UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2023-00342

September 6, 2023

Ralph Rizzo
Division Administrator
Federal Highway Administration
Suite 501 Evergreen Plaza
711 South Capitol Way
Olympia, WA 98501-1284

Todd Tillinger
U.S. Army Corps of Engineers
Regulatory Branch
4735 E. Marginal Way S. Bldg. 1202
Seattle, WA 98134-2388

Bryan K. Mercier
Bureau of Indian Affairs
Northwest Regional Office
Bureau of Indian Affairs
911 Northeast 11th Avenue
Portland, OR 97232-4169

Re: Reinitiation of the Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the SR 167 Extension Project, Puyallup to SR 509, Pierce County, Washington (HUC 171100140599, Lower Puyallup River).

Dear Mr. Rizzo, Mr. Tillinger and Mr. Mercier:

Thank you for your letter of March 17, 2023, requesting reinitiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the SR 167 Extension Project, Puyallup to SR 509. The Federal Highway Administration is the federal lead for this project. The U.S. Army Corps of Engineers will issue a Clean Water Act Section 404 permit for the project, and the project will be constructed within the reservation of the Puyallup Tribe of Indians.

The Federal Highway Administration (FHWA) prepared a summary of project design changes resulting from advancing project design. The design changes include refinements of pollution generating impervious surface and outfalls; water crossings and culverts; vegetation and wetland impacts; mitigation sites; and changes to the in-water work window. In addition to design changes, there is recent documentation of Puget Sound (PS) Chinook salmon in the action area where the species was not previously known to exist.

The design changes do not affect listed species or critical habitat in a manner not previously considered, and impacts have been reduced compared to those documented in the original biological opinion (Opinion). However, previously unknown presence of PS Chinook salmon in a portion of the action area results in an effect to the species and triggers reinitiation of the consultation with the NMFS This reinitiation also addresses potential project impacts to Southern Resident killer whale (SRKW; *Orcinus orca*), which had not been considered in previous consultations.

This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016). The enclosed document contains the Opinion prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon or PS steelhead. The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS steelhead but is not likely to result in the destruction or adverse modification of that designated critical habitat.

This Opinion modifies the incidental take statement (ITS) from the original Opinion to include take associated with potential impacts to Chinook and steelhead in Wapato Creek. The reasonable and prudent measures and terms and conditions from the original Opinion and subsequent reinitiations remain unchanged. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species. NMFS also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson–Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH for Pacific Coast Salmon. The EFH conservation recommendations are a subset of the terms and conditions and also remain unchanged from the original opinion.

Please contact Bonnie Shorin at (360) 995-2750 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz, Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Lindsey Handel, FHWA
Cindy Callahan, DOT
Jeff Dreier, WSDOT
April Magrane, WSDOT
Margaret Kucharski, WSDOT
Julie Hampden, HNTB
Maki Dalzell, HNTB

Reinitiation of Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion [and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

SR 167 Extension Project, Puyallup to SR 509

NMFS Consultation Number: WCRO-2023-00342

Action Agency: Federal Highway Administration

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	No	No
Puget Sound Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Southern resident killer whale (*Orcinus orca*)	Endangered	No	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Kim W. Kratz, Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: September 6, 2023

TABLE OF CONTENTS

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

The NMFS prepared the Opinion and ITS portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402. We also completed an EFH consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the NMFS' West Coast Region Office in Lacey, WA.

This project has been divided into 3 different construction stages: the SR 167/70th Avenue E. Vicinity Bridge Replacement Project (Stage 1a), the SR 167/I-5 to SR 509 – New Expressway Project (Stage 1b), and the SR 167/I-5 to SR 161 – New Expressway Project (Stage 2) (https://wsdot.wa.gov/construction-planning/search-projects/sr-167-completion-project) (Figure 1). WSDOT completed Stage 1a in summer 2021. Stage 1b is currently under construction, and involves construction of a new highway that will link I-5 with SR509 near the Port of Tacoma. Stage 1b also includes construction of the Hylebos Riparian Restoration Program (RRP), an integrated stormwater management and stream and wetland restoration approach that will result in the restoration of approximately 3.9 miles of Surprise Lake Tributary and Hylebos Creek and 129 acres of adjacent wetlands, restoring floodplain connectivity to those creeks. The goal of the RRP is to improve water quality in the Hylebos basin and restore salmon habitat.

Stage 2 involves construction of a 4-lane highway between Puyallup and I-5, and includes expanding on the Hylebos RRP as well as construction of 3 new stream and wetland mitigation sites as part of a similar but smaller restoration program in the Wapato basin (Wapato RRP), and construction of 3 mitigation sites in the Puyallup basin. Mitigation will result in the restoration of approximately 2.3 miles of Wapato Creek and the creation or enhancement of nearly 96 acres of riparian and depressional wetlands. This reinitiation addresses changes associated with Stage 2.

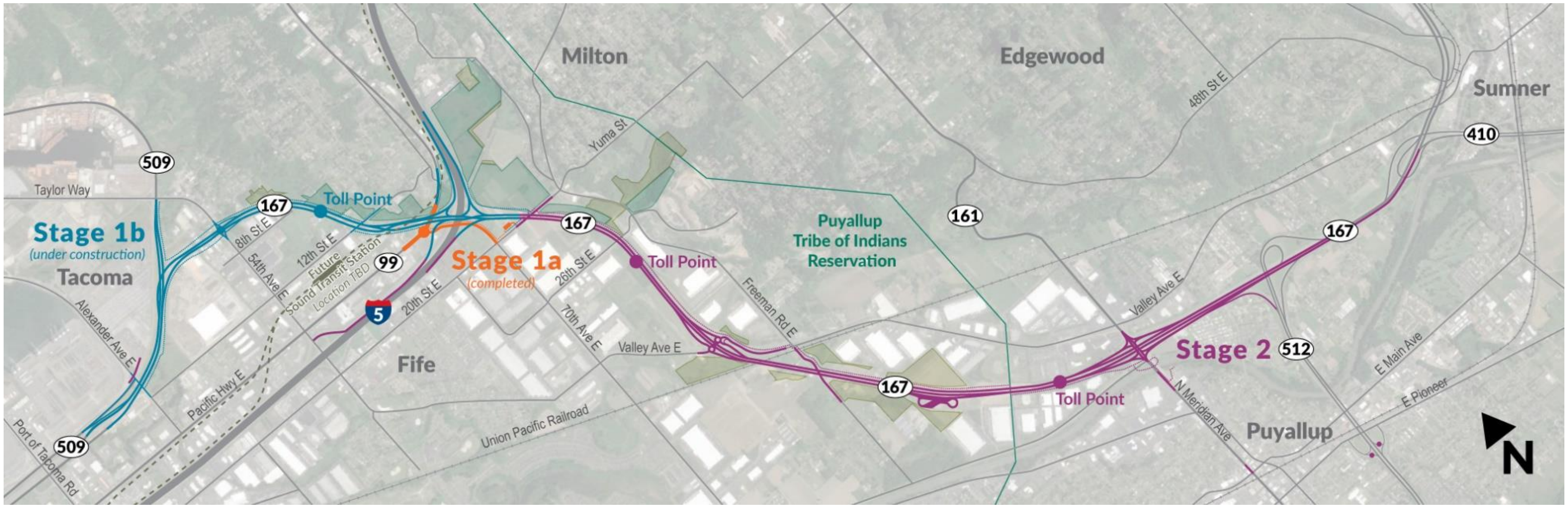

Figure 1. SR 167 Completion Project Construction Stages**.**

1.2. Consultation History

The FHWA originally consulted with the NMFS on this project in 2005 to address impacts to Puget Sound (PS) Chinook (*Oncorhynchus tshawytscha*), PS Chinook critical habitat, and EFH. NMFS issued an Opinion on September 17, 2007. On February 7, 2013, we provided a reinitiation Opinion (NWR-2012-03666) to analyze effects of the project on PS steelhead (*O. mykiss*) and concurred with informal consultation for Pacific eulachon. There have been several updates since, including an update to address project impacts to PS steelhead critical habitat (Table 1).

Table 1. SR 167 Extension Project, Puyallup to SR 509 ESA Consultation History Summary Table

WSDOT/FHWA Submittal		**NMFS Response**	
Biological Assessment	9/27/05	Opinion NMFS No. 2005/05617	9/17/07
Reinitiation: Puyallup River Bridge	7/25/12	Opinion: NMFS No. 2012/03666	2/7/13
Update: Puyallup River Bridge Modification	7/9/14	NMFS No. 2012/03666 & 2005/05617	7/9/14
Reinitiation: New species and habitat	4/18/18	NMFS No. WCR-2018-9460	10/1/18
Update: Stage 1b Geotechnical Borings	1/13/20	Confirmation of receipt	1/15/20
Update: 70th Ave Bridge Alignment	5/8/20	Confirmation of receipt	5/11/20
Update: Stage 1b Design and Hylebos RRP	9/15/20	NMFS No. 2005/05617, 2012/03666	10/13/20
Update: OPL Realignment	5/12/21	NMFS No. 2005/05617, 2012/03666	5/20/21
Update: Multiple Bridge Foundation Types	7/1/21	NMFS No. 2005/05617	7/1/21
Update: Stage 2 Site Investigation and Geotechnical Borings	12/14/21	NMFS No. 2005/05617	12/15/21
Update: Stage 1b Design Builder Geotech Borings	4/8/22	NMFS No. 2005/05617	4/9/22
Update: Stage 1b Bridge Pilings	8/8/22	NMFS No. 2005/05617	8/8/22

Early coordination with FHWA and NMFS for Stage 2 design changes began with a virtual meeting on May 5, 2022, followed up by a second meeting on January 25, 2023. The NMFS received FHWA's reinitiation request on March 17, 2023, and requested additional information on March 28th, 2023. The FHWA provided the requested information on April 7, 2023. The NMFS requested some minor clarifications on May 2, 2023, which the FHWA/WSDOT provided on May 8, 2023.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under MSA, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded or undertaken by a federal agency (50 CFR 600.910). The action is described in detail in the 2007 Opinion (NMFS Tracking No. 2005/05617) and subsequent updates and reinitiations. Only changes to the proposed action are described here.

1.3.1 Project Description Design Changes

The proposed federal action is consistent with the action described in the 2007 Opinion (NMFS Tracking No. 2005/05617) and is incorporated by reference here, with the following changes described below.

Transportation Elements

Interchange configurations at the Valley Avenue Interchange and SR 161 Interchange have been refined since the original Opinion. As part of the Stage 2 project WSDOT will construct a full diamond interchange with roundabouts at the Valley Avenue interchange instead of a half diamond interchange, as originally proposed, and a full diverging diamond interchange will be constructed at the SR 161 interchange instead of a full single point urban interchange. One additional toll point will be installed near the SR 161 interchange. One virtual weigh in motion station and associated inspection facility will be constructed along northbound SR 167 and another weigh in motion station will be installed along southbound SR 167.

Stormwater Design

Table 2 provides a summary comparison of existing and proposed pollution generating impervious surface (PGIS) quantities for each subbasin across the relevant consultations that have been completed to date. Updated numbers are highlighted in yellow. The total new PGIS for all stages (95.65 acres) is less than half of the amount estimated in the original Opinion (221 acres). Refer to Appendix A for a map of Threshold Discharge Areas (TDAs) within the project area.

