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

Refer to NMFS No: NWR/2011/05286

March 10, 2017

Jeffrey J. Rikhoff, Acting Chief
Environmental Review and Project Management Branch
Division of License Renewal
Office of Nuclear Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Renewing the Operating License for the Columbia Generating Station, Richland, Washington

Dear Mr. Rikhoff:

Thank you for your letter of March 2, 2016, requesting completion 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 renewing the operating license for the Columbia Generating Station, Richland, Washington.

The enclosed document contains a biological opinion (Opinion) prepared by NMFS pursuant to section 7(a)(2) of the ESA on the effects of the U.S. Nuclear Regulatory Commission's (NRC) renewing the operating license for the Columbia Generating Station. In this Opinion, NMFS concludes that this action is not likely to jeopardize the continued existence of Upper Columbia River spring run Chinook salmon and Upper Columbia River steelhead, and is not likely to result in the destruction or adverse modification of their designated critical habitat.

Although the NRC did not make ESA determinations for Southern Resident killer whales (*Orcinus orca*) and their critical habitat, in accordance with NMFS's policy on marine mammals, NMFS analyzed the effects of the action to this species and habitat. The attached document concludes that the action "may affect," but is "not likely to adversely affect" Southern Resident killer whales and their critical habitat.

NMFS also reviewed the likely effects of the action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act MSA) (16

U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast salmon (Chinook salmon and coho salmon). This document includes two Conservation Recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving Conservation Recommendations.
Please contact Ritchie Graves (phone: 503-231-6891, email: ritchie.graves@noaa.gov) or Lynne Krasnow (phone: 503-231-2163, email: lynne.krasnow@noaa.gov) if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Michael Tehan
for

Barry A. Thom
Regional Administrator

Enclosure

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

Renewing the Operating License for the Columbia Generating Station, Richland, Washington

NMFS Consultation Number: NWR-2011-05286

Action Agency: U.S. Nuclear Regulatory Commission

Affected Species and NMFS's Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is the Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Upper Columbia River Spring-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	Yes	No
Upper Columbia River Steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern Resident Killer Whale (*Orcinus orca*)	Endangered	No	N/A	N/A	N/A

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

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

Issued By: Michael Jehan for

Barry A. Thom
Regional Administrator

Date: March 10, 2017

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List of Acronyms

ALARA	As Low As Reasonably Achievable
BA	Biological Assessment
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
cfs	Cubic Feet Per Second
CGS	Columbia Generating Station
CHART	Critical Habitat Analytical Review Team
CWA	Clean Water Act
CWIS	Cooling Water Intake Structure
DOE	Department of Energy
DPS	Distinct Population Segment
DQA	Data Quality Act
EA	Environmental Assessment
ECOTX	Ecotoxicology Database
EFH	Essential Fish Habitat
EFSEC	Energy Facility Site Evaluation Center
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESU	Evolutionarily Significant Unit
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
GAL	Gallons
Geometric Means	Geomeans
GPM	Gallons per Minute
HUC	Hydrologic Unit Code
ICTRT	Interior Columbia Technical Recovery Team
ITS	Incidental Take Statement
MCR	Middle Columbia River

MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOEC	No Observable Effect Concentration
NPDES	National Pollutant Discharge Elimination
NRC	Nuclear Regulatory Commission
NWFSC	Northwest Fisheries Science Center
Opinion	Biological Opinion
PBF	Physical or Biological Features
PCE	Primary Constituent Element
PFMC	Pacific Fishery Management Council
RCP	Representative Concentration Pathway
REMP	Radiological Environmental Monitoring Program
RESRAD	RESidual RADioactive
RM	River Mile
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measures
SRKW	Southern Resident Killer Whale
UCR	Upper Columbia River
USDOE	United States Department of Energy
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WNP-2	WPPSS Nuclear Project No. 2
WPPSS	Washington Public Power Supply System
WSDOE	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

National Marine Fisheries Service (NMFS) prepared the biological opinion (Opinion) and incidental take statement (ITS) 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 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 (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS's Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). A complete record of this consultation is on file at the West Coast Region's Interior Columbia Basin Office in Portland, Oregon.

1.2 Consultation History

Energy Northwest initiated the proposed Federal action by submitting an application for license renewal for Columbia Generating Station (CGS) to the U.S. Nuclear Regulatory Commission (NRC) on January 19, 2010 (Energy Northwest 2010). The NRC noticed the receipt and availability of the renewal application on January 26, 2010. The renewal application requested an extension of the original license, which would have expired on December 20, 2023, for an additional 20 years beyond that date. The NRC's Federal action was therefore the extension of the license for an additional 20 years. The NRC issued the requested renewed license on May 22, 2012, prior to completing ESA consultation (NRC 2012a). The renewed license expires on December 20, 2043.

By letter of August 23, 2011, the NRC requested NMFS's concurrence with its determination that its action of renewing Energy Northwest's license for operations at CGS may affect, but is not likely to adversely affect ESA-listed anadromous fish and their critical habitats in the Columbia River. The CGS is a nuclear commercial energy facility located 12 miles northwest of Richland, Washington. It is owned and operated by Energy Northwest, a municipal corporation and joint operating agency of the State of Washington. The NRC issued the initial operating license for CGS on April 13, 1984, and CGS has been operating since that time. The renewed license authorizes Energy Northwest to operate CGS at reactor core power levels not in excess of 3,486 megawatts thermal.

In support of this request, NRC provided a draft environmental impact statement (EIS) (NRC 2011) that included a biological assessment (BA) and essential fish habitat assessment. Following review of this and other information, we determined that due to design characteristics, the CGS cooling water intake structure (CWIS) was a potential hazard to ESA-listed anadromous fish species (Upper Columbia River [UCR] spring-run Chinook salmon and UCR steelhead) and was likely to injure or kill individuals of both species. We informed the NRC that we could not concur with its “not likely to adversely affect” determination by letter of October 24, 2011 from William Stelle, NMFS, to David Wrona, NRC.

The normal process following such a determination is to conduct formal ESA section 7(a)(2) consultation, leading to issuance of a biological opinion. In response to a recommendation in our letter dated October 24, 2011, that NRC develop a CWIS design that meets NMFS’s criteria and a schedule for implementation in addition to the proposed action identified in the BA, NRC informed us in a December 20, 2011, letter that the CWIS design is regulated under the Federal Water Pollution Control Act of 1972 (Clean Water Act or CWA), which is administered by the U.S. Environmental Protection Agency (EPA) and its designated state representatives, not the NRC. At that time, the Washington State Energy Facility Site Evaluation Council (EFSEC), a state agency that has been delegated CWA authority by EPA and is authorized by the state of Washington to evaluate various aspects of energy developments in Washington State, was in the process of reviewing the Energy Northwest’s request for renewal of its National Pollutant Discharge Elimination (NPDES) Waste Discharge permit for CGS. We therefore postponed completion of this Opinion to pursue resolution of our concerns with the CGS CWIS through the NPDES permit renewal process. Discussions of pertinent technical issues occurred between technical staff of the affected agencies for several years.

This effort culminated in EFSEC’s issuance of a new NPDES permit for CGS on September 30, 2014, which became effective on November 1, 2014. With issuance of this NPDES permit, which was subsequently modified on February 8, 2016 (EFSEC 2016), the operating conditions for discharges, cooling water withdrawals, and monitoring activities that would occur for the next five years of CGS’s operations under its NRC license became sufficiently defined for NMFS to complete consultation and issue this Opinion for renewing the operating license for CGS. Although we are not consulting on the issuance of the NPDES permit by a Washington State agency (EPA previously delegated its authority to the State of Washington), without NRC’s issuance of a license CGS would not operate and would not withdraw cooling water or discharge effluents. We therefore evaluate the effects of the cooling water intake withdrawals and effluent discharges as direct effects of the action. We also consider the requirements of the NPDES permit for effluent limits, monitoring, evaluation of impingement and entrainment, and an entrainment study as well as the data on effluent constituents cited in the 2014 Fact Sheet (EFSEC 2014). In addition, we evaluate the effects of conducting the entrainment and impingement studies required by the permit as interrelated actions because if Energy Northwest did not implement these permit conditions, it would lose the ability to withdraw cooling water from the Columbia River and the NRC license would require it to shut down operations.

Although the NRC did not make ESA determinations for effects on the Southern Resident killer whale (SRKW) (*Orcinus orca*) Evolutionarily Significant Unit (ESU), NMFS's review of the action's effects on salmon and steelhead identified potential impacts on the prey availability for the whales. For this reason, and in accordance with NMFS's guidance on marine mammal consultations (Stelle 2013), the Opinion also provides an analysis of effects, concluding with a determination of "may affect, not likely to adversely affect" for SRKWs (section 2.12).

NMFS informed NRC of its intent to prepare a biological opinion and issue an incidental take statement (ITS) as required for actions that are likely to adversely affect ESA-listed species in a letter dated October 27, 2014. In a letter dated March 2, 2016, the NRC notified NMFS of its desire "to work with the NMFS to complete ESA consultation related to the application of Energy Northwest for the renewal of the [CGS] operating license for an additional 20 years from 2023 to 2043." NMFS informed NRC in an August 3, 2016 letter that it had sufficient information to complete the consultation and was working to prepare a draft biological opinion during September, 2016. Additional technical issues were discovered that delayed the completion of the draft biological opinion beyond this date, but these issues were resolved through discussions with NRC and Energy Northwest staff.

NMFS notified potentially affected tribes, the Nez Perce Tribe and the Confederated Tribes and Bands of the Yakama Nation, of this consultation and offered to share our initial findings and to consult with them in accordance with Executive Orders #3206 and 13175. We discussed our draft findings with technical representatives of the Nez Perce Tribe on January 20, 2017, and with technical representatives of the Umatilla Tribe on January 27 and 30, 2017. Neither requested further discussions or government-to-government consultation.

1.3 Federal Action

For ESA consultations, "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). For EFH consultations, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). For the purposes of this consultation, the action is identical.

Columbia Generating Station is located in Benton County, Washington, 12 miles northwest of Richland, Washington and approximately 160 miles southeast of Seattle. The CGS site is located on land leased from the U.S. Department of Energy (DOE) within the Hanford Site. The leased area is bounded on the east by the Columbia River. Figure 1 and Figure 2 show the position of CGS in the Columbia River basin (50-mile vicinity map) and within the Hanford Reach (6-mile vicinity map), respectively.

Figure 1. Location (50-mile radius) of CGS. Source: NRC (2012b)

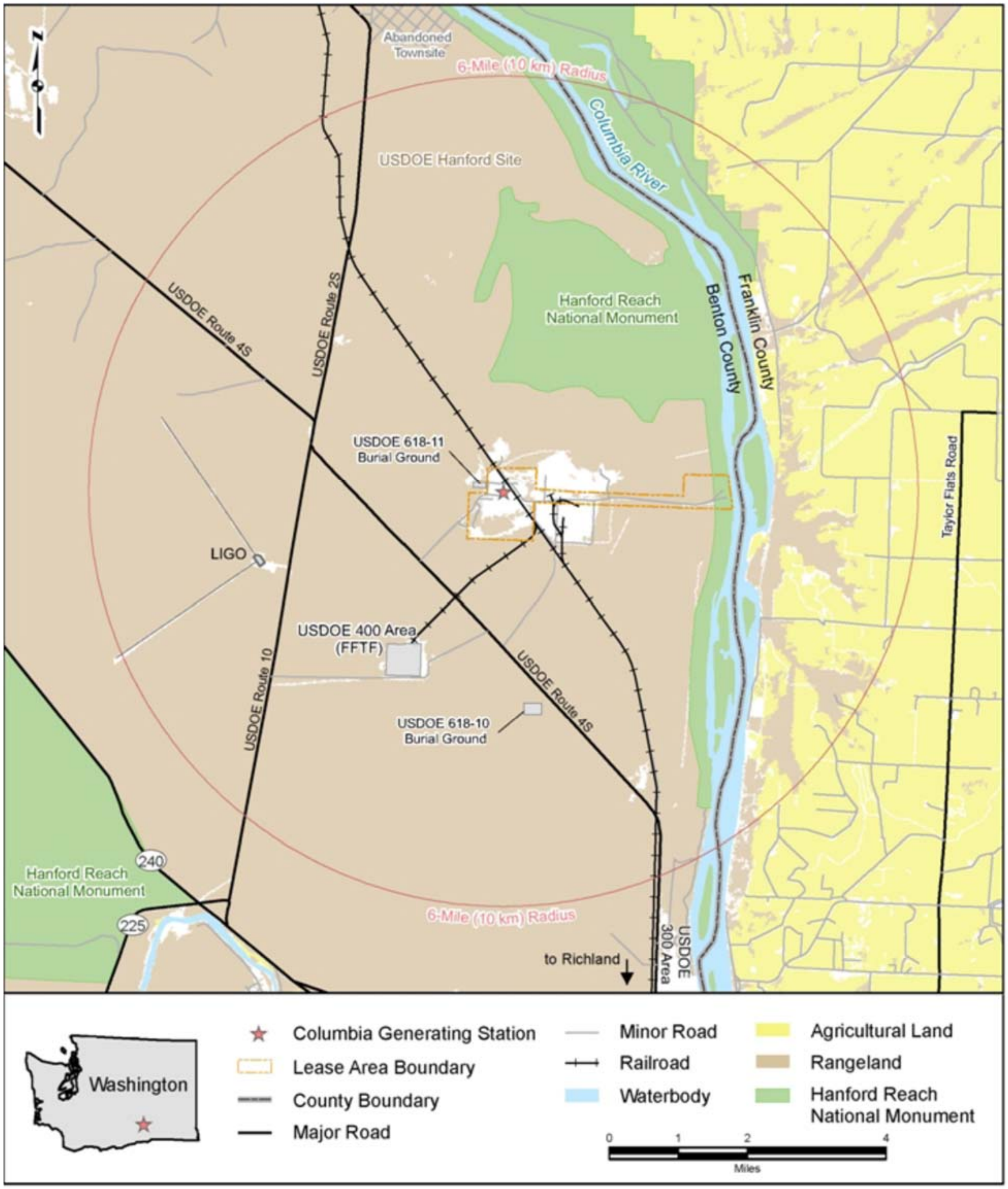


Figure 2. Location (6-mile radius) of CGS. Source: NRC (2012b)

Energy Northwest, formerly known as the Washington Public Power Supply System (WPPSS), is the owner and licensee of CGS. The CGS was formerly known as Hanford No. 2 and WPPSS Nuclear Project No. 2 (WNP-2). Energy Northwest is a municipal corporation and joint operating agency of the State of Washington. It is comprised of 27 public member utilities from across the state. All electrical energy produced at CGS is delivered to electrical distribution facilities that are owned and operated by Bonneville Power Administration (BPA) as part of the Federal Columbia River Power System (FCRPS) (NRC 2012b).

The CGS is a single unit, nuclear-powered, steam electric facility that began commercial operation in December 1984. The plant is a boiling-water reactor. The reactor core produces heat that boils water, producing steam for direct use in a turbine generator to produce electricity. The CGS circulating water system is a closed-cycle cooling system that removes heat from the condenser and transfers it to the atmosphere through evaporation using six mechanical draft cooling towers (NRC 2012b). A portion of the cooling water is lost through evaporation and drift, leading to the concentration of dissolved solids in the cooling water. A portion of the cooling water, called "blowdown" water, is routinely discharged back to the Columbia River and replenished with freshwater to control the buildup of dissolved solids in the cooling system. A circulating water system pumps water from the Columbia River to replenish the water lost from evaporation, drift, and blowdown. The makeup-water pumphouse is located 3 miles east of the CGS plant and houses three 800-horse power makeup-water pumps. The pumps are designed to each supply 12,500 gallons per minute (gpm), or half the system capacity, at the design head. Two pumps normally supply makeup water to the plant with a withdrawal capacity of 25,000 gpm (56 cubic feet per second (cfs)). During normal operating periods, the average makeup-water withdrawal is about 17,000 gpm (about 38 cfs). Average daily withdrawals from January, 2011, to December, 2016, were above 43 cfs only 5% of the time (Khounnala 2017).

The action includes renewing the ongoing operation of the reactor and containment systems, radioactive waste management, nonradiological waste management, plant operation and maintenance, the power transmission system, and the operation of the cooling and auxiliary water systems (which includes the withdrawal of water from the Columbia River for cooling purposes), and the return of effluent to the river for an additional 20 years (through 2043). The following description focuses on aspects of the action that have the potential to affect ESA-listed species or their habitat.

1.3.1 Water Withdrawals from the Columbia River

The CGS withdraws water from the Columbia River to replenish the circulating water system, the plant service water system, and the standby service water system. The circulating-water system supplies cooling water for the condenser at CGS. The plant service-water system removes the rejected heat from the auxiliary equipment during normal operation. The standby service-water system is a separate cooling water system that removes heat during a loss-of-coolant accident and removes residual reactor heat during a normal shutdown.

The CGS circulating-water system is a closed-cycle cooling system that removes heat from the condenser and transfers it to the atmosphere through evaporation using six mechanical draft cooling towers. The circulating-water pumphouse circulates the water from the condenser through the cooling towers and back again at a rate of about 550,000 gpm (1,236 cfs). The temperature of the cooling water in the circulating-water system increases by about 30.6 degrees (°) Fahrenheit (F) (17° Celsius (C)) as the water flows through the condenser. Each cooling tower is 60 feet tall and about 200 feet in diameter at its base.

The intake system for the makeup water pumps consists of two 36-inch diameter buried pipes that extend 900 feet from the pumphouse into the Columbia River, about 300 feet from the shoreline at about river mile (RM) 352 (Figure 3). An intake structure is located at the end of each of the pipes. The pipes make a 90-degree bend and extend slightly above the surface of the riverbed. Each of the pipes ends with an intake structure (20 feet in length) mounted above the riverbed and approximately parallel to the river flow (Figure 4).

