet in length. When dewatering is to occur a seine may be placed at the downstream end of the crossing structure. As the water level goes down fish inside the culvert, in theory, will evacuate downstream into the seine that is in place at the outlet. The snake may be wiggled slowly through the pipe to encourage evacuation of fish out of the culvert. Other previously listed capture techniques shall be employed if required.

- **Electrofishing** shall be performed only when other methods have been determined to be unfeasible or ineffective by the directing biologist. Electrofishing studies document injury rates to fish even at low settings. Therefore, use of this method is discouraged when unnecessary. For sites that will not be dewatered, the potential for injury to ESA-listed fish may outweigh the benefit of capture and relocation of all fish present in the work area. Electrofishing research results reveal a trend that as number of vertebrae and spine length increase, injury potential also increases. Therefore, the capture and removal of adult ESA-listed fish by electrofishing will be avoided when possible[1].

The following conditions shall apply to use of electrofishing as a means of fish removal:

1. The USFWS will be provided written notification 10 working days prior to the initiation of electrofishing.

2. Electrofishing shall only be conducted when a biologist with at least 100 hours of electrofishing experience is on site to conduct or direct all activities associated with capture attempts. The directing biologist shall be familiar with the principles of electrofishing including the interrelated effects of voltage, pulse width and pulse rate on fish species and associated risk of injury/mortality. The directing biologist shall have knowledge regarding galvanotaxis, narcosis and tetany, their respective relationships to injury/mortality rates, and have the ability to recognize these responses when exhibited by fish.

3. The following chart shall be used as guidelines for electrofishing in water where the potential to encounter ESA-listed juvenile fish exists. Only DC or pulsed DC current will be used. Visual observation of the size classes of fish in the work area is helpful to avoid injury to larger fish by the mistaken assumption that they are not present.

[1] Timing windows provided by WDFW will be used to minimize the chance of encountering adult proposed or listed fish. However, complete avoidance may not be possible with resident bull trout.

Guidelines for initial and maximum settings for backpack electrofishing[2]

	Initial Setting	Conductivity (µS/cm)	Maximum Settings
Voltage	100 V	≤ 300	800 V
		> 300	400 V
Pulse Width	500 µs		5 ms
Pulse Rate	15 Hz		60 Hz (In general, exceeding 40 Hz will injure more fish)

Each session shall begin with low settings for pulse width and pulse rate. If fish present in the area being electrofished do not exhibit an appropriate response, the settings shall be gradually increased until the appropriate response is achieved (galvanotaxis). Conducting electrofishing activity at the minimal effective settings is imperative because as pulse width and pulse rate increase, fish injury rates increase. Minimum effective voltage settings are dependent upon water conductivity and will need to increase as conductivity decreases. Higher voltages elevate the risk of serious injury to fish removal personnel. The lowest effective setting for pulse width, pulse rate and voltage will be used to minimize personnel safety concerns and help minimize fish injury/mortality rates.

4. Seasonal timing restrictions for conducting electrofishing shall be dependent upon the river system, fish composition and an analysis of the life history of documented species. Spawning adults and redds with incubating eggs will not be subjected to the effects of electrofishing. As a general rule, waters with anadromous salmon should not be electrofished from October 15 to May 15 and resident waters from November 1 to May 15. In waters with potential bull trout presence, the timing may be more restrictive. It shall be the responsibility of the directing biologist to research and assess the time of year (for each river segment) when electrofishing is appropriate.

5. An individual shall be stationed at the downstream block net continuously during electrofishing sessions to recover stunned fish in the event they are washed downstream and pinned against the net.

6. The operator shall avoid allowing fish to come into contact with the anode. The zone of potential fish injury is 0.5 m from the anode. Netting shall never be attached to the anode. Techniques employed when using an unnetted anode keep fish farther from the anode and expose them to significantly less time in the zone of potential injury. Extra care shall be taken near in-water structures or undercut banks, in shallow waters or high-density fish areas. In these areas fish are more likely to come into close contact with the anode because fish may be less visible and the voltage gradients may be abnormally intensified. Voltage settings in shallow water sections shall be checked and readjusted by the operator if necessary. When electrofishing areas near undercut banks or where structures may provide cover for fish, the anode will be used to draw the fish out by placing the activated anode near the area fish are likely present and slowly drawing the anode away. Fish experiencing

[2] Adapted from NMFS Backpack Electrofishing Guidelines, June 2000, and WDFW Electrofishing Guidelines for Stream Typing, May 2001.

galvanotaxis will be attracted to the anode and will swim away from the structure toward the anode so that they can be netted. This will not work on fish that experience narcosis or tetany. Therefore, fish response will be noted in adjacent areas prior to attempts made near structures. This should help avoid prolonged exposure of fish to the electrical field while in an immobilized state.

7. Electrofishing shall be performed in a manner that minimizes harm to fish. Once an appropriate fish response (galvanotaxis) is noted, the stream segment shall be worked systematically, moving the anode continuously in a herringbone pattern through the water without electrofishing one area for an extended period of time. The number of passes shall be kept to a minimum, will be dependent upon site-specific characteristics, and be at the discretion of the directing biologist. Adequate numbers of personnel shall be on-site to minimize the number of passes required for fish removal. Adequate staff to net, recover, and release fish as soon as possible shall be present. Fish shall be removed from the electrical field immediately. Fish shall not be held in the net while continuing to capture additional fish.

8. Condition of captured fish will be carefully observed and documented. Dark bands on the body and extended recovery times are signs of injury or handling stress. When such signs are noted, the settings for the electrofishing unit and/or manner in which the electrofishing session is proceeding need adjustment. These characteristics may be an indication that electrofishing has become an inappropriate removal method for that specific site. Each fish shall be capable of remaining upright and actively swimming prior to release (see Fish Handling, Holding and Release section).

9. Electrofishing shall not occur when turbidity reduces visibility to less than 0.5 meters, when water conductivity exceeds 350 μS/cm, or when water temperature is above 18°C or below 4°C.

<u>Fish Handling, Holding and Release:</u>

- Fish handling will be kept to the minimum necessary to remove fish from the work site.

- Fish will not be sampled or anesthetized during removal activities as this protocol is intended to address fish removal not research. Fish species, number, age class estimate, and release location will be documented.

- Individuals handling fish shall ensure that their hands are free of sunscreen, lotion, or insect repellent.

- Fish or other aquatic life captured shall be immediately put into dark colored containers filled with clean stream water. Fish removal personnel shall provide a healthy environment for fish with minimum holding periods and low fish densities in holding containers to avoid effects of overcrowding. Large fish shall be kept separate from smaller fish to avoid predation during containment. Water-to-water transfers shall occur whenever possible. ESA listed fish should not be transferred out of water to prevent added stress. Holding

container temperature and well being of specimens will be frequently monitored to assure that all specimens will be released unharmed. Potential shade areas and supplemental oxygen for fish holding shall be considered in designing fish handling operations.