Table 2. Comparison Summary of Existing and Proposed PGIS

Stormwater	**2005-2007 Original Consultation**	**2018 Re-initiation (All stages)**	**2020 Stage 1b NMFS Update**	**2023 Stage 2 Reinitiation**	**Stage 1a snapshot as of 2023**	**Stage 1b snapshot as of 2023**
Existing PGIS (acres)	**41.40**	**77.64**	**52.16***	**109.57**	**3.77**	**34.36**
Puyallup Subbasin	7.40	16.14	---	41.82	---	---
Oxbow Subbasin	---	---	---	6.64	---	---
Hylebos Subbasin	17.00	41.74	30.82	26.64	---	24.35
Surprise Lake Trib Subbasin	---	---	3.98	---	3.25	---
Wapato Subbasin	---	10.53	11.37	7.10	---	6.49
Fife Ditch Subbasin	17.00	9.23	5.99	27.37	0.52	3.52
Removed PGIS (acres)	17.00	19.00	13.00	11.90	2.20	1.60
Retrofitted PGIS (acres)	**24.40**	**59.00**	**8.00**	**26.67**	**1.53**	**2.64**
New PGIS (acres)	**221.0**	**75.61**	**23.20**	**66.20**	**2.57**	**26.88**
Puyallup Subbasin	52.00	21.66	---	19.80	---	---
Oxbow Subbasin	18.00	---	---	15.17	---	---
Hylebos Subbasin	52.00	35.71	16.80	22.71	0.01	15.63
Surprise Lake Trib Subbasin	36.00	---	---	---	2.56	---
Wapato Subbasin	36.00	7.52	0.00	7.80	---	1.95
Fife Ditch Subbasin	27.00	10.72	6.40	0.72	---	9.30

Within the Stage 2 project footprint, there are 109.57 aces of existing PGIS. Stage 2 activities will result in the addition 66.20 acres of new PGIS, removal of 11.90 acres of existing PGIS, and retrofitting of 26.67 acres of existing PGIS. All new PGIS will be treated with enhanced treatment methods such as media filter drains, compost-amended biofiltration swales, and constructed wetlands. A summary of the outfalls discharging runoff from this PGIS is as follows (Appendix A):

- Approximately 19.80 acres of new PGIS in five TDAs will discharge to the Puyallup River via four existing outfalls and one replaced outfall. Roughly 15.17 acres of new PGIS in one TDA will discharge to seven existing culverts that drain to Old Oxbow Lake prior to entering the Puyallup River through a single existing outfall.
- Approximately 22.71 acres of new PGIS in seven TDAs will discharge directly and indirectly through 14 outfalls into Surprise Lake Tributary and its tributaries that eventually drain to Hylebos Creek. Three outfalls will drain 0.72 acres to Fife Ditch (a

non-fish bearing tributary) prior to being pumped to Commencement Bay. Fourteen outfalls will discharge to Surprise Lake Tributary backwater channels prior to discharging to Hylebos Creek and will be constructed during Stage 1b of the SR 167 project. One outfall will discharge directly to Hylebos Creek.

- Approximately 7.80 acres of new PGIS in five TDAs will discharge through four dispersions that ultimately drain into Wapato Creek, and two new outfalls that will discharge to Wapato Creek.

There will be slight modifications to the ramps that extend over TDAs 21, 22, and 23 at the intersection at SR 512 and Pioneer Avenue:

- TDA 21 – Existing 6.16 acres PGIS of which 6.16 acres receives no treatment. Proposed (new and replaced) 6.40 acres PGIS will receive enhanced treatment.
- TDA 22 – Existing 0.33 acre PGIS, of which 0.26 acre receives no treatment. Proposed 0.06 acre will become non-PGIS and 0.26 acre PGIS will receive no change in treatment.
- TDA 23 – Existing 0.10 acre PGIS, of which 0.10 acre receives no treatment. Proposed 0.10 acre will receive no change in treatment. No change in PGIS or treatment in this TDA results in a 0.5 P(Exceed) result for Hi-Run loading analysis, indicating no statistically measurable change in loading is anticipated when comparing existing conditions to proposed conditions.

In total, these changes will result in 0.06 acre of existing PGIS becoming non-PGIS as part of Stage 2 activities, and 0.24 acre additional impervious surface in TDA 21 that will receive enhanced treatment, resulting in improved water quality. These TDAs drain to the existing storm main in the center of the median of SR 512 and a conveyance system that eventually outfalls to the Puyallup River.

<u>Water Crossings</u>

The Stage 2 project will construct three new bridges over Wapato Creek: one for the SR 167 mainline, one at Freeman Road (to replace the 105R120918a culvert), and one for the new shared use path near Freeman Road. All of the bridges will span over Wapato Creek and will not have piers below the ordinary high water mark (OHWM). Seven culverts will be removed as part of Stage 2 construction: two from Wapato Creek (WDFW ID 105 R120918a and 935100), two from Surprise Lake Tributary (WDFW ID 935669 and 935791), and three from non-fish-bearing streams. Three stormwater culverts and one culvert conveying a non-fish bearing stream to Oxbow Lake will be replaced. In addition, there are two culverts that were previously identified as "remain" in the Stage 1b 2020 update that will now be removed (WDFW ID 935670 and 935161) as part of the 1b project. Similarly, there is a third culvert that will be abandoned as part of the 1b mitigation activities (WDFW ID 921656). A full list of water crossing structures and maps is provided in Appendix B.

These activities will require temporary access resulting in temporary clearing to an estimated area totaling 0.73 acre: 0.30 acre in the Hylebos subbasin, 0.12 acre in the Wapato subbasin, and 0.31 acre in the Puyallup River subbasin.

Wetland Mitigation

An additional 13 wetland mitigation sites will be constructed as part of Stage 2 in the Hylebos, Wapato, and Puyallup subbasins (Figure 2) to provide compensatory mitigation for stream and wetland impacts. The first 5 sites listed below all border mitigation sites proposed for Stage 1b, and will expand on those sites to provide enhanced wetland and stream function. WSDOT proposes to provide a combination of wetland re-establishment, rehabilitation, enhancement, and upland enhancement within the following sites.

1. Upper Surprise Lake Tributary Addition
2. Middle Surprise Lake Tributary Addition
3. Lower Surprise Lake Tributary Addition
4. Upper Hylebos Addition
5. Upper Hylebos North Addition
6. Lower Hylebos Addition
7. East Wapato Riparian Restoration Program (RRP)
8. West Wapato RRP
9. Northwest Wapato RRP
10. Puyallup North
11. Puyallup South
12. Freeman Road
13. City of Fife/Wapato Creek Buffer Enhancement

Changes to the In-Water Work Window

The 2007 Opinion states that work below the OHWM must occur between July 15 and August 31. FHWA/WSDOT propose extending the in-water work window to September 15 for Wapato and Hylebos creeks and September 30 for tributaries to Hylebos and Wapato Creek. Extending the in-water work window is justified for several reasons.

- A longer in-water work window would reduce the number of seasons during which WSDOT would need to conduct in-water work, limiting construction-related impacts on listed species.
- A longer window would accelerate mitigation site construction, allowing site restoration to occur earlier that would occur otherwise
- Survey data from the Puyallup Tribe of Indians (PTOI) indicate listed fish species are highly unlikely to be present in the mainstem Hylebos or Wapato Creeks before September 15. A longer in-water work window is therefore unlikely to affect listed species to a greater extent than a shorter window.

WSDOT has coordinated extensively with the PTOI and WDFW on this new proposed in-water work window.

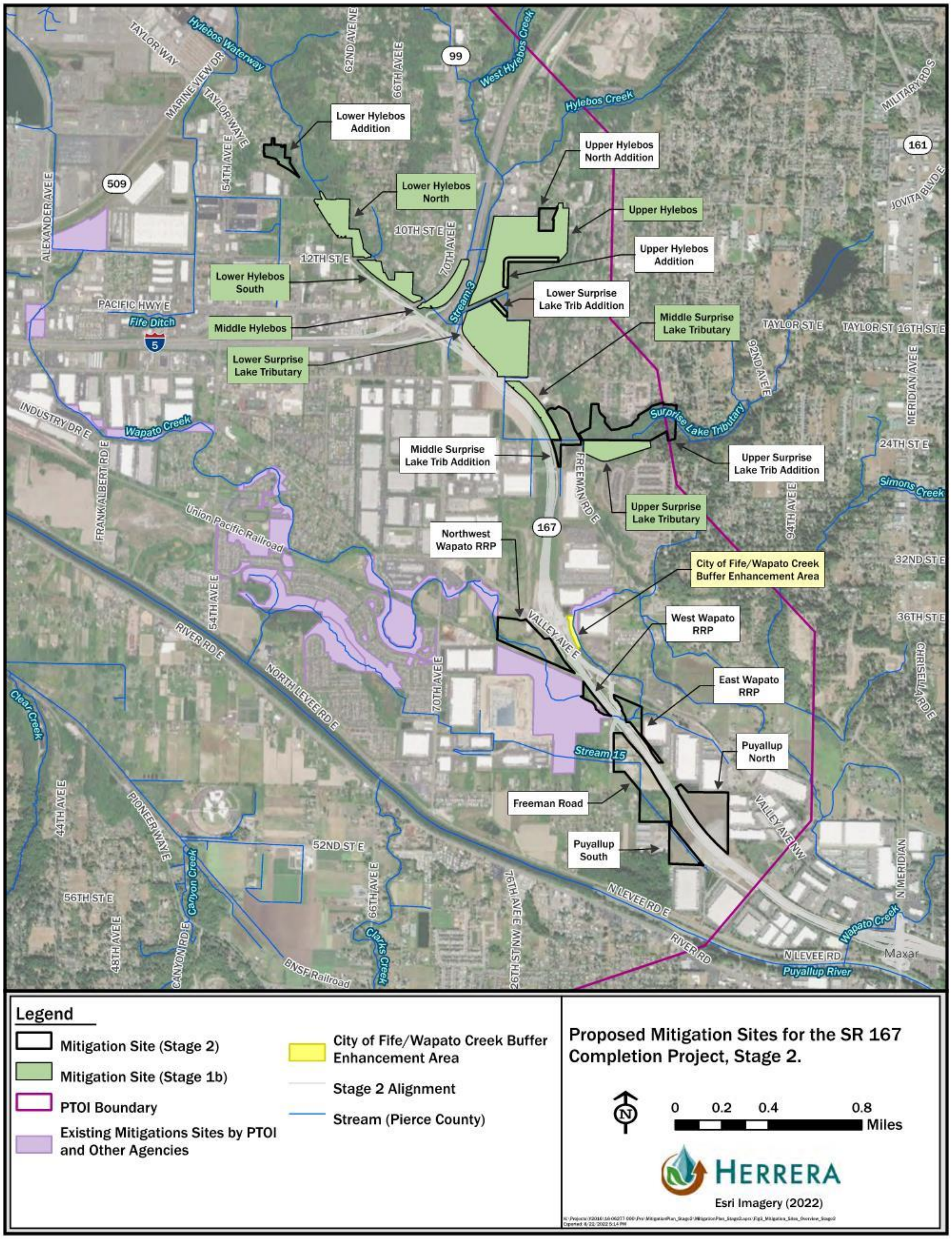

Figure 2. Proposed Mitigation Sites for the SR 167 Completion Project, Stage 2.