Each intake structure is composed of two intake screens that are each 6.5 feet in length (Figure 5) and mounted end to end. The remaining length of the intake structure consists of two solid cones at either end of the structure. The center of each intake is unscreened where it mounts to the vertical connector to the pipes that convey flow to the onshore pumphouse. The intake screens consist of an outer and inner perforated pipe sleeve (Figure 6). The holes in the outer 42-inch diameter sleeve are 3/8-inch in diameter and cover 40% of the surface area. The holes in the inner 36-inch diameter sleeve are 3/4-inch in diameter and cover 7% of the surface area. The purpose of the perforated inner sleeve is to balance the flow through the outer screen to roughly equalize approach velocities at all points on the screen surface.

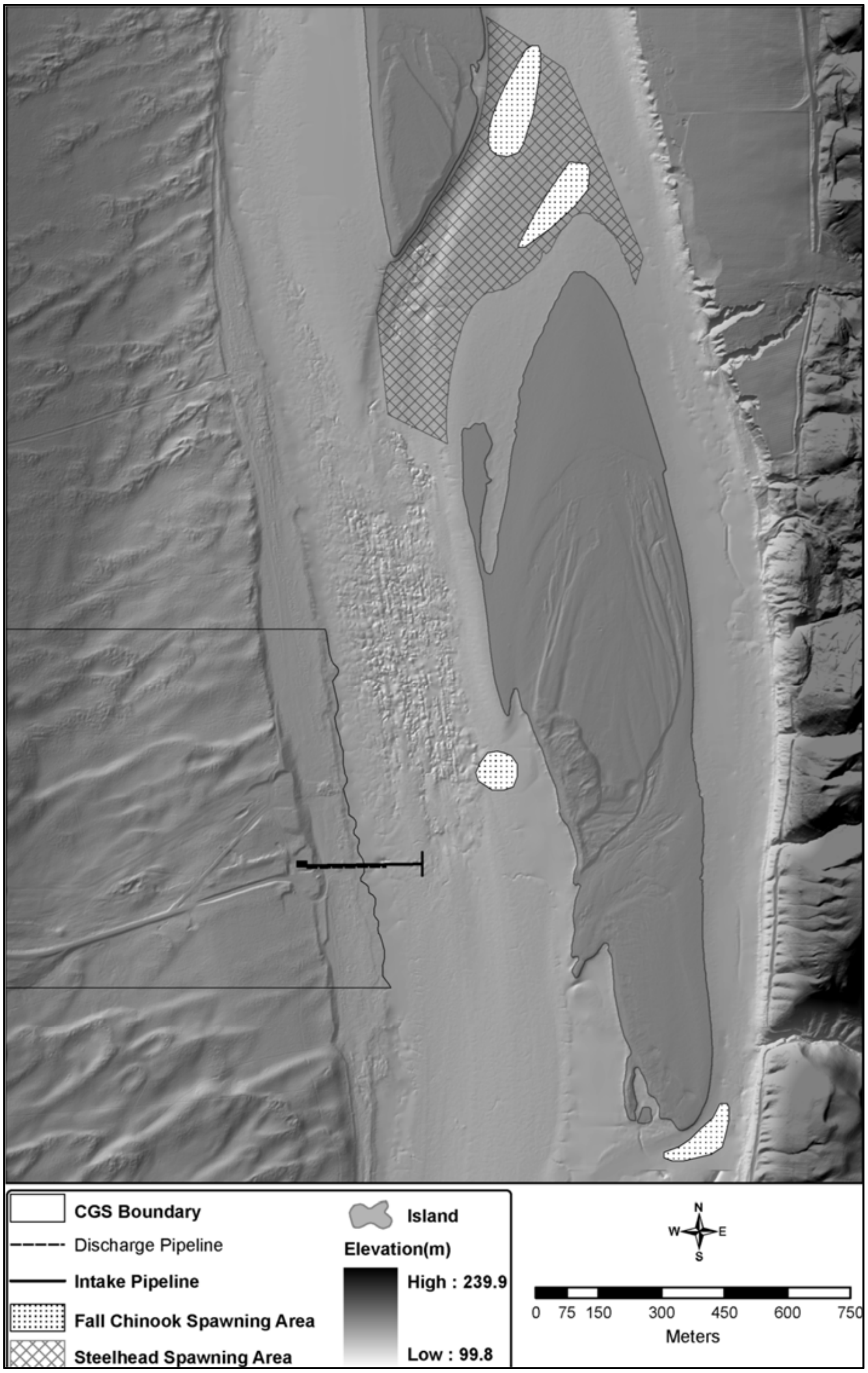


Figure 3. Plan view of the CGS cooling water intake system and outfall and known spawning locations of fall Chinook and steelhead. The intake and outfall pipes are at the same location except the intake pipe extends about 125 feet further from shore (300 feet from the shoreline). Source: NRC (2012b)

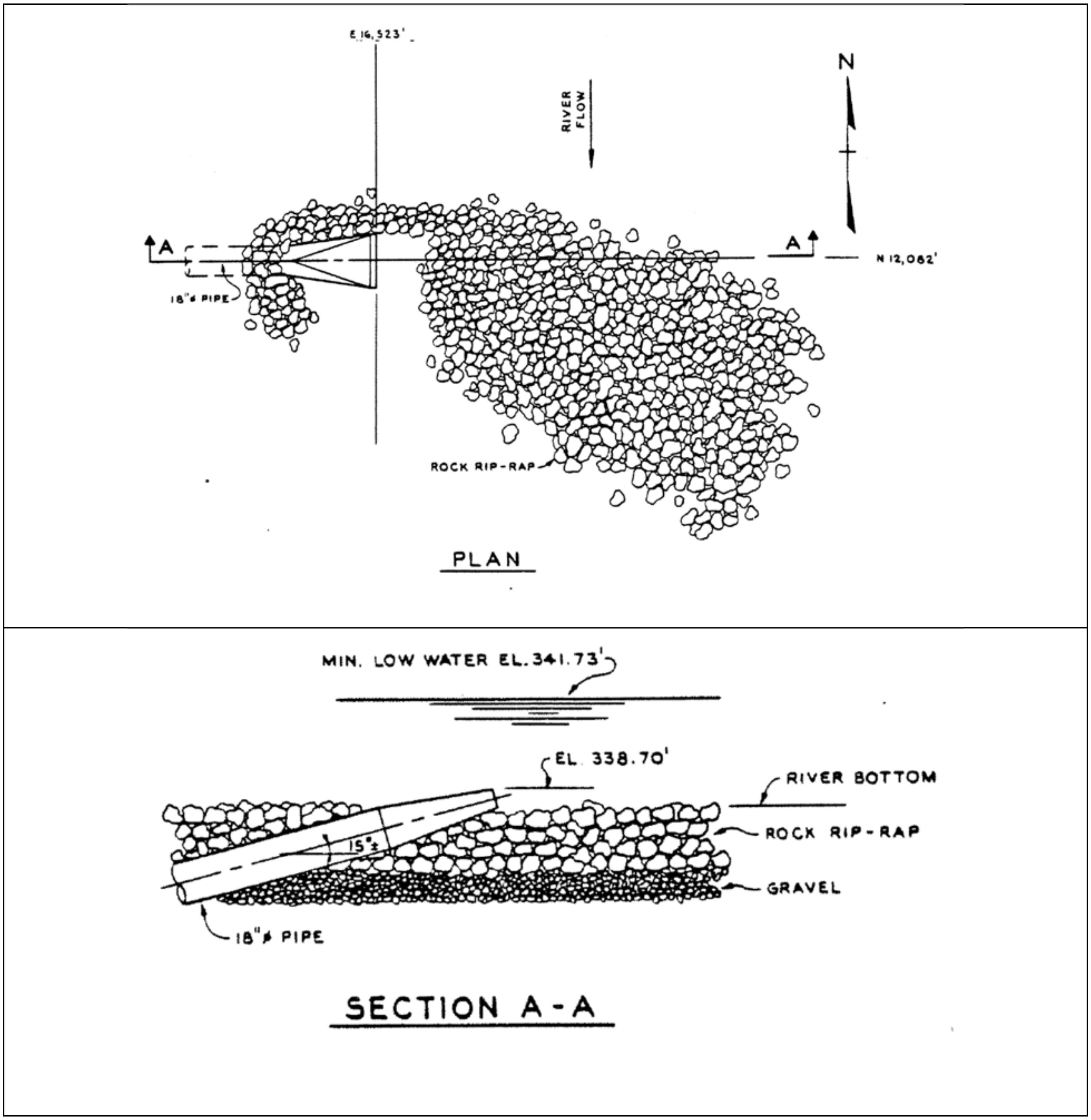


Figure 4. The CGS blowdown wastewater discharge pipe, plan and profile views. Source: NRC (2012b)

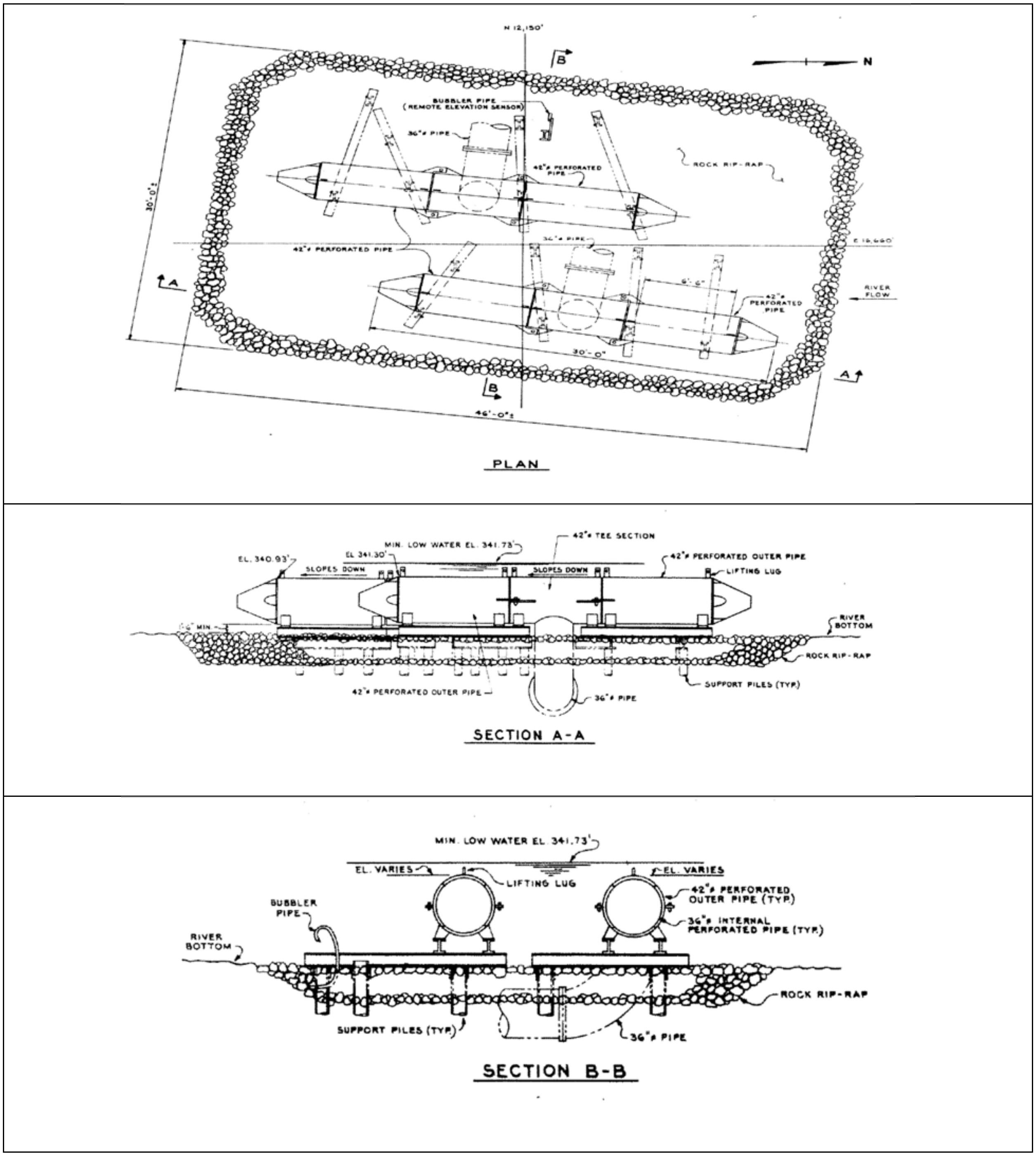


Figure 5. Plan and cross sections of the cooling water intake screens at CGS. Source: NRC (2012b)

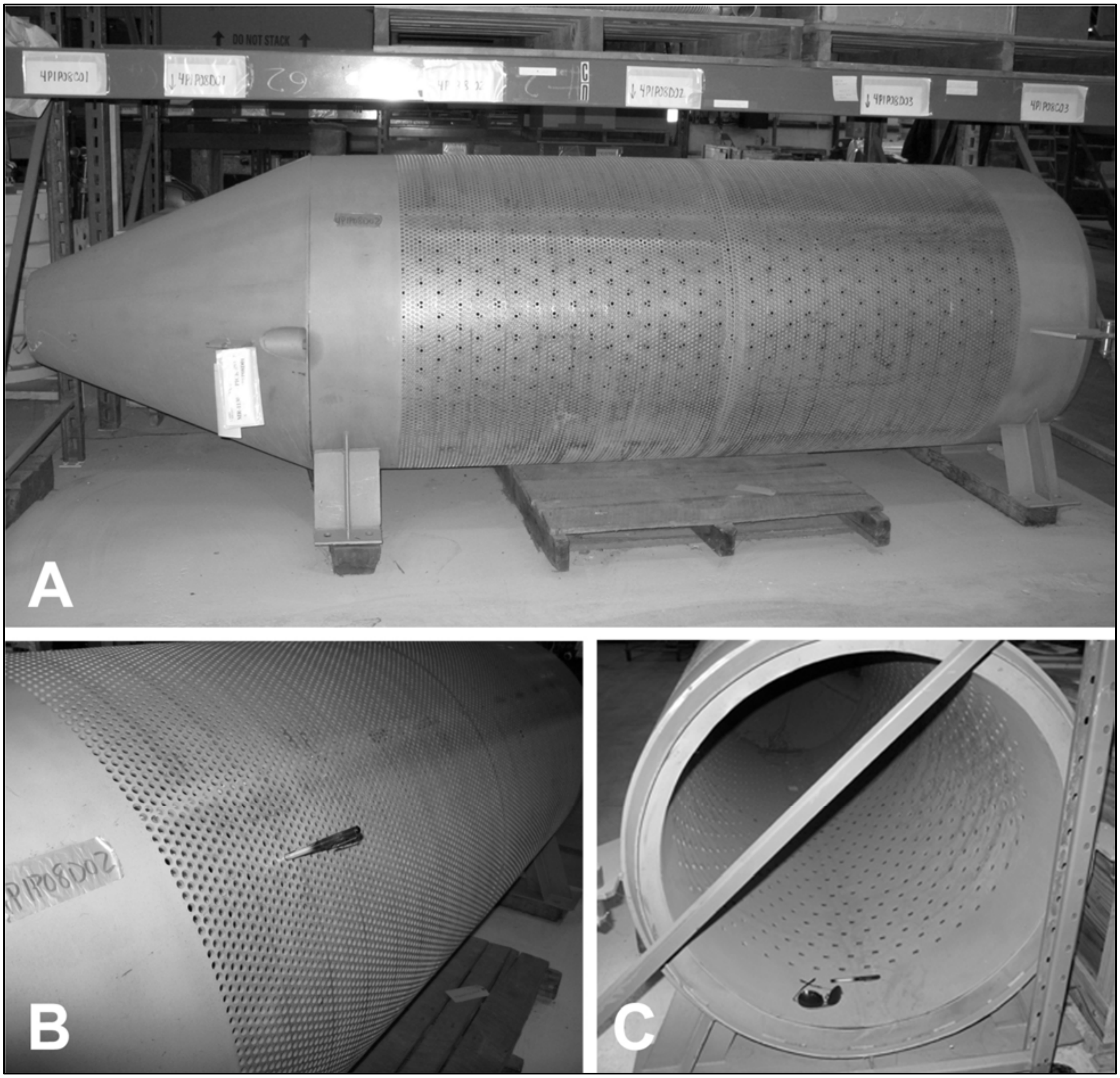


Figure 6. Photographs of a spare cooling water intake screen showing the inner and outer layers. Note: this only shows half of one of the two in-place screens in Figure 4, above. Source: NRC (2012b)

1.3.2 Discharges to the Columbia River

The State of Washington authorizes the discharge of treated wastewater to the Columbia River at Outfall 001 in accordance with the special and general conditions of NPDES Permit No. WA-002515-1 under authority delegated by EPA (EFSEC 2014). Outfall 001 is located at Columbia RM 351.75 (Figure 3). The discharge pipe, buried in the riverbed, ends in an outfall port about 175 feet from the west bank at low river flow (i.e., about 125 feet closer to the shoreline than the water intake structure). The rectangular slot port, which is 8 inches high by 32 inches wide, emerges from the bed at a 15-degree angle, perpendicular to flow (Figure 4). Discharges to the

Columbia River include blowdown from the circulating cooling water and service water systems and, infrequently (last occurrence was in 1998), effluent from the radioactive wastewater treatment system. Each type of effluent is described below.

Circulating cooling water system blowdown. The major waste stream, in terms of volume, is the blowdown from the non-contact circulating cooling water system, which cools the steam condenser and associated machinery. The blowdown discharge is nearly continuous with a maximum flow rate of 6,500 gpm (14.5 cfs) and an average of 2,000 gpm (4.5 cfs).

