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-2019-00109

October 21, 2019

Michelle Walker
Corps of Engineers, Seattle District
Regulatory Branch CENWS-OD-RG
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Boeing Company's Apron R Infrastructure Maintenance and Repair Project, King County, Washington, COE Number: NWS-2017-37, HUC: 171100120400 – Lake Washington.

Dear Ms. Walker:

Thank you for your letter of March 20, 2019, requesting initiation 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 U.S. Army Corps of Engineers (COE) authorization of the Boeing Company's Apron R Infrastructure Maintenance and Repair Project. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action is likely to adversely affect but not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS Sound steelhead. The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon but is not likely to result in the destruction or adverse modification of that designated critical habitat. As required by section 7 of the ESA, the NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures the NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the COE must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the MSA. NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast Salmon. Therefore, we have included the results of that review in Section 3 of this document.

Please contact Donald Hubner in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (206) 526-4359, or by electronic mail at Donald.Hubner@noaa.gov 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: Jason Sweeney, COE
Matthew Bennett, COE
Daniel Krenz, COE
Karen Walter, Muckleshoot Indian Tribe

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the

Boeing Company’s Apron R Infrastructure Maintenance and Repair Project
King County, Washington (COE Number: NWS-2017-37)

NMFS Consultation Number: WCRO-2019-00109

Action Agency: U.S. Army Corps of Engineers

Affected Listed Species and Critical Habitats and NMFS’s Determinations:

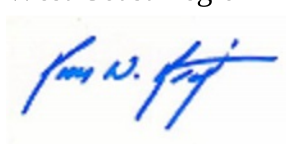
ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound (PS)	Threatened	Yes	No	Yes	No
Steelhead (*O. mykiss*) PS	Threatened	Yes	No	N/A	N/A

N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

Affected Essential Fish Habitat (EFH) and NMFS’ Determinations:

Fishery Management Plan That Describes 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: October 21, 2019

TABLE OF CONTENTS

LIST OF ACRONYMS

BE – Biological Evaluation
BMP – Best Management Practices
CFR – Code of Federal Regulations
COE – Corps of Engineers, US Army
dB – Decibel
DIP – Demographically Independent Population
DO – Dissolved Oxygen
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HDPE – High-density Polyethylene
HMA – Hot Mix Asphalt
HPA – Hydraulic Project Approval
HUC – Hydrologic Unit Code
Hz – Hertz (or cycles per second)
ISGP – Industrial Stormwater General Permit
ITS – Incidental Take Statement
JARPA – Joint Aquatic Resource Permit Application Form
mg/l – Milligram per Liter
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
MWLS – Modular Wetland Linear System
NMFS – National Marine Fisheries Service
NTU – Nephlometric Turbidity Units
OHW – Ordinary High Water
OWCO – Oregon Washington Coastal Office
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Physical or Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
PTS – Permanent Threshold Shift
RL – Received Level
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level

SWPPP – Stormwater Pollution Prevention Plan
TSS – Total Suspended Solids
TTS – Temporary Threshold Shift
VSP – Viable Salmonid Population
WCR – Westcoast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDOE – Washington State Department of Ecology

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 National Marine Fisheries Service (NMFS) prepared the biological opinion (Opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (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 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 (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Oregon Washington Coastal Office.

1.2 Consultation History

On January 11, 2017, the NMFS participated in a pre-application meeting hosted by the US Army Corps of Engineers (COE) to introduce the Boeing project and to seek comments from federal, state, and tribal representatives. Subsequent to the meeting, numerous e-mails and draft documents were exchanged between the COE, the applicant, and the NMFS, and on September 26, 2018, the COE requested formal consultation for the proposed action (NMFS tracking number WCR-2018-10771). However, on November 20, 2018, the COE withdrew their consultation request due to ongoing project development by the applicant.

On March 20, 2019, the NMFS received the current request consultation (COE 2019a), with the enclosed revised biological evaluation (BE) (Wood 2019a). Subsequent to the consultation request, numerous communications occurred to finalize project details, including a meeting that was held between the COE, the applicant's agent, the Muckleshoot Indian Tribe, and the NMFS the May 21, 2019. On July 5, 2019, the applicant's agent provided additional information and clarification about project details, including the numbers of piles involved, details about the planting of native riparian vegetation, and bathymetric information at the project site (Wood 2019b). Formal consultation for the proposed action was initiated on that date. On July 31, 2019, the applicant's agent provided more information to further refine project details (Wood 2019c).

On August 27, 2019, the regulations governing interagency consultation (50 CFR part 402) were updated (84 FR 44976), and will become effective on October 28, 2019. Because this consultation was pending and will be completed prior to that time, we are applying the previous regulations to this consultation. However, as the preamble to the final rule adopting the new regulations noted, “[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practices.” Therefore, the updated regulations would not be expected to alter our analysis in this consultation.

A multi-agency meeting was held on September 24, 2019 to discuss the status of the project and the consultation. As a result the project was modified slightly to remove cathodic protection from the project, and to remove the central ramp to increase mitigation (Wood 2019e and f).

This Opinion is based on the review of the information identified above; the recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited). A complete record of this consultation is on file at the Oregon Washington Coastal Office (OWCO) in Lacey, Washington.

1.3 Proposed Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). “Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The COE proposes to authorize the Boeing Company (Boeing) to repair Apron R at their Renton facility at the south end of Lake Washington (Figure 1). The project would extend the useful life of their apron by 50 years (Wood 2019a). Continued movement, staging, and modification of new aircraft on the apron would be interrelated and interdependent with the proposed action.

The project is described in detail in Boeing’s BE (Wood 2019a). Construction would last about 3 years, with most work being done in upland areas. No in-water work is scheduled for year 3, but the year-3 in-water work windows are reserved for in-water project components that may be delayed. The project is divided into three areas: Area 1 – West Apron; Area 2 – East Apron; and Area 3 – Central Apron (Figure 1). Project components that are common to all three areas would be upland work to install an upgraded stormwater system, perform subgrade repairs as needed, and to replace the pavement with new concrete panels. No changes to the existing lighting systems are proposed, and with the exception of extending 4 stormwater outfalls, the post-construction apron would remain within its existing footprint.

The new stormwater system would be sized to manage rainfall from 100-year storm events, and would include 5 treatment modules. Each module would consist of a coalescing plate type oil/water separator followed by a Modular Wetland Linear System (MWLS) unit, which is a multistage filter system that consists of a pretreatment chamber, a biofiltration chamber, and a discharge chamber. The pretreatment and biofiltration chambers both include filtration media that come standard with all MWLSs (Pers. Comm. Pierce 2019). The standard MWLS is advertised to provide removal efficiencies of about 85% for total suspended solids (TSS); 95%

for motor oil; 50% for total copper (38% dissolved copper); 69% for total zinc (66% dissolved zinc); 64% for total phosphorus (67% ortho phosphorus); and 45% for nitrogen (Bio Clean 2019). Where appropriate, the system would also include isolation valves to facilitate emergency spill control and containment, and sampling access locations for stormwater quality monitoring. As part of the new stormwater system, 4 of the 10 existing outfalls would be replaced with larger-diameter high density polyethylene (HDPE) pipes and extended into deeper water, 3 outfalls would be decommissioned and removed, and 3 would remain unchanged other than being connected to the new stormwater system.

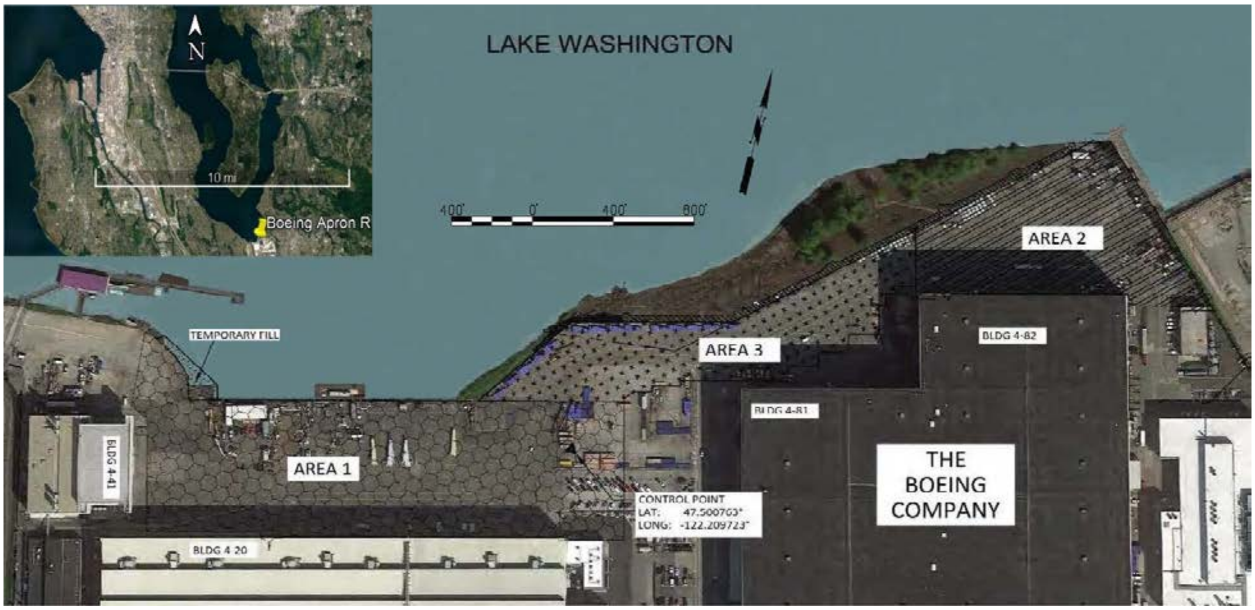


Figure 1. Google satellite photographs of the Boeing Apron R project site. The inset shows the project site at the south end of Lake Washington. The main image shows the three Apron R project areas relative to Lake Washington and the Boeing hangars and other buildings (Adapted from Wood 2019a Figure 2).

To reduce construction-related impacts on aquatic resources, all construction-related work would be conducted during daylight hours (no night work) and from land (i.e. no tugboats or barges would be used). However, as discussed under Area-1 work, tugboats and barges may be used during the removal of offshore derelict piles (Wood 2019c). All in-water work would be limited to July 16 through 31, and November 16 through December 31. Further, Boeing has committed to require their contractors to comply with all best management practices (BMP) and conservation measures identified in their BE, and with the provisions identified in the Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval (HPA) for the project (WDFW 2019a).

Area-specific in- and near-water work

Area 1: The West Apron is a 6.3-acre paved area that fronts Building 4-20 (Figures 1 and 2). About 11,200-square feet of the apron in the northwest (NW) corner of the area is supported by untreated timber piles. About 7,578 square feet of the pile-supported apron extends overwater. The West Apron currently has 5 stormwater outfalls that discharge untreated stormwater to the lake. An old pile-supported ramp and about 432 derelict untreated timber piles are offshore of the west corner of the apron, and a second pile-supported ramp and about 400 more derelict untreated timber piles are offshore of the central section of the Area 1 apron (Figure 2).

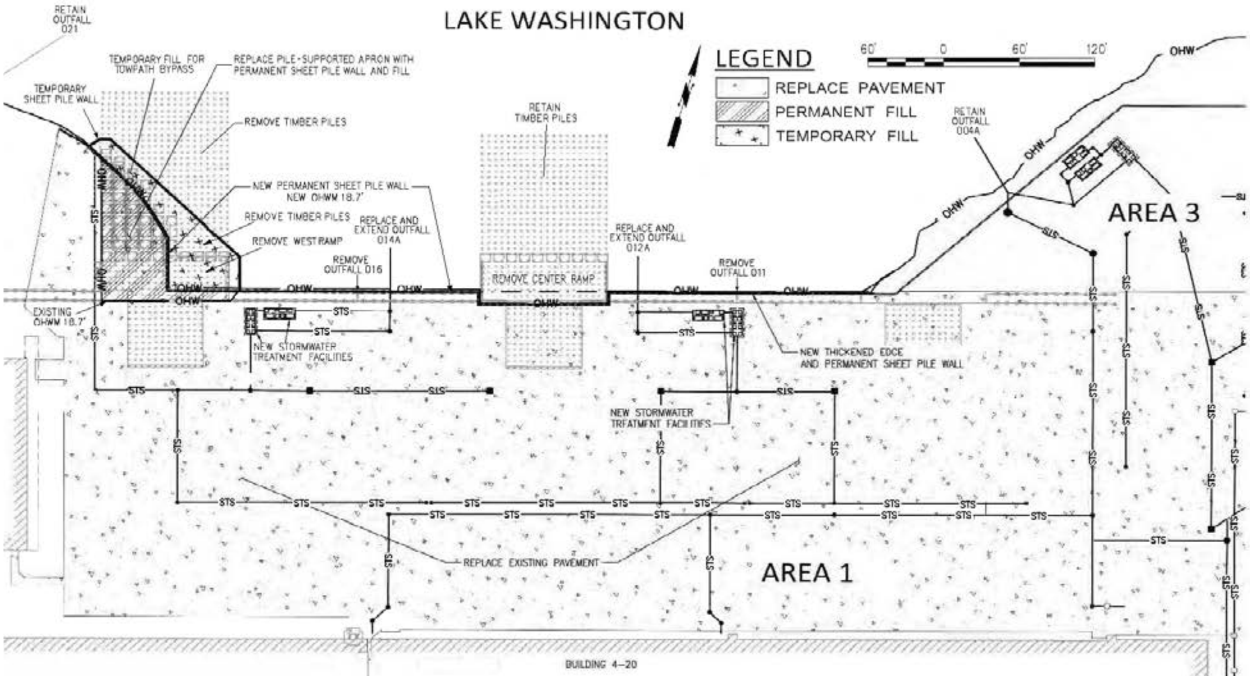


Figure 2. Plan drawing of West Apron R (Area 1) that shows the general construction plan (Adapted from Wood 2019a Figure 3).