1.4. 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). The Action Area section of the original opinion and reinitiation opinions are incorporated by reference here, except to the extent that they are inconsistent with the changes described below, in which case the description of the changes prevails.

The extent of impacts associated with Stage 2 activities largely remains within the limits of the action area documented in the original Opinion (Figure 4). However, some minor operational improvements were added to Stage 2 as well as a new mitigation site that extends beyond the original action area. There are two locations that operational improvements will occur outside the original extent of the action area: one at SR 512, and one at North Meridian Avenue (Figure 5). Along SR 512, intelligent transportation system (ITS) infrastructure will be constructed, which typically includes new pavement markings, sign structures, ramp meters, overhead lighting structures, and closed-circuit television support structures. Operational improvements at North Meridian Avenue and Stewart Avenue include construction of new signals, signal infrastructures, pavement markings, and improvements to the existing signs, illumination, and ADA ramps. Activities proposed at both locations will occur within the existing pavement.

A small portion of the Upper Surprise Lake Tributary Addition mitigation site is outside the original extent of the action area (Figure 6). The site is approximately 20 acres of forested ravine that contains Surprise Lake Tributary. At this site, WSDOT proposes to preserve and enhance existing wetlands and riparian areas. No heavy equipment will be used on site.

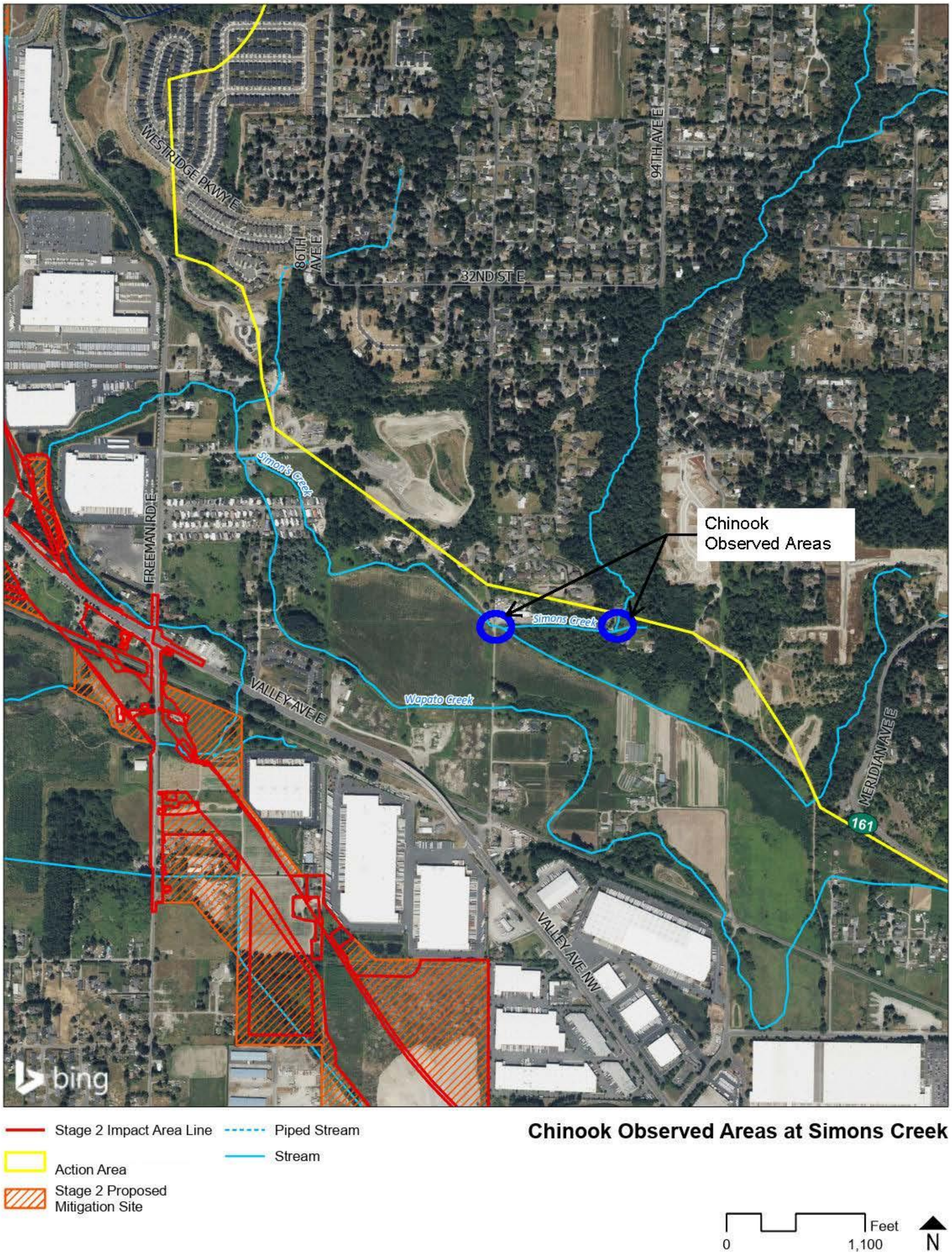

Figure 3. Chinook salmon observation locations in Simons Creek

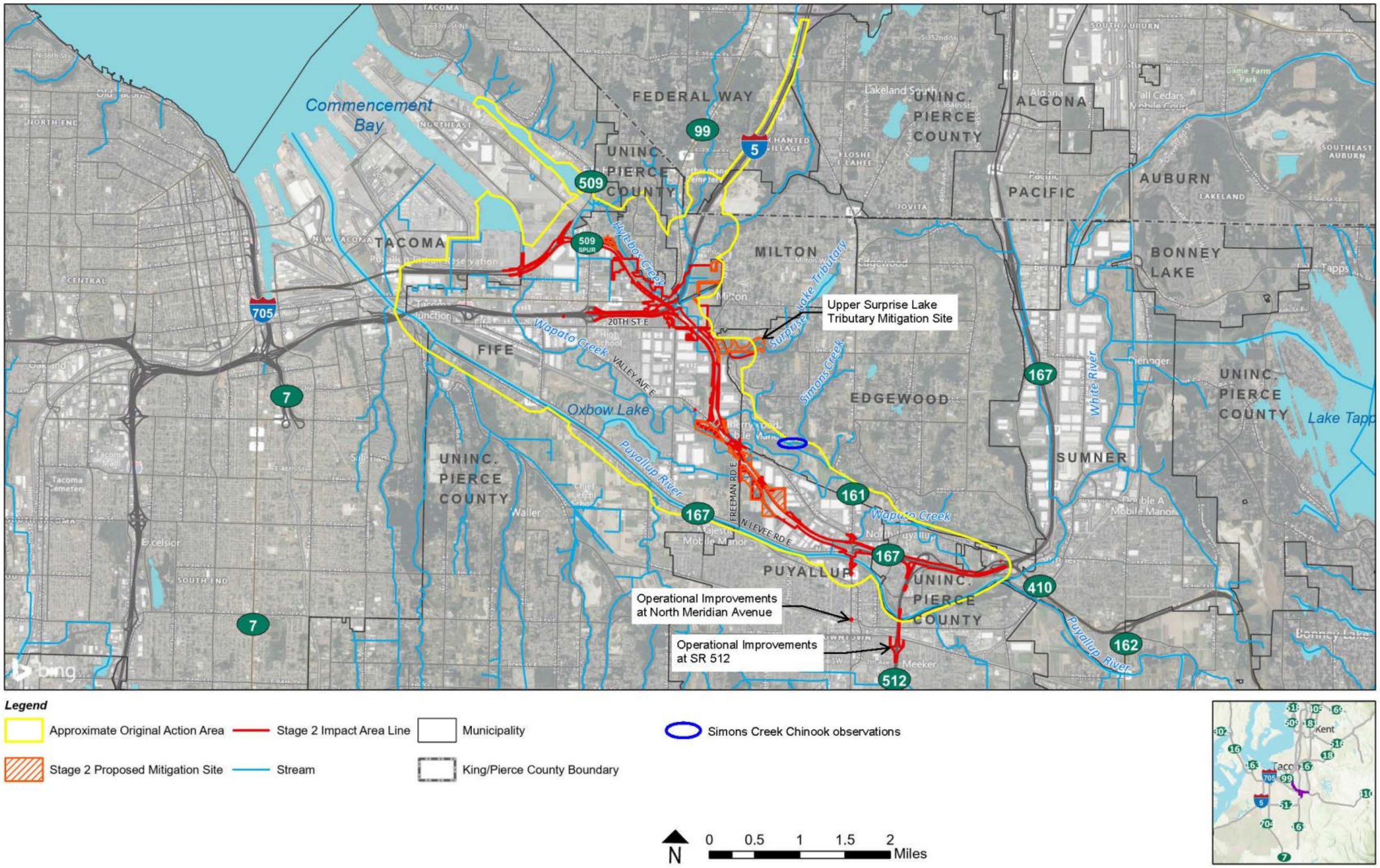

Figure 4. Action Area for the SR 167 Completion Project

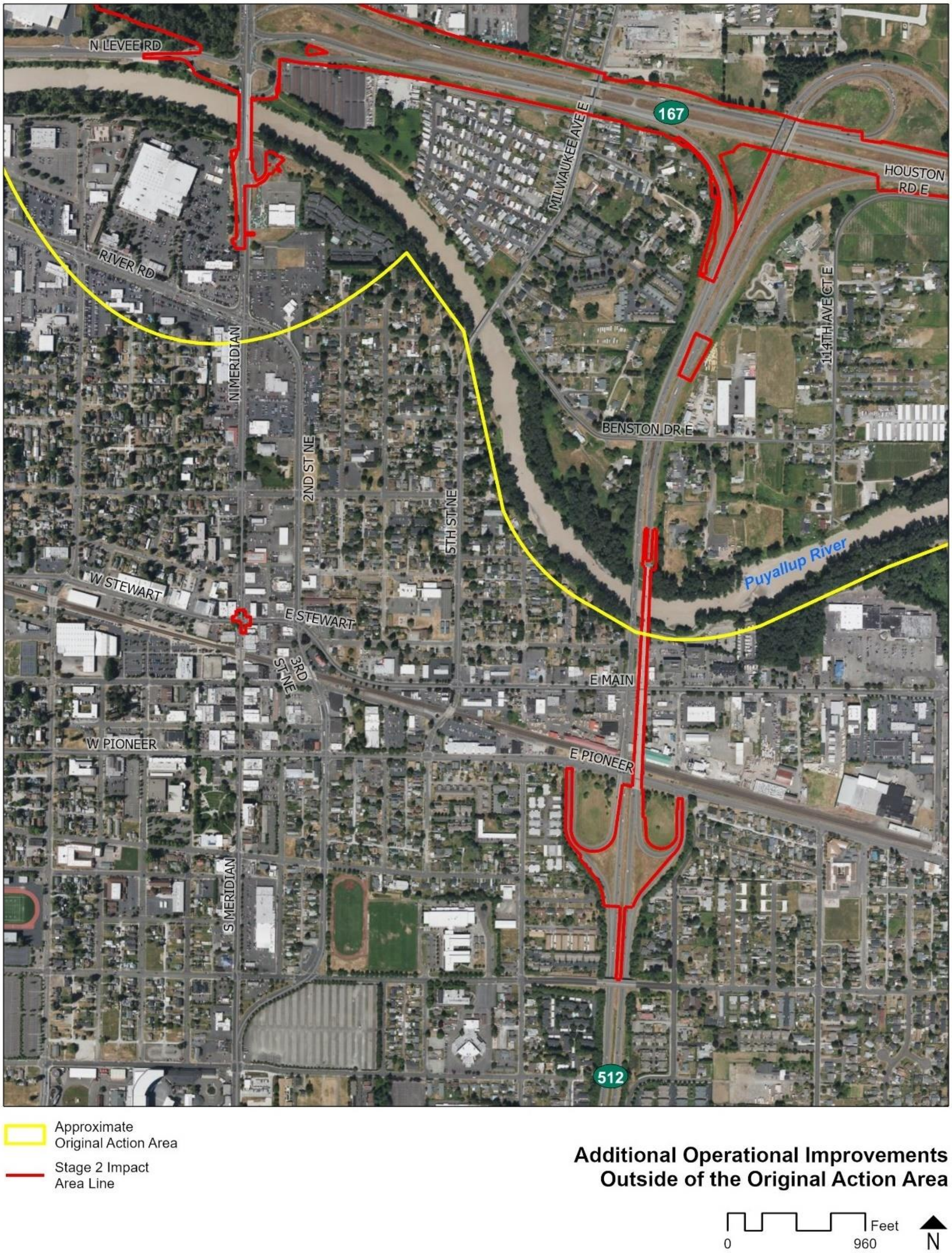

Figure 5. Additional Operational Improvements Outside of the Original Action Area