As described in EFSEC (2014), Energy Northwest adds chemicals to the circulating water system to inhibit the deposition of solids and to limit corrosion and biological growth in the system. Sulfuric acid is added to maintain pH. A polyphosphate blend is used for corrosion inhibition in mild steel and a phosphonate copolymer to minimize scale formation. Sodium tolytriazole is added separately for copper alloy corrosion control. Microbiocidal treatment is provided with sodium hypochlorite and sodium bromide two to three times per week. Blowdown is terminated during biocide treatment to allow halogen residual to decay. The discharge contains heat, residuals from treatment additives, constituents from the intake Columbia River water (concentrated by evaporation), and system corrosion products.

Periodically the main condenser becomes scaled. This reduces plant efficiency to the point that chemical cleaning of the main condenser is necessary. During cleaning, blowdown is stopped and a cleaning agent is added to the circulating water system. At the completion of the cleaning process, if any permit condition is not met, circulating water is pumped to a storage location using temporary pumps and piping. During this pumping process, the concentration of constituents in the circulating water is reduced by the addition of makeup water from the river. When the circulating water meets all conditions for the NPDES discharge permit, blowdown to the river is initiated. After the condenser cleaning process is completed, the stored water is treated (if necessary) to meet discharge requirements, then discharged. Any sediment from the cleaning process is analyzed and disposed of in accordance with the facility's solid waste control plan.

Energy Northwest replaced the main condenser in September 2011. The admiralty brass condenser tubes were replaced with titanium, removing what EFSEC called a "significant" source of copper from this discharge (EFSEC 2014).

Service water system blowdown. The service water system is a separate non-contact cooling water supply and distribution system that serves two purposes: cooling the reactor in the event of malfunction of the regular cooling system, and removing residual heat from the reactor during reactor shutdown periods. The closed-loop system contains approximately twelve million gallons of water in two interconnected basins with an evaporative spray cooling system.

Microbial growth is controlled with periodic batch additions of 50% hydrogen peroxide and Busan 77[1]. The service water is also treated with sodium silicate for corrosion inhibition. Blowdown of this system is conducted infrequently to reduce concentrations of sulfur, chloride,

[1] Busan 77 is a biocide, made up of poly(oxyethylene) (dimethyliminio) ethylene (dimethyliminio) ethylene dichloride.

suspended solids or to drain a basin for maintenance. Discharge may reach 4,000 gpm when it occurs and was last discharged in April 2013. The discharge contains concentrated minerals, other constituents of the makeup water, and some material corrosion and wear products.

Radioactive wastewater treatment system effluent. This is treated wastewater from the "primary water system" (reactor water for steam production) that Energy Northwest must occasionally discharge when the inventory becomes excessive or when the quality in terms of organic content does not meet specifications. The primary water (produced on site) is very pure (conductivity generally less than 0.2 μmho/cm), but still has the potential for some radioactive contamination. For this reason, it is filtered and treated through an ion exchange process to reduce radioactive impurities prior to discharge.

The facility discharges this wastewater in batches (15,000 gallons at up to 190 gpm), after assurance that NRC-dictated radioactivity discharge limits are met. The facility's water management practices make this an infrequent discharge, last occurring September 19, 1998.

1.3.3 Discharge to Groundwater

Until it was rerouted to a double-lined pond in 2014, some effluent from wastewater and stormwater was discharged to an unlined pond on the CGS site, 1,500 feet northeast of the reactor building (NRC 2012b). This pond received stormwater from plant roofs, backwashes of the potable water-treatment filter, and a reject stream from a process water reverse osmosis unit. It also received infrequent batch-type discharges from flushes of emergency diesel engine cooling water and flushes of the fire-protection system. The outfall to this pond was designated as Outfall 002 in the NPDES permit. Annual discharges were estimated at about 15 million gallons (gal). However, in November 2014, Energy Northwest diverted these waste streams to a lined evaporation pond system. The former groundwater pond was filled in December 2015 and capped with rock in January 2016 (Khounnala 2016). Thus, the operation under the renewed license no longer includes Outfall 002 as a potential pathway for contamination of the Columbia River via groundwater.

In the past, a third point of potential groundwater contact was an old soil borrow pit, or swale, located about 1,500 feet south-southeast of the reactor building (NRC 2012b). This site was used from 1997–2003 for the disposal of about 500,000 gal per year of backwash water from a sidestream sand filter on the standby service-water system. Regular discharges to this site ceased in October 2003 when the filter was removed from service. The outfall is no longer permitted under the NPDES permit and therefore is no longer available for the discharge of water.

Currently, the CGS site has numerous drywells for the collection of stormwater that supply a potential groundwater recharge pathway (NRC 2012b). Drywells around the cooling towers also catch the drift and spray of condenser cooling water from the towers during windy conditions. The renewed license requires Energy Northwest to continue to monitor deep and shallow groundwater around the site to determine whether tritium and gamma emitting radionuclides are released to the environment.

1.3.4 Proposed Monitoring Activities

1.3.4.1 Radiological Environmental Monitoring Program

The NRC's regulations at Appendix A to 10 CFR Part 50, requires Energy Northwest to conduct a Radiological Environmental Monitoring Program (REMP) as a requirement of the operating license. The purpose of the REMP is to ensure that any radionuclides released into the environment as a result of station operations remain below the levels listed in Table 2 of Appendix B to 10 CFR Part 20 and determined by the NRC to be protective of public health and safety and the environment. Aquatic monitoring activities associated with the REMP include the collection of water, sediment, and fish tissue samples.

Surface water samples are collected monthly from the effluent at the pumphouse (i.e., before discharge) and the City of Richland's water treatment plant, 11 miles downstream (Khounnala 2016). These samples are analyzed for tritium, gross beta, and gamma emitting radionuclides (Energy Northwest 2016a). Grab samples of river sediment are collected semiannually at two stations: 2 miles upstream (near RM 354) of Outfall 001 and 1 mile downstream (near RM 351) and analyzed for radionuclides. Neither of these sampling efforts will affect listed fish or their habitat; the water samples will be collected from facility water systems and sediment will be sampled using hand-held implements in sandy shoreline areas.

The REMP requires that one sample from each of three recreationally important species (one anadromous and two resident fish species) collected in the vicinity of Outfall 001 be tested for gamma isotopes (edible flesh only). Samples will be collected once per year unless test results indicate an impact of CGS operations (i.e., isotope levels in samples from near the plant discharge are significantly higher than those in control samples or the results of previous samples). In that case, Energy Northwest is required to sample and test for gamma isotopes semiannually.

As part of the REMP, Energy Northwest plans to obtain samples of edible flesh from one species of anadromous fish from the Washington Department of Fish and Wildlife's (WDFW) Ringold Fish Hatchery, four miles upstream of Outfall 001. These will be either listed UCR spring-run Chinook salmon or steelhead or unlisted UCR fall Chinook or coho salmon depending on availability, but in any case will be fish removed from the Columbia River under permits for hatchery operations. The control samples will be obtained from Lyons Ferry Hatchery on the lower Snake River under similar circumstances.

Energy Northwest will collect resident fish from the vicinity of Outfall 001 as follows:

- Use hook and line fishing in accordance with WDFW freshwater fishing rules for resident species. The angling gear and methods will target specific species (bass, whitefish, carp, walleye, suckers, etc.) and will be unlikely to hook salmon or steelhead.
- Hook and line fishing will be conducted from shore or from a small boat:
    - The Columbia River will be fished for indicator samples of resident species in the area bounded by River Mile (RM) 351-354 (approximate locations of the powerlines south and north of Outfall 001).

    - Target habitat types for resident species including bass, whitefish, carp, walleye, suckers, etc. within that 3-mile reach:
        - Mainstem Columbia River, 10-20 feet from the western shoreline;
        - Weedy shoreline areas with slack water;
        - Whitewater near the eastern shoreline; and
        - Shoreline areas downstream of RM 352.
    - Control samples of resident fish species will be obtained from other researchers and/or their contracted samplers, facilities (e.g., dams), state sponsored fishing programs, private anglers, or commercial fishermen.
- If hook and line fishing is not successful, electrofishing for indicator samples of resident fish will be conducted from small boats on the Columbia River between RM 351-354:
    - Depths will be less than 10 feet and
    - Operations will be at least 300 feet from any active redds.
- Hook and line fishing will take place between July and December each year. Electrofishing will take place in September-December if hook and line fishing is unsuccessful.
- If a radiological impact is identified in the samples taken from resident fish, a second sampling event will take place at least 2-3 months after the first by hook and line or electrofishing, probably January-early March.

1.3.5 Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The new NPDES Permit No. WA002515-1 for CGS, issued September 30, 2014, and modified February 18, 2016 (EFSEC 2016), requires that Energy Northwest prepare and conduct entrainment and impingement studies for the water intake structure. This action is interrelated to the NRC's renewed operating license because if Energy Northwest did not implement the permit conditions, it would lose the ability to withdraw cooling water from the Columbia River and the NRC license would require it to shut down operations.

1.3.5.1 Entrainment Study

Special Condition S12.B of the CGS NPDES permit specifies that Energy Northwest must prepare and conduct an entrainment study consistent with the content requirements in 40 CFR 122.21(r)(9). Details of this study plan are provided in Energy Northwest (2015a). Sampling will take place in the pump well at the point where the buried pipes that transport water from the river (a distance of about 300 feet) terminate. Sampling cages will be lowered 35 feet into the sump where they are in direct alignment with the openings of the inlet pipes. After the designated sampling time, each cage will be raised to a Fish Monitoring Access Platform in the pump well and the contents will be processed. Tests for the apparatus' effectiveness in capturing entrained fish will be conducted with hatchery fish of about the same size as those concurrently found in the river; these will be added experimentally to the sampling cage and retrieved after the designated sampling interval (e.g., see Mudge *et al*. 1981). Any fish entering the closed-cycle system will be assumed to be killed, regardless of its condition upon retrieval.

The entrainment study will use fall Chinook salmon fry from an unlisted hatchery stock (Energy Northwest 2015a), appropriately sized rainbow trout (a resident form of *Oncorhychus mykiss)*, or another unlisted surrogate species. Samples of entrained fish will be taken continuously for 24 hours one time per week during mid-March through mid-June and biweekly (i.e., twice per month) from July-September in each of two years when the intake pumps are operating at 60% capacity or greater. In addition, two sequential 12-hour samples will be taken during normal sampling weeks when more than 20 fish appear in the entrainment samples. This will identify any differences between daylight and dark entrainment (diel variation). Start and stop times will be approximately dawn and dusk.

All fish collected will be anesthetized and then processed with the following information recorded:

- Identification to species and life stage (fish of questionable identity will be preserved in 70% alcohol and referred to a qualified taxonomist for verification);
- Lengths of individual fish to nearest mm (if >50 of a species, then a sample of 50 can be taken);
- Weights of individual fish to nearest gram (if >50 of a species, then a sample of 50 can be taken); and
- Any outward signs of damage or disease.

The efficacy of the cages for capturing and retaining fish (capture efficiency) will be established by tests with juvenile hatchery fish twice during each annual sampling period.

1.3.5.2 Impingement Study

Special Condition S12.A of the CGS NPDES permit (EFSEC 2016) also requires an evaluation of the risk of impingement for "any life stages of fish and shellfish on the outer surface of the intake structure, including where feasible … [v]isual or remote monitoring during times when the cooling water intake structure is operational, at least weekly." The Operations and Maintenance Plan for CGS (Energy Northwest 2016b) includes semiannual observations using underwater video equipment, deployed from a boat, to collect photographic verification that fish and debris are not impinged on the intake screens. The water elevations of the river will be compared to those in the pumphouse well at least hourly to identify any abnormal differential that could be attributed to clogging of the intake screens (Energy Northwest 2015a). In addition to these observations, staff will compare river water elevations to those in the pumphouse well at least hourly to identify any abnormal differential that indicates potential clogging of the intake screens. Significant clogging would be likely to influence the through-screen velocities by increasing velocities of non-clogged pores, which would affect likelihood of fish being entrained or impinged. Energy Northwest will report the results of these observations with the entrainment data.

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 habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts. Section 7(o)(2) provides that any incidental taking that is in compliance with the terms and conditions is not prohibited.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and 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" (50 CFR 402.02).

Previously, the designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. As revised in 2016, the new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate, for the specific critical habitat.

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

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the action.
- Describe the environmental baseline in the action area.

- Analyze the effects of the 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 action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

If necessary, NMFS suggests a reasonable and prudent alternative (RPA) to the action.

2.2 Rangewide Status of the Species and Critical Habitat

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

One factor affecting the status of ESA-listed species considered in this Opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early-spring will be less affected. Low-elevation areas are likely to be more affected.

The Pacific Northwest warmed about +1.3°F between 1895 and 2011, with statistically significant warming occurring in all seasons except for spring (Snover *et al*. 2013). Relative to 1950-1999, the regional average temperature (Pacific Northwest) is projected to rise 5.8°F (range = 3.1 to 8.5°F) by the 2050s for the high greenhouse gas scenario (Representative Concentration Pathway (RCP) 8.5) with much higher warming possible after mid-century depending on rates of emissions. Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Karl *et al*. 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007; Karl *et al*. 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007; Karl *et al*. 2009).

Heavy rainfall events are likely to become more severe by mid-century. Higher winter stream flows increase the risk that winter floods in sensitive watersheds are likely to damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer are expected to degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (Karl *et al*. 2009). Other effects are likely to include altered migration patterns, accelerated embryo development and the premature emergence of fry, changes in the quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al*. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005; Zabel *et al*. 2006; Karl *et al*. 2009). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al*. 2006). Moreover, as atmospheric carbon emissions increase, increasing levels of carbon dioxide are absorbed by the oceans, creating carbonic acid and lowering the pH of the water. Marine fish species have exhibited negative responses to ocean acidification conditions that include changes in growth, survival, and behavior. Marine phytoplankton, which are the base of the food web for many oceanic species, have shown varied responses to ocean acidification that include changes in growth rate and calcification (Feely *et al*. 2012).

The effects described above are likely to manifest, at least in part, during the 20-year period covered by the renewed license.

The summaries that follow describe the status of the two 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 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 (Table 1).

Table 1. Listing status and status of critical habitat designations for the ESA-listed species considered in this Opinion.

ESU/DPS[a]	Listing Status	Critical Habitat Designation
Chinook salmon *(Oncorhynchus tshawytscha)*		
Upper Columbia River (UCR) spring-run Chinook salmon ESU		
	Endangered; June 28, 2005 (70 FR 37160)	Designated; June 28, 2005 (70 FR 52630)
Steelhead *(Oncorhynchus mykiss)*		
Upper Columbia River (UCR) steelhead DPS		
	Threatened; August 24, 2009 (74 FR 42605)	Designated; Sept. 2, 2005 (70 FR 52630)

[a] Evolutionarily Significant Unit (Chinook salmon) or Distinct Population Segment (DPS) (steelhead)

Spawning and rearing areas for these two species are within the Interior Columbia recovery domain. The Interior Columbia Technical Review Team (ICTRT) identified independent populations within each species, recommended viability criteria for those species, and described the factors that limit the species' survival. Viability criteria are recommendation of the biological conditions for populations, biogeographic strata or major population groups, and ESU that, if met, would indicate that an ESU has a negligible risk of extinction over a 100-year time frame. NMFS adopted a recovery plan for these two species (UCSRB 2007) on October 9, 2007 (72 FR 57303).

The current viability status is described below for each of these two species.

2.2.1.1 Status of UCR Spring-run Chinook Salmon

The UCR spring-run Chinook salmon ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin) (Figure 7). Also, spring-run Chinook salmon from six artificial propagation programs are included in the ESU: the Twisp River Program; Chewuch River Program; Methow Program; Winthrop National Fish local natural population(s) than what would be expected between closely related natural populations within the ESU (NMFS 2005a).Hatchery Program; Chiwawa River Program; and the White River Program (NMFS 2014a). We have determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (NMFS 2005a).