- The release site(s) will be determined by the directing biologist and may be based on specific site characteristics (flow refuge and cover) and type of fish captured (out migrating smolt, kelt, prespawn migrating adult, etc). More than one site may be designated to provide for varying migrational needs and to separate prey size fish from larger fish. The directing biologist shall consider fish migration requirements, size classes of fish, and duration of work area isolation when designing fish release plans. Each fish shall be capable of remaining upright and have the ability to actively swim upon release. ESA-listed or proposed fish will have priority over other species for release. One person shall be designated to transport specimens in a timely manner to the site selected for release.

- All ESA-listed dead fish shall be preserved and delivered to the pertinent regulatory agency (see documentation below) as outlined in the appropriate permit's conditions.

- If authorized level of take is exceeded, the pertinent regulatory agency shall be notified as soon as possible.

Documentation

- All work area isolation, fish removal and fish release activity shall be thoroughly documented in a log book with the following information: project location, date, methods, personnel, in-stream temperature, visibility, electrofisher settings, and other comments.

- Species, number of each species, age class estimate, and location of release will be recorded for all fish handled.

- Information regarding injuries or mortalities to ESA-listed or proposed species shall be documented and provided within three working days to NMFS or USFWS, depending on which agency has jurisdiction over that species.

APPENDIX C

Appendix C

Conservation Measures

The following conservation measures were proposed as part of the SR 167 Extension project:

Temporary Erosion/Sediment Control, Spill Control, Water Quality

- Construct permanent stormwater BMPs with flow control.
- Implement Temporary Erosion and Sediment Control (TESC) and Spill Prevention, Control, and Countermeasure (SPCC) plans.
- In accordance with the implementing agreement the water quality mixing zones will not exceed 300 ft in the Puyallup River, 200 ft in Hylebos and Wapato Creeks, and 100 ft in Surprise Lake Drain.
- Temporary BMPs will allow turbid water to settle for a minimum of 2 hours before discharging. The flow rate of turbid water into the stream shall not exceed one tenth of the natural flow rate of the stream at the time of discharge (when dewatering work area).
- Implement Standard Specification 8-01.3(1) General - (limits exposure of erodible soils). Controlling pollution, erosion, runoff, and related damage requires the Contractor to perform temporary work items including but not limited to:

    1. Providing ditches, berms, culverts, and other measures to control surface water;
    2. Building dams, settling basins, energy dissipaters and other measures to control downstream flows;
    3. Controlling underground water found during construction; or
    4. Covering or otherwise protecting slopes until permanent erosion-control measures are working.

The Contractor will coordinate this temporary work with the construction of permanent drainage and erosion control work. The WSDOT may require additional temporary control measures if it appears pollution or erosion may result from weather, the nature of the materials, or progress on the work. When natural elements rut or erode the slope, the Contractor will restore and repair the damage with the eroded material where possible, and clean up any remaining material in ditches and culverts.

If the WSDOT anticipates water pollution or erosion from project construction, the Contractor will schedule the work so that grading and erosion control immediately follows clearing and grubbing. The WSDOT may also require erosion control work to be done with or immediately after grading. Clearing, grubbing, excavation, borrow, or fill within the right of way shall never expose more erodible earth than as listed below, without written approval by the Engineer:

- 17 acres maximum between May 1 – September 30
- 5 acres maximum between October 1 – April 30

The WSDOT may allow the contractor to increase or decrease the limits if the grubbing is to be done separately at a later date or if the area limitation for grubbing is too restrictive to

accommodate the clearing operations and there is little potential for erosion due to the clearing operation.

Erodible earth is defined as any surface where soils, grindings, or other materials are capable of being displaced and transported by rain, wind, or surface water runoff. In western Washington, erodible soil not being worked, whether at final grade or not, shall be covered during the following time period, using an approved soil covering practice, unless otherwise authorized by the WSDOT:

- October 1 through April 30: 2 days maximum
- May 1 to September 30: 7 days maximum

- Tacifier coat will not be applied when rain is forecast.
- Materials will be clean, covered when appropriate, and placed in a manner to prevent erosion and siltation that might result from high water or heavy rains.
- Materials during demolition will be stored where upland runoff cannot cause the materials or leachate to enter into surface waters.
- Staging and or material stock pile areas will not be located within 300 ft of any streams, rivers, or wetlands unless site specific review completed by the project biologist indicates that no impacts to the sensitive resource areas will occur due to topography or other factors.
- Conditions listed in the National Pollution Discharge Elimination System (NPDES) permit for Bridge Maintenance Washing and Cleaning (WA#-0039039) specify work restrictions that minimize pollutants entering the water and the disturbance of vegetation. Notable requirements include the following:

  - Dry clean (scrape, sweep, or vacuum) before washing. This includes flaking paint. Residual grease must be removed with degreaser on absorbent-material. Areas of the bridge that cannot be safely dry cleaned should be flushed).
  - Use the minimum pressure that will clean the bridge and prevent paint chips from entering the Puyallup River. Avoid flaking paint and lower the pressure if needed to prevent the removal of bonded paint.
  - Plug bridge drains before washing.
  - Use clean wash water with no detergents or other additives.

- Saw-cut water will not enter surface water.
- Waste water will be contained and disposed of in an upland location where it will not enter surface waters.
- Waste material, debris, or spoils will be disposed of at an approved and permitted upland commercial site, approved waste site, or incorporated into embankments as appropriate.
- All forms of concrete will be completely sealed to prevent the possibility of fresh concrete from entering surface waters.
- Water that comes into contact with concrete within the first 7 days of cure will be contained and discharged to land with no possible entry to surface waters. Where land is not available for treatment, other methods of water treatment shall be utilized as approved by the WSDOT engineer.

- Debris accumulation on bridges and within bridge drains off site will be collected and disposed of properly.
- A containment boom will be used to contain and collect any floating debris and sheen during bridge removals.
- Material placed within the water will be free of sediment and other contaminants.
- Flow to temporary and relocated channels will be gradually introduced over a 24 hour period.
- Applicable activities will comply with the following regulations: Section 1-07.5 Fish and Wildlife and WDOE Regulations, 1-07.15 Temporary Water Pollution/Erosion Control and 1-07.15(1) Spill Prevention, Control, and Countermeasures Plan, and 8-01 Erosion Control and Water Pollution Control, and the most current version of the Implementing Agreement between the WDOE and the WSDOT. In addition:

    - All liquid products shall be stored and mixed on PGIS in a secure covered and contained location to eliminate the potential for spills. Paint and solvent spills shall be treated as oil spills and shall be prevented from reaching storm drains or other discharges. Cleaning solvents or chemicals used for tool or equipment cleaning will not be discharged to the ground or surface waters.
    - Fuel hoses, oil drums, oil or fuel transfer valves and fittings, etc., shall be inspected regularly for drips or leaks and shall be maintained and stored properly to prevent spills into state waters. Drip pans or other protective devices shall be required for all transfer operations.
    - Spilled waste, chemicals, or petroleum products shall be transported off site for disposal at a facility approved by the WDOE or the local County Health Department. The materials shall not be discharged to any sanitary sewer without approval of the local sewer authority.
    - Spills into State waters, spill onto land with a potential for entry into surface or groundwater, or other substantial water quality impacts shall be reported immediately to the WDOE Southwest Regional Office 24 hour telephone line at (360) 407-6300. Containment and cleanup efforts shall begin immediately and be completed as soon as possible, taking precedence over normal work. Cleanup shall include proper disposal of any spilled material and used cleanup materials. Concentrated waste or spilled chemicals shall be transported off the site for disposal at a facility approved by the WDOE or local County Health Department.