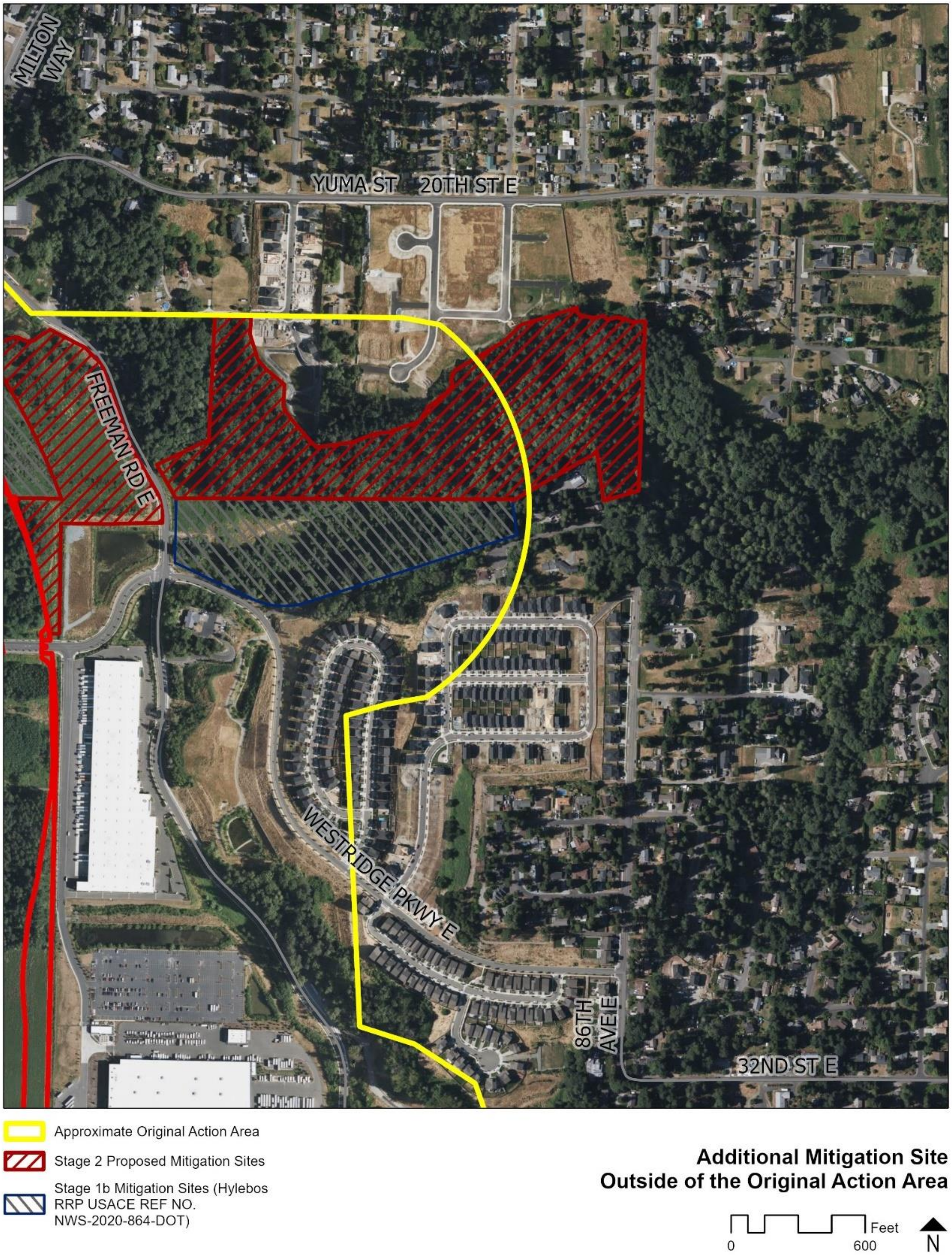

Figure 6. Additional Mitigation Site Outside of the Original Action Area

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

Because regulatory revisions have occurred since our 2007 consultation, we provide here the current articulation of the analytical approach.

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for Puget Sound salmonids use(s) the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

Since the original consultation, the status of species was reviewed to incorporate new data, in 2022. Also, some downstream barriers have been corrected. During the ongoing coordination with the PTOI on the Stage 2 Project in 2022, WSDOT was informed that the PTOI staff have identified Puget Sound Chinook salmon rearing and spawning in Simons Creek near 90th Avenue NE, east of the project alignment (Naylor 2022) (Figure 3, Figure 4). Simons Creek is a tributary to Wapato Creek that converges with the mainstem of Wapato Creek near the river mile 9.1 to the east of Freeman Road, upstream from the aquatic extent of the action area. Based on this recent finding, the mainstem of Wapato Creek within the aquatic extent of the action area likely supports migration and rearing habitat for PS Chinook salmon and steelhead.

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII 2022). Long-term trends in warming have continued at global, national and regional scales. Global surface temperatures in the last decade (2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI 2021). Globally, 2014-2018 were the 5 warmest years on record both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020). Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

Climate change will impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will occur at low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of canopy. Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 2021).

Agne et al. (2018) reviewed literature on insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest and examined how future climate change may influence disturbance ecology. They suggest that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens will be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts will differ by region and forest type.

Freshwater Environments

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

The effect of climate change on ground water availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River Basin. Projections using RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018), examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon *O. nerka* and the availability of suitable habitat for brown trout *Salmo trutta* and rainbow trout *O. mykiss*. Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead will be confined to downstream reaches typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020, Myers et al. 2018).

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018), identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short timespans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100%), while 68% of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, salmon life history traits and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019), however, impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex. Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower streamflows) have been associated with detectable declines in many of these listed units, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

Climate change effects on salmon and steelhead

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2021). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, and this in turn could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, and alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e. spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2021, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon *O. nerka* from the Skeena River of Canada. They found that sockeye migrated over a period of more than 50 days, and populations from higher elevation and further inland streams arrived in the estuary later, with different populations encountering distinct prey fields. Carr-Harris et al. (2018) recommended that managers maintain and augment such life-history diversity.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al. 2018, Kilduff et al. 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger 2018). Other Pacific salmon species (Stachura et al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey 2011; Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006; Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018), compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook from the mid-Columbia than those from the Snake River Basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (c). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

2.2.1 Status of the Species

Table 3, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 3. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05 (70 FR 37159)	Shared Strategy for Puget Sound 2007 NMFS 2006	NMFS 2016; Ford 2022	This ESU comprises 22 populations distributed over five geographic areas. All Puget Sound Chinook salmon populations continue to remain well below the TRT planning ranges for recovery escapement levels. Most populations also remain consistently below the spawner–recruit levels identified by the TRT as necessary for recovery. Across the ESU, most populations have increased somewhat in abundance since the last status review in 2016, but have small negative trends over the past 15 years. Productivity remains low in most populations. Overall, the Puget Sound Chinook salmon ESU remains at "moderate" risk of extinction.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Puget Sound steelhead	Threatened 5/11/07	NMFS 2019	NMFS 2016; Ford 2022	This DPS comprises 32 populations. Viability of has improved somewhat since the PSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance were observed in a number of populations over the last five years within the Central & South Puget Sound and the Hood Canal & Strait of Juan de Fuca MPGs, primarily among smaller populations. There were also declines for summer- and winter-run populations in the Snohomish River basin. In fact, all summer-run steelhead populations in the Northern Cascades MPG are likely at a very high demographic risk.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization
					•

2.3. Environmental Baseline

The Environmental Baseline section of the original opinion and reinitiation opinions are incorporated by reference here, except to the extent that they are inconsistent with the changes described below, in which case the description of the changes prevails.

In general, the trends of development and urbanization in the action area have continued since the original Opinion. Impervious surface and population within the Puyallup River subbasin as a whole have continued to increase, indicating greater development and degradation of natural resources. The Washington State Department of Ecology's 303(d) list of impaired waterways has been updated to reflect current water quality assessment data. The Puyallup River within the action area is listed as impaired for temperature, bacteria, and mercury (WDOE 2022). The Puyallup was not listed for temperature at the time of the original consultation. Wapato Creek is listed as impaired for bacteria and dissolved oxygen within the action area. At the time of the original consultation, Wapato Creek was not listed as impaired on the 303(d) list. Hylebos Creek was not listed as impaired within the action area for the original consultation, but for the 2018 reinitiation/update, Hylebos Creek was listed as impaired due to fecal coliform (WDOE 2018). East Fork Hylebos Creek is currently listed for bacteria; mainstem Hylebos Creek is listed for bacteria; and West Fork Hylebos Creek is listed for temperature, bacteria, and dissolved oxygen. Surprise Lake Tributary is listed for mercury (WDOE 2022).

Field visits conducted since 2020 to assess aquatic and riparian habitat in the action area confirmed baseline data in the original Opinion and subsequent reinitiations and updates. Streams contain sparse, if any, large woody debris, and instream conditions are generally poor due to lack of channel complexity (Herrera 2022). Vegetation in the Stage 2 project area is largely disturbed amid a variety of upland, wetland, riparian, and stream habitats. Hydrology in the project area has been altered by placement of fill material and rerouting surface water through agricultural and roadside ditches (Herrera 2022). Land development in the project vicinity is ongoing and is likely to have continued impacts on vegetation and hydrology in the project area (WSDOT 2016). Only small, fragmented patches of riparian vegetation are remaining in the action area, the largest patch of which is located in the proposed RRP area west of I-5.

Wetlands within the project corridor have been delineated, verified, and re-delineated between 1997 and 2022. Since the original Opinion, total wetland acreage in the corridor has increased by 126 acres, likely due to changes in land use in the corridor that led to changes in hydrology. Ongoing restoration projects continue to improve the quality of the riparian corridor surrounding the Puyallup River, Hylebos Creek, and Wapato Creek since the original 2005-2007 consultation.