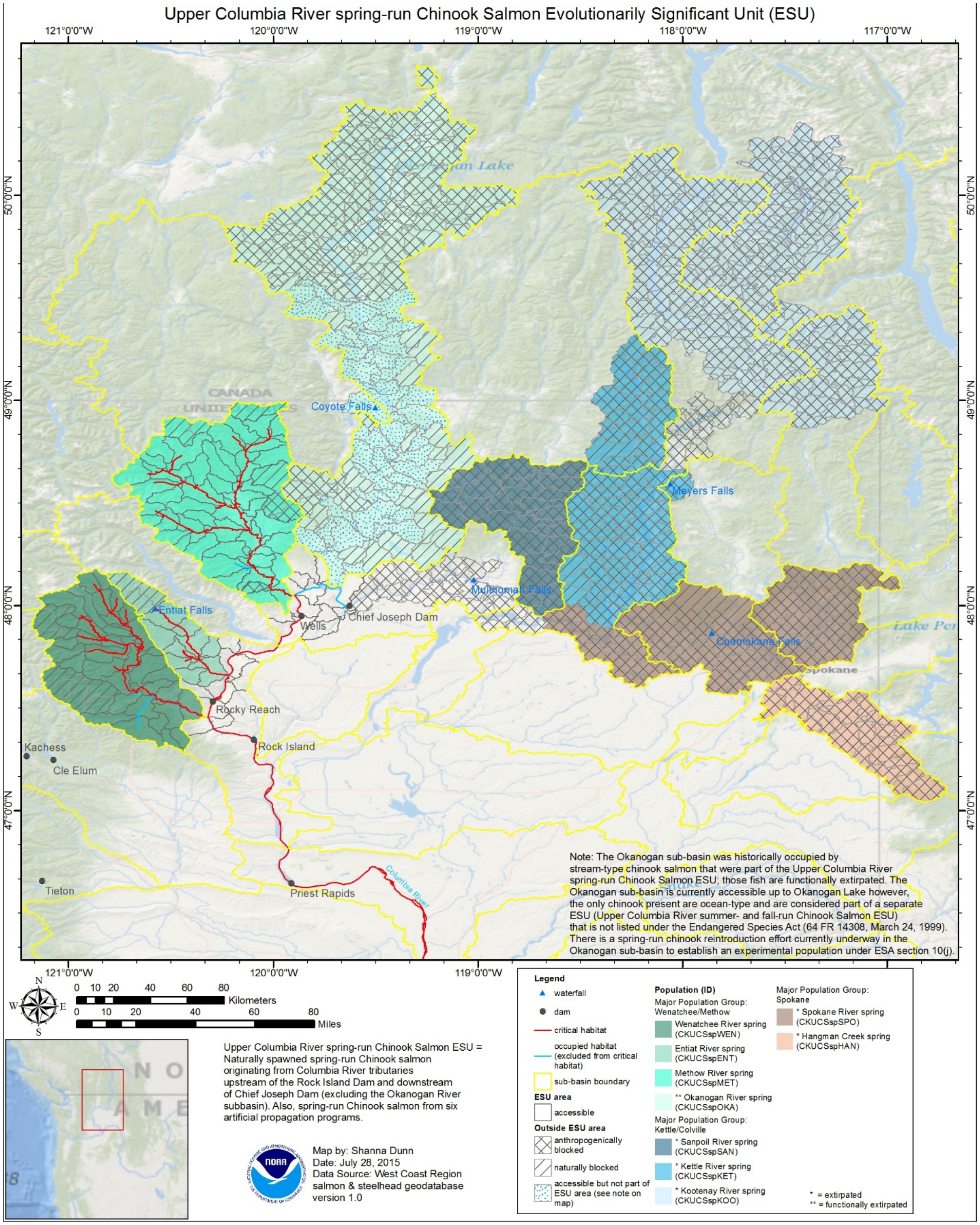


Figure 7. Population structure of the UCR spring-run Chinook salmon ESU including extant (green) and historical populations. Source: NMFS (2016a)

Limiting Factors. Limiting factors for this species include (UCSRB 2007):

- Effects related to the hydropower system in the mainstem Columbia River, including reduced upstream and downstream fish passage, altered ecosystem structure and function, altered flows, and degraded water quality;
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality;
- Degraded estuarine and nearshore marine habitat;
- Hatchery-related effects;
- Persistence of both native and non-native (exotic) fish species continues to affect habitat conditions for listed species; and
- Harvest in Columbia River fisheries.

New information since NMFS's last status review indicates an increase in levels of avian and pinniped predation on UCR spring-run Chinook salmon in the 150-mile reach below Bonneville Dam (NMFS 2016a). The avian predation management actions that were implemented in 2014-2015 and are ongoing were too recent to have affected the productivity of this species during the period considered in NMFS (2016a), but should contribute to improved status of the species in the future.

Current Status. Our updated status review (using data series for each population that include return years 2009-2014; NWFSC 2015) indicates that the viability rating for UCR spring-run Chinook salmon remains at high risk of extinction and does not meet the viability criteria recommended by the ICTRT. The 5-year review compared the current status of the species to the recovery criteria in the 2007 Recovery Plan. All three extant populations remain below the minimum threshold for a 5% risk of extinction. Our analysis indicates that the collective risk to the persistence of the ESU has not changed significantly since the previous status review. Improvements have been made in operations and fish passage at tributary dams and at the FCRPS dams, and numerous habitat restoration projects have been completed in many upper Columbia River tributaries. Conversely, habitat problems are still common throughout the region and many more habitat improvements are likely needed to achieve viability. Harvest rates remain relatively low and stable, but changes in hatchery management are needed to reduce the number of hatchery-origin fish used as broodstock and to reduce the number of hatchery fish allowed to spawn naturally. In addition, predation from an increase in pinniped populations and significant avian impacts remain concerns, as do the impacts that climate change poses to long-term recovery. After considering the biological viability of the UCR ESU and the current status of it threats and limiting factors, we conclude that the status of the UCR spring-run Chinook salmon ESU has not improved significantly since the final listing determination in 2005.

Recovery Potential. The implementation of sound management actions in hydropower, habitat, hatcheries, and harvest are essential to achieve species recovery. The biological benefits of habitat restoration and protection efforts, in particular habitat restoration, have yet to be fully expressed and will likely take another five to 20 years to result in measurable improvements to population viability (NMFS 2016a). By continuing to implement actions that address the factors limiting population survival and monitoring the effects of the actions over time, we will ensure that restoration efforts meet the biological needs of each population and, in turn, contribute to the recovery of this species. The recovery plan (UCSRB 2007) is the primary guide for identifying future actions to target and address threats and limiting factors.

2.2.1.2 Status of UCR Steelhead

The UCR steelhead DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border (Figure 8). Also, steelhead from six artificial propagation programs are included in the DPS: the Wenatchee River Program; Wells Hatchery Program (in the Methow and Okanogan Rivers); Winthrop National Fish Hatchery Program; Omak Creek Program; and the Ringold Hatchery Program (NMFS 2014a). We have determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the DPS (NMFS 2006).

The ICTRT (2003) described stream reaches within the Wenatchee, Entiat, and Methow subbasins as areas where the highest density of spawning occurs. These reaches are core areas of productivity within each population. Numbers of adults in less productive areas such as the mainstem Columbia River can be tied to those in the primary spawning areas through straying.

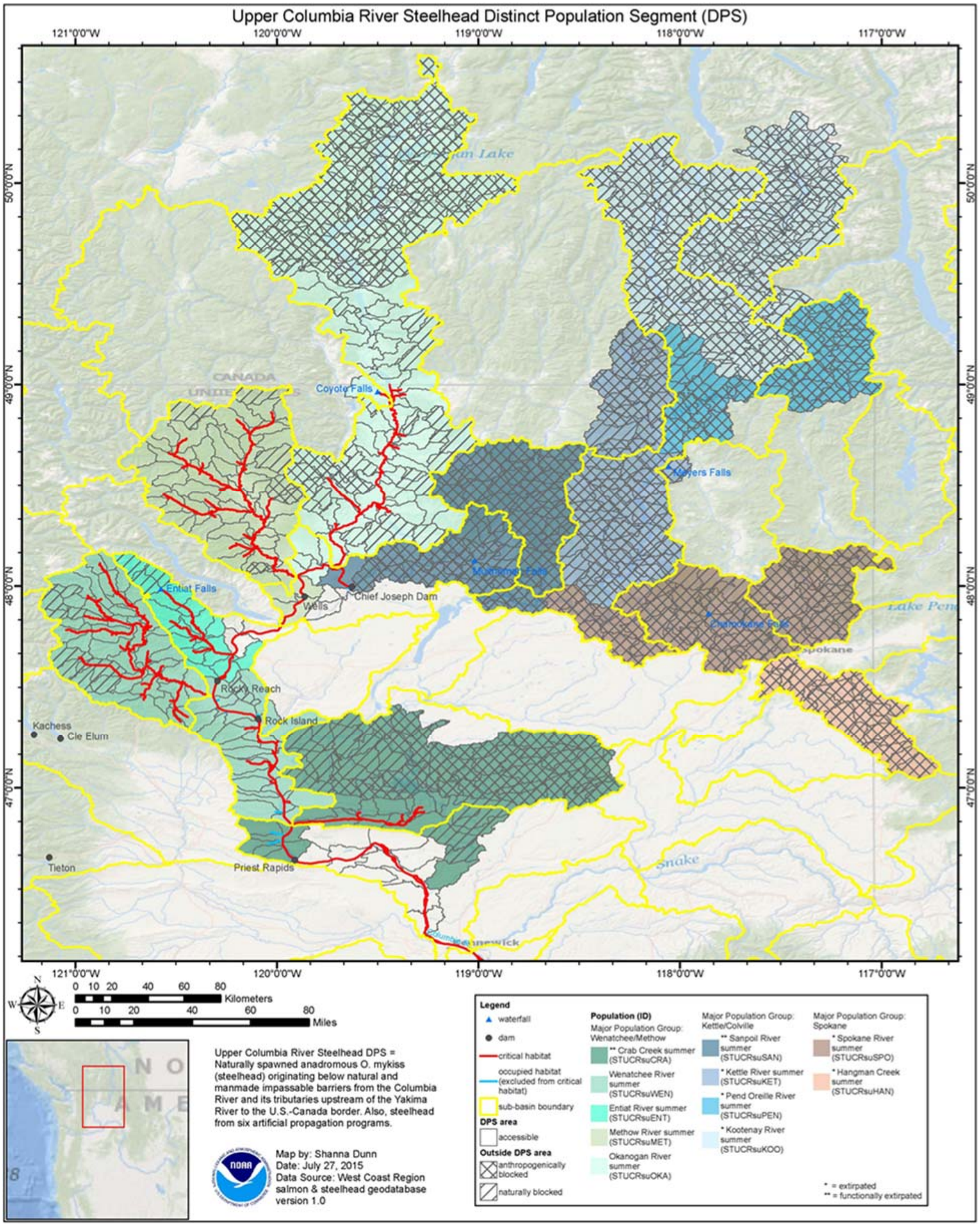


Figure 8. Population structure of the UCR steelhead DPS including extant (green) and historical populations. Source: NMFS (2016a)

Updated Biological Risk Summary. The following is a summary from NMFS's status review for this DPS (NMFS 2016a).[2]

Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations (NWFSC 2015). The status of the Wenatchee River steelhead population has continued to improve based on the additional years of information available for our 2016 status review (NMFS 2016a). The abundance and productivity viability rating for the Wenatchee River population exceeds the minimum threshold for 5% risk of extinction, but at the DPS level, risk remains high. This is driven by low abundance and productivity relative to viability objectives and concerns about genetic diversity.

Given the recent changes in hatchery practices in the Wenatchee River and the potential for reduced hatchery contributions or increased spatial separation of hatchery versus natural origin spawners, it is possible that genetic diversity could improve in the future. The proportions of hatchery-origin returns in natural spawning areas remain high across the DPS, especially in the Methow and Okanogan river populations. The improvements in natural returns in recent years largely reflect several years of relatively good natural survival in the ocean and tributary habitats. Tributary habitat actions called for in the Upper Columbia River Recovery Plan are anticipated to be implemented over the next 25 years and the benefits of some of those actions will take decades to be realized (NWFSC 2015).

Limiting Factors. Limiting factors for this species include (UCSRB 2007):

- Adverse effects related to the mainstem Columbia River hydropower system;
- Impaired tributary fish passage;
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality;
- Hatchery-related effects;
- Predation and competition; and
- Harvest-related effects.

New information available since NMFS's last status review indicated an increase in levels of avian and pinniped predation on UCR steelhead in the 150-mile reach below Bonneville Dam (NMFS 2016a). The avian predation management actions that were implemented in 2014-2015 and are ongoing were too recent to have affected the productivity of this species during the period considered in NMFS (2016a), but should contribute to improve the status of the species in the future.

Current Status. Our updated status review (NWFSC 2015, NMFS 2016a) indicates that the viability rating for UCR steelhead remains at high risk of extinction and does not meet the viability criteria recommended by the ICTRT and adopted in the 2007 Recovery Plan. Three of the four extant populations remain below viability thresholds with only the Wenatchee population exceeding the minimum threshold for 5% risk of extinction (NWFSC 2015). Our

[2] The data series were updated brood cycle year 2013/2014 for each extant population (NWFSC 2015).

analysis indicates that the collective risk to the persistence of the DPS has not changed significantly since previous status review. Improvements have been made in operations and fish passage at tributary dams and at the FCRPS dams, and numerous habitat restoration projects have been completed in many upper Columbia River tributaries. Conversely, habitat problems are still common throughout the region and many more habitat improvements are likely needed to achieve viability. Harvest rates remain relatively low and stable, but changes in hatchery management are needed to reduce the number of hatchery-origin fish used as broodstock and to reduce the number of hatchery fish allowed to spawn naturally. In addition, predation from an increase in pinniped populations and significant avian impacts remain concerns, as do the impacts that climate change poses to long-term recovery. After considering the biological viability of the UCR steelhead DPS and the current status of its threats and limiting factors, we concluded that the status of UCR steelhead has not improved significantly since the final listing determination in 2006 (NMFS 2016a).

Recovery Potential. The implementation of sound management actions in hydropower, habitat, hatcheries, and harvest are essential to recovery. The biological benefits of habitat restoration and protection efforts, in particular habitat restoration, have yet to be fully expressed and will likely take another five to 20 years to result in measurable improvements to population viability. By continuing to implement actions that address the factors limiting population survival and monitoring the effects of the action over time, we will ensure that restoration efforts meet the biological needs of each population and, in turn, contribute to the recovery of this species. The recovery plan (UCSRB 2007) is the primary guide for identifying future actions to target and address threats and limiting factors.

2.2.2 Status of Designated Critical Habitat

In this section, we examine the range-wide status of critical habitat designated for UCR spring-run Chinook and steelhead. UCR spring-run Chinook salmon critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to Chief Joseph Dam, as well as specific stream reaches in the Chief Joseph, Methow, Upper Columbia/Entiat and Wenatchee subbasins. UCR steelhead critical habitat includes river reaches proceeding upstream to Chief Joseph Dam, as well as specific stream reaches in the following subbasins: Columbia River/Lynch Coulee, Chief Joseph, Okanogan, Salmon, Methow, Similkameen, Chewuch, Twisp, Entiat, Wenatchee, Chiwawa, Nason, and Icicle.

These species have overlapping ranges and similar life history characteristics and except for reaches in the uppermost areas of their geographical range and the Okanogan River basin, most areas of critical habitat are co-extensive. Our assessment of the current status of critical habitat was based primarily on a watershed-level analysis of conservation value that focuses on the presence of ESA-listed species and PBFs that are essential to their conservation. NMFS organized information at the 5th field hydrologic unit code (HUC) watershed scale because it corresponds to the spatial distribution and site fidelity scales of salmon and steelhead populations (McElhany *et al*. 2000). The analysis for the 2005 designations was completed by NMFS's Critical Habitat Analytical Review Teams (CHARTs), which focused on large geographical areas that corresponded approximately to recovery domains (NMFS 2005b). Each watershed was ranked using a conservation value attributed to the quantity of stream habitat with PBFs, the present condition of those PBFs, the likelihood of achieving PBF potential (either naturally or through active restoration), support for rare or important genetic or life history characteristics, support for abundant populations, and support for spawning and rearing populations. In some cases, our understanding of these interim conservation values has been further refined by the work of technical recovery teams and other recovery planning efforts that have better explained the habitat attributes, ecological interactions, and population characteristics important to each species. Physical and biological features of critical habitat essential for the conservation of UCR spring-run Chinook salmon and UCR steelhead are listed in Table 2.

The physical or biological features of freshwater spawning and incubation sites include water flow, quality, and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 2). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Table 2. Essential PBFs of critical habitat designated for UCR spring-run Chinook salmon and UCR steelhead (NMFS 2005c).

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

2.2.2.1 Critical Habitat for Upper Columbia River Spring-run Chinook salmon

The UCR spring-run Chinook salmon ESU consists of 31 watersheds. The CHART assigned five watersheds a medium rating and 26 received a high rating of conservation value to the ESU (NMFS 2005b).

Many factors, both human-caused and natural, have contributed to the decline of UCR spring-run Chinook salmon critical habitat. Upper Columbia River spring-run Chinook salmon habitat has been altered through activities such as urban development, logging, grazing, power generation, and agriculture, resulting in the loss of important spawning and rearing habitat and the loss or degradation of migration corridors. The following are the major factors limiting the conservation value of UCR spring-run Chinook salmon critical habitat:

1. Passage mortality associated with the hydroelectric projects owned by the mid-Columbia public utility districts (Douglas, Chelan, and Grant Public Utility

Districts (PUD)) and the Federal Columbia River Power System (freshwater migration corridors without obstructions);

2. Degraded tributary riparian condition and loss of in-channel large wood (freshwater rearing sites with natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams to form and maintain physical conditions that support juvenile growth and development);

3. Altered tributary floodplain and channel morphology (freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; freshwater rearing sites with floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and development);

4. Reduced tributary stream flow and altered passage (freshwater spawning sites with water quantity conditions supporting spawning, incubation and larval development; freshwater rearing sites with water quantity to form and maintain physical habitat conditions that support juvenile growth and development); and

5. Ongoing effects of inaccessibility of historically suitable habitats in the Okanogan basin.

Climate change is expected to alter critical habitat by increasing stream temperatures and peak flows and decreasing base flows (loss of snowpack). Although changes will not be homogenous across the species' range, effects of climate change are likely to decrease the capacity of critical habitat to support successful spawning, rearing, and migration.

2.2.2.2 Critical Habitat for Upper Columbia River Steelhead

The UCR steelhead DPS's range includes 42 watersheds. The CHART assigned low, medium, and high conservation value ratings to three, eight, and 31 watersheds, respectively (NMFS 2005b).

Many factors, both human-caused and natural, have contributed to the decline of UCR steelhead over the past century, as well as the conservation value of essential features and PBFs of designated critical habitat. Steelhead habitat has been altered through activities such as urban development, logging, grazing, power generation, and agriculture. These habitat alterations have resulted in the loss of important spawning and rearing habitat and the loss or degradation of migration corridors. The following are the major factors limiting the conservation value of critical habitat for UCR steelhead:

1. Passage mortality associated with the mid-Columbia PUD hydroelectric projects and the Federal Columbia River Power System (freshwater migration corridors without obstructions);

2. Reduced tributary stream flow (freshwater spawning sites with water quantity conditions supporting spawning, incubation and larval development; freshwater rearing sites with water quantity to form and maintain physical habitat conditions that support juvenile growth and development);

3. Degraded tributary riparian condition and loss of in-channel large wood (freshwater rearing sites with natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams to form and maintain physical conditions that support juvenile growth and development);

4. Altered tributary floodplain and channel morphology (freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; freshwater rearing sites with floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and development);

5. Excessive sediment in tributaries (spawning sites with substrate to support egg incubation and larval growth and development; juvenile migration corridors and rearing sites with forage to support juvenile growth and development);

6. Degraded tributary water quality (spawning sites with water quality to support egg incubation and larval growth and development; juvenile rearing sites and migration corridors with water quality supporting juvenile growth and development); and

7. Substantial truncation of their range in the Okanogan Basin due to migration barriers (dams and water diversions).

Climate change is expected to alter critical habitat by increasing stream temperatures and peak flows and decreasing base flows (loss of snowpack). Although changes will not be homogenous across the species' range, effects of climate change are likely to decrease the capacity of critical habitat to support successful spawning, rearing, and migration.