In overview of the planned West Apron improvements, Boeing's contractors would install a new permanent steel sheet pile bulkhead along the north boundary of the apron, install a new stormwater system with 2 treatment modules, and repave the area with concrete slabs (slab on grade). As part of the stormwater system improvements, they would decommission and remove stormwater outfalls 011 and 016, replace and extend outfalls 012A and 014A, and reroute the small portion of Apron R stormwater that currently discharges through outfall 021, away from that outfall, and into the new treatment system. Outfall 021 is otherwise unrelated to the project, and will remain unmodified. Construction equipment would include cranes, a vibratory pile driver, and land-based construction equipment such as trucks, excavators, and concrete delivery equipment. Work skiffs and divers would also be used during outfall extension work.

Demolition and construction of the pile-supported portion of the apron in the northwest corner of the area would include the installation of a temporary sheet-pile bulkhead and temporary fill to create a temporary towpath bypass. The work would be phased, and the aircraft towpath shifted around the work area to provide continuous access to the airfield during construction (Figure 3). As part of Area 1 work, the western ramp and the 432 derelict piles off the west corner of the apron would be permanently removed.

With the exception of bulkhead work described below, Area 1 work to be done inland of the lakeside edge of the apron would have no timing restrictions, and therefore may occur anytime during the project. Inland work would include the use of land-based heavy equipment and standard demolition and construction techniques to demolish and remove the existing pavement, perform needed sub-grade repairs, and to install the new stormwater drains, pipes, and treatment systems. They would then install new concrete slab on grade pavement across the area.

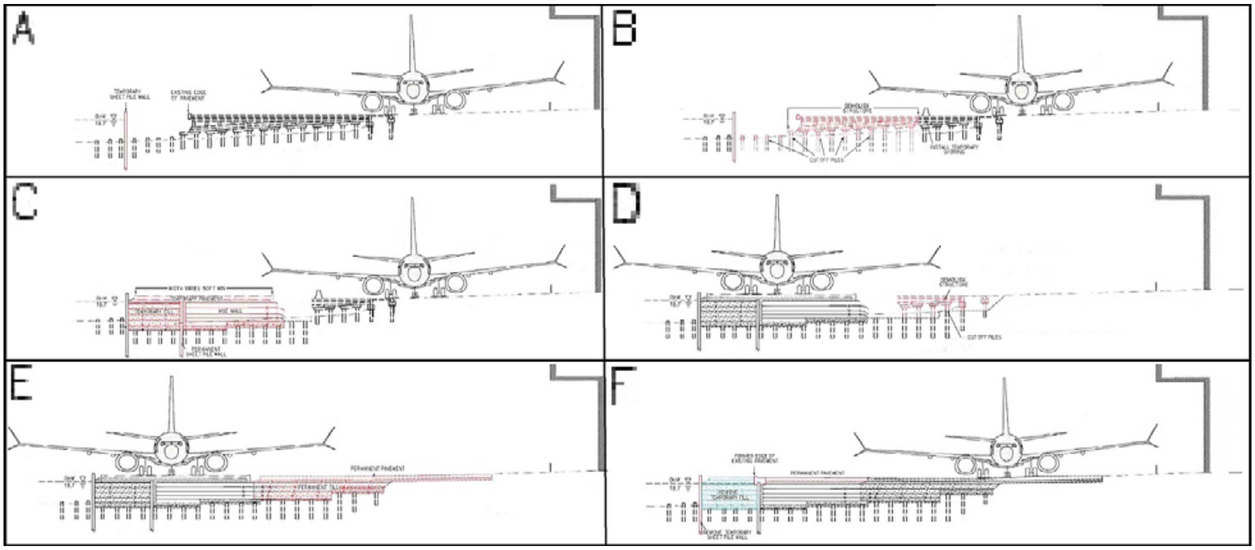


Figure 3. Profile drawings of the pile-supported section of the West Apron, showing the phased reconstruction the apron, including construction of the temporary towpath bypass (Adapted from Wood 2019a Figures 5a - f).

Most Area 1 in-water work would be completed during the Year-1 winter work window (November 16 through December 31). Prior to the start of in-water work, Boeing would temporarily shift their aircraft towpath away from the apron edge. During the window, Boeing's contractors would operate land-based equipment to install about 192 feet of temporary sheet-pile bulkhead around the NW corner of the area, install about 155 feet of permanent sheet-pile bulkhead along the NW edge of the apron, install about 500 feet of new sheet-pile backing immediately landward of the central concrete bulkhead, and to conduct in-water work related to Area 1 outfalls (Figures 2 & 3a).

In the NW corner of the area, the contractors would operate a crane with a vibratory pile driver to install a temporary sheet-pile bulkhead around the pile-supported portion of the apron and the west ramp at the NW corner of the area (Figures 2 & 3a). About 10 days of vibratory pile driving would be required to install the temporary bulkhead that would enclose about 0.11 acre of the lake immediately northeast of the existing apron boundary. No impact driving is planned. After the temporary bulkhead is installed, they would conduct fish salvage in compliance with the current U.S. Fish and Wildlife Service Fish Exclusion and Handling Guidelines (USFWS 2012) as well as any additional permit conditions. Captured fish would be released to the lake.

After fish salvage, the area would be partially dewatered, and the contractors would demolish the west ramp and the northern portion of the pile supported apron. They would use concrete saws to cut-up the existing apron decking, concrete pile caps, and the west ramp. They would remove the debris with cranes or excavators. The contractors would then cut-off the exposed timber piles and pile stubs at 2 to 5 feet below the mudline, and remove them with cranes or excavators as well (Figure 3b). All debris would be removed from the area by truck for disposal at appropriate disposal facilities. After the pile-supported structure has been removed, the contractors would conduct about 10 days of vibratory pile driving to install the new permanent sheet-pile bulkhead along the NW outline of the existing apron.

Some or all of the work to construct the temporary towpath bypass, after the installation of the permanent sheet-pile bulkhead, may occur outside of the in-water work window. After the new permanent sheet-pile bulkhead is installed, the contractors would use excavators and cranes to install geotextile-wrapped layers of structural fill (lifts) between the temporary and permanent bulkheads, and to install permanent lifts landward of the new permanent bulkhead. They would then install a layer of hot mix asphalt (HMA) pavement over both sections of fill to complete the temporary towpath bypass (Figure 3c). The aircraft towpath would be temporarily shifted onto the bypass, then the remaining portion of the pile-supported apron would be demolished, permanent lifts would be installed, and permanent concrete pavement would be installed over the lifts (Figures 3d and e). The aircraft towpath would again be temporarily shifted to the southwest, and permanent lifts and pavement would installed out to the edge of the permanent sheet-pile bulkhead (Figure 3f). The temporary fill and bulkhead would be removed during the Year-2 summer in-water work window of July 16 through 31 (Figure 3f).

Along the edge of the apron east of the northwest corner, the contractors would install a steel sheet-pile bulkhead immediately inland of the existing concrete bulkhead (Figure 2). During the Year-1 winter in-water work window, they would pulverize and remove an 8-foot wide strip of the existing concrete decking along the lakeside edge of the apron, then conduct about 10 days of vibratory pile driving to install about 500 linear feet of steel sheet-piles along the inner length of the existing concrete bulkhead. Landward of the new sheet-piles, they would excavate and/or remove old concrete and piles as needed, then install structural fill before constructing a new concrete bulkhead cap and pavement over the area. Some or all of the work done inland of the new sheet-piles may occur outside of the in-water work window.

Also during the Year-1 winter in-water work window, the contractors would conduct in-water work to decommission and remove stormwater outfalls 011 and 016, and to replace and extend outfalls 012A and 014A. About 10 days of work are expected for each outfall extension, but the work may overlap. They would operate land-based equipment such as concrete saws, excavators, and cranes. They are also likely to use a work skiff and divers. They would construct two lengths of 12-inch diameter HDPE pipe, and install a Tideflex check-valve at the outflow end of each pipe. They would also conduct upland excavation and in-water work to install stub-outs through the existing bulkhead. The stub-outs would connect the new outfall pipes to the upland segments of the new stormwater system. Once the stub-outs are installed and the HDPE pipes are assembled, the pipes would be sunk into their respective positions, then connected to the stub-outs by a diver. The installed outfalls would extend offshore, perpendicular to the bulkhead. Outfall 012A would extend about 31 feet, and 014A would extend about 37 feet. Upland work to install the inland stormwater piping and two treatment modules would involve standard construction techniques and BMPs, and would not be limited to the in-water work window.

The contractors would also remove the derelict timber piles that are offshore of the temporary sheet-pile bulkhead in the NW corner of the area, and they would also remove the central ramp and it's supporting piles (Wood 2019d). These are the only project components that may require the use of tugboats and barges. As such, this work would be restricted a winter in-water work window. With the exception that some or all of this work may be done from a barge, the work and debris disposal would be done in the same manner as that described above for the ramp and pile removal within the temporary sheet-pile bulkhead.

<u>Area 2:</u> The East Apron is a 3.1-acre paved area that fronts Building 4-82 (Figures 1 and 4). About 290 feet of double-walled steel sheet-pile flume with a solid-wood deck wraps around the northeast corner of the apron. The single stormwater outfall for Area 2 (002) discharges untreated stormwater into the flume near the northeast corner of the project area.

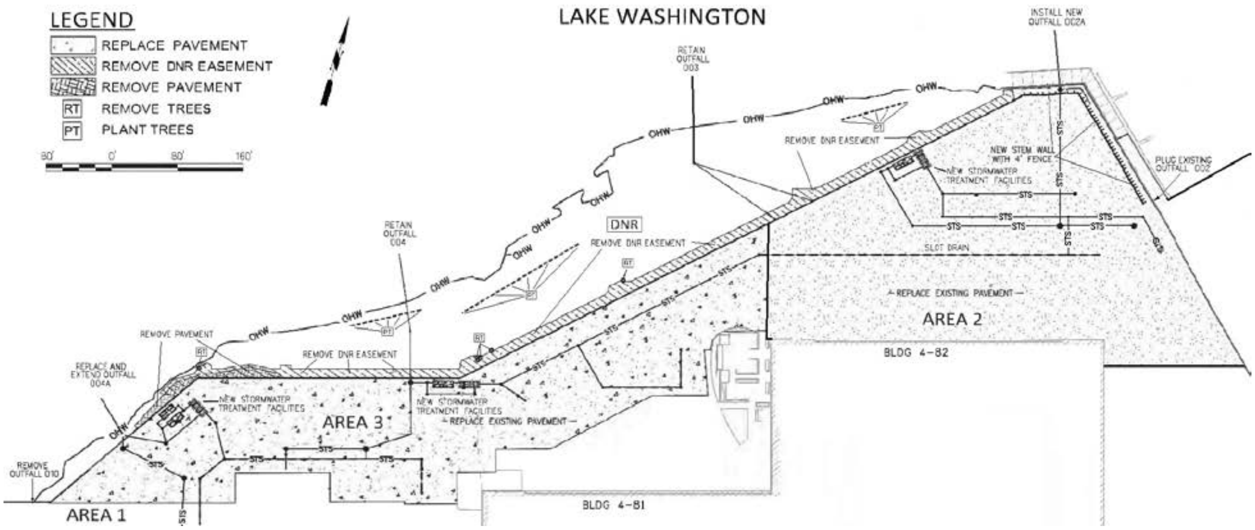


Figure 4. Plan drawing of East and Central Apron R (Areas 2 and 3) that shows the general construction plan (Adapted from Wood 2019a Figures 10, 12, and 13).

In overview of the planned East Apron improvements, Boeing's contractors would install a new concrete stem wall around the northeast corner of the apron area to increase apron elevation. They would also install a new stormwater system with 1 treatment module, and repave the area with slab on grade concrete. As part of the stormwater system improvements, they would decommission and plug stormwater outfall 002, and install a new outfall 002A that would be connected to the new system. They would also install a cathodic protection system to reduce corrosion of sheet-pile stormwater flume. Construction equipment would likely include land-based construction equipment such as a crane, trucks, excavators, and concrete delivery equipment. Work skiffs and divers would also be used during the installation of outfall 002A, and the cathodic protection system.

With the exception of the outfall relocation, Area 2 work would be done well inland of the lake, and therefore may occur anytime during the project. Inland work would include the use of land-based heavy equipment and standard demolition and construction techniques to demolish and remove the existing pavement, install the stem wall, perform sub-grade repairs, and to install new stormwater drains, pipes, and treatment systems. They would then install new concrete slab on grade pavement across the area.