2.4. Effects of the Action

The Effects of the Action sections of the original opinion and reinitiation opinions are incorporated by reference here, except to the extent that they are inconsistent with the changes described below, in which case the description of the changes prevails.

2.4.1 Effects on Listed Species

The Effects on Listed Species section of the original Opinion and subsequent Opinions are incorporated here, except to the extent that they are inconsistent with the changes described below, in which case the description of the changes prevails.

Stormwater

There is new information about the effects of stormwater runoff on listed salmonids. Highways collect a variety of pollutants from vehicular traffic and are disproportionate contributors to overall pollutant loads in water bodies (Wheeler et al. 2005). Vehicle brake pad components include metals shown to have deleterious effects on fish. Even at very low levels, chronic exposures to contaminants from road runoff can have a wide range of adverse effects on the ESA-listed species considered in this opinion. Dissolved copper (DCu) and dissolved zinc (DZn) are constituents of notable concern because they are prevalent in stormwater, they are biologically active at low concentrations, and they have adverse effects on salmonids, (Sprague 1968; Sandahl et al. 2007). Olfactory responsiveness in juvenile salmonids in freshwater laboratory studies are reduced by DCu (Baldwin et al. 2003), and fish have shown avoidance reactions to elevated levels of DZn (Sprague 1968), which can be fatal to salmon in high concentrations. Additional effects include reduced growth, altered immune function, and decreased predator avoidance in exposed individuals.

In addition to TSS and vehicle brake pad metals, recent studies have shown that salmon, particularly coho (*O. kisutch*), show high rates of pre-spawn mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified the tire rubber antioxidant 6-PPD quinone as the cause (Tian et al. 2020). Although Chinook salmon and steelhead do not experience the same level of mortality, tire leachate is still a concern for all salmonids. Stormwater runoff also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

The intensity of effects depends largely on the pollutant, its concentration, and/or the duration of exposure. However, the incremental addition of small amounts of these pollutants are a source of potential adverse effects to salmon and steelhead, even when the source load cannot be distinguished from ambient levels. Some contaminants accumulate in both the tissues and prey of salmon and steelhead and cause a variety of lethal and sublethal effects (Hecht et al. 2007). Repeated and chronic exposures, even at very low levels, are still likely to injure or kill individual fish, by themselves and through synergistic interactions with other contaminants already present in the water (Baldwin et al. 2009; Feist et al. 2011; Hicken et al. 2011; Spromberg and Meador 2006; Spromberg and Scholz 2011).

Although the predicted concentration levels of the discharge are below lethal levels for DZn and DCu, and the dilution zones are extremely small, juvenile salmonids are likely to be exposed to chronic low levels of a wide array of contaminants, including fuels and oils, PAHs, and road material and tire wear particles. Steelhead and Chinook salmon have relatively long freshwater residency periods and thus are likely to experience latent effects from exposure.

HI-RUN modeling was completed for Stage 2 to evaluate potential impacts to listed fish species and critical habitat. Pollutant loads in some TDAs will increase as a result of additional PGIS and decrease in other TDAs due to proposed BMPs and treatment trains. This pattern is consistent with prior loading models developed in the action area for the 2018 reinitiation and 2020 update.

Dilution modeling identifies the distance from the discharge point where it becomes impossible to discern the additional levels of pollutants from the background level. However, this does not mean that the receiving water bodies or downstream waters are not impaired by this additional source of contaminants, but rather that the additional load can no longer be meaningfully measured based on their aqueous limits of detection. Stream and riparian restoration will contribute to improved water quality in Wapato Creek; however, increased pollutant loading will result in a chronic slight reduction in water quality.

Stormwater runoff in all TDAs will be treated with enhanced treatment methods before discharging to the nearby water bodies. Enhanced treatment BMPs are known to be effective for removing pollutants and/or reducing flow rates; however, BMP effectiveness in removing 6PPD-quinone is largely unknown because few studies are available. Some studies indicated that BMPs with biofiltration using compost have the highest potential to reduce 6PPD-quinone (Navickis-Brasch et al. 2022). Biofiltration BMPs will be applied along the corridor wherever feasible.

Although there will be an increase in PGIS compared to the 2018 update, new PGIS constructed by the project is less than half of that analyzed in the original Opinion. Stormwater pollutants discharged to receiving water bodies will therefore be much less than what was originally analyzed.

Temperature

Anticipated impacts associated with Stage 2 design changes in vegetation impacts and wetland impacts are summarized in Table 4. The RRP areas are reflected in the vegetation removal areas.

The original consultation estimated a maximum of 218 acres of permanent vegetation removal and 280 acres of temporary vegetation removal. WSDOT estimated approximately 143 acres of permanent vegetation removal and 160 acres of clearing as part of Stage 1b (Table 4). Approximately 55 acres of vegetation will be permanently removed as part of Stage 2, and 121 acres of temporarily cleared. The total area of permanent vegetation removal is less than the estimate from the original consultation. The area of temporary vegetation impacts is slightly higher than the original consultation estimate. However, vegetation in the Stage 2 work area is largely disturbed and land area is devoted primarily to commercial, residential, and agricultural uses. As a result, the types of vegetation that will be temporarily impacted by Stage 2 activities are limited to roadside vegetation, agricultural crops, and mowed grasses that do not provide suitable habitat for listed species. These temporarily cleared areas will be restored with native vegetation that provides higher quality of natural shading and reduces water temperatures

The original consultation estimated approximately 33 acres of permanent wetland impacts and 7 acres of temporary wetland impacts; actual impacts will be nearly 40 acres of permanent fill and 13 acres of temporarily clearing (Table 4). This increase in wetland impact areas is due to the overall increase in wetland acreage along the corridor, which increased by 125 acres compared to the original estimate. However, newly identified wetland areas are mostly former agricultural fields that do not provide suitable habitat for listed species.

Table 4. Comparison Summary of Vegetation and Wetland Impact Areas

Impact Types (acres)	**2005-2007 Original Consultation**	**2018 Re-initiation**	**2020 NMFS Stage 1b Update**	**Stage 2 Reinitiation**
Clearing and Grading	500.00	250.00	90.00	**32.00**
Permanent Vegetation Removal	218.10	110.20	143.40	**54.60**
Temporary Vegetation Removal	280.20	140.70	160.10	**120.70**
Permanent Wetland Impact	32.90	25.00	14.88	**24.86**
Temporary Wetland Impact	6.60	Not Reported	4.80	**7.74**

In the 2007 Opinion the permanent and temporary vegetation impacts for the action area as a whole were used to define riparian vegetation take limits. This approach substantially overestimated impacts to riparian resources. To better reflect impacts to riparian vegetation, FHWA/WSDOT recalculated riparian impacts for all three stages (Table 5). Total riparian impact numbers are well below the take limits analyzed in the original Opinion.

Removing mature riparian vegetation reduces shade and evapotranspiration. Shade from temporary and/or permanent structures may minimize some of that reduction; however, concrete components of structures themselves absorb radiant heat during the day and disperse it back into the environment, especially in the summer (Huang et al 2008; Sen and Roesler 2017), though the composition of the concrete can influence the degree of thermal conductivity (Kahn 2002). Replanting of riparian vegetation and riparian restoration throughout the project footprint will provide increasing canopy, shade, and evapotranspiration to re-establish cooling values to the riverine habitat, but this effect may take up to 10 years to become appreciable. Response to warm conditions in the freshwater environment depend on a variety of factors, such as acclimatization opportunity, and will vary by species and life stage, but warmer temperatures generally increase metabolic demand of juvenile salmonids, may reduce growth, and can increase the risk of disease, and mortality, particularly when coupled with other ambient stressors, such as high turbidity, and competition for space (McCullough 1999).

Table 5. Comparison Summary of Riparian Vegetation Impacts for Each Project

Vegetation Removal Area (acres)	Take Limits from 2007 NMFS BO	Stage 1a Riparian Impact Area	Stage 1b Riparian Impact Area	Proposed Stage 2 Riparian Impact Area	Total Riparian Impact Area for Phase 1 (Stage 1a,1b ,and 2)
Permanent Riparian Vegetation Removal	**158.20**	**1.94**	**10.19**	**10.89**	**23.02**
Puyallup subbasin	76.30	--	--	1.41	**1.41**
Hylebos subbasin	81.90	1.94	9.65	5.83	**17.42**
Wapato subbasin	Not included	--	0.54	3.65	**4.19**
Temporary Riparian Vegetation Removal	**188.80**	**0.08**	**21.26**	**2.21**	**23.55**
Puyallup subbasin	17.50	--	--	0.04	**0.04**
Hylebos subbasin	171.30	0.08	20.17	1.96	**22.21**
Wapato subbasin	Not included	--	1.09	0.21	**1.30**

2.4.2 Effects on Critical Habitat

The Effects of the Action sections of the 2007 Opinion (NMFS Tracking No. 2005/05617) and reinitiation Opinions (NMFS No. 2012/03666 and NMFS No. WCR-2018-9460) are incorporated by reference here.

The prior opinion indicated 5 features of critical habitat would be adversely affected by the proposed project: water quantity, water quality, forage, natural cover, and passage, which are features of both rearing and migration habitat. None of the effects were considered so significant that they would result in adverse modification or destruction of critical habitat. The proposed revisions indicate that project effects associate with stormwater effluent may in fact be less than previously described.

2.5. Cumulative Effects

The Cumulative Effects section of the 2007 Opinion (NMFS Tracking No. 2005/05617) and reinitiation Opinions (NMFS No. 2012/03666 and NMFS No. WCR-2018-9460) is incorporated by reference here. We supplement that section with information on climate effects which are likely to be co-extensive with the infrastructure of the proposed action.

While site specific climate effects are difficult to predict, it is reasonably certain that western Washington, including the action area, will experience more periods of warmer, drier, weather, increased air temperatures, increased water temperatures, lower flows, along with flashier conditions as rainfall and storm patterns shift. Glacial melt is likely to increase, adding sediment load. Floods are likely to scour streams impacting redd and juvenile survival. Food webs are likely to shift or diminish.

PS Chinook are considered to have high vulnerability overall to climate effects, with high exposure risk and high biological sensitivity (Crozier et al. 2019). PS steelhead similarly are considered to have high overall vulnerability, high exposure risk, and high biological sensitivity (Crozier et al 2019).

2.6. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Both salmonid species considered in this opinion are threatened with extinction. Adult and juvenile PS Chinook salmon and steelhead have the potential to be exposed to the ongoing effects of stormwater runoff and riparian vegetation removal. The baseline conditions in the action area are most notably affected by poor water quality and poor riparian condition. Recovery goals for the Puyallup watershed are to protect and restore estuarine and floodplain connectivity and riparian habitat and to restore fish passage.

<u>Population level effects</u>: We add the project effects to the baseline to determine population level effects. Road construction will affect approximately 442 feet of Wapato Creek, which provides migration and rearing habitat for listed salmonid species. RRP construction will realign another approximately 3,000 feet of the creek. Limiting in-water construction to the in-water work window is scheduled to avoid peak juvenile salmonid outmigration and returning adults, minimizing the number of individuals exposed to elevated turbidity and fish exclusion/handling, so only a relatively small number of fish are likely to be affected during construction. However, because Chinook and steelhead have extended freshwater residency, juveniles could be present year-round and exposed to the effects of in-water work. Because Wapato Creek likely supports relatively few individuals compared to the overall population, only a small portion of the population would be affected.