- Extreme care will be taken to insure that no petroleum products, hydraulic fluid, fresh concrete, sediments, sediment-laden water, chemicals, or any other toxic or deleterious materials are allowed to enter or leach into the receiving waters. A separate area shall be set aside, that does not have any possibility of draining to surface waters, for wash out of concrete delivery trucks, pumping equipment and tools.
- Project operations will cease under high flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage.

Pile Driving

- A vibratory hammer will be used to install sheet piles and cofferdams.
- Sheet piles and cofferdams will be placed using machines kept outside the wetted width.

- Piles will be installed with a vibratory hammer and limit impact hammer to proofing.
- Noise levels will be limited to 180 to 185 Decibels (dB) at a reference pressure of one micro-Pascal (dB re: 1μPa) measured at mid-depth 10 meters from the piling, utilizing bubble curtain sound attenuation. Note: all decibel levels discussed hereafter will assume a reference pressure of 1 μPa.
- Work will be limited to daylight hours when impact pile driving.
- Pilings will not be installed within the channel of Hylebos Creek.

Temporary Access Roads

- Existing roads or travel paths will be used whenever possible.
- The number of stream crossings will be minimized. Crossings will be perpendicular to the main channel whenever possible.
- Stabilized construction entrances and wheel washing stations will be used where determined appropriate.
- Culverts will be sized to maintain hydraulic capacity.

Fish Handling/Exclusion

- The fish handling protocol in Appendix B will be used.
- A maximum of three electrofishing passes will be made.
- Fish will remain in buckets for a maximum of 15 minutes during transport to release point.
- With the exception of pile driving, in-water work will be conducted in dewatered area.
- Dam installation will either be by hand or by equipment operated from the banks, overhead bridges, or outside the wetted width.

Invasive Weed Control

- Manual methods will be used where appropriate.
- Herbicides will applied only during dry conditions, use wicking vs. broadcast spray and dense planting of desired vegetation, use of hummocks to increase survival of shade plants, use either Agri-Dex (preferred) or LI700 as surfactants.
- Glyphosate products identified as "toxic to fish" will not be used.
- Herbicides will be applied in accordance with label requirements to avoid over application and drift.
- Herbicide application boundaries will be marked and replanted with native species.

Temporary Crossings

- Temporary structures will be kept in place for the minimum amount of time necessary.
- Holes left from removal of temporary pilings will be filled with clean native substrate that matches surrounding substrate materials when feasible.
- Untreated wood will be used for temporary bridge decking.

- Where stream crossings are essential, the design will take into account reasonably foreseeable risks such as flooding, bedload, and debris in order to prevent stream diversions from leaving the channel in the event of a crossing failure.

Permanent Crossings

- Drilled shaft construction will be used for all permanent bridges.
- Holes left from pilings will be filled with clean native substrate that matches surrounding substrate materials when feasible.
- Pier shafts will be placed to a depth adequate to prevent future scour.
- Stream simulation and other currently approved design criteria will be used so that new stream crossing structures will not impede fish passage and will facilitate wildlife passage where possible.
- Water crossings will comply with fish passage design criteria in Integrated Streambank Protection Guidelines (ISPG) and Fish Passage Design at Road Culverts which are accessible online at http://wdfw.wa.gov/hab/ahg/ispgdoc.htm and http://www.wdfw.wa.gov/hab/engineer/cm.
- Holes will be backfilled from the Puyallup River bridge abutments with rock, or new abutments will be placed in existing holes.
- Piers and abutments will be placed outside the channel of Hylebos Creek.
- There will be no in-water work for clear-span bridges.
- In-water work for removal of temporary crossings will occur during low flows.
- Piles will be removed from existing road when removing Hylebos H5 Bridge. Equipment will not enter wetlands for removal of this bridge. Fill holes left by piers with suitable materials.
- The size of cofferdams and caissons will be minimized.

Stormwater Outfalls

- The construction of new outfalls will be avoided or minimized to the extent possible, by connecting project drainage to existing conveyance systems such as pipes or non fish-bearing ditches or by dispersing flows in uplands or riparian areas.
- Rock placement will be avoided by dissipating energy and reducing flow prior to reaching outfall and locate outfalls on already armored banks.
- River rock or cobble will be used for dissipator pads where velocity allows.
- Minimize footprint of dissipator pad and outfall and locate to minimize habitat impact.
- Rock shall be placed and not end dumped.
- Where practicable, use ditches instead of pipes for the stormwater outfall. Ditches to the Puyallup River will not be feasible due to the presence of the levee.
- Locate stormwater outfalls to allow backwatering and reduce velocities.

Utility Relocation

- Drilling terminus will be set outside of the OHWM of the channel.
- A 2-foot minimum drill depth will be established below channel.

Footprint Minimization

- Vegetation impacts will be limited to the maximum extent possible.
- Work boundaries will be delineated with construction fencing prior to clearing/grubbing, to minimize disturbance to sensitive areas.
- Construction of the RRP will avoid and minimize impacts to existing desirable habitat. Existing desirable riparian vegetation will be maintained unless the impact is unavoidable.

Revegetation

- Native vegetation will be replanted where possible.
- Planting of recessed floodway on Surprise Lake Drain will be timed to maximize plant establishment prior to flood events.
- If streambanks are disturbed by project activities, stabilization and revegetation techniques will follow the ISPG.
- Native trees and shrubs will be planted to increase benthic diversity over the long-term at new Hylebos Channel.

Lighting

- Work areas will not be lit at night or lighting will not be directed at the water.
- All nighttime lighting will be kept to the minimum that is necessary for the intended purpose, in terms of both the intensity and area illuminated.

Riparian Restoration and Stream Relocation

- Length of time the Hylebos Creek diversion channel is used will be minimized.
- The RRP will be implemented in accordance with the recommendations from the RRP Technical Advisory Group (for design, maintenance, and monitoring).

Wetlands

- No net loss of wetland function or area from the proposed project, based on 2006 estimates of 32.9 acres of wetland impacts will occur. Replacement ratios will depend on whether creation or enhancement is required and the category of wetland being impacted.
- Where practicable, wetland mitigation will occur within the impacted subbasins.
- The project's Final Mitigation Plan will be fully implemented.
- The rate of flow will be regulated into mitigation sites through slow removal of cofferdams.
- Low-flow connecting channels will be incorporated into streamside wetlands designs to ensure that they do not strand fish. This will allow floodwaters to flow back into the channel and preclude standing water.