During the Year-2 summer in-water work window (July 16 through 31), the contractors would perform about 15 days of in-water work to install the new outfall 002A at the northeast corner of Area 2. Working on land, they would operate standard construction equipment to remove concrete and to excavate the substrate landward of the flume's inner sheet-pile wall, near the northeast corner of the apron. They would also install about 89 cubic yards of gravel over about 0.01 acre of the lake floor outside of the flume's outer sheet-pile wall to create an even slope along for the outfall pipe.

Working from a skiff or other workboat, divers would use a cutting torch to cut holes through the sheet-pile walls of the flume. They would then weld flanges around the holes, and insert a short section of pipe through the flanges. The pipe would extend into the upland excavated area where it would be connected to the inland plumbing of the new stormwater system. Then the inland area would be backfilled and paved. The contractors would hoist a temporarily sealed 71-foot long length of 36-inch diameter HDPE pipe onto the lake. They would float it to the installation location, where they would fit it with concrete anchor collars. They would then sink the pipe into position. Divers would connect the pipe to the flange on the outer flume wall, and install a Tideflex check-valve at the outflow end of the pipe. The new outfall would extend about 71 feet offshore, perpendicular to the bulkhead.

The remaining Area 2 construction would consist of inland work that may occur any time during the project. Boeing's contactors would use standard land-based construction equipment and techniques, and employ appropriate BMPs, to conduct the upland work. They would demolish and remove the existing pavement. They would also excavate the existing apron along a line about 10 feet inland from the flume to install about 258 linear feet of stem wall around the northeast corner of the apron. They would install forms and use cast-in-place concrete to construct a 2- to 4-foot-tall wall on top of a concrete footing. Along the 10-foot wide area between the new stem wall and the flume, they would install new pavement that would be graded to drain toward the flume. Inland of the stem wall, they would install new stormwater drains, pipes, and the treatment system, and install fill as needed. They would then install concrete pavement to complete construction.

<u>Area 3:</u> The Central Apron is a 2.7-acre paved area that fronts Buildings 4-20, 4-81, and 4-82 (Figures 1 and 4). A Department of Natural Resources (DNR) mitigation area lays between the apron and the lake shoreline, with a 15-foot wide Boeing utilities easement extending the length of DNR mitigation area just outside of the apron. There are 4 existing stormwater outfalls that cross the restoration area and currently discharge untreated stormwater to the lake.

In overview of the planned Central Apron improvements, Boeing's contractors would install a new stormwater system with 2 treatment modules, and repave the area with slab on grade concrete. As part of the stormwater system improvements, they would decommission and remove stormwater outfall 010, replace and extend stormwater outfall 004A, and connect unchanged outfalls 003 and 004 to the new system. They would also conduct upland work to relocate their utilities out of the DNR easement. DNR easement work would include planting native shoreline trees and shrubs to replace those lost due to construction.

With the exception of the outfall removal and extension work described below, Area 3 work would be done well inland of the lake, and therefore may occur anytime during the project. Inland work would include the use of land-based heavy equipment and standard demolition and construction techniques to demolish and remove the existing pavement, perform needed sub-grade repairs, install the new stormwater drains, pipes, and treatment systems, relocate utilities, install new concrete slab on grade pavement across the area, and to plant riparian vegetation.

During the Year-2 winter in-water work window (November 16 through December 31), the contractors would perform about 10 days of in-water work to replace and extend outfall 004A at the west end of Area 3. The contractors would construct a temporarily sealed 48-foot long length of 36-inch diameter HDPE pipe. They would also operate land-based equipment such as excavators and cranes to excavate about 41 cubic yards of existing rip rap from about 0.01 acre of the lake floor to allow the installation of the new pipe, and to create a slope that would achieve proper drainage. The contractors would operate concrete saws and excavators to remove concrete and to excavate the substrate from the apron’s edge, and then install a stub-out to the stormwater system. Once the stub-out is ready and the HDPE pipe has been assembled, the pipe would be hoisted onto the lake, floated to the site, fitted with concrete anchor collars, and sunk into position. Divers would connect the pipe to the stub-out, and install a Tideflex check-valve at the outflow end of the pipe. The contractors would then reinstall the rip rap over the pipe in the area from where it was removed. The new outfall would extend about 48 feet perpendicular to the shoreline.

The remaining Area 3 construction would consist of inland work that may occur any time during the project. Boeing’s contactors would use standard land-based construction equipment and techniques, and employ appropriate BMPs, to demolish and remove the existing pavement, and to install new stormwater drains, pipes, and two treatment systems. They would also excavate the along the length of the DNR easement and relocate the existing utilities (electrical, compressed air, chilled water, fire water, and communications lines) to within the apron footprint. They would install fill as needed, and install concrete pavement. They would also return the disturbed DNR easement area to its original conditions, replant lost vegetation, and plant additional native shoreline trees and shrubs to help compensate for construction disturbance.

Interrelated and Interdependent Activities

Boeing uses Apron R to temporarily store newly manufactured jet airplanes, currently Boeing 737s, to perform minor work on those aircraft, and to move those aircraft to the Renton Airfield. They currently produce about 52 new airplanes per month, and move about 2 to 3 airplanes to the airfield per day (Wood 2019a). They also use portions of Apron R to store pre-assembly aircraft parts such as wings and other large structural components, and to park vehicles (Figure 1).

After assembly within the construction buildings, new aircraft are parked in designated stalls on the apron. There, they to undergo system checks and minor modifications and repairs that may be needed prior to their movement to the Renton airfield. No painting or major airframe or engine work is done, nor are aircraft fueling or jet engine operations done on the apron. Aircraft movement is accomplished by pulling the aircraft along designated tow paths with specially designed tow tractors. Most aircraft movement and some aircraft work occurs at night. To support the nighttime work and movement, the apron is illuminated by lights that are installed on the sides of the adjacent buildings, and by mobile light carts (Appendix B in Wood 2019a).

To limit the introduction of pollutants into the stormwater from aircraft manufacture and movement, Boeing employs BMPs and source controls that are outlined in their approved Stormwater Pollution Prevention Plan (SWPPP) as required by their Industrial Storm Water Permit. The measure employed at the Boeing, Renton facility include, but are not limited to: the presence of an active Stormwater Pollution Prevention Team; use of good housekeeping activities, routine inspections and preventative maintenance, spill response training for employees, and record keeping.

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 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 provides an opinion stating how the agency's actions would affect listed species and their critical habitat. 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 non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

Table 1. ESA-listed species and critical habitat that may be affected by the proposed action.

ESA-listed species and critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
steelhead (*O. mykiss*) Puget Sound	Threatened	LAA	N/A	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)

LAA = likely to adversely affect NLAA = not likely to adversely affect
N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that 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 relies on the definition of "destruction or adverse modification," which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (81 FR 7214).

Past critical habitat designations have used the terms primary constituent element (PCE) or essential feature (EF) to identify important habitat qualities. However, the new critical habitat regulations (81 FR 7414; February 11, 2016) replace those terms with physical or biological features (PBF). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified PCE, EF, or PBF. For simplicity, we universally apply the term PBF in this Opinion for all critical habitat, regardless of the term used in the specific critical habitat designation.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or to cause the destruction or adverse modification of designated critical habitat:

- Identify the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a reasonable and prudent alternative (RPA) to the proposed action.

2.2 Range-wide Status of the Species and Critical Habitat

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. This 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 PBF that help to form that conservation value.

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the action area and are considered in this opinion. More detailed information on the biology, habitat, and conservation status and trend of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register and in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

Listed Species

Viable Salmonid Population (VSP) Criteria: For Pacific salmonids, we commonly use four VSP criteria (McElhany *et al*. 2000) to assess the viability of the populations that constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits.

"Abundance" generally refers to the number of naturally-produced adults that return to their natal spawning grounds.

"Productivity" refers to the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is in decline.

For species with multiple populations, we assess the status of the entire species based on the biological status of the constituent populations, using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany *et al*. 2000).
The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register.

Puget Sound (PS) Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and the final supplement to the Shared Strategy's Puget Sound salmon recovery plan (NMFS 2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus *et al*. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 2) achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

Table 2. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus *et al*. 2002, NWFSC 2015).

Biogeographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

General Life History: Chinook salmon are anadromous fish that require well-oxygenated water that is typically less than 63º F (17º C), but some tolerance to higher temperatures is documented with acclimation. Adult Chinook salmon spawn in freshwater streams, depositing fertilized eggs in gravel "nests" called redds. The eggs incubate for three to five months before juveniles hatch and emerge from the gravel. Juveniles spend from three months to two years in freshwater before migrating to the ocean to feed and mature. Chinook salmon spend from one to six years in the ocean before returning to their natal freshwater streams where they spawn and then die.

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type Chinook salmon tend to rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage. Both stream- and ocean-type Chinook salmon are present, but ocean-type Chinook salmon predominate in Puget Sound populations.

Chinook salmon are further grouped into "runs" that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon. In Puget Sound, spring-run Chinook salmon tend to enter their natal rivers as early as March, but do not spawn until mid-August through September. Returning summer- and fall-run fish tend to enter the rivers early-June through early-September, with spawning occurring between early August and late-October.

Yearling stream-type fish tend to leave their natal rivers late winter through spring, and move relatively directly to nearshore marine areas and pocket estuaries. Out-migrating ocean-type fry tend to migrate out of their natal streams beginning in early-March. Those fish rear in the tidal delta estuaries of their natal stream for about two weeks to two months before migrating to marine nearshore areas and pocket estuaries in late May to June. Out-migrating young of the year parr tend to move relatively directly into marine nearshore areas and pocket estuaries after leaving their natal streams between late spring and the end of summer.

Spatial Structure and Diversity: The PS Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPGs), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 2).

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners. Between 1990 and 2014, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed (NWFSC 2015).

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now show that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the PSTRT as consistent with recovery (NWFSC 2015). The current information on abundance, productivity, spatial structure and diversity suggest that the Whidbey Basin MPG is at relatively low risk of extinction. The other four MPGs are considered to be at high risk of extinction due to low abundance and productivity (NWFSC 2015). The most recent 5-year status review concluded that the ESU should remain listed as threatened (NMFS 2017a).

<u>Limiting Factors:</u> Factors limiting recovery for PS Chinook salmon include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation 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

<u>PS Chinook Salmon within the Action Area:</u> The PS Chinook salmon that occur in the action area would likely be fall-run Chinook salmon from the Cedar River population (NWFSC 2015; WDFW 2019b). Both stream- and ocean-type Chinook salmon are present in the population, with the majority being ocean-types. The Cedar River population is relatively small, with a total annual abundance fluctuating at close to 1,000 fish (NWFSC 2015; WDFW 2019c). Between 1965 and 2018, the total abundance for PS Chinook salmon in the basin has fluctuated between about 133 and 2,451 individuals, with the average trend being slightly negative. The 2015 status review reported that the 2010 through 2014 5-year geometric mean for natural-origin spawner abundance had shown a positive change since the 2010 status review, with natural-origin spawners accounting for about 82% of the population. WDFW data suggest that natural-origin spawners accounted for about 83% of a combined total return of 877 fish in 2018 (WDFW 2019c). Some returning adults and out-migrating juveniles from the Cedar River population, as well as the individuals that spawn in the numerous smaller streams across the basin, are likely to pass through the action area. Adult Chinook salmon pass through Chittenden Locks (aka Ballard Locks) between mid-June through September, with peak migration occurring in mid-August (City of Seattle 2008). Spawning occurs well upstream of the action area between early August and late October. Juvenile Chinook salmon are found in Lake Washington between January and July, primarily in the littoral zone (Tabor *et al*. 2006). Outmigration through the ship canal and

through the locks occurs between late-May and early-July, with the peak in June (City of Seattle 2008).

Puget Sound (PS) steelhead

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). The recovery plan for this DPS is under development. In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics. Those DIPs are distributed among three geographically-based major population groups (MPGs); Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers *et al.* 2015) (Table 3).

Table 3. PS steelhead Major Population Groups (MPGs), Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard *et al.* 2015).