Stormwater discharges will occur continuously year-round, regularly overlapping with the presence of listed species in Wapato Creek. Adverse effects to Chinook and steelhead are likely to occur every year when juveniles and prespawn adults are exposed. The migration of salmonids will be rapid at or near the stormwater outfalls and project stormwater discharges will be intermittent and in unpredictable pulses. Some individuals may experience compromised health from exposure to stormwater contaminants but the vast majority will pass through quickly without long-term exposure or short-term exposure at lethal or sub-lethal levels. Thus, those affected individuals represent a small fraction of their populations. Enhanced stormwater treatment provided throughout the project corridor for all new PGIS will also help reduce adverse effects.

Reduction of riparian vegetation could lead to increased stream temperatures, which are detrimental to salmonids. Higher water temperature lowers the availability of dissolved oxygen, disrupts fish metabolism, increases susceptibility of fish to toxins, reduces the ability of fish to avoid predators, and reduces food supply as preferred invertebrates die off and are replaced by less desirable species. Temporarily cleared areas will be replanted with native riparian vegetation, and construction of the Hylebos and Wapato Riparian Restoration Programs will result in re-establishment of hundreds of acres of riparian vegetation designed to increase stream shading and moderate water temperatures. However, riparian vegetation will take approximately 10 years to become established. The proposed action may reduce fitness of some individuals until riparian vegetation is established. This effect will occur primarily during summer months when stream temperatures are highest, but when the fewest numbers of Chinook and steelhead would be present and exposed to this stressor.

Recovery actions for salmonids in WRIA 10 are unlikely to be impeded by the proposed action, and will to some extent be accelerated by the proposed action: construction of the RRP and other stream and wetland mitigation sites will improve water quality, aquatic habitat, and riparian function within the action area through the restoration of approximately 6.2 miles of stream channel and 232 acres of wetlands in the Hylebos Creek, Surprise Lake Tributary, Wapato Creek, and Puyallup River basins. Most of the restored wetlands are associated with salmon-bearing streams. WSDOT will restore and enhance roughly 8,268 of stream and riparian habitat in Wapato Creek, and create, rehabilitate, or enhance 20.29 acres of floodplain wetlands adjacent to the creek. Increasing and improving aquatic habitat and replacing invasive vegetation with native species in the riparian area will assist recommended recovery actions. Therefore, we do not anticipate the recovery trajectory of the entire PS Chinook ESU or PS steelhead DPS being affected.

Conservation value effects: Similar to our presentation on population level effects, when we add the project effects to the baseline, we evaluate if the change in PBFs or PCEs will reduce the conservation role for which the critical habitat was designated. Here, when compared to the original Opinion, SR 167 Completion Project Stage 2 design changes will result in a reduction of impact associated with PGIS and clearing of riparian vegetation. Area of new PGIS has been reduced from 221 to 95.46 acres, and riparian vegetation impacts have been reduced from 158.20 to 23.02 acres. Other design changes will result in impacts to listed species consistent with those described in the 2007 Opinion. While adverse effects to critical habitat remain, the effects do not reduce the conservation value of the critical habitat to support PS Chinook salmon and steelhead life stages.

2.7. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon or PS steelhead or destroy or adversely modify designated critical habitat.

2.8. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create 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." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

- Take in the form of harm from reduced riparian vegetation and in-water work.

- Take in the form of harm, injury, or death, from water quality reductions associated with excess turbidity and stormwater runoff.

Because the listed fish are highly mobile and their presence is influence by a wide variety of factors, the number of fish that could be exposed to project effects and respond with these forms of take are impossible to predict. In such circumstances, we provide an observable or measurable surrogate estimate which is causally tied to the form of take, called an 'extent' of take. Here the extent of take is as follows.

1. For harm from reduced riparian vegetation and RRP construction, the extent of take can be measured as the area of riparian modification within the Hylebos and Wapato subbasin RRPs and along the Puyallup River, including:
    a. the acreage of permanent and temporary vegetation removal listed in Table 5
    b. Mitigation at 13 mitigation sites for the acreage of wetland impacts listed in Table 4
    c. Invasive plant management within the replanted vegetation areas and wetland mitigation sites for up to 10 years

d. New and replaced water crossing structures over Hylebos Creek, Surprise Lake Tributary, and Wapato Creek that support channel-forming processes, floodplain functions, and habitat connectivity
e. the approximately 950-foot long portion of Hylebos Creek and X-foot long portion of Wapato Creek where temporary diversions will be placed
f. the approximately 4,000-foot long portion of Hylebos Creek, 5,300-foot long portion of Surprise Lake Tributary, and 3,500-foot long portion of Wapato Creek where permanent relocation will occur where permanent relocation will occur

2. For harm from reduced water quality:
   a. For take from excess turbidity, the extent is measured temporally, when nephelometric turbidity units will above background levels for 3 days. A second measure of this extent is spatial: an area of 300 feet downstream from the in-water construction activities in the Puyallup River; 100 feet downstream from in-water construction activities in Surprise Lake Tributary, Hylebos Creek, and Wapato Creek; and 200 feet downstream from in-water construction activities in Hylebos or Wapato creeks if significant rainfall during the in-water work window results in discharges in excess of 10 cfs.
   b. For take in the form of harm, injury or death from stormwater discharges in Hylebos and Wapato creeks and the Puyallup River, the extent of take is the amount of PGIS listed in Table 2.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). The FHWA shall:

1. Minimize incidental take from riparian and in-water work
2. Minimize incidental take from water quality degradation
3. Ensure completion of a monitoring and reporting program to confirm that the terms and conditions in this Incidental Take Statement are effective in avoiding and minimizing incidental take from permitted activities.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The FHWA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse. The NMFS modifies the terms and conditions from the original opinion as follows:

1. The following terms and conditions implement reasonable and prudent measure 1 (riparian and in-water work):
    a. Ensure that staging and stockpile areas shall be a minimum of 300 feet from any sensitive area (e.g. streambanks, riparian areas, wetlands) unless site specific review completed by the project biologist, indicates that no impacts to listed species will occur due to topography or other factors.
    b. Use all manual methods in the control of invasive plant species prior to the use of Glyphosate and other herbicides to the maximum extent practicable.
    c. Ensure that the surfactant LI 700® shall not be used in the formulation of Glyphosate or other herbicides for the control of invasive plant species.
    d. Ensure that existing and relocated Hylebos Creek, Surprise Lake Tributary, and Wapato Creek. and new, replaced, or widened, permanent stream crossing structures within the RRPs shall, where feasible, support natural channel forming processes, floodplain functions, and aquatic and riparian habitat connectivity. The existing and relocated streams shall be designed according to an accepted design methodology. To determine geomorphically appropriate channel types, dimensions, patterns, and profiles, the channel design process shall take the following parameters and considerations into account:
        i. Channel type, dimension, pattern, and profile of a western Washington reference stream shall be used as an analog for the stream design.
        ii. The new channel shall accommodate the current and estimated future 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 new channel shall be geomorphically appropriate for the desired pattern, dimensions and locations of habitat features of the new channel. That means the placement and spacing of pools and riffles needs to be a function of the channel's length, sinuosity, width, depth and gradient.
        v. The new channel shall be constructed using native and/or imported streambed sediments where appropriate. The stream should not be built or stabilized with large rock because the native geology does not provide this material.
        vi. The new channel shall incorporate imported and/or locally sourced large woody material (LWM) using coniferous and deciduous trees native to western Washington. If LWM is imported, it shall be imported from within the State of Washington. All in-stream and floodplain LWM shall be stabilized as needed to prevent displacement when subjected to hydraulic forces. The design of all LWM features shall be in accordance with Chapter 10 of the WSDOT Hydraulics Manual (the most current version).
        vii. Floodplain storage and side channels shall be constructed to minimize stranding of fish during receding waters. Isolated depressions shall not be constructed; all depressions shall be connected to the main channel.

viii. To allow the new channel to laterally migrate, the banks of the new stream channel should not be hardened with rock. Soft bank armoring as outlined in the ISPG (Cramer et al. 2003) may be used to stabilize banks until vegetation is mature enough to provide needed stability.

e. Maintain the RRP such that sites evolve over time with minimal intervention by WSDOT except that which is necessary to ensure that the habitat forming processes, floodplain functions, and habitat connectivity of the RRPs are met. Protection of highway infrastructure shall only be contemplated when the infrastructure is at risk. The selection of appropriate protection measures, as outlined in the ISPG, will be used on a case-by-case basis, only using riprap as a last resort. Use of riprap will require reinitiation of consultation with NMFS.
f. Minimize the project's effects on in-water and riparian habitat in the Puyallup River basin (exclusive of the Wapato and Hylebos basins) by improving riparian habitat at a site within the basin.
g. Submit the project's final wetland mitigation plan, including monitoring and contingencies, to NMFS a minimum of 60 days prior to implementation.

2. The following terms and conditions implement reasonable and prudent measure 2 (water quality):
   a. Develop a Temporary Erosion and Sediment Control plan that addresses site-specific topographic, geologic, vegetative, hydrologic, and habitat conditions and is included as a provision of the contract. The TESC plan shall be continuously implemented, monitored, and modified as necessary, for the duration of the project, to eliminate or minimize the movement of soils and sediments both into the river from all upland construction areas and within the river, within the limits of the 300 foot water quality mixing zone for the Puyallup River, and the 100-foot mixing zone for Hylebos and Wapato creeks and Surprise Lake Tributary. Significant rainfall during the in-water work window, resulting in discharges in excess of 10 cfs in Hylebos or Wapato creeks, or Surprise Lake Tributary, will necessitate a 200 foot mixing zone.
   b. Provide flow control where required per the Highway Runoff Manual, unless alternative flow control has been approved as an HRM deviation. Flow control must be designed using a continuous flow model calibrated to predevelopment land covers in accordance with the HRM.
   c. Restore natural hydrology in the Puyallup River subbasin to the maximum extent possible. Utilize the sites identified as potential wetland mitigation sites with the objective of maximizing the potential to create, restore and enhance infiltration through the use of native woody vegetation.
   d. Treat all project stormwater from water crossings to ensure that there is no direct discharge of untreated stormwater to receiving waters.
   e. Ensure regular maintenance of stormwater treatment structures, which is assumed to minimize discharge of 6PPD-quinone and other stormwater pollutants to receiving waters.

3. The following terms and conditions implement reasonable and prudent measure 3 (monitoring and reporting):
    a. Develop and implement a monitoring plan to ensure that the RRPs and the relocated channels and stormwater facilities provide stormwater flow control, as well as habitat forming processes, floodplain functions, and habitat connectivity; and provide quality rearing and migratory habitat for ESA listed PS Chinook salmon. The monitoring plan shall contain contingencies consistent with the above functions and shall be undertaken over a 10-year period following project completion. The results of monitoring shall be submitted to NMFS at the end of the calendar years during which monitoring was conducted.
    b. Document all listed salmonids encountered during work area isolation by submitting In-water Construction Monitoring Report forms or equivalent to NMFS within 30 days of work area isolation.
    c. Monitor erosion control terms and conditions, including minimization measures and BMPs, and take corrective action if necessary to ensure protection of riparian and in-water habitats.
    d. Submit all monitoring reports to NMFS within 60 days of the end of each calendar year.