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).

The action area for this consultation is defined as the width (about 1,400 feet) of the Columbia River from 1 mile downstream from the water withdrawal intake and effluent discharge structures located near RM 352 (specifically, RM 351.75) to two miles upstream (RM 354). The extent of the action area is defined by the area over which the licensee, Energy Northwest, will conduct hook and line fishing and, if needed, electrofishing, for the Radiological Environmental Monitoring Program. Other effects of the action (i.e., water withdrawals and effluent discharge) occur within the lower mile of the action area (RM 351-352).

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).

2.4.1 Presence of Listed Salmonids in the Action Area

The action area is within the migration corridor for juveniles and adults of both UCR spring-run Chinook and UCR steelhead. Life stages of that occur within the action area are shown in Table 3.

Table 3. Life stages and timing of UCR spring-run Chinook and UCR steelhead within the action area.

Species	Yearling Migrants[1]	Adult Migrants[2]	Spawning & Rearing[3,4]
UCR spring-run Chinook	April thru June	Mid-Apr thru mid-June	None
UCR steelhead	April thru mid-May	Mid-April thru mid-Nov (peak in September)	Spawning: Feb. thru early June (peak in mid-May) Rearing: Incubation timing depends on temperature[3] Rearing: year round

[1] Migration timing of yearling spring-run Chinook and steelhead is based on 10-year average (2007-2016) juvenile passage indices for Rock Island and Priest Rapids dams (Columbia River DART 2016a).
[2] Migration timing of adults is based on 10-year average (2007-2016) ladder counts at Priest Rapids Dam (Columbia River DART 2016b).
[3] Eldred (1970), Watson (1973), and Becker (1985), as cited in Mueller and Geist (1999); Quinn (2005)
[4] US DOE (2015)

Adults. Adult UCR spring-run Chinook and steelhead pass through the action area to major spawning areas in the upstream tributaries. A limited tagging study in 1967 found that adult steelhead migrated near shorelines at depths less than 10 feet (Coutant 1973, cited in Nugent and Cranna 2015).

Steelhead can hold in the Hanford Reach for six to eight months before continuing upstream (Nugent and Cranna 2015). A relatively small number of UCR steelhead[3] spawn within the Hanford Reach. The maximum count of 43 redds in 2015 (Nugent and Cranna 2015) was the highest recorded since 1998 when Dauble (1998, cited in Nugent and Cranna 2015 and USDOE 2015) documented "up to 75" in an aerial survey on April 30th. It is unclear whether the higher

[3] Some individuals could be strays from Ringold Fish Hatchery, located just four miles upstream of the water intake and outfall structures for CGS (aerial and boat surveys have shown limited spawning near Ringold Hatchery Creek; Poston 2010), but this hatchery stock is also part of the listed Upper Columbia River DPS.

number of redds detected in 2015 compared to the years since 1998 was due to increased spawning in the reach or to better conditions for observation.

The locations of UCR steelhead redds in 1968 and 1970 and in 2015 are shown in Figures 9 and 10, respectively. Redds were identified within a mile both upstream and downstream of the Energy Northwest site (Area C in Figure 9 and Area 1 in Figure 10) during both time periods, indicating that steelhead are likely to have spawned within or near the action area over time.

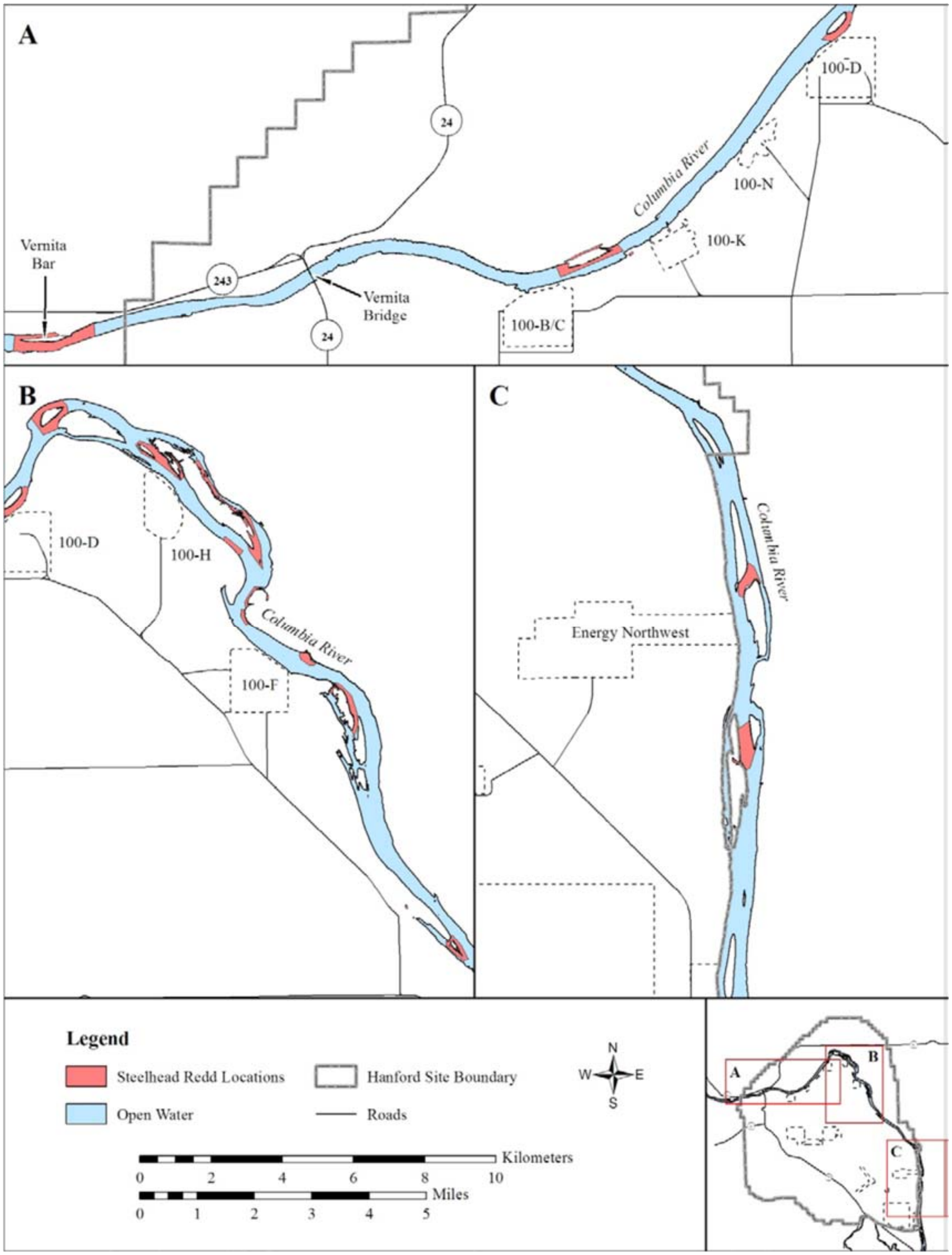
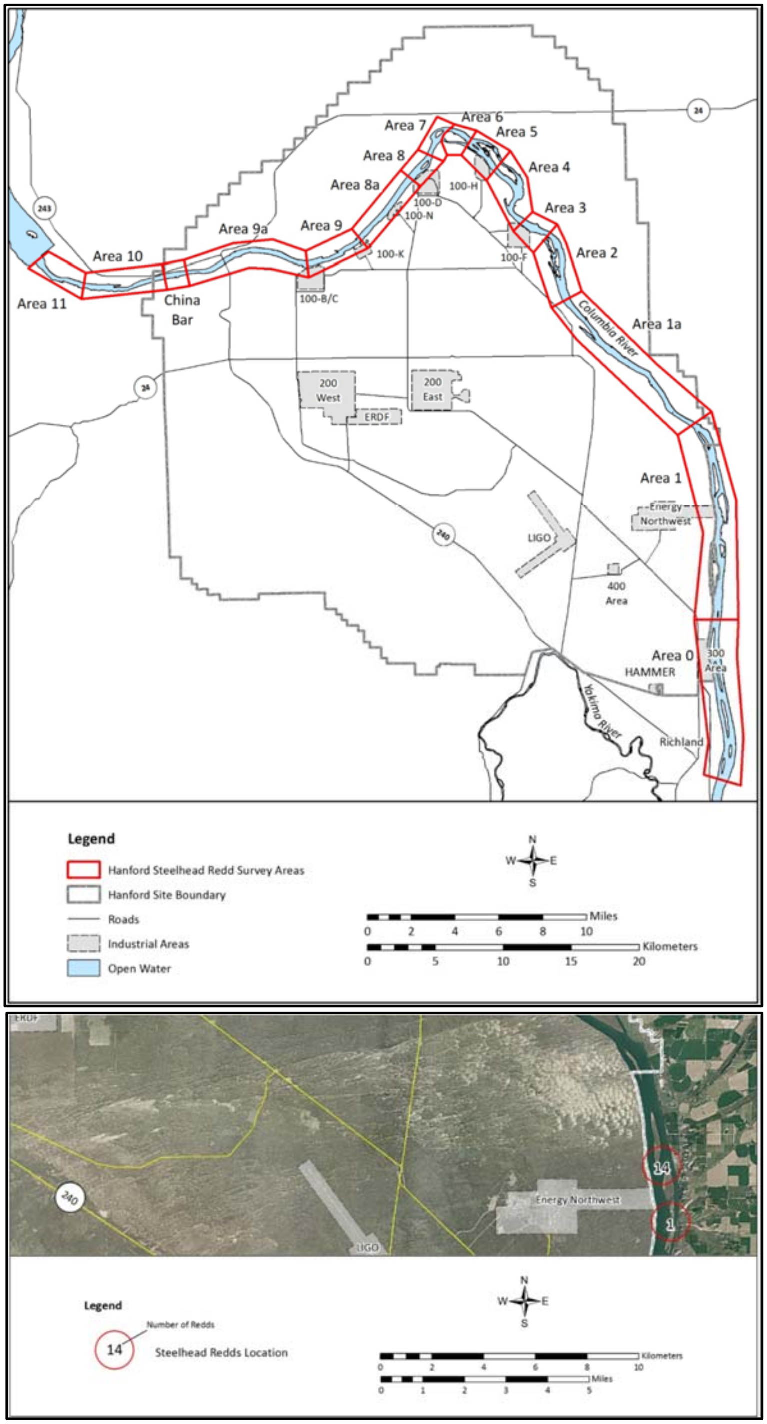


Figure 9. Locations of UCR steelhead redds observed in the Hanford Reach during aerial surveys in 1968 and 1970. Some of the redds in Figure 9C are within the action area for this consultation; redds in Figures 9A and 9B are upstream of the action area, but produce fry and parr that rear in the action area. Source: USDOE (2015)



16 redds in Area 4

15 redds in Area 1
(see below)

Within Area 1:
14 redds upstream
(north) of the intake
screens/outfall

1 redd downstream

Figure 10. Locations of Hanford Reach aerial surveys for UCR steelhead redds during 2015 (top) and detail of redd locations in Area 1 that were within the action area (bottom). Source: Nugent and Cranna (2015)

Eggs and Yolk-sac Fry[4] (Alevins). Salmonid eggs and embryos remain in the gravel nest or redd for periods ranging between about 2 and 8 months (DeVries 1997). Steelhead eggs hatch in about 50 days when water temperatures are 10ºC (50ºF) (Wydoski and Whitney 1979).

Fry and Parr. Fry emerge from the gravel nest 2 to 3 weeks after hatching and school within submerged vegetation near the margins of the river and over shallow water gravel bars (Peven 1990, as cited in USDOE 2015). Overhanging streamside and submerged vegetation provide protection from predators, moderate temperatures, and colonization sites for steelhead food sources (Shapovalov and Taft 1954; Bustard and Narver 1975; Peven 1990).

For the purpose of NMFS's fish screen criteria, fry are defined as less than 60 mm in length (NMFS 2011). Yearling fish ("fingerlings" or "parr") are larger than 60 mm and have vertical camouflage bars on the sides of the body.

Smolts. Upper Columbia River spring-run Chinook and UCR steelhead leaving their core spawning areas in the Wenatchee, Entiat, Methow, and for steelhead, Okanogan subbasins are spring migrants. Yearling steelhead smolts (predominantly upstream hatchery stocks) have been collected mainly from the bottom, mid-channel zone of the river (Dauble *et al*. 1989). No juvenile steelhead were collected in shoreline fyke nets, but they have been obtained in shoreline areas with electroshocking gear.

Feeding juveniles. Fry forage primarily along the bottom of the river; prey include midges, mayflies, stoneflies, and beetle larvae (Wydoski and Whitney 1979). The diet changes seasonally, depending on fluctuations in the availability of food items.

2.4.2 Conditions within the Action Area

Columbia Generating Station is located on a 1,089-acre (about 1.7 square miles) site leased by Energy Northwest from the DOE, which lies within the 586-square mile Hanford Site. The Hanford site was used to produce plutonium fuel for atomic weapons during World War II and the Cold War. As a result of these past activities, the groundwater beneath the Hanford Site is contaminated with radiological and chemical constituents. The most extensive plumes are those of tritium and nitrate, which emanate from the 200 Areas (Figure 11) and are moving east and southeast towards the river and CGS site (NRC 2012b). Much of the radiological contamination of water and sediment described in the following sections for sites within or upstream of the action area (RM 351-354) is likely to stem from these past and some ongoing activities at the DOE's Hanford Site, which are not a subject of this consultation. However, because the action includes both water withdrawals from and effluent discharged to the Columbia River, water quantity and quality within the action area are relevant to the environmental baseline for this consultation.

[4] Yolk sac fry inhabit the interstices of gravel, and can be washed downstream if the substrate is mobilized. They can subsist on yolk-sac reserves for up to five weeks depending on water temperature and quality, but generally use their reserves within 3 to 7 days (Pauley *et al*. 1986, cited in Fulton 2004).

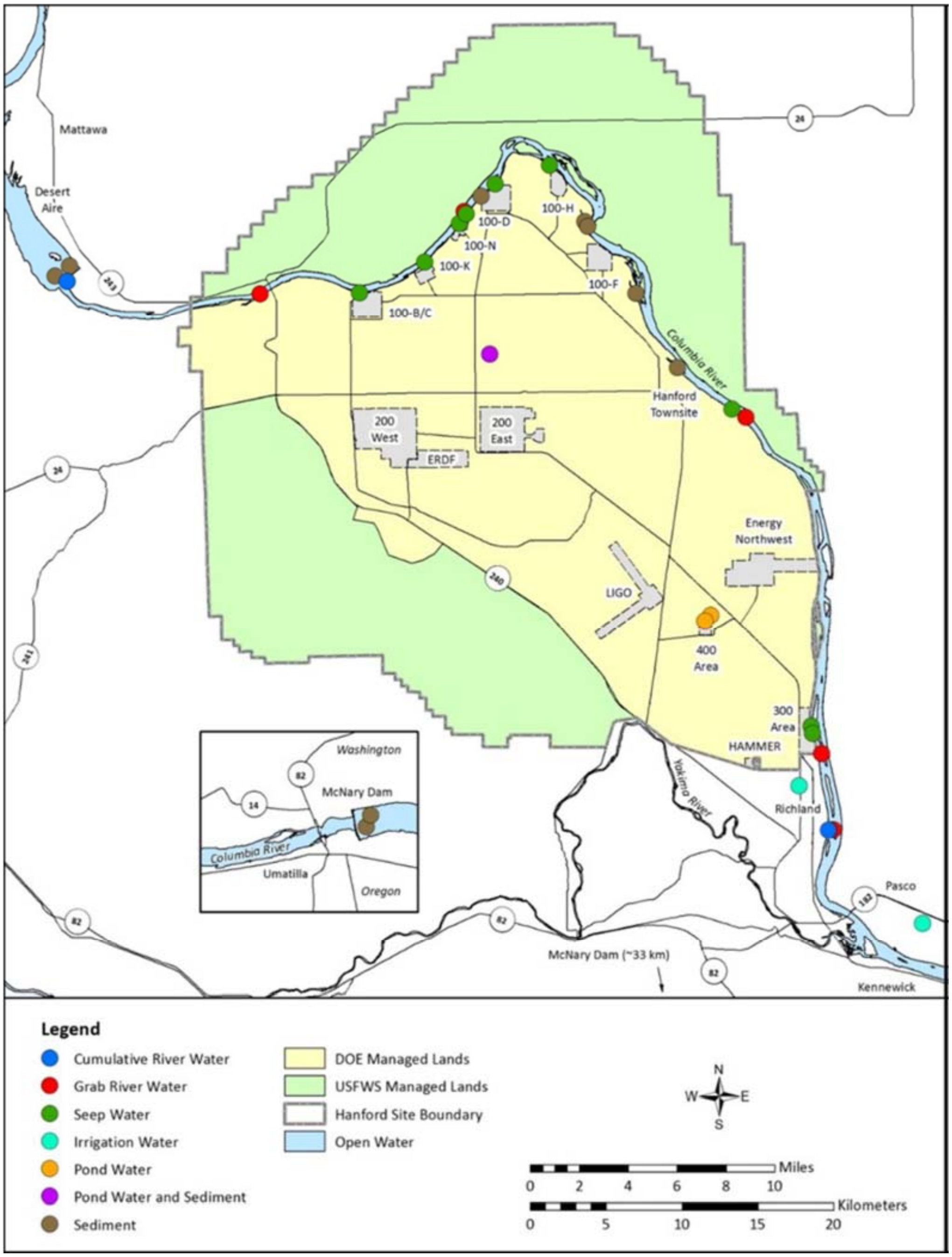


Figure 11. Location of Energy Northwest's Columbia Generating Station (CGS) within the larger Hanford Site and water and sediment sampling locations in 2015. The Vernita Bridge station is shown as a Grab River Water station (red dot) in the upper left. Source: Mission Support Alliance (2016)

2.4.2.1 Water Quantity

The action area lies within a 57-mile unimpounded section of the mid-Columbia River between the tailwater of Priest Rapids Dam and the reservoir created by McNary Dam. Flows in this reach typically peak during spring runoff (April–July) and are lowest in the fall (September–October). The U.S. Geological Survey (USGS) publishes flow records for a gage located 5 miles below Priest Rapids Dam, about 60 miles upstream of the action area.[5] On an annual basis, flows have averaged 115,637 cfs for the water years 1984–2015, which coincide with the period of CGS's operation (range = 80,640 cfs in 2001 to 165,600 in 1997; USGS 2016a). Mean monthly flows ranged from 75,600 cfs during September to 171,000 cfs during June (USGS 2016b).