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
Northern Cascades	Drayton Harbor Tributaries Winter Run	Moderate
	Nooksack River Winter Run	Moderate
	South Fork Nooksack River Summer Run	Moderate
	Samish River/Bellingham Bay Tributaries Winter Run	Moderate
	Skagit River Summer Run and Winter Run	Moderate
	Nookachamps River Winter Run	Moderate
	Baker River Summer Run and Winter Run	Moderate
	Sauk River Summer Run and Winter Run	Moderate
	Stillaguamish River Winter Run	Low
	Deer Creek Summer Run	Moderate
	Canyon Creek Summer Run	Moderate
	Snohomish/Skykomish Rivers Winter Run	Moderate
	Pilchuck River Winter Run	Low
	North Fork Skykomish River Summer Run	Moderate
	Snoqualmie River Winter Run	Moderate
	Tolt River Summer Run	Moderate
Central and South Puget Sound	Cedar River Winter Run	Low
	North Lake Washington and Lake Sammamish Winter Run	Moderate
	Green River Winter Run	Low
	Puyallup River Winter Run	Low
	White River Winter Run	Low
	Nisqually River Winter Run	Low
	South Sound Tributaries Winter Run	Moderate
	East Kitsap Peninsula Tributaries Winter Run	Moderate
Hood Canal and Strait de Fuca	East Hood Canal Winter Run	Low
	South Hood Canal Tributaries Winter Run	Low
	Skokomish River Winter Run	Low
	West Hood Canal Tributaries Winter Run	Moderate
	Sequim/Discovery Bay Tributaries Winter Run	Low
	Dungeness River Summer Run and Winter Run	Moderate
	Strait of Juan de Fuca Tributaries Winter Run	Low
	Elwha River Summer Run and Winter Run	Low

In 2015, the PSSTRT concluded that the DPS is at "very low" viability; with most of the 32 DIPs and all three MPGs at "low" viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard *et al*. 2015). Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40 percent or more of its component DIP are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40 percent or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85 percent, as calculated by Hard *et al*. (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

<u>General Life History:</u> Steelhead are anadromous fish that require well-oxygenated water that is typically less than 63º F (17º C). PS steelhead exhibit two major life history strategies. Ocean-maturing, or winter-run fish typically enter freshwater from November to April at an advanced stage of maturation, and then spawn from February through June. Stream-maturing, or summer-run fish typically enter freshwater from May to October at an early stage of maturation, migrate to headwater areas, and hold for several months prior to spawning in the following spring. After hatching, juveniles rear in freshwater from one to three years prior to migrating to marine habitats (two years is typical). Smoltification and seaward migration typically occurs from April to mid-May. Smolt lengths vary between watersheds, but typically range from 4.3 to 9.2 inches (109 to 235 mm) (Myers *et al*. 2015). Juvenile steelhead are generally independent of shallow nearshore areas soon after entering marine water (Bax *et al*. 1978, Brennan *et al*. 2004, Schreiner *et al*. 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore *et al*. 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca from one to three weeks. PS steelhead feed in the ocean waters for one to three years (two years is again typical), before returning to their natal streams to spawn. Unlike Chinook salmon, most female steelhead, and some males, return to marine waters following spawning (Myers *et al*. 2015).

<u>Spatial Structure and Diversity:</u> The PS steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts (USDC 2014). PS steelhead are the anadromous form of *O. mykiss* that occur below natural barriers to migration in northwestern Washington State (NWFSC 2015). Non-anadromous ''resident'' *O. mykiss* (a.k.a. rainbow trout) occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard *et al*. 2015). As stated above, the DPS consists of 32 DIP that are distributed among three geographically-based MPG. An individual DIP may consist of winter-run only, summer-run only, or a combination of both life history types. Winter-run is the predominant life history type in the DPS (Hard *et al.* 2015).

<u>Abundance and Productivity:</u> Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIP. However, low productivity persists throughout the 32 DIP, with most showing

downward trends, and a few showing sharply downward trends (Hard *et al.* 2015, NWFSC 2015). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIP but remain predominantly negative, and well below replacement for at least 8 of the DIP (NWFSC 2015). Smoothed abundance trends since 2009 show modest increases for 13 DIP. However, those trends are similar to variability seen across the DPS, where brief periods of increase are followed by decades of decline. Further, several of the upward trends are not statistically different from neutral, and most populations remain small. Nine of the evaluated DIP had geometric mean abundances of fewer than 250 adults, and 12 had fewer than 500 adults (NWFSC 2015). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (NWFSC 2015). The PSSTRT recently concluded that the PS steelhead DPS is currently not viable (Hard *et al.* 2015). The DPS's current abundance and productivity are considered to be well below the targets needed to achieve delisting and recovery. Growth rates are currently declining at 3 to 10% annually for all but a few DIPs, and the extinction risk for most populations is estimated to be moderate to high. The most recent 5-year status review concluded that the DPS should remain listed as threatened (NMFS 2017a).

<u>Limiting Factors:</u> Factors limiting recovery for PS steelhead include:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

<u>PS Steelhead within the Action Area:</u> The PS steelhead that most likely occurs in the action area would be winter-run fish from the Cedar River DIP, which is among the smallest within the DPS (NWFSC 2015; WDFW 2019d). WDFW reports that the total PS steelhead abundance in the Cedar River basin has fluctuated between 0 and 900 individuals between 1984 and 2018, with a strong negative trend. Since 2000, the total annual abundance has remained under 50 fish. NWFSC (2015) suggests that the returns may have been above 1,000 individuals during the 1980s, but agrees with the steep decline to less than 100 fish since 2000. It is unclear what proportion of the returns are natural-origin spawners, if any, and a total of only 4 adults are thought to have returned in 2018 (WDFW 2019d).

Some returning adults and out-migrating juveniles from the Cedar River DIP are likely to pass through the action area. Adult steelhead pass through Chittenden Locks (aka Ballard Locks) and the Lake Washington Ship Canal between January and May, and may remain within Lake Washington through June (City of Seattle 2008). The timing of steelhead spawning in the basin is uncertain, but occurs well upstream of the action area. Juvenile steelhead enter Lake Washington in April, and typically migrate through the ship canal and past the action area to the locks between April and May (City of Seattle 2008).

Critical Habitat

This section describes the status of designated critical habitat that would be affected by the proposed action by examining the condition and trends of PBFs that are essential to the conservation of the listed species throughout the designated areas. The PBFs are essential because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). The proposed project would affect critical habitat for PS Chinook salmon.

The NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). That critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon.

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. The PBF for PS Chinook salmon CH are listed in Table 4.

Table 4. Physical or biological features (PBFs) of designated critical habitat for PS Chinook salmon, and corresponding life history events. Although offshore marine areas were identified in the final rule, none was designated as critical habitat.

Physical or Biological Features		
Site Type	**Site Attribute**	**Life History Event**
Freshwater spawning	Water quantity Water quality Substrate	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Water quantity and Floodplain connectivity Water quality and Forage Natural cover	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	(Free of obstruction and excessive predation) Water quantity and quality Natural cover	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine	(Free of obstruction and excessive predation) Water quality, quantity, and salinity Natural cover Forage	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine	(Free of obstruction and excessive predation) Water quality, quantity, and forage Natural cover	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine	Water quality and forage	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek. Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood (LW) from the waterways, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors of critical habitat throughout the basin.

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and LW. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence *et al*. 1996; SSPS 2007).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist *et al*. 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and LW to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007). The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

<u>Critical Habitat within the Action Area</u>: All of Lake Washington, and well upstream into the Cedar River watershed has been designated as freshwater critical habitat for PS Chinook salmon. The critical habitat in within the action area primarily supports the Freshwater Migration PBF for juvenile and adult PS Chinook (WDFW 2019b).

2.3 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). As described in Section 2.5, elevated turbidity and impacted water quality within about 300 feet (91 m) around the project site would be the project-related stressor with the greatest range of effect. All other project-related effects, including indirect effects would be undetectable beyond that range. This action area overlaps with the geographic ranges and boundaries of the ESA-listed species and designated critical habitat identified earlier in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon.

2.4 Environmental Baseline

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

<u>Environmental conditions at the project site and the surrounding area:</u> The project site is located along the south shore of Lake Washington, immediately east of the mouth of the Cedar River (Figure 1). Lake Washington is a long, narrow, freshwater lake with steeply sloping sides. It is about 22 miles long, north to south, has an average width of 1.5 miles, and covers about 21,500 acres. The lake has an average depth of about 100 feet, and is just over 200 feet deep at its deepest (City of Seattle 2010). The Lake Washington watershed covers about 300,000 acres (472 square miles), and its major influent streams are the Cedar and Sammamish Rivers. The Cedar

River enters at the southern end of the lake and contributes about 57 percent of the lake's water. The Sammamish River enters at the north end of the lake, and contributes about 27 percent of the lake's water (King County 2016). Numerous creeks, including Coal, Forbes, Juanita, May, McAleer, Ravenna, and Thornton Creeks also flow directly into Lake Washington.

The geography and ecosystems in and adjacent to the action area have been dramatically altered by human activity since European settlers first arrived in the 1800s. Historically, Lake Washington's waters flowed south to the Duwamish River via the now absent Black River, and the Cedar River did not enter the lake. In 1911, engineers rerouted the Cedar River into Lake Washington to create an industrial waterway and to prevent flooding in Renton. In 1916, the Lake Washington Ship Canal was opened, which lowered water levels in the lake by about nine feet, and stopped flows through the Black River. Between 1916 and 1936, the project site was used as a hay farm. Immediately east of the site, the coal-fired Shuffleton power plant was built on filled swampland in 1929. The property was transferred to the federal government at the start of World War II, and the site became an aircraft factory in 1941.

The majority of the lake's watershed is now highly developed and urban in nature with 63 percent of the area considered fully developed (King County 2016). The City of Seattle boarders most of the west side of the lake. The cities of Bellevue and Kirkland are along the eastern shoreline, with the Cities of Kenmore and Renton on the north and south ends, respectively.

Water quality in the lake has been impacted by urban and residential runoff and by past sewage discharges. It has also been impacted by upstream forestry and agricultural practices. Cleanup efforts since the 1960s and 1970s, including diversion of wastewater away from the lake, have improved conditions, such that water quality in the lake is generally considered good (City of Seattle 2010). However, lake waters at the project site are currently listed on the State's 303(d) list of impaired and threatened water bodies for bacteria (WDOE 2019).

Urban development has converted most of the original lake shoreline from a mix of thick riparian forests, shrub-scrub, and emergent wetlands to residential gardens and lawns. Only small scattered patches of natural riparian growth remain (Toft 2001). Additionally, as of the year 2000, over 70 percent of the lake's shoreline had been armored by bulkheads and rip rap, and over 2,700 docks had been installed around the lake (Toft 2001). It is almost certain that those numbers have increased since then.

The armored shorelines at the project site and around most of Lake Washington, have converted the gently sloping gravel shorelines with very shallow waters that are favored by juvenile salmon, into artificially steep substrates with relatively deep water. The numerous piers and docks create harsh over-water shadows that limit aquatic productivity and hinder passage of juvenile salmon along much of the lake's shoreline. Additionally, the artificial shorelines and overwater structures provide habitat conditions that favor fish species that prey on juvenile salmonids, especially the non-native smallmouth bass. Other predators in the lake include the native northern pikeminnow and the non-native largemouth bass (Celedonia *et al*. 2008a and b; Tabor *et al*. 2010).

The area around the project site is highly developed, consisting mostly of armored shoreline with large expanses of pavement and a mix of commercial and industrial buildings and an airfield. West of the apron, the Cedar River flows straight, running between hardened banks for nearly a mile. The Renton airfield extends along that distance on the west side of the river. The SECO Southport development borders the east side of the project site. The SECO development is completely paved and includes several 5- to 12-story hotel and apartment buildings that are built to about 50 feet from the shore, and a vertical bulkhead runs along the shoreline.

Boeing's Apron R consists of a 14-acre concrete-paved apron with multiple hangars and buildings that are used for the construction of 737 jet airplanes. The apron is surrounded on three sides by buildings with lights mounted along the outsides of the buildings to provide the majority of the light needed for nighttime work on the apron. Light fixtures are also installed in the parking lots, and mobile light stands are used on the apron to provide additional illumination as needed (Casne Engineering 2017). The apron has 10 stormwater outfalls that currently discharge untreated stormwater directly to Lake Washington.

The shoreline along Apron R consists of a steep rip rap bank for the first 400 feet east of the Cedar River. A 10- to 20-foot wide strip of riparian vegetation extends along the top of the bank. The vegetation consists primarily of Himalayan blackberry, Japanese knotweed, English ivy, and unidentified grass and weed species. However, a single small alder tree and some small vine maples are located among the invasive species. About 50 feet from shore, a 375-foot long dock runs parallel to the shore in this area.

East of the rip rap, the bank turns south, and the ordinary high water line extends under a section of the apron that consists of concrete slab over untreated timber piles. The lakeside edge of this section is about 155 feet long, with the eastern-most 50 feet consisting of a pile-supported concrete ramp (west ramp) that would be removed as part of this project. A field of about 432 untreated timber piles extends offshore from the west ramp. East of that section, the shoreline becomes a 500-foot length vertical concrete bulkhead, with a second concrete ramp (central) located near the middle of the bulkhead. A second field of about 400 untreated timber piles extends offshore of the central ramp.

From the east edge of the bulkhead, sand and pea gravel shoreline with artificial log jams extends about 1,100 feet to the northeast along the DNR mitigation area. The apron is between 20 and 180 feet inland from the OHW line along this section. Native riparian grasses, shrubs and trees grow along the DNR mitigation area. Most of the trees are in the north half of the area. East of the DNR mitigation area, an old double-walled steel sheet-pile flume with a solid-wood deck wraps around the northeast corner of the apron for about 290 feet.

The lake bed adjacent to the western apron bulkhead is relatively flat, with depths between about 12 and 18 feet along the shore. The lake floor rises to less than 10 feet at about 50 feet offshore, before descending again about 200 feet out. The nearshore substrate within the action area is dominated by organically-enriched, fine-grained sediments that likely supports a benthic community that consists predominantly of Chironomid fly larvae and oligochaete worms. Little to no macroalgae or other submerge aquatic vegetation (SAV) occurs within the action area.

Washington State's Department of Ecology (WDOE) identified exceedances of water quality standards for bacteria in the waters off of the City of Renton and within portions of the action area. Further, summer surface water temperatures within the area often exceed 17.5°C between July and September, and can exceed 16°C though October.