Miscellaneous

- Work will not inhibit passage of juvenile fish throughout the construction period.
- Culverts will be removed following stream relocation when there is no flow.
- Pilings to be removed will either be pulled directly, vibrated out, or cut off 2 ft below existing ground.
- Creosoted materials will be disposed of in a landfill according to Ch 173-304-190 WAC: Owner responsibilities for solid waste. The owner, operator, or occupant of any premise, business establishment, or industry shall be responsible for the satisfactory and legal arrangement for the solid waste handling of all solid waste accumulated by them on the property.
- FWS will be notified in the case of accidental fish kills.
- The in-water work window is expected to be July 15 – August 31.
- Activities will comply with HPA requirements.

APPENDIX D

APPENDIX D

FRAMEWORK FOR ASSESSING SEDIMENT IMPACTS (2006)1

The general impacts of sedimentation within an aquatic system are well known. When a biologist reviews a biological assessment or biological evaluation under section 7 of the Endangered Species Act, effects are evaluated based on the data or information provided. In most cases, specific information is not supplied by the action agency, or is not available for the biologist to conduct a thorough review and make that vital link between the project and the effect on listed fishes, specifically bull trout (*Salvelinus confluentus*) and their habitat.

Specific information needed by a biologist is related to the physical and biological effects of sediment in a stream. The physical questions include the following:

1) Will the project increase sediment input into the stream?
2) How much sediment will result and for what duration?
3) How far downstream will the sediment move?

Based on these physical questions, the biological effects to listed fish species can then be determined. The biological questions include the following:

1) What life stage(s) are affected by the sediment input?
2) What levels of sedimentation cause adverse effects?
3) What are the biological effects of sediment on fish and their habitat?

SEDIMENT CLASSIFICATIONS AND DEFINITIONS

Sediment within a stream can be classified into a variety of different categories: turbidity, suspended sediment, bedload, deposited sediment, and wash load (Waters 1995; Bash et al. 2001). A geomorphologist may classify sediment differently than a fisheries biologist. Sediment category definitions include:

- Turbidity - Optical property of water which results from the suspended and dissolved materials in the water that cause light to be scattered rather than transmitted in straight lines. Turbidity is measured in nephelometric turbidity units (NTUs). Measurements of turbidity can quickly estimate the amount of sediment within a sample of water.
- Suspended sediment - Represents the actual measure of mineral and organic particles transported in the water column. Suspended sediment is measured in mg/l and is an important measure of erosion, and is linked to the transport of nutrients, metals, and industrial and agricultural chemicals through the river system.

1 Cite appendix as: U.S. Fish and Wildlife Service. 2006. Framework for Assessing Sediment Impacts. Western Washington Fish and Wildlife Office, Lacey, WA. 21pp.

- Bedload - Consists of larger particles on the stream bottom that move by sliding, rolling, or saltating along the substrate surface. Bedload is measured in tons/day, or tons/year.
- Deposited sediment - The intermediate sized sediment particles that settle out of the water column in slack or slower moving water. Based on water velocity and turbulence, these intermediate size particles may be suspended sediment or bedload.
- Wash load - Finest particles in the suspended load that are continuously maintained in suspension by the flow turbulence, and thus, significant quantities are not found in the bed.

Suspended sediment, turbidity, and deposited sediment are not mutually exclusive as to particle size, because they will overlap considerably depending on velocity, turbulence, and gradient (MacDonald et al. 1991; Waters 1995). Turbidity cannot always be correlated with suspended solid concentrations due to the effects of size, shape and refractive index of particles (Bash et al. 2001). Turbidity and suspended sediment affect the light available for photosynthesis, visual capability of aquatic animals, gill abrasion and physiological effects to fish. Suspended and deposited sediment affect the habitat available for macroinvertebrates, quality of gravel for fish spawning, and amount of habitat for fish rearing (Waters 1995).

Particle size is also important. Particle diameters less than 6.4 mm are generally defined as "fines" (Bjornn et al. 1977; Bjornn and Reiser 1991; Shepard et al. 1984; Hillman et al. 1987; Chapman 1988; Reiman and McIntyre 1993; Castro and Reckendorf 1995; MBTRT 1998). The quantity of "fines" within a stream ecosystem is usually associated with the degradation of a fish population (Castro and Reckendorf 1995).

INFORMATION SOURCES

To determine the overall impact of a project on bull trout, and to specifically understand whether increased sediment may adversely affect bull trout, the biologist will need to review specific information relating to the watershed and stream in which the project is located.

The following documents are important to review:

1) Washington State Conservation Commission's Limiting Factors Analysis. The 1998 Washington State Legislative session produced a number of bills aimed at salmon recovery. One bill was to identify the limiting factors to salmonid populations within watersheds in Washington State. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon." Limiting factors analyses have been developed for numerous watersheds. The status of the limiting factors analyses for each Water Resource Inventory Area (WRIA) can be found at http://salmon.scc.wa.gov. The Endangered Species Division has final copies of completed documents.

2) Washington Department of Fish and Wildlife's (1998) Salmonid Stock Inventory (SaSI). The Washington Department of Fish and Wildlife (WDFW) inventoried bull trout and

Dolly Varden (*S. malma*) stock status throughout the State. The intent of the inventory is to help identify available information and to guide future restoration planning and implementation. SaSI defines the stock within the watershed, life history forms, status and factors affecting production. Spawning distribution and timing for different life stages are provided (migration, spawning, etc.), if known.

3) U.S. Fish and Wildlife Service's (USFWS 1998a) Matrix of Diagnostics/Pathways and Indicators (MPI). The MPI was designed to facilitate and standardize determination of project effects on bull trout. The MPI provides a consistent, logical line of reasoning to aid in determining when and where adverse affects occur and why they occur. The MPI provides levels or values for different habitat indicators to assist the biologist in determining the level of effects or impacts to bull trout from a project and how these impacts may cumulatively change habitat within the watershed.

4) Individual Watershed Resource Publications. Other resources may be available within a watershed that will provide information on habitat, fish species, and recovery and restoration activities being conducted. Local groups can provide valuable information specific to the watershed.

5) Washington State Department of Ecology (DOE) Water Quality Database. The DOE has long- and short-term water quality data for different streams within the State. Data can be found at www.ecy.wa.gov/programs/eap/fw_riv/rv_main. Clicking on a stream or entering a stream name will provide information on current and past water quality data. This information will be useful for determining the specific turbidity/suspended sediment relationship for that stream (more information below).

6) DOE Stream Conditions Database. The DOE has also been collecting benthic macroinvertebrates and physical habitat data to describe conditions under natural and anthropogenic disturbed areas. Data can be found at www.ecy.wa.gov/programs/eap/fw_benth/93-98. Clicking on a stream or entering a stream name will provide habitat and macroinvertebrate data.