2.9. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, "conservation recommendations" are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

Due to increasing evidence that pollutants in highway runoff are detrimental to aquatic life, including numerous fish species, the NMFS believes that the following conservation recommendation is necessary to avoid, mitigation, or offset the impacts of the proposed action on EFH. This conservation recommendation replaces the conservation recommendations of the original opinion.

1. Modify stormwater treatment methods or protocols as new and/or more effective options become available.

2.10. Reinitiation of Consultation

This concludes formal consultation for the SR 167 Completion Project, Stage 2: SR 167/I-5 to SR 161 –New Expressway Project. Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.11. "Not Likely to Adversely Affect" Determinations

The Southern Resident killer whale (SRKW) Distinct Population Segment (DPS), composed of J, K and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year status review under the ESA completed in 2021 concluded that SRKW should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008). This section summarizes the status of SRKW throughout their range based on information in the Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*) (NMFS 2008) and the recent 5-year review (NMFS 2022).

The SRKW spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and then move south into Puget Sound in early autumn. While these are seasonal patterns, SRKW have the potential to occur throughout their range (from central California north to the Queen Charlotte Islands) at any time during the year.

Critical habitat for the SRKW includes approximately 2,560 square miles of Puget Sound, excluding areas with water less than 20 feet deep relative to extreme high water. The three specific areas designated as critical habitat are (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca.

SRKWs and SRKW critical habitats do not occur in the proposed project action area.
The proposed project action area is not within SRKW critical habitat and SRKWs will not be present in the action area. However, Puyallup River salmon, particularly Chinook salmon, serve as primary prey for SRKWs. The proposed construction and long-term operation and maintenance the project are expected to adversely affect four listed species of salmonids: Chinook salmon and steelhead. Though deleterious effects to these species are anticipated to be low, some individuals of each species may experience a risk of exposure and thus diminish available prey for SRKW recovery. As stated above in Section 2.5, the total number of individuals, particularly Chinook salmon, affected by this project are expected to be inconsequential to supporting sufficient prey abundance to measurably affect SRKWs.

In addition, construction of the RRP and other stream and wetland mitigation sites will result in restoration of approximately 6.2 miles of stream channel, and approximately 232 acres of wetlands, many of which are associated with salmon-bearing streams. Stream and floodplain restoration will offset many adverse impacts associated with the project. Therefore, prey quantity as a SRKW habitat feature is only insignificantly affected. Based on this analysis, the proposed action is not likely to adversely affect SRKW, or their designated critical habitat.

3. MAGNUSON–STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 3 of the original opinion is incorporated by reference here, without change.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 4 of the original opinion is incorporated by reference here, without change.

5. REFERENCES

Agne, M.C., P.A. Beedlow, D.C. Shaw, D.R. Woodruff, E.H. Lee, S.P. Cline, and R.L. Comeleo. 2018. Interactions of predominant insects and diseases with climate change in Douglas-fir forests of western Oregon and Washington, U.S.A. Forest Ecology and Management 409(1). https://doi.org/10.1016/j.foreco.2017.11.004

Alizedeh, M.R., J.T. Abatzoglou, C.H. Luce, J.F. Adamowski, A. Farid, and M. Sadegh. 2021. Warming enabled upslope advance in western US forest fires. PNAS 118(22) e2009717118. https://doi.org/10.1073/pnas.2009717118

Anderson, S. C., J. W. Moore, M. M. McClure, N. K. Dulvy, and A. B. Cooper. 2015. Portfolio conservation of metapopulations under climate change. Ecological Applications 25:559-572.

Baldwin, D.H., J.F. Sandahl, Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environ. Toxicol. Chem. 22:2266-2274.

Baldwin, D.H., J.A. Spromberg, T.K. Collier, and N.L. Scholz. 2009. A fish of many scales: extrapolating sublethal pesticide exposures to the productivity of wild salmon populations. Ecological Applications 19(8):2004-2015.

Barnett, H.K., T.P. Quinn, M. Bhuthimethee, and J.R. Winton. 2020. Increased prespawning mortality threatens an integrated natural- and hatchery-origin sockeye salmon population in the Lake Washington Basin. Fisheries Research 227. https://doi.org/10.1016/j.fishres.2020.105527

Beechie, T., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation, 130(4), pp.560-572.

Black, B.A., P. van der Sleen, E. Di Lorenzo, D. Griffin, W.J. Sydeman, J.B. Dunham, R.R. Rykaczewski, M. García-Reyes, M. Safeeq, I. Arismendi, and S.J. Bograd. 2018. Rising synchrony controls western North American ecosystems. Global change biology, 24(6), pp. 2305-2314.

Braun, D.C., J.W. Moore, J. Candy, and R.E. Bailey. 2016. Population diversity in salmon: linkages among response, genetic and life history diversity. Ecography, 39(3), pp.317-328.

Burke, B.J., W.T. Peterson, B.R. Beckman, C. Morgan, E.A. Daly, M. Litz. 2013. Multivariate Models of Adult Pacific Salmon Returns. PLoS ONE 8(1): e54134. https://doi.org/10.1371/journal.pone.0054134

Carr-Harris, C.N., J.W. Moore, A.S. Gottesfeld, J.A. Gordon, W.M. Shepert, J.D. Henry Jr, H.J. Russell, W.N. Helin, D.J. Doolan, and T.D. Beacham. 2018. Phenological diversity of salmon smolt migration timing within a large watershed. Transactions of the American Fisheries Society, 147(5), pp.775-790.

Chasco, B. E., B. J. Burke, L. G. Crozier, and R. W. Zabel. 2021. Differential impacts of freshwater and marine covariates on wild and hatchery Chinook salmon marine survival. PLoS ONE 16:e0246659. https://doi.org/0246610.0241371/journal.pone.0246659.

Cooper, M.G., J. R. Schaperow, S. W. Cooley,S. Alam,L. C. Smith, D. P. Lettenmaier. 2018. Climate Elasticity of Low Flows in the Maritime Western U.S. Mountains. Water Resources Research. https://doi.org/10.1029/2018WR022816

Crozier, L. 2015. Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2014. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L. 2016. Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2015. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L. 2017. Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2016. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L. G., and J. Siegel. 2018. Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2017. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L.G. and R.W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. Journal of Animal Ecology. 75:1100-1109.

Crozier, L., R.W. Zabel, S. Achord, and E.E. Hockersmith. 2010. Interacting effects of density and temperature on body size in multiple populations of Chinook salmon. Journal of Animal Ecology. 79:342-349.

Crozier L.G., M.M. McClure, T. Beechie, S.J. Bograd, D.A. Boughton, M. Carr, T. D. Cooney, J.B. Dunham, C.M. Greene, M.A. Haltuch, E.L. Hazen, D.M. Holzer, D.D. Huff, R.C. Johnson, C.E. Jordan, I.C. Kaplan, S.T. Lindley, N.Z. Mantua, P.B. Moyle, J.M. Myers, M.W. Nelson, B.C. Spence, L.A. Weitkamp, T.H. Williams, and E. Willis-Norton. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711. https://doi.org/10.1371/journal.pone.0217711

Crozier, L.G., B.J. Burke, B.E. Chasco, D.L. Widener, and R.W. Zabel. 2021. Climate change threatens Chinook salmon throughout their life cycle. Communications biology, 4(1), pp.1-14.

Dorner, B., M.J. Catalano, and R.M. Peterman. 2018. Spatial and temporal patterns of covariation in productivity of Chinook salmon populations of the northeastern Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 75(7), pp.1082-1095.

Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. Plos One 6(8):e23424.

FitzGerald, A.M., S.N. John, T.M. Apgar, N.J. Mantua, and B.T. Martin. 2020. Quantifying thermal exposure for migratory riverine species: Phenology of Chinook salmon populations predicts thermal stress. Global Change Biology 27(3).

Ford, M. J. (editor). 2022. Biological Viability Assessment Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-171.

Freshwater, C., S. C. Anderson, K. R. Holt, A. M. Huang, and C. A. Holt. 2019. Weakened portfolio effects constrain management effectiveness for population aggregates. Ecological Applications 29:14.

Gliwicz, Z.M., E. Babkiewicz, R. Kumar, S. Kunjiappan, and K. Leniowski, 2018. Warming increases the number of apparent prey in reaction field volume of zooplanktivorous fish. Limnology and Oceanography, 63(S1), pp.S30-S43.

Gosselin, J. L., Buhle, E. R., Van Holmes, C., Beer, W. N., Iltis, S., & Anderson, J. J. 2021. Role of carryover effects in conservation of wild Pacific salmon migrating regulated rivers. Ecosphere, 12(7), e03618.

Hard, J.J., J.M. Myers, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Viability criteria for steelhead within the Puget Sound distinct population segment. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-129.

Halofsky, J.S., D.R. Conklin, D.C. Donato, J.E. Halofsky, and J.B. Kim. 2018. Climate change, wildfire, and vegetation shifts in a high-inertia forest landscape: Western Washington, U.S.A. PLoS ONE 13(12): e0209490. https://doi.org/10.1371/journal.pone.0209490

Halofsky, J.E., Peterson, D.L. and B. J. Harvey. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. Fire Ecology 16(4). https://doi.org/10.1186/s42408-019-0062-8

Healey, M., 2011. The cumulative impacts of climate change on Fraser River sockeye salmon (*Oncorhynchus nerka*) and implications for management. Canadian Journal of Fisheries and Aquatic Sciences, 68(4), pp.718-737.

Herrera. 2022. SR 167 Completion Project, Stage 2: DRAFT Wetland and Stream Assessment Report. Prepared for WSP and WSDOT by Herrera Environmental Consultants, Inc., Seattle, Washington.

Herring, S. C., N. Christidis, A. Hoell, J. P. Kossin, C. J. Schreck III, and P. A. Stott, Eds., 2018: Explaining Extreme Events of 2016 from a Climate Perspective. Bull. Amer. Meteor. Soc., 99 (1), S1–S157.

Hicken, C.E., T.L. Linbo, D.H. Baldwin, M.L. Willis, M.S. Myers, L. Holland, M. Larsen, M.S. Stekoll, S.D. Rice, T.K. Collier, N.L. Scholz, and J.P. Incardona. 2011. Sublethal exposure to crude oil during embryonic development alters cardiac morphology and reduces aerobic capacity in adult fish. Proceedings of the National Academy of Sciences 108(17):7086-7090.

Holden, Z.A., A. Swanson, C.H. Luce, W.M. Jolly, M. Maneta, J.W. Oyler, D.A. Warren, R. Parsons and D. Affleck. 2018. Decreasing fire season precipitation increased recent western US forest wildfire activity. PNAS 115(36). https://doi.org/10.1073/pnas.1802316115

Holsman, K.K., M.D. Scheuerell, E. Buhle, and R. Emmett. 2012. Interacting effects of translocation, artificial propagation, and environmental conditions on the marine survival of Chinook Salmon from the Columbia River, Washington, USA. Conservation Biology, 26(5), pp.912-922.

Huang, L., J. Li, D. Zhoa, and J. Zhu. 2008. A fieldwork study on the diurnal changes of the urban microclimate in four types of ground cover and urban heat island of Namjing China. Building and Enviroment. 43:1 pp 7-17.