The past and ongoing anthropogenic impacts described above have reduced the action area's ability to support out-migrating juvenile PS Chinook salmon and PS steelhead. However, the action area continues to provide migratory habitat for adult and juvenile of both species, and the area has also been designated as critical habitat for PS Chinook salmon.

<u>Climate Change:</u> Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. However, the effects of climate change have not been homogeneous across the region, nor are they likely to be in the future. During the last century, average air temperatures in the Pacific Northwest have increased by 1 to 1.4° F (0.6 to 0.8 ^{o}C), and up to 2° F (1.1 ^{o}C) in some seasons (based on average linear increase per decade; Abatzoglou *et al*. 2014; Kunkel *et al*. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote *et al*. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10° F (1.7 to 5.6^{o} C), with the largest increases predicted to occur in the summer (Mote *et al*. 2014).

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote *et al*. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote *et al*. 2013 and 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote *et al*. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez *et al*. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote *et al*. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015, this resulted in 3.5 to 5.3^{o}C increases in Columbia Basin streams and a peak temperature of 26^{o}C in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua *et al*. 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak *et al*. 2012; Mantua *et al*. 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier *et al*. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer *et al*. 1999; Raymondi *et al*. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier *et al*. 2008; Raymondi *et al*. 2013; Wainwright and Weitkamp 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode *et al*. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (Lawson *et al*. 2004; McMahon and Hartman 1989).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney *et al*. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.5 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Direct effects are caused by exposure to action-related stressors that occur at the time of the action. Indirect effects are effects caused by the proposed action that occur later in time but are still reasonably certain to occur.

As described in Section 1.3, the applicant's contractors would conduct demolition and construction over a 3-year period. The majority of the work would occur inland of the Lake Washington shoreline, and all heavy equipment would be land-based. No barge use is planned for the project.

In-water and shoreline work would begin during the Year-1 winter in-water work window (November 16 through December 31). During that window, Boeing's contractors would perform in-water vibratory installation of steel sheet-piles to create a temporary bulkhead around the NW corner of the Area 1 apron (Figure 2). They would also operate submersible saws to cut-off and remove close to 400 derelict timber piles from the lake outside of the temporary bulkhead. The contactors would demolish the concrete decking along the lakeside edge of the apron, and install steel sheet-piles along the in-shore edge of the existing concrete bulkhead, as well as decommission 2 stormwater outfalls and extend 2 others. Outfall work would likely include the use a mix of land-based equipment and divers operating from relatively small workboats and platforms. Otherwise, all work would be performed from shore.

During the Year-2 summer in-water work window (July 16 through 31), and after the fill has been removed, Boeing's contractors would operate a land-based vibratory pile extractor to remove the temporary steel sheet-pile bulkhead around the NW corner of Area 1. In Area 2, they would use a mix of land-based equipment and divers operating from relatively small workboats and platforms to decommission stormwater outfall 002, install gravel and a new outfall (002A) at the NE corner of the apron (Figure 4). During the Year-2 winter in-water work window, Boeing's contractors would operate a land-based excavator to temporarily remove riprap from the shoreline to replace and extend outfall 004A, then to replace the riprap over the new outfall pipe. As above, outfall work would likely include the use a mix of land-based equipment and divers operating from relatively small workboats and platforms.

No in-water work is scheduled for Year-3. However, Boeing reports that unforeseen delays may prevent the on-schedule completion of some in-water work, and necessitate the rescheduling of some in-water work elements such that in-water work may occur during the Year-3 in-water work windows. Based on this uncertainty, the NMFS expects that it is possible for some part of all in-water work identified above to occur during a summer in-water work window.

As described in Section 2.2, PS Chinook salmon and PS steelhead regularly migrate through the action area, and critical habitat has been designated for PS Chinook salmon within the action area. The proposed in-water work windows avoid the typical migration periods for both adult and juvenile PS steelhead, as does the winter in-water work window for adult and juvenile PS Chinook salmon. However, the summer in-water work window is near the center of the typical in-migration period for adult PS Chinook salmon, and it overlaps with the last two weeks of the typical out-migration period for juveniles.

Therefore, summer in-water construction is likely to cause direct effects on PS Chinook salmon and the PBFs of their critical habitat through exposure to construction-related elevated noise, water quality impacts, and exposure to propeller wash. The COE-authorized bulkhead repairs would have the additional effect of extending the apron's useful life several decades (50 years) beyond that of the existing apron. Over that time, the apron and its interrelated aircraft manufacturing activities would cause effects on both species and on the PBFs of PS Chinook salmon critical habitat through the presence of armored shoreline, as well as apron-related artificial illumination and stormwater runoff.

2.5.1 Effects on List Species

Construction-related Elevated Noise

Exposure to construction-related noise would cause adverse effects in PS Chinook salmon. However, because the planned work windows avoid the expected presence of PS steelhead, it is very unlikely that any steelhead would be exposed to construction-related noise. Elevated in-water noise at levels capable of causing detectable effects in exposed fish would be caused by the in-water use of vibratory pile installation and extraction equipment, concrete pulverizers, and handheld underwater power saws.

The effects of a fishes’ exposure to noise vary with the hearing characteristics of the exposed fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin *et al*. 2009), startle responses and altered swimming (Neo *et al*. 2014), abandonment or avoidance of the area of acoustic effect (Mueller 1980; Picciulin *et al*. 2010; Sebastianutto *et al*. 2011; Xie *et al*. 2008) and increased vulnerability to predators (Simpson *et al*. 2016). At higher intensities and/or longer exposure durations, the effects may rise to include temporary hearing damage (a.k.a. temporary threshold shift or TTS, Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may lead to physical injury that can range from the onset of permanent hearing damage (a.k.a. permanent threshold shift or PTS) and mortality.

The best available information about the auditory capabilities of the fish considered in this Opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin *et al*. 2010; Scholik and Yan 2002; Xie *et al*. 2008).

The NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds. The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Any received level (RL) below 150 dB_{SEL} is considered “Effective Quiet”. The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when there is a difference between the ranges to the isopleths for effective quiet and SEL_{cum}, the shorter range shall apply.

The discussion in Stadler and Woodbury (2009) makes it clear that the thresholds likely overestimate the potential effects of exposure to impulsive sounds. Further, the assessment did not consider non-impulsive sound because it is believed to be less injurious to fish than impulsive sound. Therefore, any application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, this assessment applies the criteria to both impulsive and non-impulsive sounds for continuity, and as a tool to gain a conservative idea of the sound energies that fish may be exposed to during the majority of this project.

The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, as described in recent acoustic assessments for a similar project (NMFS 2016; 2017b; 2018) and in other sources (CalTrans 2009; FHWA 2017). Based on the available information, the SLs for all sources would be below the 206 dB_{peak} threshold for the onset of instantaneous injury in fish, but some are above the 150 dB_{SEL} threshold.

In the absence of location-specific transmission loss data, variations of the equation RL = SL – #Log(R) are often used to estimate the received sound level at a given range from a source (RL = received level (dB); SL = source level (dB, 1 m from the source); # = spreading loss coefficient; and R = range in meters (m). Acoustic measurements in shallow water environments support the use of a value close to 15 for projects like this one (CalTrans 2009). This value is considered the practical spreading loss coefficient. Application of the practical spreading loss equation to the expected SLs suggests that in-water noise levels above the 150 dB_{SEL} threshold could extend to about 151 feet (46 m) from vibratory installation of the temporary sheet-pile bulkhead (Table 5).

Table 5. Estimated in-water dB_{peak} and dB_{SEL} Source Levels for construction-related sound sources. The ranges to the applicable source-specific effects thresholds for fish are highlighted in grey.

Source	Acoustic Signature	Source Level	Threshold Range
Vib. Install 24-inch Steel Sheet Pile	< 2.5 kHz Non-Impulsive	190 dB_{peak}	206 @ N/A
		175 dB_{SEL}	183 @ 123 m
		175 dB_{SEL}	187 @ 66 m
		175 dB_{SEL}	150 @ 46 m
Tugboat Propulsion	< 1,000 Hz Combination	185 dB_{peak}	206 @ N/A
		170 dB_{SEL}	183 @ N/A
		170 dB_{SEL}	187 @ N/A
		170 dB_{SEL}	150 @ 22 m
Backhoe-Mounted Impact Hammer	< 1 kHz Impulsive	188 dB_{peak}	206 @ N/A
		168 dB_{SEL}	183 @ UNK
		168 dB_{SEL}	187 @ UNK
		168 dB_{SEL}	150 @ 16 m
Saw	< 4 kHz Non-Impulsive	145 dB_{peak}	206 @ N/A
		135 dB_{SEL}	183 @ N/A
		135 dB_{SEL}	187 @ N/A
		135 dB_{SEL}	150 @ N/A

Working within the partially dewatered area inside of the temporary sheet-pile bulkhead could reduce the in-water sound levels from vibratory installation of the permanent sheet-pile bulkhead, but the level of attenuation is uncertain. Similarly, the expected in-water sound levels from pulverization of concrete along the water's edge and sheet-pile installation directly behind the concrete bulkhead are also uncertain. Attenuation due to propagation through the substrate or through a structure in direct contact with the water is often highly variable. In some cases, in-water RLs from an upland source are lower than an identical in-water source at the same range. In other cases, there is little to no difference between the two (CalTrans 2009). Additionally, sound propagation tends to increase as the density of the medium increases. Sound transmission though concrete is typically very good. To be protective of listed fish, given the uncertainty of sound attenuation through concrete and the substrate, this assessment assumes that all vibratory pile work and all concrete pulverization would occur in direct contact with lake waters.

Boeing reports that sheet pile installation and concrete pulverization is planned for the Year-1 winter work window, when adults and juveniles of both species are very unlikely to be present. However, as explained at the beginning of this section, some of this work could occur during a summer work window due to unexpected delays, and sheet pile extraction is planned for the Year-2 summer work window. Therefore, to avoid underestimating potential impacts on PS Chinook salmon, this assessment assumes that up to 16 days of in-water noise from some combination of vibratory sheet-pile installation/extraction and concrete pulverization may occur during both of the Year-2 and Year-3 summer in-water work windows. The NMFS further assumes that less than 12 hours of continuous noise would occur on any workday. The use of tugboats, if any, would be restricted to a winter in-water work window. Therefore, exposure to that noise source is considered very unlikely.

PS Chinook salmon that are beyond the 150 dB_{SEL} isopleth would be unaffected by the exposure. However, fish within the 150 dB_{SEL} isopleth are likely to experience a range of impacts that would depend on their distance from the source and the duration of their exposure. All of the adult PS Chinook salmon that may be exposed to construction noise would be much larger than 2 grams, independent of shoreline waters, and extremely unlikely to remain near enough to the project site to accumulate injurious levels of sound energy. The most likely effect of exposure to project-related noise would be temporary minor behavioral effects, such as avoidance of the area within about 177 feet around the project site. The exposure would cause no measurable effects on the fitness of exposed adults. Further, it is extremely unlikely that any avoidance of the project site would prevent fish from moving past the area, nor would it prevent them from accessing important habitat resources.

The juvenile PS Chinook salmon that may be present would be shoreline obligated, and some may be smaller than 2 grams. Juveniles that are within the 150 dB_{SEL} isopleth, are likely to experience behavioral disturbance, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation. Individuals that remain within the range where accumulated sound energy would exceed the 183/187 dB SEL_{cum} thresholds may also experience some level of auditory- and non-auditory tissue injury, which could reduce their likelihood of survival.

The number of juvenile PS Chinook salmon that may be impacted by construction-related noise is unquantifiable with any degree of certainty. However, it is expected to be very low because the July work window occurs after the density of juvenile PS Chinook salmon in the lake typically drops sharply following the June out-migration peak. Further, the area of acoustic effect would be relatively small and located in an area where the density of late-migrating fish would be lowest due to its distance from the lake's outlet to marine waters. Therefore, the number of juvenile PS Chinook salmon that may be affected by construction-related noise would comprise such a small subset of their cohort, that their loss would cause no detectable population-level effects.

<u>Construction-related Degraded Water Quality</u>

Exposure to construction-related degraded quality would cause minor effects in PS Chinook salmon, and it is very unlikely that any PS steelhead would be exposed. Water quality would be temporarily affected through increased turbidity. It may also be temporarily affected by reduce dissolved oxygen (DO) concentrations and by toxic materials that may be introduced to the water through construction-related spills and discharges.

<u>Turbidity:</u> Sheet-pile extraction, gravel installation, and riprap movement during outfall extension would mobilize bottom sediments that would cause episodic, localized, and short-lived turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe

the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison *et al*. 2010). Therefore, the two units of measure are easily compared.

The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Newcombe and Jensen (1996) reported minor physiological stress in juvenile salmon only after about three hours of continuous exposure to concentration levels of about 700 to 1,100 mg/l. Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson *et al*. 2006).

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Much of the mobilized sediment likely included material that fell out of the hollow piles. Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. The planned extraction of sheet-piles is extremely unlikely to mobilize as much sediment as described above, because they would have smaller surface areas for sediments to adhere to, and no tube to hold packed-in sediments. Therefore, the mobilization of bottom sediments, and resulting turbidity from the planned pile extraction is likely to be less than that reported by Bloch.