Regional managers regulate the flow of the river to meet electrical demands, limit impacts on spawning UCR fall Chinook salmon (a species that is not listed under the ESA), and protect other instream uses and water withdrawals. Flows vary daily and hourly, causing the river stage to fluctuate more than 10 feet on some days. River depth in the unimpounded Hanford reach varies from about 25–45 feet for normal high-water and flood high-water levels respectively, and velocities vary from 3 feet per second (fps) to over 11 fps (NRC 2012b). Bathymetry and depth measurements for the outfall evaluation study and the NPDES permit determined that the depth at the upstream end of the action area were 6.9 feet at 36,000 cfs, the minimum regulated flow, and about 22 feet at 271,000 cfs, the 7-day average high flow with a recurrence interval of 10 years (7QlO high flow) (Energy Northwest 2008).

The State of Washington's Administrative Code (WAC 173-563) establishes minimum flows in the Columbia River for the protection of anadromous fish. These include a minimum year-round instantaneous flow at Priest Rapids Dam of 50,000 cfs, subject to a reduction of up to 25% in low flow years, except that "in no case shall the outflow from Priest Rapids Dam be less than 36,000 cfs." Minimum average weekly flows at Priest Rapids Dam are to range from 40,000 cfs in September and early October to 130,000 cfs during May, the peak runoff period.

The NRC (2012b) describes mainstem water withdrawals that interact with those at CGS to affect flow and fish habitat within the action area. According to this analysis, water rights for an estimated 17 users account for a withdrawal rate of about 31.5 cfs. The Department of Energy has a water right to support operations at the Hanford Site and in 2006, withdrew about 0.9 cfs from the Columbia River (USDOE 2009, cited in NRC 2012b). All of these withdrawals could affect flows within the action area. These add up to a total combined withdrawal rate (including 56 cfs for CGS) of 88.4 cfs. This is equivalent to:

- About 0.11% of the lowest mean-annual discharge at Vernita Bridge[6] during 1984-2015 (i.e., 80,640 cfs in 2001);
- Less than 0.12% of the 10th percentile average daily flow during mid-May through mid-June (when small juvenile steelhead are likely to be present) for the period 1984-2015 (i.e., 71,300 cfs); and

[5] Because there are no large tributaries to the Columbia in the intervening reach, flows measured near Priest Rapids Dam are representative of those within the action area.
[6] The Vernita Bridge water quality gage is at the same location as the "Grab River Water" station shown as a red dot in the upper left of Figure 11.

- About 0.17% of the 7-day average low flow with a recurrence interval of 10 years (7Q10 low flow) (52,700 cfs; EFSEC 2014).

These estimates of the total flow reduction experienced by listed salmon and steelhead within the action area, including the proposed water withdrawals under the renewed license, are each less than 0.2%.

2.4.2.2 Water and Sediment Quality

Several sources of water and sediment quality data are relevant to the description of the environmental baseline for the renewed operating license. Contractors for the DOE publish annual reports of conditions (including radiological and chemical contaminants) within the area influenced by past operations and the ongoing cleanup at its Hanford Site (e.g., Mission Support Alliance 2016). Although most of these sampling sites are outside the 3-mile action area for this consultation, we assume that surface water and sediments collected elsewhere in the Hanford Reach are surrogates for local background conditions. The second data source, annual reports for the REMP, directly addresses the potential for radiological impacts from operations at CGS (e.g., Energy Northwest 2016a). The third source is the ambient water quality data used to describe chemical contaminants within the NPDES permit mixing zone for Outfall 001 (EFSEC 2014). We summarize recent results below. Potential sources of these contaminants include past operations at the DOE's Hanford Site and at CGS; groundwater seepage and irrigation return water associated with irrigated agriculture on land north and east of the Columbia River; and industrial and mining effluent introduced upstream (Mission Support Alliance 2016).

Surface Water Quality.

Radionuclides

The U.S. Department of Energy's guideline for radiation dose rates from environmental sources recommends limiting the radiation dose to aquatic biota to no more than 1 rad/d (0.01 Gray/day (Gy/d)) (USDOE 2002). This guideline was derived by reviewing the results of experimental data that indicated there would not be any negative population-level effects on aquatic biota at doses up to 1 rad/d (Blaylock *et al*. 1993). Significant histological effects on the gonads of small tropical fish were detected at a dose of 1 rad/d, although most of the controlled studies that examined the potential chronic effects of ionizing radiation on aquatic organisms did not find significant effects unless the dose was much greater than 1 rad/d. Real *et al*. (2004, cited in NRC 2013) summarized several chronic irradiation studies on fish (mostly from gamma radiation at dose rates of 0.2 to 120 rad/d) that reported effects such as lowered fecundity, delayed spawning, reduced testis mass and sperm production, reduced immune response, reduced larval survival, and increased vertebral anomalies. They concluded that dose rates of less than approximately 10 rad/d to any life stage are unlikely to affect survival (Real *et al*. 2004, cited in NRC 2013). Kryshev and Sazykina (1998, cited in NRC 2013) reported that ecological effects of ionizing radiation on aquatic biota occur at dose rates between 0.2 and 80,000 rad/d. For comparison, Brown *et al*. (2004, cited in NRC 2013) used models to estimate doses to aquatic biota from naturally occurring radionuclides as ranging from 0.00024 to 0.11 rad/d for European freshwater ecosystems and 0.00024 to 0.06 rad/d for European marine waters.

The NRC discussed evaluating the potential for exposure of the aquatic organisms to radionuclides during license renewal of nuclear power plants in its 2013 generic environmental impact statement (GEIS) (NRC 2013). In the GEIS, the NRC determined that doses to aquatic organisms are expected to be well below the U.S. Department of Energy's guidelines developed to protect these organisms and that this issue would be of "SMALL" significance for continued operation at all nuclear power plants, including CGS. The NRC defines "SMALL" to mean that environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource (NRC 2013).

Specific to the Columbia River, the DOE assesses doses to non-human biota at the Hanford Site using a tiered approach that compares radionuclide concentrations measured during annual routine monitoring to a set of biota concentration guides using the RESidual RADioactive (RESRAD)-BIOTA software program. The soil, water, or sediment concentrations of a radionuclide that would produce 1 rad/day are used as biota concentration guides. For samples containing multiple radionuclides, a sum of fractions is calculated to account for the contribution toward the dose limit for each radionuclide. If this sum of fractions exceeds 1.0, the dose limit has been exceeded. In its 2015 Columbia River surface water and sediment samples, DOE detected the following radionuclides across all locations in river water: carbon-14, cobalt-60, cesium-137, plutonium-238, plutonium-239/-240, strontium-90, technetium-99, tritium, uranium-234, uranium-235, and uranium-238 (Mission Support Alliance 2016). The sum of the fractions of these radionuclides was less than 1.0, indicating that the dose to aquatic biota was below the 1 rad/day guideline (Table 4.5 in Mission Support Alliance 2016). Biota doses upstream at the Hanford Townsite (RM 360) and downstream near the 300 Area (RM 345) were similar and likely related to background concentrations in water and sediment (Mission Support Alliance 2016).

With respect to the REMP for CGS, NRC (2012b) stated "[t]here is no evidence of significant impact to the environment due to CGS operation in the plant intake, plant discharge, or river or drinking water results analyzed in 2010." More recently, monthly tritium results for the plant intake, plant discharge, and surface river/drinking water samples were below analytical detection limits in 2015 and gamma spectroscopy results identified only naturally occurring radionuclides (Energy Northwest 2016a).

Chemical Constituents

Copper, uranium, and zinc were detected in Hanford Reach water samples both upstream and downstream of the action area during 2015; results were similar to those previously observed. For copper and zinc, concentrations remained below Washington State ambient surface-water quality criteria for the protection of aquatic life (Table 4). Levels of antimony, arsenic, beryllium, cadmium, chromium, lead, nickel, selenium, silver, and thallium were below analytical detection limits in 2015 (Mission Support Alliance 2016), but nickel was also detected during 2014 (Mission Support Alliance 2015). This is an indication of year-to-year variability in the distribution of metals in surface water within the Hanford Reach.

Past operations at CGS were suspected to be a major source of dissolved copper due to corrosion of the admiralty brass components of the main steam condenser (EFSEC 2014). Energy

Northwest replaced the copper tubes with titanium in September 2011, reducing concentrations in the effluent (Figure 12).

Ground Water Quality.

As described in NRC (2012b), historical operations at the Hanford Site disposed of large volumes of operational wastewater to the unconfined aquifer and led to many changes in the groundwater characteristics. Operational discharges to groundwater decreased beginning in 1984 and were nearly eliminated by 1996, but as a result of these past operations at the Hanford Site (i.e., not related to CGS operations), the groundwater beneath the Site became contaminated by radiological and chemical constituents. The most extensive contaminant plumes are those of tritium and nitrate, emanating from the 200 Areas (see Figure 11) and moving east and southeast towards the river and the CGS site. In 2007, groundwater contaminant levels were greater than drinking water standards beneath 12% of the area of the Hanford Site. (Poston *et al*. 2008).

The DOE discovered high concentrations of tritium emanating from a dry waste landfill (DOE Waste Site 618-11) next to the northwest corner of the CGS site in 1999 (Energy Northwest 2010). This waste site was used between 1962 and 1967 for the disposal of fission products and plutonium from Hanford Site operations. The highest concentrations in groundwater, up to 17,400 picocuries per liter (pCi/L), have been found in an upgradient well, MW-5, and have been attributed to Department of Energy's Hanford Site operations (NRC 2012b). Measured concentrations have been decreasing, but still remain above the drinking-water threshold of 20,000 pCi/L. In addition, elevated nitrate, gross beta, technetium-99, and iodine-129 have been detected in wells near Waste Site 618-11. The DOE continues to monitor the groundwater around the dry waste landfill and is focused on remediation using a process described in Mission Support Alliance (2016) as "the enhanced attenuation of uranium using sequestration by phosphate application."

With respect to groundwater at the CGS site, Energy Northwest monitors deep and shallow groundwater around the site to determine whether tritium and gamma emitting radionuclides are released to the environment (e.g., for past wastewater disposal to an unlined pond located 1,500 northeast of the CGS reactor building and for the ongoing use of drywells around the site that catch stormwater and the drift and spray of condenser cooling water from the towers during windy conditions). Energy Northwest took quarterly samples from three deep wells during 2015 to meet requirements of CGS's Offsite Dose Calculation Manual and EFSEC Resolution No. 332. Consistent with results seen in previous years, tritium was below detection limits and none of the gamma emitting radionuclides related to CGS operation were identified (Energy Northwest 2016a). Nor were any of these gamma emitting radionuclides identified in samples from the nine shallow monitoring wells. Tritium concentrations in water from the shallow wells ranged from below the detection limit to 14,500 pCi/liter. The highest tritium concentrations were measured at MW-5, which is hydraulically up-gradient of CGS. All tritium identified in the shallow monitoring well samples was attributed to past DOE activities and not CGS operation.

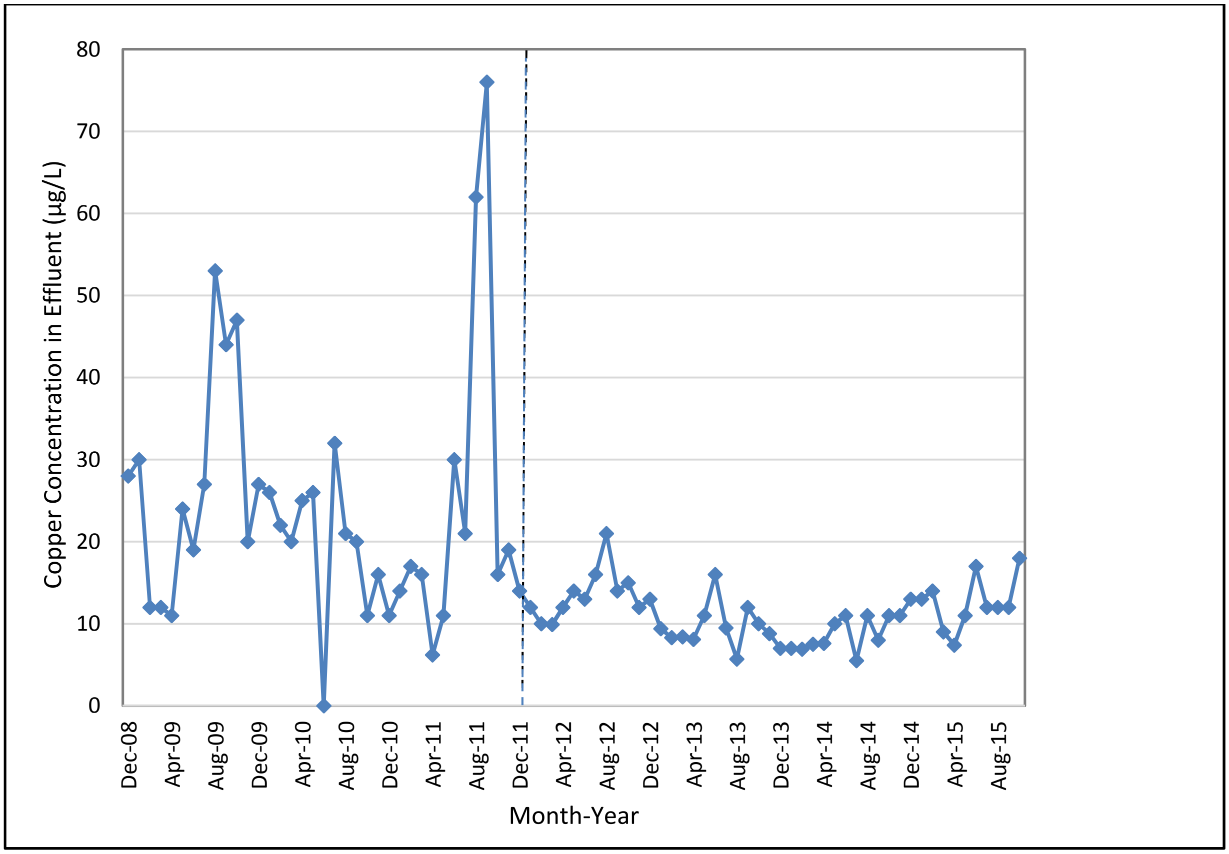


Figure 12. Copper concentration in the effluent from CGS as sampled at the pumphouse before discharge at Outfall 001, December 2008-August 2015. Vertical line separates data collected before and after replacement of copper tubes in the condenser with titanium. Source: Khounnala (2015).

Sediment Quality.

Reactor operations at the DOE's Hanford Site discharged large amounts of effluent to the Columbia River during its peak operating years (Mission Support Alliance 2016). Some constituents in these effluents may have accumulated in riverbed sediments, particularly in slack-water areas. Most short-lived radioactive constituents have decayed, but some longer-lived radionuclides such as isotopes of cesium, plutonium, strontium, and uranium are still detectable. Fluctuations in flow from upriver hydroelectric dam operations, high spring flows, and occasional floods have resuspended, relocated, and subsequently re-deposited this sediment downstream. Upper-layer sediment in the Columbia River downstream of the Hanford Site contains low concentrations of radionuclides, metals of Hanford Site origin, and radionuclides from worldwide atmospheric fallout, as well as metals and other nonradioactive contaminants from mining and agricultural activities.

Radionuclides

Testing of sediment in the Hanford Reach during 2015 consistently detected radionuclides including cesium-137, uranium-234, uranium-235, uranium-238, plutonium-239/-240, and decay products from naturally occurring radionuclides (Mission Support Alliance 2016).

Gamma spectroscopy results of river sediment collected during 2015 for CGS's REMP identified several naturally occurring radionuclides (potassium-40, bismuth- 214, beryllium-7) and cesium-137 (Energy Northwest 2016a). Cesium-137 was detected both upstream and downstream of Outfall 001. Downstream cesium-137 activity levels were slightly higher than the upstream levels, but all results were within the ranges identified in previous years and known to be present in Hanford area sediments and soil.[7]

As described above for surface water, researchers used the RESRAD-BIOTA computer code to evaluate potential effects on biota from the maximum concentrations of radionuclides measured in Columbia River sediment. The concentrations in all Columbia River sediment samples passed the Tier 1 screen and indicate that the calculated doses (sum of fractions) were less than one (Table 4.5 in Mission Support Alliance 2016). Biota doses upstream at the Hanford Townsite and downstream were all similar and likely related to background concentrations in sediment.