7) U.S. Forest Service (USFS) Watershed Analysis Documents. The USFS is required by the Record of Decision for Amendments to the USFS and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl to conduct a watershed analysis for watersheds located on USFS lands. The watershed analysis determines the existing condition of the watershed and makes recommendations for future projects that move the landscape towards desired conditions. Watershed analysis documents are available from individual National Forests or from the Western Washington Fish and Wildlife Office, Forest Plan Branch.

8) U.S. Fish and Wildlife Service Bull Trout Recovery Plans and Critical Habitat Designations. The draft Bull Trout Recovery Plan for the Coastal-Puget Sound Distinct Population Segment (DPS) and the final critical habitat designations provide current species status, habitat requirements, and limiting factors for bull trout within specific

individual recovery units. These documents are available from the Western Washington Fish and Wildlife Office and the Service's web page (www.fws.gov).

These documents and websites provide information on stream and watershed conditions as of 2005. This information is critical to understanding baseline conditions and determining future sediment impacts to the aquatic system. A stream has a natural amount of sediment that is transported through the system. This amount of sediment is based on numerous factors: precipitation, topography, geology, streamflow, riparian vegetation, stream geomorphological characteristic, human disturbance, etc (Bash et al. 2001). However, baseline or background levels need to be analyzed with respect to the limiting factors within the watershed.

Different watersheds have different levels of turbidity or suspended sediment. A glaciated stream will have higher sediment levels than a spring-fed stream. Aquatic organisms are adapted to the natural variation in sediment load that occurs seasonally within their stream habitat (ACMRR 1976; Birtwell 1999). Field experiments have found a thirty-fold increase in tolerance of fish to suspended solids between August and November when naturally occurring concentration are expected to be high (Cederholm and Reid 1987). The question at hand is whether additional input of sediment may result in increased bull trout impacts.

Sediment levels in excess of natural amounts can have multiple adverse effects on channel conditions and bull trout (Rhodes et al. 1994). The effect can be fatal at high levels. Low levels may result in sublethal effects such as loss or reduction of foraging capability, reduced growth, and reduced resistance to disease, increased stress, and interference with orientation in homing and migration (McLeay et al 1987; Newcombe and McDonald 1991; Bash et al. 2001).

Work-timing windows are usually incorporated into projects to minimize construction impacts to fish. Work-timing windows are time periods when salmonids are at a stage in their life cycle when they are least sensitive to disturbances or are least likely to be present. This is typically outside of the spawning or egg incubating period. Work-timing windows allow the fish to either move away from impacts or to better cope with short-term, minimal changes to the habitat and/or decreased water quality. The work-timing windows are usually in July through September. This time may reduce impacts to spawning fish and egg incubating periods, but may exacerbate impacts to juveniles, sub-adults, and adults. Protective mucous secretions are inadequate during the summer months, when natural sediment levels are low in a stream system, and thereby sediment introduction at this time may increase risk to stress and disease (Bash et al. 2001).

BIOLOGICAL EFFECTS OF SEDIMENT ON BULL TROUT

Classification of Sediment Effects

In the absence of detailed local information on population dynamics and habitat use, any increase in the proportion of fines in substrates should be considered a risk to the productivity of an environment and to the persistence of associated bull trout populations (Rieman and McIntyre 1993). Specific effects of sediment on fish and their habitat can be put into three classes that include (Newcombe and MacDonald 1991; Waters 1995; Bash et al. 2001):

Lethal: Direct mortality to any life stage, reduction in egg-to-fry survival, and loss of spawning or rearing habitat. These effects damage the capacity of the ecosystem to produce fish and future populations.

Sublethal: Reduction in feeding and growth rates, decrease in habitat quality, reduced tolerance to disease and toxicants, respiratory impairment, and physiological stress. While not leading to immediate death, may produce mortalities and population decline over time.

Behavioral: Avoidance and distribution, homing and migration, and foraging and predation. Behavioral effects change the activity patterns or alter the kinds of activity usually associated with an unperturbed environment. Behavior effects may lead to immediate death or population decline or mortality over time.

Environmental factors affecting sediment impacts on individual fish include duration of exposure, frequency of exposure, toxicity, temperature, life stage of fish, angularity and size of particle, severity/magnitude of pulse, time of occurrence, general condition of biota, and availability of and access to refugia (Bash et al. 2001). Aquatic systems are complex interactive systems, and isolating the effects of sediment on fish populations is difficult (Castro and Reckendorf 1995). Determining which environmental variables act as limiting factors has made it difficult to establish the specific effects of sediment impacts on fish populations (Chapman 1988). For example, excess fines in the spawning gravels may not lead to smaller populations of adults if the amount of juvenile winter habitat limits the number of juveniles that reach adulthood. Often there are multiple independent variables with complex inter-relationships that can influence population size.

The ecological dominance of a given species is often determined by environmental variables. A chronic input of sediment could tip the ecological balance in favor of one species in a mixed salmonid population, or in species communities composed of salmonids and nonsalmonids (Everest et al. 1987). Bull trout have more spatially restrictive biological requirements than other salmonids at both the individual and population levels (USFWS 1998b). Therefore, they are especially vulnerable to environmental changes such as sediment deposition.

Bull trout are apex predators that prey on a variety of species including terrestrial and aquatic insects and fish (Reiman and McIntyre 1993). Fish are common in the diet of individual bull trout that are over 110 millimeters or longer. Large bull trout can feed almost exclusively on fish. Therefore, when analyzing impacts of sediment on bull trout, it is very important to consider other fish species. While sediment may not directly impact bull trout, the increased sediment input may affect the spawning and population levels of Chinook and coho salmon, cutthroat trout, and steelhead, which are potential prey species for bull trout. The following effects of sediment are not just bull trout specific. All salmonids can be affected similarly.

Direct Effects

Gill Trauma

High levels of suspended sediment and turbidity can cause fish mortality by damaging and clogging gills. Fish gills are delicate and easily damaged by abrasive silt particles (Bash et al. 2001). As sediment begins to accumulate in the gill filaments, fish excessively open and close their gills to expunge the silt. If irritation continues, mucus is produced to protect the gill surface, which may impede the circulation of water over the gills and interfere with fish respiration (Bash et al. 2001). Gill flaring or coughing abruptly changes buccal cavity pressure and is a means of clearing the buccal cavity of sediment. Gill sediment accumulation may result when fish become too fatigued to continue clearing particles via the cough reflex (Servizi and Martens 1991).

Spawning, Redds, Eggs, and Alevins

When suspended sediment deposits in a redd, it can reduce water flow, smothering eggs or alevins or impeding fry emergence, depending on the sediment particle sizes of the spawning habitat (Bjornn and Reiser 1991). Sediment particle size determines the pore openings in the redd gravel. With small pore openings, more suspended sediments are deposited and water flow is reduced compared to large pore openings.

Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Eggs and alevins are generally more susceptible than adults to stress from suspended solids. Accelerated sedimentation can reduce the flow of water and, therefore, oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Cederholm and Reid 1987; Chapman 1988; Bash et al. 2001), delay development of alevins (Everest et al. 1987), reduce growth and cause premature hatching and emergence (Birtwell 1999). Fry delayed in their timing of emergence are less able to compete for environmental resources than other fish that have undergone normal development and emergence (intra- or interspecific competition) (Everest et al. 1987).

Several studies have documented that fine sediment can reduce the reproductive success of salmonids. Natural egg-to-fry survival of coho salmon, sockeye and kokanee has been measured at 23, 23, and 12 percent, respectively (Slaney et al. 1977). Substrates containing 20 percent fines can reduce emergence success by 30-40 percent (MacDonald et al. 1991). A decrease of 30 percent in mean egg-to-fry survival can be expected to reduce salmonid fry production to extremely low levels (Slaney et al. 1977).

Although bull trout generally have a narrow, specific spawning habitat requirement and therefore, spawn in a small percentage of the stream habitat available to them (MBTRT 1998), they seem to be more tolerant of sedimentation during development and emergence than other salmonids. Survival of bull trout embryos through emergence appears to be unaffected when the percentage of fines comprise up to 30 percent of the streambed. However, at levels above 30 percent, embryo survival through emergence dropped off sharply with survival below 20 percent for substrates with 40 percent fine material (Shepard et al. 1984).

Indirect Effects

Macroinvertebrates

Macroinvertebrates are a significant food source for salmonids. Turbidity and suspended solids can affect macroinvertebrates in multiple ways through increased invertebrate drift, feeding impacts, respiratory problems, and loss of habitat (Cederholm and Reid 1987). Salmonids favor certain groups of macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987; Waters 1995).

The effect of light reduction from turbidity has been well documented as increasing invertebrate drift (Waters 1995; Birtwell 1999). This may be a behavioral response associated with the night-active diel drift patterns of macroinvertebrates. While increased turbidity results in increased macroinvertebrate drift, it is thought that the overall invertebrate populations would not fall below the point of severe depletion (Waters 1995).

Increased suspended sediment can abrade the respiratory surface of macroinvertebrates and interfer with food uptake for filter-feeders (Birtwell 1999). Increased suspended sediment levels tend to clog feeding structures and reduce feeding efficiencies, which results in reduced growth rates, increased stress, or death of the invertebrates (Newcombe and MacDonald 1991). Invertebrates living in the substrate are also subject to scouring or abrasion which can damage respiratory organs (Bash et al. 2001).

Benthic invertebrates inhabit the stream bottom. Therefore, any modification of the streambed by deposited sediment will most likely have a profound effect upon the benthic invertebrate community (Waters 1995). Increased sediment can affect macroinvertebrate habitat by filling interstitial space and rendering attachment sites unsuitable. This may cause invertebrates to seek a more favorable habitat (Rosenberg and Snow 1975b). The degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrate abundance and composition (Birtwell 1999). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995).

Feeding Efficiency

Increased turbidity and suspended sediment can affect salmonid feeding rates, reaction distance, and prey selection (Bash et al. 2001). Changes in feeding behavior are primarily related to the reduced visibility in turbid water. Effects on feeding ability are important as salmonids must meet energy demands to compete with other fishes for resources and to avoid predators.

Distance of prey capture and prey capture success both were found to decrease significantly when turbidity was increased (Berg and Northcote 1985). Waters (1995) states that the loss of visual capability, leading to reduced feeding, is one of the major sublethal effects of high suspended sediment. Increases in turbidity was reported to decrease the percentage of prey captured (Bash et al. 2001). At 0 NTUs, 100 percent of the prey items were consumed. At 20 to

60 NTUs, significant delay in the response of fish to prey was observed. At 10 NTUs, fish were frequently unable to capture prey species; at 60 NTUs, only 35 percent of the prey items were captured. Loss of visual capability and capture of prey leads to depressed growth and reproductive capability.

Sigler et al. (1984) found that a reduction in growth occurred in steelhead and coho salmon when turbidity was as little as 25 NTUs. The slower growth was presumed to be from a reduced ability to feed; however, other complex mechanisms, such as the quality of light, may also affect feeding success rates. Redding et al. (1987) found that suspended sediment may inhibit normal feeding activity, as a result of a loss of visual ability or as an indirect consequence of increased stress.

Habitat Effects

Compared to other salmonids, bull trout have more specific habitat requirements that appear to influence their distribution and abundance (Reiman and McIntyre 1993). All life history stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools. Other habitat characteristics important to bull trout include channel and hydrologic stability, substrate, temperature, and the presence of migration corridors (Reiman and McIntyre 1993).

The physical effects of sediment in streams include degradation of spawning and rearing habitat, simplification and damage to habitat structure and complexity, loss of habitat, and decreased connectivity between habitats (Bash et al. 2001). Biological implications of this habitat damage include underutilization of stream habitat, abandonment of traditional spawning habitat, displacement of fish from their habitat, and avoidance of habitat (Newcombe and Jensen 1996).

As sediment enters a stream, it is transported downstream under normal fluvial processes and deposited in areas of low shear stress (MacDonald and Ritland 1989). These areas are usually behind obstructions, near banks (shallow water) or within interstitial spaces. This episodic filling of successive storage compartments continues in a cascading fashion downstream until the flow drops below the threshold required for movement or all pools have reached their storage capacities (MacDonald and Ritland 1989). As sediment load increases, the stream compensates by geomorphologic changes in increased slope, increased channel width, decreased depths, and decreased flows (Castro and Reckendorf 1995). These processes, in turn, contribute to increased erosion and sediment deposition which further degrade salmonid habitat.

Loss of acceptable habitat and refugia, as well as decreased connectivity between habitats reduces the carrying capacity of streams for salmonids (Bash et al. 2001). In systems lacking adequate number, distribution, and connectivity of habitat, fish may travel longer distances or use less desirable habitat and may encounter a variety of other conditions that can increase biological demands.

The addition of fine sediment (less than 6.4 mm) to natural streams during summer decreased abundance of juvenile Chinook salmon in almost direct proportion to the amount of pool volume lost to fine sediment (Bjornn et al. 1977; Bash et al. 2001). Similarly, the inverse relationship

between fine sediment and densities of rearing Chinook salmon indicate how high sediment loads effect important winter habitat (Bjornn et al. 1977). As fine sediments filled the interstitial spaces between the cobble substrate, juvenile Chinook salmon were forced to leave preferred habitat and to utilize cover that may be more susceptible to ice scouring, predation, and decreased food availability (Hillman et al. 1987). Deposition of sediment on substrate may lower winter carrying capacity for bull trout (Shepard et al. 1984). Food production in the form of aquatic invertebrates may also be reduced.