The amount of sediment mobilization that may be cause by gravel installation and/or riprap movement during outfall extension work is uncertain. However, given the low intensity of the work, and small size of the two affected areas, it is extremely unlikely that the extent and duration of any turbidity plumes that would result from this work would exceed that of pile extraction discussed above. Based on the best available information, construction-related turbidity would be very short-lived and at concentrations too low to cause more than very brief, non-injurious behavioral effects such as avoidance of the plume, mild gill flaring (coughing), and slightly reduced feeding rates and success in the PS Chinook salmon that may be exposed to it. None of these potential responses, individually, or in combination would affect the fitness or normal behaviors in exposed fish.

<u>Dissolved Oxygen (DO):</u> Mobilization of anaerobic sediments can decrease dissolved oxygen (DO) levels (Hicks *et al*., 1991; Morton 1976). The impact on DO is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz *et al*. 1988). Reduced DO can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low DO levels (Hicks 1999), and impacts tend to be more severe lower in the water column (LaSalle 1988). However, the small amount of sediments that would be mobilized suggests that any impacts on DO would be too small and short-lived to cause detectable effects in exposed fish.

Toxic Materials: Toxic materials may enter the water through construction-related spills and discharges, the mobilization of contaminated sediments, and/or the release of PAHs from creosote-treated timber piles during their removal. Fish can uptake contaminants directly through their gills, and through dietary exposure (Karrow *et al*. 1999; Lee and Dobbs 1972; McCain *et al*. 1990; Meador *et al*. 2006; Neff 1982; Varanasi *et al*. 1993). Petroleum-based fuels, lubricants, and other fluids commonly used by construction-related equipment contain Polycyclic Aromatic Hydrocarbons (PAHs). Other contaminants can include metals, pesticides, Polychlorinated Biphenyls (PCBs), phlalates, and other organic compounds. Depending on the pollutant, its concentration, and/or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Brette *et al*. 2014; Feist *et al*. 2011; Gobel *et al*. 2007; Incardona *et al*. 2004, 2005, and 2006; Mcintyre *et al*. 2012; Meadore *et al*. 2006; Sandahl *et al*. 2007; Spromberg *et al*. 2015).

Many of the fuels, lubricants, and other fluids commonly used in motorized vehicles and construction equipment are petroleum-based hydrocarbons with PAHs that are known to be injurious to fish. However, the project includes BMPs to reduce the risk and intensity of discharges and spills during construction. In the unlikely event of a construction-related spill or discharge, the event would likely be very small, quickly contained and cleaned. Also, non-toxic and/or biodegradable lubricants and fluids are strongly encouraged by the State, and are commonly used by many of the local contractors. Based on the best available information, the in-water presence of spill and discharge-related contaminants would be very infrequent, very short-lived, and at concentrations too low to cause detectable effects should a listed fish be exposed to them.

For similar projects that included pile removal and the use tugboats that may extend the range of water quality impacts, the estimated range of water quality effects is typically limited to the area within 300 feet. Based on the limited amount of in-water work and tugboat use for this project, the NMFS expects that construction-related water quality effects for this action would extend no more than 300 feet from the project site. Further, based on the best available information, as described above, any fish that may be exposed to construction-related water quality impacts would experience no more than temporary low-level behavioral effects, which individually, or in combination would not affect the fitness of exposed individuals.

Construction-related Propeller Wash

Construction-related propeller wash is likely to adversely affect PS Chinook salmon, but it is very unlikely that any PS steelhead would be exposed. Spinning boat propellers kill fish and small aquatic organisms (Killgore *et al*. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water that is known as propeller wash. Exposure to propeller wash can displace and disorient small fish. It can also mobilize sediments and dislodge aquatic organisms, including SAV, particularly in shallow water and/or at high power settings. This is called propeller scour.

Chinook salmon and steelhead are very unlikely to be present during the winter in-water work windows when tugboats may be used. However, during the summer in-water work window, the small workboats used to perform outfall decommissioning and extension work would episodically cause propeller wash when Chinook salmon are reasonably likely to be present. Adult Chinook salmon that migrate through the action area are likely to remain in relatively deep water and avoid construction-related noise and activity. Further, they would be able to swim against most propeller wash they might be exposed to without any measurable effect on their fitness or normal behaviors. Conversely, juvenile Chinook salmon that are within the area are likely to be relatively close to the surface and too small to effectively swim against the propeller wash. Individuals that are struck or very nearly missed by the propeller would be injured or killed by the exposure. Farther away, propeller wash may displace and disorient fish. Depending on the direction and strength of the thrust plume, displacement could increase energetic costs, reduce feeding success, and may increase the vulnerability to predators for individuals that tumble stunned and/or disoriented in the wash.

The number of individuals that would be affected by propeller wash is unquantifiable with any degree of certainty. However, based on the timing and location of the work, and on the relatively low number of workboat trips that would occur, the numbers of affected individuals would represent such a small subset of their cohort that their loss would cause no detectable population-level effects.

Construction-related propeller scour may also reduce SAV and diminish the density and diversity of the benthic community at the project site. However, the affected area would be limited to a very small area where little to no SAV is believed to exist. Further, any affected resources, such as benthic invertebrates would likely recover very quickly after work is complete. Therefore, the effects of project-related propeller scour would be too small to cause any detectable effects on the fitness and normal behaviors of juvenile Chinook salmon and steelhead in the action area.

<u>Armored Shoreline</u>

The post-construction Area 1 bulkhead is likely to adversely affect juvenile PS Chinook salmon and PS steelhead that annually pass through the action area. The proposed project would install about 188 linear feet of new sheet-pile bulkhead along the lakeside edge of the currently pile-supported apron in the northwest corner of Area 1, and reinforce about 500 feet of concrete bulkhead immediately east of the new sheet-pile bulkhead. Together these bulkheads would create/maintain a simplified and vertical shoreline habitat that would remain at the site several decades beyond the useful life of the exiting bulkhead and over-water apron.

Survival of out-migrating juvenile PS Chinook salmon and other salmonids is positively influenced by early rapid growth. While in freshwater, and for several weeks to months after they leave their natal streams, juvenile Chinook salmon and many other salmonids typically prefer undisturbed, gently sloping, shallow nearshore habitats. These habitats are very important to juvenile salmon because they provide high quality forage resources and refuge from predators. A growing body of research indicates that shoreline armoring negatively impacts aquatic and marine shoreline areas. It artificially steepens the shoreline and interrupts sediment recruitment and transport, which alters grain size. It often disconnects aquatic and terrestrial ecosystems that are naturally inter-dependent. It limits the retention of wood and beach wrack that support invertebrate organisms that are prey resources for juvenile salmon (Dethier *et al*. 2016; Heerhartz and Toft 2015; Sobocinski *et al*. 2010). Armoring with sheet pile bulkheads can also interrupt hyporheic flows that are important to healthy shoreline gravel habitats.

The steepened banks that are typical along armored shorelines effectively force migrating juvenile salmon to swim in deeper waters where foraging often comes at a higher energetic cost, and where they may encounter increased predation risk. Heerhartz and Toft (2015) report that feeding behaviors of juvenile salmon are higher along unarmored shorelines than along armored shorelines, and that decreased or altered prey availability along armored shorelines is detrimental to juvenile salmon in nearshore ecosystems. Deeper water also favors freshwater predatory species, such as smallmouth bass and northern pikeminnow that are known to prey heavily on juvenile salmonids (Celedonia *et al*. 2008a; Tabor *et al*. 2010). Willette (2001) reports that marine piscivorous predation of juvenile salmon increased fivefold when the juvenile salmon were forced to leave shallow nearshore habitats.

Along the post-project bulkhead, the aquatic habitat would consist of about 688 feet of vertical bank with depths between about 12 and 18 feet, virtually no SAV, and no riparian vegetation. While swimming along the bulkhead, juvenile Chinook salmon are likely to experience increased energetic costs during a life stage when rapid growth is critical. They may also experience increased exposure to piscivorous predators. Individuals that fail to escape predatory attacks would be killed. Individuals that do escape would experience reduced fitness due to increased energetic costs and stress-related effects that may reduce their overall likelihood of survival. Although typically larger and less shoreline obligated than out-migrating juvenile Chinook salmon, out-migrating juvenile steelhead that pass along this section of shoreline would also experience reduced forage success and increased exposure to piscivorous predators.

The annual numbers of juvenile Chinook salmon and PS steelhead that would be exposed to this stressor are unquantifiable with any degree of certainty, as are the intensities of the resulting effects exposed individuals would experience. However, over the life of the bulkhead, some Chinook salmon and steelhead are reasonably likely to experience measurably reduced fitness or mortality due to the exposure. The relatively small affected area suggests that the probability of exposure would be very low for any individual fish. Therefore, the annual numbers of fish that may experience measurably reduced fitness or mortality due to apron-related shoreline armoring would likely comprise extremely small subsets of the cohorts from their respective populations, and the numbers of exposed fish would be too low to cause detectable population-level effects.

<u>Apron-related Artificial Illumination</u>

Post-construction artificial illumination of Apron R is likely to adversely affect juvenile PS Chinook salmon and PS steelhead that annually pass through the action area. Boeing uses Apron R to work on and to move newly manufactured jet airplanes. Most aircraft movement and some aircraft work is done at night. The proposed action would not change the existing lighting at Apron R, but it would extend the useful life of the apron, and its interrelated and interdependent nighttime aircraft activities, several decades (about 50 years) beyond that of the exiting apron.

Nighttime artificial illumination of the water's surface attracts fish (positive phototaxis) and often shifts nocturnal behaviors toward more daylight-like behaviors. It may also affect lightmediated behaviors such as migration timing. Becker *et al*. (2013) found that the abundance of fish increased in artificially illuminated estuarine waters. Ina *et al*. (2017) reported strong positive phototaxis in juvenile Pacific bluefin tuna. In the Lake Washington Ship Canal, Celedonia and Tabor (2015) found that juvenile Chinook salmon were attracted to artificially lit areas at 0.5 to 2.5 lumens per square meter. Tabor *et al*. (2017) found that sub yearling Chinook, coho, and sockeye salmon in lacustrine environments exhibit strong nocturnal phototaxis when exposed to 5.0 to 50.0 lumens per square meter, with phototaxis positively correlated with light intensity. In the absence of artificial illumination, juvenile Chinook salmon in lacustrine environments typically feed and migrate during the day, and are inactive at night, residing at the bottom in shallow waters. They tend to move off the bottom and become increasingly active at dawn when light levels reach 0.8 to 2.1 lumens per square meter (Tabor and Piaskowski 2002). Celedonia and Tabor (2015) reported that attraction to artificial lights can delay the onset of early morning migration by up to 25 minutes for juvenile Chinook salmon in freshwater, but it didn’t alter migration timing in the evening.

Numerous lights are installed along the upper sides of the buildings that border the apron. Also, light fixtures are installed in the parking lots, mobile light stands are used on the apron, and light from open hangar bay doors also illuminate the apron and adjacent lake waters. Casne Engineering (2017) measured illumination levels along the shoreline and 200 feet offshore of the apron, and reported the levels in foot-candles. One foot-candle equals 1 lumen per square foot. The international standard (SI) counterpart of the foot-candle is lumens per square meter (a.k.a. lux). One foot-candle equals 10.76 lumens per square meter.

The reported average illumination levels along the shoreline and 200 feet offshore were 0.7 and 0.33 foot-candle (7.5 and 3.2 lumens per square meter), respectively. The reported maximum illumination levels at those distances were 2.7 and 0.5 foot-candles (29.1 and 5.4 lumens per square meter), respectively (Casne Engineering 2017). Even the lowest average illumination levels exceed the 0.5 lumen per square meter level where phototaxis has been documented in Chinook salmon (Celedonia and Tabor 2015). Further, the measurements were taken when no light carts were in operation on the apron, and the hangar doors were closed. Therefore, it is reasonable to expect that lakeside illumination levels may periodically exceed the reported levels.

Based on the best available information, overwater illumination caused by the existing lighting systems is likely to exceed the threshold where the onset of daylight activities and phototaxis would occur, and that the illumination would extend more than 200 feet beyond the edge of the apron. Therefore, juvenile Chinook salmon and steelhead that are close to the apron’s edge are likely to experience some level of nocturnal phototaxis and other altered behaviors, such as delayed resumption of migration in the morning.

The annual numbers of juvenile Chinook salmon and PS steelhead that would be exposed to this stressor are unquantifiable with any degree of certainty, as are the intensities of the resulting effects exposed individuals would experience. However, over the life of the apron, some juvenile Chinook salmon and steelhead are reasonably likely to experience measurably reduced fitness due to the exposure. The relatively small affected area suggests that the probability of exposure would be low for any individual fish. Therefore, the annual numbers of fish that may experience measurably reduced fitness or mortality due to apron-related artificial illumination would likely comprise small subsets of the cohorts from their respective populations, and the numbers of exposed fish would be too low to cause detectable population-level effects.

Apron-related Stormwater

Stormwater runoff from Apron R is likely to adversely affect PS Chinook salmon and PS steelhead. Over its extended life, stormwater runoff discharged from the repaired apron is likely to episodically introduce into lake waters contaminants at levels capable of causing detectable effects in exposed fish.