Chemical Constituents

Sediment testing for metals in the Hanford Reach detected most of the constituents of concern during 2015 (Table 5). Compared to benthic toxicity screening levels for negative effects at dredged material disposal sites (RSET 2016), the upper end of the detected range of sediment chromium in 2015 (96.5 milligrams per kilogram of sediment dry wt (mg/kg)) indicated the potential for more than minor adverse effects on benthic and epibenthic organisms. However, chromium levels in 2014 (Table C.12 in Mission Support Alliance 2015) were below levels of concern. Similarly, the upper end of the range for detected levels of silver in 2015 (0.74 mg/kg) indicated the potential for minor adverse effects, but sediment concentrations were below screening levels during 2014. As with water quality, it is likely that sediment quality varies from year-to-year in ways that affect its biological significance.

[7] Cesium-137 was not identified in any samples of plant cooling water discharged to the Columbia River (Energy Northwest 2016a).

Table 4. Concentrations of dissolved metals detected in Columbia River water samples collected near the Hanford Site in 2015. The sampling stations at Vernita Bridge, 100-N Area, and Hanford Townsite are upstream of the action area; the 300 Area and Richland stations are downstream. Source: Appendix C in Mission Support Alliance (2016)

Metal	No. of Samples	No. of Detections	Maximum (μg/L)[a]	Minimum (μ/L)[a]	Average (± 2 SD) (μg/L)[a]	Minimum Detectable Concentrations	WA State Ambient WQ Chronic Criteria[b]
Vernita Bridge							
Copper	9	9	0.64	0.45	0.54 ± 0.13	0.35	6
Uranium	9	9	0.57	0.47	0.51 ± 0.073	0.067	
Zinc	9	4	0.61	3.5	4.3 ± 2.04	3.5	55
100-N Area							
Copper	5	5	0.57	0.5	0.53 ± 0.047	0.35	6
Uranium	5	5	0.5	0.47	0.48 ± 0.02	0.067	
Zinc	5	0	–	–	–	3.5	55
Hanford Townsite							
Copper	5	5	0.55	0.47	0.5 ± 0.063	0.35	6
Uranium	5	5	0.65	0.46	0.51 ± 0.15	0.067	
Zinc	5	0	–	–	–	3.5	55
300 Area							
Copper	6	6	0.77	0.48	0.57 ± 0.19	0.35	6
Uranium	6	6	0.54	0.48	0.5 ± 0.053	0.067	
Zinc	6	0	-	-	-	3.5	55
Richland							
Copper	12	12	0.96	0.44	0.6 ± 0.26	0.35	6
Uranium	12	12	0.63	0.47	0.54 ± 0.093	0.067	
Zinc	12	6	5.2	3.5	4.0 ± 1.2	3.5	55

[a] Dashes indicate results at or below minimum detectable concentrations. "SD" = Standard deviation.

[b] WAC 173-201A-240, and WAC 173-201A-250. Table 240(3) Toxic Substances Criteria for the protection of aquatic life. Increased water hardness (primarily higher concentrations of calcium and magnesium ions) can reduce the toxicity of some metals by limiting their absorption into aquatic organisms. For hardness-dependent criteria, minimum USGS value of 47 mg $CaCO_3$/L was used for 1992–2000 water samples collected near Vernita Bridge (USGS-12472900).

Table 5. Dissolved metal concentrations in Columbia River sediment near the Hanford Site, 2015. Sources: Hanford Reach sediment levels, Appendix C in Mission Support Alliance (2016); benthic toxicity screening levels in RSET (2016)[a]

Metal	**Hanford Reach[b] (mg/kg dry wt)**	**Benthic Toxicity Screening Levels (mg/kg dry wt)**	
		SL1[c]	**SL2[d]**
Antimony	0.52 – 5.5	--	--
Arsenic	2.4 – 8.2	14	120
Beryllium	0.45 – 1.28	--	--
Cadmium	0.16 – 0.21	2.1	5.4
Chromium	12.9 – 96.5	72	88
Copper	9.7 – 23.9	400	1,200
Lead	9.1 – 48.6	360	1,300
Mercury	0.01 – 0.05	0.66	0.8
Nickel	10.1 – 20.9	26	110
Selenium	0.72 – 8.5	11	>20
Silver	0.12 – 0.74	0.57	1.7
Thallium	0.61 – 0.92	--	--
Zinc	47 – 362	3,200	4,200

[a] The benthic toxicity screening levels in NRSET (2016) have been adopted by the State of Washington as sediment management standards (see Table VI in WA DOE 2013)

[b] 100-F Slough at RM 366 (n=2), Hanford Slough at RM 362 (n=1), White Bluffs Slough at RM 370 (n=1), 100-D Spring 102-1 at RM 378 (n=1), 100-K 63-1 at RM 382 (n=1), Adjacent to Locke Island at RM 372 (n=1), Adjacent to Savage Island at RM 358 (n=1); where n = number of samples.

"ND" = not detected

[c] Screening Level 1 corresponds to a concentration below which adverse effects to benthic communities would not be expected

[d] Screening Level 2 corresponds to a concentration above which more than minor adverse effects may be observed in benthic organisms

National Pollutant Discharge Elimination System (NPDES) Permit. The State of Washington issued a new 5-year permit (NPDES Permit WA002515-1) for CGS on September 30, 2014, and modified the permit on February 8, 2016 (EFSEC 2016). The permit allows Energy Northwest (permittee) to discharge circulating cooling water blowdown, service water system blowdown, and radioactive wastewater treatment system effluent, to the Columbia River at the permitted location subject to complying with specified average monthly and maximum daily limits. The permit also requires Energy Northwest to monitor the flow, pH, and temperature of the effluent continuously; turbidity monthly; total residual halogen after each treatment; copper, chromium, and zinc monthly; and total priority pollutant metals, volatile organic compounds, acid-extractable compounds, base-neutral compounds, and dioxin once per year. Monitoring data are to be summarized as described in the permit and submitted to the Washington State Department of Ecology via its web-based WQWebDMR system. In addition, Energy Northwest must ensure that the cooling water intake structure is designed, operated, and maintained to minimize impingement and entrainment. This includes designing and conducting entrainment and impingement studies, which we have determined are interrelated to the action for this consultation (section 1.3.5).

2.4.2.2.1 Summary: Water and Sediment Quality within the Action Area

Based on the data reviewed above, the risk of toxicity due to exposure to background levels of radionuclides in water and sediment within the action area is small for juvenile and adult UCR spring-run Chinook and steelhead that actively migrate through the Hanford Reach. In general, any eggs and yolk-sac fry incubating within the action area are vulnerable to the adverse effects of contaminants, as are mobile fry and parr that rear within this reach. Radionuclide levels have been below screening levels for the protection of human health, but we have no standards or criteria that describe effects of chronic exposures to aquatic organisms. Most sediment metal concentrations are below levels for which the federal and state agencies have established screening levels (RSET 2016), although values for chromium and silver varied from below screening levels in 2014 to above in 2015. These chemical contaminants could pose a small risk if mobile steelhead fry and parr feed along the bottom in shoreline areas where fine sediments accumulate.

2.4.2.3 Water Temperature in the Action Area

Another measure of water quality for anadromous salmonids is water temperature. There is no temperature gage in the mainstem within the action area, but average daily water temperatures at Vernita Bridge (RM 388) for 2006-2012 are shown in Figure 13. We assume these temperatures represent background conditions relevant to effects of the action because no large tributary streams enter the Columbia River in the 34-mile reach between Vernita Bridge and the action area (RM 354). During 2015, a combination of low snow levels in the interior basin and low spring precipitation resulted in below average mainstem flows. These combined with June air temperatures that were 5.4-7.6°F degrees above average to result in unseasonably high water temperatures both in the tributaries and the mainstem Columbia River (NMFS 2016b) and thus in the water coming into the action area.

NMFS considers a water temperature of 13°C during spawning through fry emergence (February through early June for steelhead; Table 3) protects gametes before spawning and provides protective temperatures for egg incubation (EPA 2003). Average daily temperatures at the Vernita Bridge gaging station have been below this level during the last decade except during early June 2015 (Columbia River DART 2016c). A water temperature of 18°C protects against lethal conditions for juveniles and adults, prevents migration blockages for adults, provides sub-optimal growth conditions during summer and optimal conditions during non-summer months of the year, and minimizes the exposure time of adults and juveniles to temperatures associated with a high risk of disease. On average, daily water temperatures at the Vernita Bridge gage have exceeded 18°C during mid-July through September over the last decade (Figure 13). Because average daily water temperatures have already exceeded 18°C before traveling downstream and into the action area, NMFS assumes that baseline water temperatures within the action area are also likely to have exceeded 18°C during this period. The frequency and severity of water temperatures exceeding 13°C or 18°C and the associated risks to the listed species are expected to increase as air temperatures increase and snow packs diminish under climate change scenarios for the Pacific Northwest.

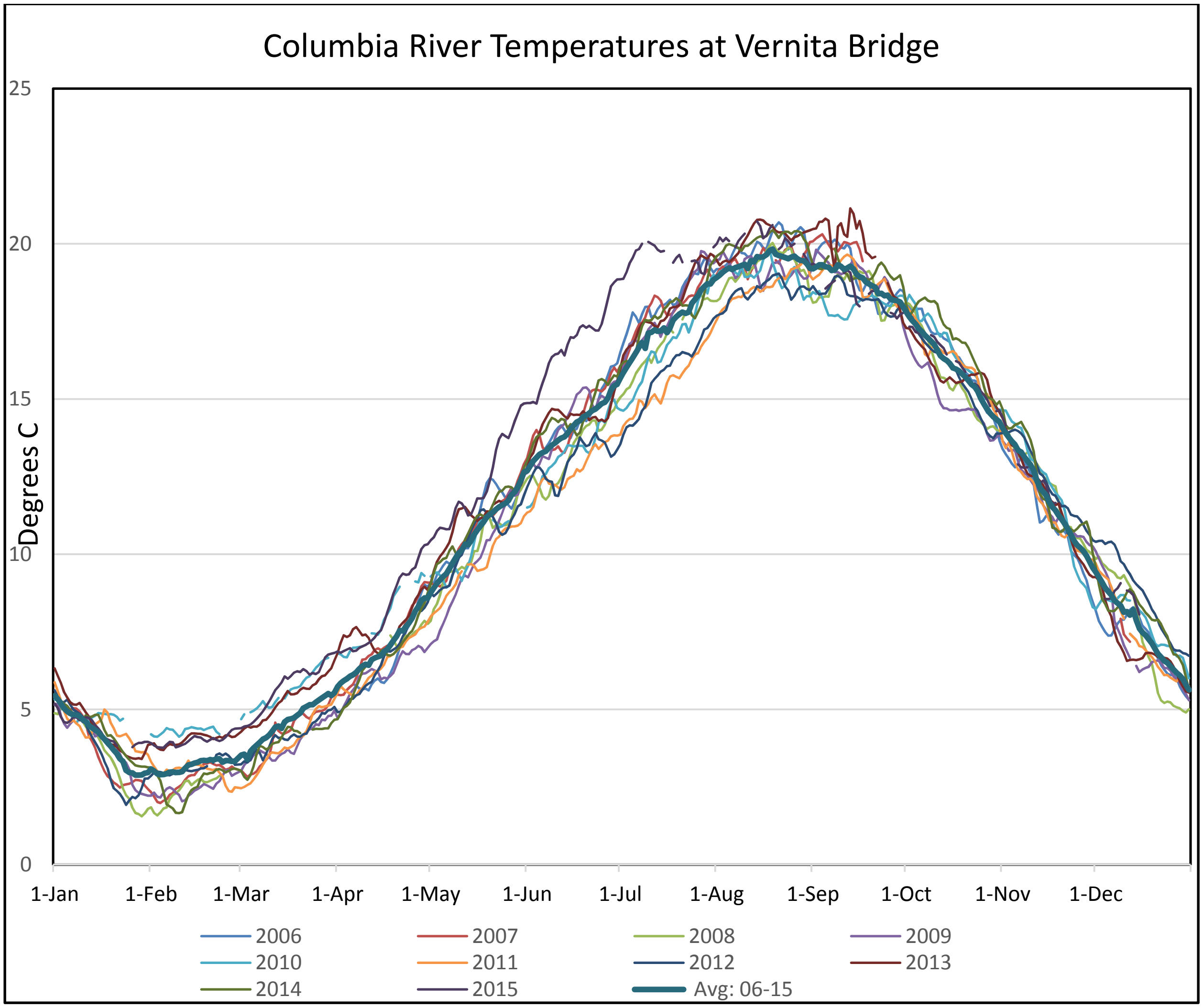


Figure 13. Average daily water temperatures at the monitoring station at Vernita Bridge (RM 388) during 2006-2015 and the average for that period. Source: Columbia River DART (2016c)

<u>2.4.3 Summary: Effects of Environmental Conditions within the Action Area on the Listed Species</u>

Although copper, uranium, and zinc have been detected in surface water samples, and a number of dissolved metals have been detected in sediments from the Hanford Reach, concentrations are low and do not appear to pose a risk to adult or juvenile life stages of anadromous fish.

Based on water temperatures at the Vernita Bridge gage, 34 RM upstream of the action area, we assume that water temperatures in the action area have generally been within the ranges required for spawning, rearing, and migration during the last decade. The exception is the mid-July through September period when juvenile spring-run Chinook are still migrating from the core spawning areas in the Wenatchee, Entiat, and Methow subbasins and temperatures exceeding

18°C have entered the action area due to conditions upstream. The frequency and severity of water temperatures exceeding 13°C or 18°C and risks to the listed species are expected to increase as air temperatures increase and snow packs diminish under climate change scenarios for the Pacific Northwest.

2.4.4 Effects of Environmental Conditions within the Action Area on Designated Critical Habitat

In general, the functioning of physical and biological features of critical habitat that are relevant to effects of the action (water quantity, water quality, and sediment quality) appear adequate to support the conservation of the listed species. An exception is the temperature component of water quality, which due to conditions upstream of the action area, has exceeded levels needed to support the later juvenile migrants from core spawning areas of UCR spring-run Chinook salmon. Under climate change scenarios, exceedances of the 18°C temperature criterion for juvenile migrants could be larger and could affect a larger proportion of the run in future years.

2.5 Effects of the Action

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

The operation of CGS under the renewed license has the potential to affect individual UCR spring-run Chinook salmon and UCR steelhead and the physical and biological features of their designated critical habitat through the following exposure pathways:

- Water withdrawals from the Columbia River (water quantity)
- Water intake screens (safe passage)
- Effluent toxicity (water and sediment quality)
- Water temperature (water quality)
- Biological monitoring activities

In the following sections, we discuss whether negative effects are likely to occur and if so, the extent of risk to individuals and populations of each species and to the conservation value of critical habitat.

2.5.1 Water Withdrawals from the Columbia River

The CGS pumps water from the Columbia River to replenish the water lost from its closed-cycle cooling system due to evaporation, drift, and blowdown. Water withdrawals associated with the operation of the CGS under its original license are included in the environmental baseline (section 2.4.2.1). Withdrawals that continue into the future as part of the renewed license are an effect of the action. Therefore, we evaluate here the continuation of water withdrawals due to the operation of CGS through 2043.

The CGS make-up water pumps have the capacity to supply 56 cfs of water from the Columbia River to the plant (section 1.3.1). During normal operating periods (i.e., when the plant is operating at 100% power during a non-refueling year), the average makeup-water withdrawal within a given year is about 38 cfs (NRC 2012b; Khounnala 2016). We assume a range of withdrawals between the annual average (38 cfs) and pumphouse capacity (56 cfs) to evaluate effects on natural resources within the action area. The maximum withdrawal of 56 cfs would be less than 0.2% (rounded up) of any of three measures of low annual flows in the Columbia River (section 2.4.2.1).

We conservatively include pumphouse capacity in this analysis because, under climate change scenarios for the Pacific Northwest, higher air temperatures are likely to cause more evaporation of cooling tower water, increasing the need to make up additional volumes by withdrawals from the Columbia River. Even during the 20-year term of the renewed license, the need for increased water withdrawals to meet cooling tower demand could occur earlier during summer and perhaps during spring when smolts from major upstream spawning areas are migrating through the action area.

2.5.1.1 Effects of Reduced Mainstem Flows by Species and Life Stage

A total ongoing mainstem flow reduction of less than 0.2%, including the other withdrawals in the Hanford Reach described in section 2.4.2.1, is not likely to elicit a biological response from either adult UCR spring-run Chinook salmon or steelhead or yearling smolts of either species that migrate through the action area from the core upstream population areas. There could be an ongoing negative effect on the amount and quality of habitat available to the steelhead fry or parr that rear within the action area through a small reduction in wetted area (although less than those associated with a 10-foot per day variation in river stage due to flow management at upstream hydroelectric projects; section 2.4.2.1), but these small fish are likely to find suitable microhabitat by moving short distances as described for coho and Chinook salmon in Shirvell *et al*. (1994). Even if some fry and parr are negatively affected, these individuals are not from the core upstream population areas and any reduction in their individual fitness or survival would not affect our estimates of numbers or productivity at the population level. Losses would have a very small effect on the diversity and spatial structure of the DPS.

2.5.1.2 Effects of Reduced Mainstem Flows on the Functioning of Critical Habitat

Water withdrawals for operations at CGS under the renewed license would continue to have a very small effect on water quantity within the action area. These effects are not likely to reduce the conservation value of the physical and biological features that make the mainstem suitable for migration by adult and juvenile UCR spring-run Chinook salmon and steelhead and for spawning and rearing by UCR steelhead.

2.5.2 Water Intake Screens

Flow through the 3/8-inch diameter exterior perforations in the screens on the water intake structure could entrain and impinge small steelhead fry that emerge from redds within the action area (NMFS 2013). At the time the project was developed, the operator (Washington Public

Power Supply System, WPPSS) estimated the likelihood of entrainment or impingement as very small based on the results of a modeling exercise that estimated velocity through the inlets and outside the screens at a distance of 1/3 inch (WPPSS 1977). In the following sections we describe the pre-operational field studies conducted by WPPSS in an effort to validate the modeling results and the expected risk to juvenile salmonids.