Juvenile bull trout densities are highly influenced by substrate composition (Shepard et al. 1984; Reiman and McIntyre 1993; MBTRT 1998). During the summer, juvenile bull trout hold positions close to the stream bottom and often seek cover within the substrate itself. When streambed substrate contains more than 30 percent fine materials, juvenile bull trout densities drop off sharply (Shepard et al. 1984). Any loss of interstitial space or streambed complexity through the deposition of sediment would result in a loss of summer and winter habitats (MBTRT 1998). The reduction in rearing habitats ultimately reduces the potential number of recruited juveniles and ultimately reduces population numbers (Shepard et al. 1984).

Although fish avoidance in response to increased sediment may be an initial adaptive survival strategy, displacement from cover could be detrimental. The possible consequences of fish moving from preferred habitat to avoid increasing levels of suspended sediment may not be beneficial if displacement is to sub-optimal habitat, where they also become stressed and more vulnerable to predation (Birtwell 1999).

Physiological Effects

Sublethal levels of suspended sediment may cause undue physiological stress to fish, reducing the ability of the fish to perform vital functions (Cederholm and Reid 1987). At the individual fish level, stress can reduce growth, increase disease, and reduce the ability to tolerate additional stress (Bash et al. 2001). At the population level, the effects of stress may include reduced spawning success, increased larval mortality, and reduced recruitment to succeeding life stages and, therefore, overall population declines (Bash et al. 2001).

Tolerance to suspended sediment may be the net result of a combination of physical and physiological factors related to oxygen availability and uptake by fish (Servizi and Martens 1991). The energy needed to perform repeated coughing (see Gill trauma section) increases metabolic oxygen demand. Metabolic oxygen demand is related to water temperature. As temperatures increase, so does metabolic oxygen demand, but the concentration of oxygen available in the water decreases. Therefore, fish tolerance of suspended sediment may be primarily related to the capacity of the fish to perform work associated with the cough reflex. However, as sediment increases, fish have less capability to do work, and therefore less tolerance for suspended sediment (Serizi and Martens 1991).

Redding et al. (1987) observed higher mortality in young steelhead trout exposed to a combination of suspended sediment (2,500 mg/l) and a bacterial pathogen, than when exposed to the bacteria alone. Physiological stress in fish appears to decrease immunological competence, growth, and reproductive success (Bash et al. 2001).

Behavioral Effects

Increased turbidity and suspended sediment may also cause behavior changes in salmonids. Avoidance, distribution, and migration may be affected. Many behavioral effects result from changes in stream habitat as well (see Habitat effects section). As suspended sediment concentration increases, habitat may be lost which results in abandonment and avoidance of preferred habitat. Stream reach emigration is a bioenergetic demand that may affect the growth or reproductive success of the individual fish (Bash et al. 2001). Sediment pulses result in downstream migration of fish, which disrupts social structures, and causes downstream displacement of other fish (McLeay et al 1987; Bash et al. 2001). Loss of territoriality and the breakdown of social structure can lead to secondary effects of decreased growth and feed rates, which may lead to mortality (Berg and Northcote 1985; Bash et al. 2001).

To the contrary, when not motivated by excess sediment, downstream migration by bull trout can provide access to more prey, better protection from avian and terrestrial predators, and alleviate potential intraspecific competition or cannibalism in rearing areas (MBTRT 1998). Benefits of migration from tributary rearing areas to larger rivers or estuaries may be increased growth potential. Increased sedimentation may result in premature or early migration of both juveniles and adults, or avoidance of habitat and migration of nonmigratory resident bull trout. Such migration exposes fish to many new hazards, including passage of sometimes difficult and unpredictable physical barriers, increased vulnerability to predators, exposure to introduced species, exposure to pathogens, and the challenges of new and unfamiliar habitats (MBTRT 1998).

High turbidity can also delay migration back to spawning sites, although turbidity alone does not seem to affect homing. Delays in spawning migration and associated energy expenditure may reduce spawning success and therefore population size (Bash et al. 2001).

EFFECTS DETERMINATION

The point at which adverse effects to fish occur from a specific project can be difficult to determine without adequate data. There are numerous variables that affect the determination, and for which data may be unavailable. These include project specific sediment input, existing sediment conditions, stream conditions (velocity, depth, etc.) during construction, weather or climate conditions (precipitation, wind, etc.), fish presence or absence (bull trout plus prey species), effectiveness of the best management practices employed, plus many others.

The Western Washington Fish and Wildlife Office (WWFWO) is currently drafting protocol to obtain specific project related sediment data. This protocol will be used to identify project related sediment input during construction, as well as long-term sedimentation that may result after completion of the project (i.e. high-flow events, channel adjustments, etc.). Following the protocol will provide consistent information on project-related sediment input to assist in evaluating effects and quantifying incidental take in biological opinions.

Newcombe and Jensen (1996) provide a basis for determining when a project will be "likely to adversely affect" bull trout. They conducted a literature review of pertinent documents on sediment effects to salmonids and nonsalmonids, and developed a model that calculated the severity of effect (SEV) based on the suspended sediment dose (exposure) and concentration.

A 15-point scale is used to qualitatively rank the effects of sediment on fish (Table 1). Specific SEV levels will be used to determine when a project is "likely to adversely affect" bull trout.

The following procedure will be used:

1) Select either a. or b. below.

a) Based on water quality monitoring data, determine the amount of sediment and the duration of sediment input into the stream. (Currently not enough data are available to use this step. As more project specific data becomes available this step will be used).

b) Use State water quality standards. Because action agencies must meet State water quality standards you can use the standard for determining sediment input into the stream. The Washington State water quality standards for turbidity are provided in Table 2.

Table 1 – Scale of the severity (SEV) of ill effects associated with excess suspended sediment.

SEV	Description of Effect
	Nil effect
0	No behavioral effects
	Behavioral effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal effects
4	Short-term reduction in feeding rates; short-term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Lethal and paralethal effects
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to sever habitat degradation
11	> 20 – 40% mortality
12	> 40 – 60% mortality
13	> 60 – 80% mortality
14	> 80 – 100% mortality

The State water quality standard allows for a mixing zone downstream of the project site. The point of compliance is based on stream discharge (Table 3).

The water quality standard must be converted from turbidity (NTUs) to suspended solids (mg/l). A ratio of 1:1 to 1:5 has been derived for converting turbidity to suspended solids (Birtwell 1999). WDOE or U.S. Geological Survey data should be used to determine specific turbidity:suspended solid ratios for the stream on which the project will be conducted (see Documents and Background Information section). If site specific ratios can not be determined use worse case ratio of 1:4 or 1:5.

2) Based on the background information gathered, determine what life stage(s) of bull trout will be affected by sedimentation (see Documents and Background Information section). Use Figures 1 through 4 to determine what SEV level will result for the life stage affected by the project.

3) Use Table 4 to determine what ESA determination is made for the life stage affected.

4) If a LAA determination is made, then the basis for the rationale for "take" occurring is based on the SEV value obtained. The rationale is not just for that specific level (SEV = 6), but includes previous SEVs as well.