Stormwater runoff has been identified as an important source of water contamination in Puget Sound watersheds, and untreated stormwater runoff from roads and bridges has been directly linked to pre-spawner die off in adult coho salmon and to mortality in aquatic invertebrates that are important forage resources for juvenile salmonids (Mcintyre *et al*. 2015; Spromberg *et al*. 2015).

The major sources of stormwater pollutants from the apron would be contaminants that may leak or leach from the aircraft, vehicles, and materials that are stored on the apron and accumulate on the apron surface (Mcintyre *et al*. 2015; McQueen *et al*. 2010; Peter *et al*. 2018; Spromberg *et al*. 2015), as well as contaminants that accumulate on the rooftops of nearby buildings (WDOE 2008, 2014). The contaminants from the apron likely include petroleum-based PAHs, heavy metals, and a growing list of other transportation-related contaminants that are just beginning to be identified (Peter *et al*. 2018). Some of the materials stored on the ramp may also be sources of metals and other contaminants. Many common roofing materials leach metals, particularly arsenic, copper, and zinc (WDOE 2014). Rooftop structures such as air conditioners and ducting that are made of unprotected galvanized steel may also leach high levels of zinc (WDOE 2008). Additionally, roof runoff is likely to contain pollutants that accumulate through atmospheric deposition (Lye 2009).

PS Chinook salmon can uptake contaminants directly through their gills, and through dietary exposure (Karrow *et al*. 1999; Lee and Dobbs 1972; McCain *et al*. 1990; Meador *et al*. 2006; Neff 1982; Varanasi *et al*. 1993). Direct exposure to runoff-borne pollutants can cause effects in exposed fish that range from avoidance behaviors, to reduced growth, altered immune function, and immediate mortality in exposed individuals. The intensity of effects depends largely on the pollutant, its concentration, and/or the duration of exposure (Beitinger and Freeman 1983; Brette *et al*. 2014; Feist *et al*. 2011; Gobel *et al*. 2007; Incardona *et al*. 2004, 2005, and 2006; Mcintyre *et al*. 2012; Meadore *et al*. 2006; Sandahl *et al*. 2007; Spromberg *et al*. 2015).

Beitinger and Freeman (1983) report that fish possess acute chemical discrimination abilities and that very low levels of some water-borne contaminants can trigger strong avoidance behaviors. Exposure to PAHs can cause reduced growth, increased susceptibility to infection, and increased mortality in juvenile salmonids (Meador *et al*. 2006; Varanasi *et al*. 1993). Zinc can bind to fish gills and cause suffocation (WDOE 2008). In freshwater, exposure to dissolved copper at concentrations between 0.3 to 3.2 µg/L above background levels has been shown to cause avoidance of an area, to reduce salmonid olfaction, and to induce behaviors that increase juvenile salmon's vulnerability to predators (Giattina *et al*. 1982; Hecht *et al*. 2007; McIntyre *et al*. 2012; Sommers *et al*. 2016; Tierney *et al*. 2010). Acute exposure to untreated stormwater runoff from roads and bridges has been directly linked to pre-spawner die off in adult coho salmon (Mcintyre *et al*. 2015; Spromberg *et al*. 2015). However, the specific contaminants and mechanisms that cause the mortality are still not well understood. Some level of synergism between the various contaminants may be involved.

Indirect (trophic) exposure to runoff-borne pollutants can injure juvenile salmonids. Stormwater contaminants that settle to the bottom would be biologically available at the site into the foreseeable future. Amphipods and copepods uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum *et al*. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other fish through the food web. Varanasi *et al*. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the contaminated Duwamish Waterway. They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador *et al*. (2006) demonstrated that dietary exposure to PAHs caused "toxicant-induced starvation" with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon.

As a part of their coverage under their Industrial Stormwater General Permit (ISGP), Boeing Renton is required to perform quarterly sampling of its stormwater to verify that discharges don't exceed maximum acceptable levels of specific pollutants (i.e. 25 NTU for turbidity, pH between 5.0 and 9.0, no visible oil sheen, and maximum concentrations for total copper and zinc of 14 and 117 µg/L, respectively), and to immediately take corrective actions if needed. Also in compliance with their ISGP, Boeing employs BMPs and source control measures identified in their approved SWPPP to limit the introduction of pollutants into the stormwater. These include, but are not limited to the designation of a Stormwater Pollution Prevention Team, use of good housekeeping activities, routine inspections and preventative maintenance, spill response training for employees, and record keeping.

However, meeting the ISGP standards does not ensure that exposure to stormwater discharge would not adversely affect listed salmonids. For example, the ISGP-allowable copper concentration (14 µg/L) is above the known threshold for the onset of injurious behavioral effects in salmonids (0.3 to 3.2 µg/L). Unfortunately, the available science concerning other contaminants, their specific thresholds of effects, and their fate in the environment over time is woefully incomplete. However, the available information does make it clear that the list anthropogenic pollutants in stormwater is long and growing, and that alone and/or in combinations many of those contaminants are harmful to listed fish and to the habitat resources they depend on.

The proposed apron repairs would include the installation of 5 in-line stormwater treatment modules that would each consist of a coalescing plate type oil/water separator followed by a Modular Wetland Linear System (MWLS) unit. The proposed treatment system would remove high levels of pollutants from the stormwater, especially petroleum-based oils, but not all of them. The oil/water separators would first remove an undescribed amount of petroleum-based pollutants before the stormwater flows to the MWLS units. The MWLS units are advertised to remove about 85% of the total suspended solids (TSS); 95% of the motor oil; 50% of the total copper; 69% of the total zinc; 64% of the total phosphorus; and 45% of the nitrogen from the incoming stormwater (NMFS 2019b). However, because infiltration is not a reasonable option at the site, the stormwater with its residual contaminants would be discharged directly into lake Washington through several outfalls that are located along the apron's edge (Figures 2 and 4).

The proposed stormwater treatment system would be a large improvement over the existing situation where untreated stormwater is discharged to the lake. However, the treated stormwater is likely to contain residual pollutants, and the allowable concentration levels under the ISGP for the facility are not adequately protective of listed fish. Therefore, the NMFS expects that stormwater discharges from Apron R would sporadically contain harmful concentrations of pollutants, and that over the extended life of the apron, some PS Chinook salmon and PS steelhead are likely to be exposed to those harmful discharges. Juvenile PS Chinook salmon and PS steelhead may also be indirectly exposed to apron-related stormwater pollutants through the consumption of prey that uptake residual contaminants that settle to the substrate.

The concentrations of the various contaminants that would remain in the effluent are unknown and likely to be highly variable depending on apron activities and the timing and intensity of individual storm events. The concentrations would be positively correlated with the level of aircraft production and movement, spill and discharge events, and the length of time between precipitation events. Based on highway studies (CalTrans 2005), the highest concentrations would likely occur near the start of a heavy downpour event that occurs after a long dry spell that allows pollutants to build-up on the apron, such as in early- to mid-fall. Lower concentrations would occur later in a given storm and/or later in the season when precipitation events are more frequent because the build-up of pollutants would be lower. Similarly, the distance from the outfalls where the contaminants would dilute to levels too low to cause detectable direct and/or indirect effects is also unknown and expected to be highly variable.

The annual numbers of PS Chinook salmon and PS steelhead that would experience measurable fitness impacts from exposure to apron-related stormwater is unquantifiable with any degree of certainty, but the numbers are expected to be very low. In general, low numbers of returning adult Chinook salmon, and very low numbers of rearing stream-type juvenile Chinook salmon and juvenile steelhead could be within the action area during the early to middle fall season when the apron's stormwater would be most likely to contain injurious pollutant concentrations.

Most returning adult Chinook salmon would move through the action area relatively quickly to reach upstream spawning areas. Most would tend to swim in relatively deep water instead of along the shoreline where effluent concentrations would be highest. Therefore, the overlap of adult Chinook salmon with injurious concentrations of pollutants would typically be very brief, and involve very small subsets of any year's cohort. Rearing juveniles of both species tend to shelter and feed in shallow nearshore habitats where the concentrations of stormwater-borne pollutants would be highest. However, the use of the action area for rearing is very low for both species, especially compared to areas higher in the watershed. Further, the action area represents an incredibly very small amount of the rearing habitat used by both of these species. Therefore, any individuals that may be exposed apron-related pollutants would represent extremely small proportions of any year's cohort for their respective populations. Based on the available information, the numbers of either species that would experience reduced fitness or likelihood of survival due to apron-related stormwater would be too low to cause any detectable population-level effects.

2.5.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected Primary Biological Features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely last for weeks, and long-term effects are likely to last for months, years or decades.

Puget Sound Chinook Salmon Critical Habitat: The proposed action, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for PS Chinook salmon. The expected effects would be limited to the impacts on the PBF of freshwater migration corridors free of obstruction and excessive predation as described below.

1. Freshwater spawning sites – None in the action area.
2. Freshwater rearing sites – None in the action area.
3. Freshwater migration corridors:
   a. Free of obstruction and excessive predation – The proposed action would cause long-term minor adverse effects on this PBF. Extending the life of the apron would maintain nighttime artificial illumination at the site that may delay the resumption of morning migration by up to 25 minutes for exposed juveniles. Extending the life of the Area 1 bulkhead would maintain previously altered habitat conditions that may slightly improve the success of piscivorous predators by forcing juveniles swim in relatively deep water. Conversely, the removal of more than 400 derelict piles from the northwest portion of the apron may reduce the number of piscivorous predators in the action area.
   b. Water quantity – The proposed project would cause no effect on this PBF.
   c. Water quality – The proposed action would cause ephemeral and long-term minor adverse effects on this PBF. The action would cause no measurable changes in water temperature or salinity, but construction would briefly increase suspended solids and may slightly reduce DO, it may also temporarily introduce low levels of contaminants. Stormwater discharge would episodically introduce low levels of pollutants to the water over the life of the apron. Detectable construction-related effects are expected to be limited to the area within 300 feet of the project site, and to persist no more than several hours after work stops. The range of detectable stormwater-related effects is uncertain but likely less than 300 feet.
   d. Natural Cover – The proposed action would cause long-term minor effects on this PBF. Extending the life of the Area 1 bulkhead would maintain previously altered habitat conditions at the site that limit natural shoreline processes that would support the growth of submerged aquatic vegetation, thereby limiting the availability of natural cover in the action area.
4. Estuarine areas – None in the action area.
5. Nearshore marine areas – None in the action area.
6. Offshore marine areas – None in the action area.

2.6 Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to the consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section (Section 2.4).

The current condition of ESA-listed species and designated critical habitat within the action area are described in the Status of the Species and Critical Habitat and the Environmental Baseline sections above. The contribution of non-federal activities to those conditions include past and on-going bankside development in the action area, as well as upstream forest management, agriculture, urbanization, road construction, water development, and restoration activities. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of conservation groups dedicated to restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

The NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, the NMFS is reasonably certain that future non-federal actions such as the previously mentioned shoreline and upstream activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of the waters within the action area are also likely to increase as the human population grows.

The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead within the watersheds that flow into the action area. However, the implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. 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) appreciably reduce 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 for the conservation of the species.

As described in more detail above at Section 2.4, climate change is likely to increasingly affect the abundance and distribution of the ESA-listed species considered in the Opinion. It is also likely to increasingly affect the PBF of designated critical habitats. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to cause reduced instream flows in some systems, and may impact water quality through elevated in-stream water temperatures and reduced DO, as well as by causing more frequent and more intense flooding events.

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but is likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. The proposed action will cause direct and indirect effects on the ESA-listed species and critical habitats considered in the Opinion well into the foreseeable future. However, the action's effects on water quality, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA-listed Species

PS Chinook salmon and PS steelhead are both listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Both species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale.

PS Chinook salmon

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative, and the South Puget Sound MPG, which includes the Cedar River population, is considered at high risk of extinction due to low abundance and productivity. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species.

The project site is located along the southern shore of Lake Washington, immediately east of the mouth of the Cedar River. The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Short-term construction-related impacts, and long-term structure-related impacts, are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and possible mortality in low numbers of exposed individuals for decades to come. The annual numbers of individuals that are likely to be impacted by action-related stressors is unknown, but they are expected to be very low.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

PS Steelhead

The PS steelhead DPS is currently considered “not viable”, and the extinction risk for most DIPs is estimated to be moderate to high. Long-term abundance trends have been predominantly negative or flat across the DPS, especially for natural spawners, and growth rates are currently declining at 3 to 10% annually for all but a few DIPs. The abundance trend between 1984 and 2016 is strongly negative for the Cedar River DIP. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The project site is located along the southern shore of Lake Washington, immediately east of the mouth of the Cedar River. The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

PS steelhead are unlikely to be exposed to project-related work. However, long-term structure-related impacts, are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and possible mortality in low numbers of exposed individuals for decades to come. The annual numbers of individuals that are likely to be impacted by action-related stressors is unknown, but they are expected to be very low.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

As described above at Section 2.5, the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon.

Chinook salmon critical habitat

Past and ongoing land and water use practices have degraded salmonid critical habitat throughout the Puget Sound basin. Hydropower and water management activities have reduced or eliminated access to significant portions of historic spawning habitat. Timber harvests, agriculture, industry, urbanization, and shoreline development have adversely altered floodplain and stream morphology in many watersheds, diminished the availability and quality of estuarine and nearshore marine habitats, and reduced water quality across the region. Global climate change is expected to increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater habitats across the region. Rising sea levels are expected to increase coastal erosion and alter the composition of nearshore habitats, which could further reduce the availability and quality of estuarine habitats. Increased ocean acidification may also reduce the quality of estuarine habitats.