Intergovernmental Panel on Climate Change (IPCC) Working Group I (WGI). 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou editor. Cambridge University Press (https://www.ipcc.ch/report/ar6/wg1/#FullReport).

IPCC Working Group II (WGII). 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. H.O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama (eds.) Cambridge University Press (https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_FullReport.pdf)

Isaak, D.J., C.H. Luce, D.L. Horan, G. Chandler, S. Wollrab, and D.E. Nagel. 2018. Global warming of salmon and trout rivers in the northwestern U.S.: Road to ruin or path through purgatory? Transactions of the American Fisheries Society. 147: 566-587. https://doi.org/10.1002/tafs.10059

Jacox, M. G., Alexander, M. A., Mantua, N. J., Scott, J. D., Hervieux, G., Webb, R. S., & Werner, F. E. 2018. Forcing of multi-year extreme ocean temperatures that impacted California Current living marine resources in 2016. Bull. Amer. Meteor. Soc, 99(1).

Johnson, B.M., G.M. Kemp, and G.H. Thorgaard. 2018. Increased mitochondrial DNA diversity in ancient Columbia River basin Chinook salmon Oncorhynchus tshawytscha. PLoS One, 13(1), p.e0190059.

Kahn, M.I. 2002. Factors affecting the thermal properties of concrete and applicability of its prediction models. Building and Environment. 37:6 pp 607-614.

Keefer M.L., T.S. Clabough, M.A. Jepson, E.L. Johnson, C.A. Peery, C.C. Caudill. 2018. Thermal exposure of adult Chinook salmon and steelhead: Diverse behavioral strategies in a large and warming river system. PLoS ONE 13(9): e0204274. https://doi.org/10.1371/journal.pone.0204274

Kilduff, D. P., L.W. Botsford, and S.L. Teo. 2014. Spatial and temporal covariability in early ocean survival of Chinook salmon (Oncorhynchus tshawytscha) along the west coast of North America. ICES Journal of Marine Science, 71(7), pp.1671-1682.

Koontz, E.D., E.A. Steel, and J.D. Olden. 2018. Stream thermal responses to wildfire in the Pacific Northwest. Freshwater Science, 37, 731 - 746.

Krosby, M. D.M. Theobald, R. Norheim, and B.H. McRae. 2018. Identifying riparian climate corridors to inform climate adaptation planning. PLoS ONE 13(11): e0205156. https://doi.org/10.1371/journal.pone.0205156

Lindley S.T., C.B. Grimes, M.S. Mohr, W. Peterson, J. Stein, J.T. Anderson, et al. 2009. What caused the Sacramento River fall Chinook stock collapse? NOAA Fisheries West Coast Region, Santa Cruz, CA. U.S. Department of Commerce NOAA-TM-NMFS-SWFSC-447.

Malek, K., J.C. Adam, C.O. Stockle, and R.T. Peters. 2018. Climate change reduces water availability for agriculture by decreasing non-evaporative irrigation losses. Journal of Hydrology 561:444-460.

McCullough, D. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to chinook salmon. Prepared for US EPA Region 10. EPA 910-R-99-010.

McIntyre, J.K., Davis, J.W., Hinman, C., Macneale, K.H., Anulacion,B.F., Scholz, N.L. & Stark, J.D. (2015) Soil bioretention protects juvenile salmon and their prey from the toxic impacts of urban stormwaterrunoff.Chemosphere,132, 213–219.

Munsch, S. H., C. M. Greene, N. J. Mantua, and W. H. Satterthwaite. 2022. One hundred-seventy years of stressors erode salmon fishery climate resilience in California's warming landscape. Global Change Biology.

Myers, J.M., J. Jorgensen, M. Sorel, M. Bond, T. Nodine, and R. Zabel. 2018. Upper Willamette River Life Cycle Modeling and the Potential Effects of Climate Change. Draft Report to the U.S. Army Corps of Engineers. Northwest Fisheries Science Center. 1 September 2018.

Naylor, C. 2022. Personal communication between Char Naylor, Puyallup Tribe of Indians, and Vivian Erickson, SR 167 Stage 2 Environmental Lead. April 11, 2022.

NMFS. 2008. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2022. 2021 Southern Resident Killer Whales (Orcinus orca) 5-Year Review: Summary and Evaluation January 04, 2022.

NOAA National Centers for Environmental Information (NCEI), State of the Climate: Global Climate Report for Annual 2021, published online January 2022, retrieved on February 28, 2022 from https://www.ncdc.noaa.gov/sotc/global/202113.

Ohlberger, J., E.J. Ward, D.E. Schindler, and B. Lewis. 2018. Demographic changes in Chinook salmon across the Northeast Pacific Ocean. Fish and Fisheries, 19(3), pp.533-546.

Olmos M., M.R. Payne, M. Nevoux, E. Prévost, G. Chaput, H. Du Pontavice, J. Guitton, T. Sheehan, K. Mills, and E. Rivot. 2020. Spatial synchrony in the response of a long range migratory species (*Salmo salar*) to climate change in the North Atlantic Ocean. Glob Chang Biol. 26(3):1319-1337. doi: 10.1111/gcb.14913. Epub 2020 Jan 12. PMID: 31701595.

Ou, M., T. J. Hamilton, J. Eom, E. M. Lyall, J. Gallup, A. Jiang, J. Lee, D. A. Close, S. S. Yun, and C. J. Brauner. 2015. Responses of pink salmon to CO2-induced aquatic acidification. Nature Climate Change 5:950-955.

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A Sensory System at the Interface Between Urban Stormwater Runoff and Salmon Survival. Environmental Science and Technology 41(8):2998–3004.

Schindler, D. E., J. B. Armstrong, and T. E. Reed. 2015. The portfolio concept in ecology and evolution. Frontiers in Ecology and the Environment 13:257-263.

Sen, S., and J. Roesler. 2017. Microscale heat island characterization of rigid pavements. Transportation Research Record. 2639:1 pp 73-83.

Shared Strategy for Puget Sound. 2007. Puget Sound Salmon Recovery Plan. https://repository.library.noaa.gov/view/noaa/16005

Siegel, J., and L. Crozier. 2019. Impacts of Climate Change on Salmon of the Pacific Northwest. A review of the scientific literature published in 2018. Fish Ecology Division, NWFSC. December 2019.

Siegel, J., and L. Crozier. 2020. Impacts of Climate Change on Salmon of the Pacific Northwest: A review of the scientific literature published in 2019. National Marine Fisheries Service, Northwest Fisheries Science Center, Fish Ecology Division. https://doi.org/10.25923/jke5-c307

Sprague, J.B. 1968. Avoidance reactions of rainbow trout to zinc sulphate solutions. Water Research. 2(5): 367-372.

Spromberg, J.A., and J.P. Meador. 2006. Relating chronic toxicity responses to population-level effects: A comparison of population-level parameters for three salmon species as a function of low-level toxicity. Ecological Modeling 199:240-252.

Spromberg, J.A., and N.L. Scholz. 2011. Estimating future decline of wild coho salmon populations resulting from early spawner die-offs in urbanizing watersheds of the Pacific Northwest, USA. Integrated Environmental Assessment and Management 7(4):648-656.

Sridhar, V., M.M. Billah, J.W. Hildreth. 2018. Coupled Surface and Groundwater Hydrological Modeling in a Changing Climate. Groundwater Vol. 56, Issue 4. https://doi.org/10.1111/gwat.12610

Stachura, M.M., N.J. Mantua, and M.D. Scheuerell. 2014. Oceanographic influences on patterns in North Pacific salmon abundance. Canadian Journal of Fisheries and Aquatic Sciences, 71(2), pp.226-235.

Sturrock, A.M., S.M. Carlson, J.D. Wikert, T. Heyne, S. Nusslé, J.E. Merz, H.J. Sturrock and R.C. Johnson. 2020. Unnatural selection of salmon life histories in a modified riverscape. Global Change Biology, 26(3), pp.1235-1247.

Thorne, K., G. MacDonald, G. Guntenspergen, R. Ambrose, K. Buffington, B. Dugger, C. Freeman, C. Janousek, L. Brown, J. Rosencranz, J. Holmquist, J. Smol, K. Hargan, and J. Takekawa. 2018. U.S. Pacific coastal wetland resilience and vulnerability to sea-level rise. Science Advances 4(2). DOI: 10.1126/sciadv.aao3270

Tian, Z., and 28 others. 2020. A ubiquitous tire rubber-derived chemical induces acute mortality in coho salmon. *Science* 371, no. 6525: 185-189. Retrieved from: https://www.science.org/doi/10.1126/science.abd6951.

Trudeau, M.P. 2017. State of the knowledge: Long-term, cumulative impacts of urban wastewater and stormwater on freshwater systems. Final Report Submitted to the Canadian Water Network. January 30, 2017.

Veilleux, H.D., Donelson, J.M. and Munday, P.L., 2018. Reproductive gene expression in a coral reef fish exposed to increasing temperature across generations. Conservation physiology, 6(1), p.cox077.

Wainwright, T.C. and L.A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. Northwest Science, 87(3), pp.219-242.

Ward, E.J., J.H. Anderson, T.J. Beechie, G.R. Pess, M.J. Ford. 2015. Increasing hydrologic variability threatens depleted anadromous fish populations. Glob Chang Biol. 21(7):2500–9. Epub 2015/02/04. pmid:25644185.

WDOE (Washington State Department of Ecology). 2018. Washington State's Water Quality Assessment, 2012 303(d) List. Accessed March 23, 2018. https://fortress.wa.gov/ecy/approvedwqa/ApprovedSearch.aspx.

WDOE. 2022. Washington State's Water Quality Assessment, 2018 Candidate 303(d) List. Accessed June 8, 2022. https://apps.ecology.wa.gov/waterqualityatlas/wqa/proposedassessment.

Wheeler, A.P., P.L. Angermeier, and A.E. Rosenberger. 2005. Impacts of New Highways and Subsequent Landscape Urbanization on Stream Habitat and Biota. Reviews in Fisheries Science 13(3):141–164.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L.G. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. NOAA Fisheries Southwest Fisheries Science Center, Santa Cruz, CA: U.S. Dep Commerce NOAA Tech Memo NMFS SWFSC 564.

Williams, C. R., A. H. Dittman, P. McElhany, D. S. Busch, M. T. Maher, T. K. Bammler, J. W. MacDonald, and E. P. Gallagher. 2019. Elevated CO2 impairs olfactory-mediated neural and behavioral responses and gene expression in ocean-phase coho salmon (Oncorhynchus kisutch). 25:963-977.

WSDOT (Washington State Department of Transportation). 2016. Wetland Inventory Technical Memorandum: SR 167 Extension Project – Puyallup to SR 509. Washington State Headquarters Environmental Services and Washington State Olympic Region Environmental and Hydraulic Services. Olympia, Washington. November.

Yan, H., N. Sun, A. Fullerton, and M. Baerwalde. 2021. Greater vulnerability of snowmelt-fed river thermal regimes to a warming climate. Environmental Research Letters 16(5). https://doi.org/10.1088/1748-9326/abf393

Young, A., Kochenkov, V., McIntyre, J.K., Stark, J.D., and Coffin, A.B. 2018. Urban stormwater runoff negatively impacts lateral line development in larval zebrafish and salmon embryos. Scientific Reports 8: 2830.