5) Table 5 summarizes the project-specific water quality monitoring data received by the Service for individual projects and indicates that, in some cases, adverse effects that rise to the level of "incidental take" may occur up to at least 600 feet downstream of project locations. Water quality monitoring data can indicate, by analogy, typical levels of sediment impacts for different project types, and can be used to estimate the minimum extent of impact. The data include the distance from the project where water quality sampling occurred and the maximum NTU levels were observed. Additional monitoring data will be incorporated when available.

Table 2 - Turbidity water quality standards for various classes of surface waters in the State of Washington.

Washington State Classes for Surface Waters	**Turbidity Characteristic**
Class AA (extraordinary)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU.
Class A (excellent)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU
Class B (good)	Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 20 percent increase in turbidity when the background turbidity is > 50 NTU

Table 3 - Turbidity mixing zones for turbidity water quality standards.

Waterbody Type	Point of Compliance
Stream:	
≤ 10 cfs Stream Flow at Time of Construction	100 ft downstream of activity causing turbidity exceedance
>10 cfs up to 100 cfs Stream Flow at Time of Construction	200 ft downstream of activity causing turbidity exceedance
> 100 cfs Stream Flow at Time of Construction	300 ft downstream of activity causing turbidity exceedance

Figure 1 - Severity-of-ill-effect scores for juvenile and adult salmonids.

Juvenile and Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	10	11	11	12	12	13	14	14	-	-	-
59874	9	10	10	11	12	12	13	13	14	-	-
22026	8	9	10	10	11	11	12	13	13	14	-
8103	8	8	9	10	10	11	11	12	13	13	14
2981	7	8	8	9	9	10	11	11	12	12	13
1097	6	7	7	8	9	9	10	10	11	12	12
403	5	6	7	7	8	9	9	10	10	11	12
148	5	5	6	7	7	8	8	9	10	10	11
55	4	5	5	6	6	7	8	8	9	9	10
20	3	4	4	5	6	6	7	8	8	9	9
7	3	3	4	4	5	6	6	7	7	8	9
3	2	2	3	4	4	5	5	6	7	7	8
1	1	2	2	3	3	4	5	5	6	7	7
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 2 - Severity-of-ill-effect scores for adult salmonids.

Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	11	11	12	12	13	13	14	14	-	-	-
59874	10	10	11	11	12	12	13	13	14	14	-
22026	9	10	10	11	11	12	12	13	13	14	14
8103	8	9	9	10	10	11	11	12	12	13	13
2981	8	8	9	9	10	10	11	11	12	12	13
1097	7	7	8	8	9	9	10	10	11	11	12
403	6	7	7	8	8	9	9	10	10	11	11
148	5	6	6	7	7	8	8	9	9	10	10
55	5	5	6	6	7	7	8	8	9	9	9
20	4	4	5	5	6	6	7	7	8	8	9
7	3	4	4	5	5	6	6	7	7	7	8
3	2	3	3	4	4	5	5	6	6	7	7
1	2	2	3	3	4	4	5	5	5	6	6
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 3 - Severity-of-ill-effect scores for juvenile salmonids.

Juvenile Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	9	10	11	11	12	13	14	14	-	-	-
59874	9	9	10	11	11	12	13	14	14	-	-
22026	8	9	9	10	11	11	12	13	13	14	-
8103	7	8	9	9	10	11	11	12	13	13	14
2981	6	7	8	9	9	10	11	11	12	13	13
1097	6	6	7	8	9	9	10	11	11	12	13
403	5	6	6	7	8	9	9	10	11	11	12
148	4	5	6	6	7	8	9	9	10	11	11
55	4	4	5	6	6	7	8	8	9	10	11
20	3	4	4	5	6	6	7	8	8	9	10
7	2	3	4	4	5	6	6	7	8	8	9
3	1	2	3	4	4	5	6	6	7	8	8
1	1	1	2	3	4	4	5	6	6	7	8
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 4 - Severity-of-ill-effect scores for eggs and alevins of salmonids.

Eggs and Alevins of Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	7	9	10	11	12	13	14	-	-	-	-
59874	7	8	9	10	12	13	14	-	-	-	-
22026	7	8	9	10	11	12	13	-	-	-	-
8103	7	8	9	10	11	12	13	14	-	-	-
2981	6	7	8	10	11	12	13	14	-	-	-
1097	6	7	8	9	10	11	12	14	-	-	-
403	6	7	8	9	10	11	12	13	14	-	-
148	5	6	7	9	10	11	12	13	14	-	-
55	5	6	7	8	9	10	12	13	14	-	-
20	5	6	7	8	9	10	11	12	13	-	-
7	4	5	7	8	9	10	11	12	13	14	-
3	4	5	6	7	8	10	11	12	13	14	-
1	4	5	6	7	8	9	10	11	13	14	-
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Table 4 - ESA Effect calls for different bull trout life stages in relation to the duration of effect and severity-of-ill-effect.

Life Stage	SEV	ESA Effect Call
Egg/alevin	1 to 4	not applicable - alevins are still in gravel and are not feeding.
	5 to 14	LAA - any stress to egg/alevin reduces survival
Juvenile	1 to 4	NLAA
	5 to 14	LAA
Subadult and Adult	1 to 5	NLAA
	6 to 14	LAA

Table 5 - Water quality monitoring data received by the Western Washington Fish and Wildlife Office showing distance downstream where data were recorded and the maximum magnitude of turbidity observed.

Project	Distance downstream from project that data were recorded	Distance downstream that State water quality standards are met, or the maximum turbidity levels observed.
Debris jam removal (SR - 20)	Not provided	Met standard
Rock placed in stream (Hoh River emergency bank protection)	100 feet - 200 feet	Met standard
Bridge construction (SR - 90) Stated removal of coffer dams and diversion resulted in increased turbidity.	Not provided	Maximum daily magnitude measured: 25 NTUs over standard.
River scour protection (SR 12) Contract no. C-6186	300 feet and 600 feet	Maximum daily magnitude measured: 9.3 NTUs over standard.
Bridge construction	200 feet	Maximum daily magnitude measured: 169 NTUs.
Culvert replacement project not described (SR241) - Contract # 6270 - Sulfur Cr.	100 feet and 200 feet	Maximum daily magnitude measured: over 30 NTUs.
Bank stabilization (Saxon Cr.)	300 feet	Maximum daily magnitude measured: 35.2 NTUs over standard.
Culvert replacement – (Stossel Cr Way.)	Not provided	Maximum daily magnitude measured: 24 NTUs over background.
Culvert Replacement – (Stevens Creek)	178 feet and 576 feet	Maximum daily magnitude measured: 185 NTUs over background.
Culvert Replacement – (Sunbeam Creek)	72 feet and 147 feet	Maximum daily magnitude measured: 454 NTUs over background.
Culvert Replacement – (Unnamed Waddell Creek Tributary)	62 feet	Maximum daily magnitude measured: 600 NTUs over background.

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