In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid critical habitat is uncertain, as is the degree to which those impacts may be tempered by adoption of less environmentally impacting land use practices, by the implementation of non-federal plans that are intended to benefit salmonids, and by efforts to address the effects of climate change.

The PBF for PS Chinook salmon critical habitat in the action area is limited to freshwater migration corridors free of obstruction and excessive predation. The site attributes of that PBF that would be affected by the action are limited to freedom from obstruction and excessive predation, water quality, and natural cover. As described above, the project site is located along a heavily impacted shoreline, and all of these site attributes currently function at greatly reduced levels as compared to undisturbed freshwater migratory corridors. Construction and the long-term presence of the Boeing apron and its interrelated activities would cause ephemeral and long term minor adverse effects on obstruction and predation, water quality, and natural cover.

Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would cause minor long-term negative changes in the quality or functionality of the freshwater migration corridors PBF in the action area. However, those changes are not expected to measurably reduce this critical habitat's current level of functionality or its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is the NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for PS Chinook salmon.

2.9 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). "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 incidental take statement (ITS).

2.9.1 Amount or Extent of Take

NMFS determined that incidental take is reasonably certain to occur as follows:

Harm of PS Chinook salmon from exposure to:

- construction-related noise,
- construction-related propeller wash,
- armored shoreline
- apron-related artificial illumination, and
- apron-related stormwater.

Harm of PS steelhead from exposure to:

- armored shoreline
- apron-related artificial illumination, and
- apron-related stormwater.

The NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be injured or killed by exposure to any of these stressors. The distribution and abundance of the fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can the NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that directly relate to the magnitude of the expected take.

For this action, the timing and duration of work, the type and size of the piles to be installed/extracted and the method of their installation are the best available surrogates for the extent of take of juvenile PS Chinook salmon from exposure to construction-related noise. The timing and duration of work is also the best available surrogate for the extent of take of juvenile PS Chinook salmon from exposure to construction-related propeller wash. Timing and duration of work is applicable for construction-related take because the planned work windows were selected to reduce the potential for juvenile salmonid presence at the project site. Therefore, working outside of the planned work window and/or working for longer than planned could increase the number of fish likely to be exposed to construction-related noise and propeller wash.

The type and size of the piles and the method of their installation/extraction are applicable for construction-related noise because pile installation/extraction is expected to be the loudest source of in-water noise for this project, and because the intensity of effect is is positively correlated with the loudness of the sound, which is determined by those details. Further, the number of fish that would be exposed to the noise is positively correlated with the size of the area of acoustic effect and the number of days that the area would be ensonified. In short, as the sound levels increase, the intensity of effect and the size of the ensonified area increases, and as the size of the ensonified area increases, and/or as the number of days the area is ensonified increases, the number of PS Chinook salmon that would be exposed to the sound would increase despite the low density and random distribution of individuals of these species in the action area. Based on the best available information about the planned pile installation/extraction, as described in Section 2.5, the daily duration of vibratory work would have no effect on the size of the area of acoustic effects for this project. Therefore, daily duration of vibratory work is not considered a measure of take for this action.

The length and configuration of the Area-1 bulkhead is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to armored shoreline. Increasing the bulkhead's length would increase energetic costs and risk of predation for juveniles of both species. Increased length would increase the distance they must swim where forage efficiency would be reduced and where deeper water would increase their vulnerability to piscivorous predators. Alteration of the bulkhead's configuration through the installation of exposed rip rap would increase the risk of predation by improving habitat conditions for piscivorous predators.

The post-construction lighting configuration of Apron R is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to apron-related artificial illumination. This is because the size of the artificially illuminated area and the intensity of the over-water illumination would be positively correlated with number, location, and types of lights that are installed throughout the apron area. As the number and intensity of the lights increase, the size and intensity of the artificially illuminated area would also likely increase. Increases in either would increase the number of exposed fish and/or increase the intensity of phototaxis and other light altered behaviors that the exposed fish would experience.

The best available surrogates for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to apron-related stormwater are the size of the apron and the design of the stormwater treatment system. The size the apron is appropriate because the volume of stormwater would be directly related to the amount of impervious area. Any increase in the volume of contaminated stormwater would increase in the amount of contaminants that enter the lake. The design of the stormwater treatment system is an appropriate surrogate because the concentration of contaminants that would remain in post-treatment stormwater would be directly related to the system’s level of contaminant removal, and to the system’s ability to manage flows before bypass of treatment occurs. Lower levels of contaminant removal and/or bypass of the filter system at lower flow levels would also increase the amount of contaminants that enter the lake. Any increase in the amount of contaminants that enter the lake could increase the number of individuals that would be exposed to them and/or increase the intensity of the impacts from the exposure (directly or through the trophic web).

In summary, the extent of take for this action is defined as:

Puget Sound Chinook salmon:

- In-water work July 16 through 31, and November 16 through December 31;
- Up to 16 days of in-water and/or shoreline vibratory installation/extraction of 24-inch steel sheet-piles during each summer in-water work window;
- Up to 16 days of shoreline concrete pulverization during each summer in-water work window;
- Up to 16 days of workboat operations during each summer in-water work window; and
- The size and configuration of the apron and bulkhead, as described in the proposed action section of this biological opinion.

Puget Sound steelhead:

- The size and configuration of the apron and bulkhead, as described in the proposed action section of this biological opinion.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that would trigger the need to reinitiate consultation.
Although these take surrogates could be construed as partially coextensive with the proposed action, they nevertheless function as effective reinitiation triggers. If the size and configuration of the structure exceeds the proposal, it could still meaningfully trigger reinitiation because the Corps has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for PS Chinook salmon (Section 2.8).

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

The COE shall require the applicant to:

1. Minimize incidental take of PS Chinook salmon from exposure to construction-related noise and propeller wash.

2. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to armored shoreline, and apron-related artificial illumination and stormwater.

3. Ensure the implementation of monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary. The COE or any applicant must comply with them in order to implement the RPM (50 CFR 402.14). The COE 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.

1. To implement RPM Number 1, Minimize incidental take of PS Chinook salmon from exposure to construction-related noise and propeller wash, the COE shall require the applicant to require their contractors to:
    a. Limit pile installation/extraction, shoreline concrete pulverization, and the use of workboats to July 16 through 31 and November 16 through December 31;
    b. Limit the use of tugboats and barges to November 16 through December 31;
    c. Limit pile installation to 24-inch steel sheet-piles;
    d. Limit pile installation/extraction to vibratory equipment. No impact pile driving shall be done; and
    e. Limit summertime pile installation/extraction, and any summertime concrete pulverization within 8 feet of the shoreline to no more than 16 days of work annually. Pile work and concrete pulverization may occur concurrently.

2. To implement RPM Number 2, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to armored shoreline, and apron-related artificial illumination and stormwater, the COE shall require the applicant to ensure that the post-construction size and configuration of the repaired apron do not exceed the dimensions, and include stormwater treatment as described in this biological opinion. In particular:
    a. The post-construction length of the Area-1 bulkhead shall not exceed 655 feet, and shall include no exposed rip rap;
    b. The stormwater treatment system shall meet or exceed the volume capacity and levels of treatment described in this biological opinion; and
    c. No additional lighting shall be installed, and no changes made to the existing lighting system that would increase nighttime illumination of the waters of Lake Washington.

3. To implement RPM Number 3, Implement monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded, the COE shall require the applicant to develop and implement a plan collect and report details about the take of listed fish. That plan shall:
    a. Require the contractor to maintain and submit construction logs to verify that all take indicators are monitored and reported. Minimally, the logs should include:
        i. The dates (with workday start and stop times) and descriptions of all in-water and near-shore work;
        ii. The type, size, and number of piles installed or extracted per day;
        iii. The method of pile installation and/or extraction; and
        iv. A description of best management practices and conservation measures employed, including the installation of containment booms and/or full-depth silt curtains.
    b. Require the contractor to establish procedures for the submission of the construction logs and other materials to the appropriate COE office and to NMFS; and
    c. Require the contractor to submit an electronic post-construction report to NMFS within six months of project completion. Send the report to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2019-00109 in the subject line.

2.10 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).

1. The COE and the applicant should encourage contracted tugboat operator(s) to use the lowest safe maneuvering speeds and power settings when maneuvering in shallow waters close to the shoreline to minimize propeller wash and mobilization of sediments.

2. The COE should encourage the applicant to develop a long-term plan to reduce the environmental impacts of Apron R. Suggested measures include:
    a. Remove the derelict piles that are offshore from the central ramp;

b. Install fill and plant native riparian vegetation along the lakeside edge of the Area-1 bulkhead to create shallow shoreline habitat that would be similar to the DNR mitigation area that is located along the northeastern part of the apron; and
c. Adjust and/or modify the existing lighting systems and nighttime work practices to reduce over-water artificial illumination.

3. The Corps should conduct or support continuing research to better understand the distribution, abundance, and habitat use of PS Chinook salmon, PS steelhead, and other species in southern Lake Washington and the lower Cedar River.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S. Army Corps of Engineers' authorization of the Boeing Company's Apron R Infrastructure Maintenance and Repair Project in King County, Washington. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitats in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitats that was not considered in this Opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect essential fish habitat (EFH). The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. This analysis is based, in part, on the description of EFH for Pacific Coast salmon contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC 2014) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The waters and substrates of the action area is designated as freshwater EFH for Pacific Coast Salmon, which within Lake Washington include Chinook and coho salmon. Freshwater EFH for

Pacific Coast Salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014), and consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat.

Those components of freshwater EFH for Pacific Coast Salmon depend on habitat conditions for spawning, rearing, and migration that include: (1) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); (2) water quantity, depth, and velocity; (3) riparian-stream-marine energy exchanges; (4) channel gradient and stability; (5) prey availability; (6) cover and habitat complexity (e.g., LWD, pools, aquatic and terrestrial vegetation, etc.); (7) space; (8) habitat connectivity from headwaters to the ocean (e.g., dispersal corridors); (9) groundwater-stream interactions; and (10) substrate composition.

The action area provides migratory habitat for juvenile and adult Chinook and coho salmon. No salmon spawning habitat occurs within the action area, and the action area includes no known habitat features that meet the definition of habitat areas of particular concern (HAPC) for Pacific Coast Salmon.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitat, and is relevant to the effects on EFH for Pacific Coast Salmon. Based on the analysis of effects presented in Section 2.5 the proposed action will cause small scale long-term adverse effects adverse effects on EFH for Pacific Coast Salmon through direct or indirect impacts as summarized below.

1. Water quality: – The proposed action would cause a long term mix of minor adverse effects on water quality. Construction would briefly increase suspended solids and may temporarily introduce low levels of contaminants. Stormwater discharge would episodically introduce low levels of pollutants to the water over the life of the apron. Detectable effects are expected to be limited to the area within about 300 feet of the project site.

2. Water quantity, depth, and velocity: – The proposed temporary towpath bypass would cause the temporary loss of about 0.11 acre of the lake habitat. The proposed action may also cause long term minor adverse effects on water velocity. The post-construction bulkhead and the retention of the central derelict pile field may slightly alter the direction and velocity of the water flows immediately adjacent to the structures.

3. Riparian-stream-marine energy exchanges: – No changes expected.

4. Channel gradient and stability: – No changes expected.

5. Prey availability: – The proposed action would cause long term minor adverse effects on prey availability. The post-construction bulkhead would maintain deep water shoreline

conditions that limit aquatic productivity and increase the energetic costs for juvenile Chinook and coho salmon that forage within the action area.

6. Cover and habitat complexity: – The proposed action would cause long term minor adverse effects on cover and habitat complexity. The post-construction bulkhead would prevent the formation of complex habitat at the project site.

7. Space: – No changes expected.

8. Habitat connectivity from headwaters to the ocean: – No changes expected.

9. Groundwater-stream interactions: – The proposed action would cause long term minor adverse effects on groundwater-stream interactions. The post-construction sheet-pile bulkhead may slightly disrupt hyporheic flow along its length.

10. Substrate composition: – No changes expected.

3.3 Essential Fish Habitat Conservation Recommendations

The proposed action includes conservation measures, BMP, and the installation of a new stormwater treatment system to reduce construction- and structure-related impacts on the quantity and quality of Pacific Coast salmon EFH. It also includes the removal of over 400 derelict piles. With the exception of the following conservation recommendations to reduce impacts on water quantity, depth, and velocity; and on prey availability, the NMFS knows of no other reasonable measures to further reduce effects on EFH.

To reduce adverse impacts on water quantity, depth, and velocity, and on prey availability, the COE should require the applicant to:

1. Remove the derelict piles that are offshore from the central ramp; and

2. Install fill and plant native riparian vegetation along the lakeside edge of the Area-1 bulkhead to create shallow shoreline habitat that would be similar to the DNR mitigation area that is located along the northeastern part of the apron.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the COE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The COE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this Opinion is the COE and the Boeing Company. Other users could include WDFW, the governments and citizens of King County and the City of Renton, and Native American tribes. Individual copies of this Opinion were provided to the COE. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by the NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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