<u>Entrainment.</u> Physical entrainment studies used two mesh cages attached to the collection pipes within the pumphouse (Mudge *et al*. 1981). These cages were 1.75 m (5.8 feet) long by 1.07 m (3.5 feet) and lined with a 2.0-mm mesh. Each cage was positioned to collect 100% of the water entering the pump well through one of the 36-inch diameter pipes leading from the river. Each cage could be raised independently and any captured fish retrieved through a 3.5-foot door. The cages were designed to collect only small individuals (e.g., fish no more than 100 mm long) because the diameter of the perforated screen holes limits the size of entrainable organisms. The entrainment studies were conducted on 69 occasions (a total of 682 hours) between May 1979 and May 1980. About 30% of the total volume of water withdrawn from the river for normal operations was routed through the cages. Beach seining showed that Chinook salmon fry were in the area of the CGS intakes from at least March through May during sampling (no steelhead fry or parr were reported). However, no Chinook salmon eggs or fry were observed in the collection cages.

The WPPSS (1986) conducted a second entrainment study in 1985. Twenty-four hour samples were collected each week during April 3 to May 2 and July 23 to September 11, 1985 (the plant was shut down May 3 to July 22, 1985). The same method was used with the collection cages inspected for fish or fish parts at the end of each sampling interval, rinsed with water to remove "scum," and re-inspected. Again, no fish, eggs, or larvae were observed. Each test required that the plant provide near-maximum pumphouse flow rates (preferably 1.451 m^3/s) during the sampling period and that both intake pipe gates remain open so that in this case, the actual volume sampled was about half of the total pumphouse flow. Five beach seining operations during April 11 through June 11 documented the presence of newly emerged Chinook salmon fry in the area of the intake structures during the entrainment study, but no juvenile steelhead. A total of 101 Chinook salmon juveniles were collected by seine with minimum and maximum lengths of 36 mm and 62 mm, respectively (Table 12-2 in WPPSS 1986).

In addition to the routine monitoring, tests were conducted in May and June 1979 to assess the sampling efficiency of the collection cages because the seal between the square opening to the collection cage and the round 36-inch diameter inlet pipe was imperfect. To ensure that collected fish were not destroyed or washed out of the collection baskets, Mudge *et al*. (1981) performed efficiency tests. The authors introduced marked coho into the cages for a 12-hour pumping period and then retrieved any that had been retained. The test measured a collection efficiency of about 80% (77.8% for live coho fry and 84.6% for dead coho fry), which the authors judged to be adequate. However, this indicates that if some fry-sized salmon had been entrained at the screens, about 20% might not have been retained in the cages used in the Mudge *et al*. (1981) evaluation.

In its letter to EFSEC during the NPDES permitting process, NMFS (2013) noted several reasons for concern that the intake screens could impinge and entrain juvenile salmon and steelhead. As a result, EFSEC (2016) included a requirement that Energy Northwest conduct an entrainment study in its NPDES permit for CGS. This study is interrelated to the action (section 1.3.5).

Impingement. EFSEC (2014) also requires Energy Northwest to conduct an impingement study as a condition of the NPDES permit. Impingement occurs when organisms are trapped against cooling-water intake screens by the force of moving water (NRC 2012b). Impingement can kill organisms immediately or contribute to their death over time from exhaustion, suffocation, or injury.

The WPPSS (1986) conducted a total of nine impingement studies during March through October and December 1985. Divers inspected the screens and reported any fish impingement on or interaction with the structures, accumulation of submerged debris, or plugging of water entrance orifices by periphyton. Although no fish were observed impinged on the intake screens, it is possible that the study design (the inspection frequency and duration) did not adequately address the potential for harm of smaller life stages.

NRC (2012b) reasoned that the screen design makes it unlikely that organisms including listed salmonids will become impinged because the velocity of water across the face of the screens is several times faster than the intake velocity:

- The velocity through the external screen openings is about 0.5 fps under normal operating conditions where 12,500 gpm (28 cfs) is removed through both intake structures; and
- The approach velocity to the intake screens under the same conditions is less than 0.2 fps (WPPSS 1980) compared to river velocities measured near the perforated pipes ranging from 4–5 fps (WPPSS 1986).

However, the flow field from each screen’s bow wave could collapse back onto the screen surface (NMFS 2015), changing approach velocities along the length of the screen and increasing the risk of impingement for steelhead fry- and smolt-sized spring-run Chinook and steelhead along the downstream third. Thus, the potential for injury or mortality due to impingement could be higher than that stated by NRC.

2.5.2.1 Risk of Entrainment and Impingement by Species and Life Stage

Although the studies conducted at CGS to date have not shown entrainment or impingement of juvenile Chinook salmon or steelhead, the studies using pumphouse cages to capture entrained fry were 80% efficient (Mudge *et al*. 1981). We therefore base the following analysis on the conservative assumption that some salmon fry could have been entrained at the screens, but not captured in the cages. In addition, we consider the risk that variable approach velocities along the length of each screen could create areas in which listed salmonids are susceptible to impingement, as described in the previous section.

Adults. Adult UCR spring-run Chinook salmon and steelhead are strong enough swimmers to avoid contact with the intake screens. There is no risk of entrainment and the risk of impingement for this life stage is negligible.

Eggs and Yolk-Sac Fry. Steelhead eggs and yolk-sac fry scoured from any of the redds described in section 2.4.1 could move through the action area. These individuals would have no ability to direct their movements and could be entrained into or impinged on the intake screens. However, these individuals are unlikely to survive without the protection afforded by the gravel nests (DeVries 1997), regardless of the intake screen. We therefore discount the risk of injury or mortality due to interaction with the screens for the purpose of this analysis.

Fry. UCR spring-run Chinook fry are not present in the action area. Steelhead fry (length < 60 mm; NMFS 2011) are the life stage most likely to be entrained or impinged on the intake screens because they do not have the swimming ability to overcome the ambient flow field. Although fry are likely to prefer the slower velocities and vegetative cover along the shoreline, their actual distribution within the flow field near the intake screens is unknown. For the purpose of this analysis, we conservatively assume they are distributed evenly across the river. We also assume that the hydraulic effect of the screens is proportional to the width of the river occupied by the screens. At the location of the intake, the channel is 1,400 feet wide at the 7Q10 flow (52,700 cfs; see Figure 3 in EFSEC 2014). The two 42-inch diameter screens influence at least 84 inches (7 feet) of the river width or about 0.5% of the river width at this flow.

To estimate the number of individuals that could be entrained or impinged due to interaction with the screens, we assume that any fry produced within a 35-mile mainstem reach above the water intake structure could rear within the action area. We bracketed the number of redds producing fry by (1) the maximum number observed in recent years (i.e., 75) and (2) an assumption of two redds per river kilometer (i.e., [3.22 redds/mile] * 35 miles from Vernita Bridge to the water intake structure = 113 redds). Based on Table 15-1 in Quinn (2005), we assume 4,923 eggs per steelhead redd and an egg-to-fry survival rate of 0.293. Thus, a maximum of between about 108,000 and 163,000 steelhead fry could rear within the action area (Table 6).[8]

Steelhead fry are likely to rear in shallow areas along the banks where there is some potential for vegetative cover. If this assumption is correct, many of these fish will not interact with the flow field around the intake structure. However, under the conservative assumption that these fish are distributed evenly across the width of the river, a maximum of about 0.5% of the fry rearing in the action area, or 540 to 815 individuals, could be entrained or impinged due to interaction with the screens.

Table 6. Estimates of the maximum numbers of steelhead fry from upstream redds likely to be rearing in the action area each year. See table footnotes for data sources.

Scenario	Redds	Eggs/Redd	Egg-to-Fry Surv	Fry[a]
Observed redds	75[a]	4,923[b]	0.293[c]	108,183
3.22 redds/mile	113[d]	4,923	0.293	162,996

[a] Nugent and Cranna (2015)

[b] Table 15-1 in Quinn (2005)

[c] Table 15-1 in Quinn (2005)

[d] Assumes 2 redds per kilometer or 3.22 redds per mile over the 35 mile reach from Vernita Bar to the water intake structure for CGS.

[8] This estimate is conservative because it does not account for losses to predators or other sources of mortality in the egg-to-fry life stage before these fish enter the action area.

Parr. Steelhead parr (length about 60 to 120 mm; NMFS 2011, Fulton 2004) are large enough that they are not likely to be entrained or impinged at the intake screens.

Smolts. Juvenile spring-run Chinook salmon and steelhead in this size category (length ± 100 mm; Fulton 2004) are large enough that they are not vulnerable to entrainment or impingement on the intake screens.

2.5.2.2 Effects of the Risk of Entrainment and Impingement on the Functioning of Critical Habitat

The risks of entrainment and impingement at the water intake structure for the CGS would have a small effect on safe passage for UCR steelhead fry within the action area. These effects are not likely to reduce the conservation value of the physical and biological features within the action area that make it suitable for migration for adult or juvenile spring-run Chinook salmon and steelhead or for spawning and rearing areas for steelhead.

2.5.3 Effects of the Discharge at Outfall 001 on Water Quality

2.5.3.1 Effects of Radionuclides Discharged at Outfall 001

The water discharged at Outfall 001 can include effluent from the CGS radioactive wastewater treatment system. This system receives excess inventory from the primary water system (the reactor water used in steam production) or reactor water that does not meet specifications in terms of its organic content. Because the reactor water has the potential for radioactive contamination, it is filtered and treated through an ion exchange process to reduce radioactive impurities to meet the NRC-dictated limit of as low as is reasonably achievable (ALARA) and to be within the NRC dose standards set forth in 10 CFR Part 20 and Appendix I to 10 CFR Part 50 prior to discharge in batches of 15,000 gallons. Energy Northwest manages CGS in such a way as to make such discharges infrequent. The last radioactive liquid discharge from Outfall 001 occurred on September 19, 1998.

We have reviewed the information presented in NRC (2012b) and the most recent annual reports for CGS's Radiological Environmental Monitoring Program (REMP; Energy Northwest 2015b, 2016). Aquatic environmental monitoring under the REMP consists of analyzing samples of river water, river sediment, and edible fish flesh:

Surface Water. Surface water samples were collected from two locations in the Columbia River (RM 343 and 354) and from the plant effluent before discharge on a monthly basis. These were analyzed for tritium, gross beta, and gamma-emitting radionuclides.

- Gross beta testing results for river water stations were below the analytical detection limits in both 2014 and 2015 with the exception of the May, 2014, sample collected near Richland, which was just above the detection limit;
- Gross beta levels in the plant discharge water, which represents levels of radioactivity present in the effluent before any mixing with river water, were above the detection limits in eleven of the twelve samples in 2014 and nine of the

twelve samples during 2015; these positive results were expected due to the scrubbing action of the cooling towers which incorporates atmospheric particulate material into the discharge water and the concentration of natural radioactivity in the water by evaporative loss;

- Tritium results for all plant discharge and river water samples were below the detection limit for the analytical method; and
- Gamma spectroscopy analyses for all plant discharge and river water samples identified only naturally occurring radionuclides during both years.

River Sediment. River sediment samples are collected semiannually from two locations: 2 miles upriver from Outfall 001 (RM 354) and about 1 mile downstream (RM 351). Each sample consists of shallow surface sediment scooped from areas where sediment accumulation is likely. These were analyzed for Cesium 137 and gamma-emitting radionuclides.

- Gamma spectroscopy tests of river sediment identified naturally occurring radionuclides (potassium-40, bismuth-214, and cesium-137) during both years; and
- Cesium-137 was detected in samples collected downstream, but not upstream of Outfall 001 in 2014 and at both the upstream and downstream stations in 2015 (Note: cesium-137 was not identified in any samples of plant cooling water before discharge to the Columbia River).

Fish Tissue. Anadromous fish samples were obtained from the Ringold Fish Hatchery to serve as indicator samples and from Lyons Ferry Fish Hatchery on the Snake River to serve as controls. Only edible portions of the fish were tested for gamma-emitting radionuclides.

- The gamma spectroscopy analyses of fish samples collected from both the indicator (Ringold Fish Hatchery) and control locations (Lyons Ferry Hatchery on the Snake River) identified only naturally occurring radionuclides.

Energy Northwest (2015b, 2016a) concluded that all routine testing results were consistent with those obtained from control locations, results from the preoperational period, and historical results for the site. All radioactive material identified outside the area controlled by the station was of natural origin or known to be present in the local environment in the quantities identified. No radioactive materials were identified that could be attributed to the licensed operation.

Thus, it is not likely that UCR spring-run Chinook salmon or steelhead are exposed to radionuclides discharged at Outfall 001 due to operations at CGS. Therefore, no effects on fish survival or condition or the functioning of water and sediment quality in designated critical habitat are expected as a result of ongoing operations under the action.

2.5.3.2 Effects of Chemical Constituents Discharged at Outfall 001

Energy Northwest provided data on the concentrations of chemical constituents in the effluent, as sampled at the pumphouse, for the renewal of its NPDES discharge permit (Table 7).

Table 7. Wastewater effluent constituents discharged at Outfall 001. Source: Appendix D in EFSEC (2014)

Parameter (µg/L)	# of Samples	90th Percentile (µg/L)
Ammonia	22	106
Chlorine	1,000	100
Chromium VI	38	2.32
Copper	16	19.5
Zinc	38	33.94
Bromoform	3	1.43
Antimony	3	3.51
Arsenic	3	6.8
Lead	3	0.74
Mercury	3	0.0058
Nickel	3	3.65
Selenium	3	1.94

The effects of chemical constituents on aquatic organisms when discharged to the Columbia River are estimated from laboratory toxicity tests. These are controlled experiments designed to assess the response of one or more test organisms (usually an amphipod crustacean and a minnow) to a single chemical or a mixture. Toxicity tests measure acute and chronic responses. Tests for acute toxicity are designed to determine the concentration at which 50% of the test sample is killed (the lethal concentration [LC] 50). Exposure durations vary, but 24- to 48-, 72-, and 96-hours are typical.

Chronic toxicity tests are designed to determine the concentration at which no observational effect occurs. One measure is the no observable effect concentration (NOEC), the highest concentration in a laboratory test with a mean response that does not differ significantly from the control (Crane and Newman 2000). These laboratory tests look for endpoints such as mortality or reduced growth or reproduction after exposure durations of seven days to several months or more.

For this biological opinion, we evaluate the likely:

- Concentration of the *individual* constituents at the edges of the acute and chronic mixing zones (shown to scale in Figure 14);
- Responses of individual salmon and steelhead to these concentrations based on a review of the scientific literature on toxicity testing relevant to these species; and
- Effects of the *mixtures* of metals and organic compounds in the effluent based on a "concentration addition" model.

We then consider the likelihood that the listed species and their respective life stages in the action area will be exposed to these effluent concentrations. Our findings are described below.[9]

[9] NMFS (2014b) reviewed the assumption that effects on aquatic organisms in laboratory tests are reasonable

2.5.3.2.1 Salmonid Responses to Concentrations of Individual Toxic Constituents from the Effluent Discharge

The expected concentrations of each effluent constituent at the edges of the mixing zones are shown in Table 8. These estimates are were derived by EFSEC for its “reasonable potential analysis” for the purpose of the NPDES discharge permit.

Table 8. Expected concentrations of individual effluent constituents at the edges of the acute and chronic mixing zones. Source: Appendix D in EFSEC (2014)

	Concentrations at Edges of Acute and Chronic Mixing Zones[a]	
Constituent	**Acute**	**Chronic**
Ammonia (total NH_3)	45 µg/L	38 µg/L
Chlorine (total residual halogen)	11.111 µ/L	1.075 µ/L
Chromium VI	1.498 µ/L	1.409 µ/L
Copper	3.401 µ/L	1.142 µ/L
Zinc	5.800 µ/L	2.639 µ/L
Bromoform (halomethane)	n/a[b]	0.019 µ/L
Antimony (inorganic)	n/a	0.045 µ/L
Arsenic (dissolved)	2.226 µ/L	0.219 µ/L
Lead	0.204 µ/L	0.110 µ/L
Mercury	0.002 µ/L	0.000 µ/L
Nickel	1.124 µ/L	0.117 µ/L
Selenium	0.647 µ/L	0.063 µ/L

[a] The edge of the acute mixing zone is 31 feet and the edge of the chronic mixing zone is 308 feet downstream from the outfall.

[b] n/a = not applicable because the State of Washington has set only chronic water quality criteria for bromoform and antimony and only for the protection of human health.

The likely effects of these constituents vary between life stages of salmonids as described in NMFS (2012). The geometric means (geomeans) and ranges of the effects concentrations for acute toxicity tests (LC50s) and lowest endpoint concentrations in chronic effects testing for specific life stages are summarized below and compared to the expected concentrations at the edges of the mixing zones. All effects endpoints are for salmon and trout unless otherwise stated (e.g., with respect to the chronic toxicity data for chlorine). The abbreviation “NR” indicates that either the test concentration, the life stage tested, or both were not reported.

<u>Ammonia.</u> The geomean of exposure concentrations for the LC50 (acute effects) is 32,000 µg/L (range = 7,300 to 89,300 µg/L, n = 56; NMFS 2012). The 95th percentile concentration of ammonia in the effluent at the point of discharge is 106 µg/L, which is diluted at the edge of the acute mixing zone, 31 feet downstream, to 45 µg/L.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Growth - 300 µg/L (life stage not reported (NR)) for 120 days

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predictors of effects in field situations. The responses of animals in laboratory aquaria could differ from those in the wild because a range of factors including nutritional state, the presence of disease or parasites, prior exposure to stressors, and density dependence could influence the effects of a chemical stressor on an aquatic organism. While there is some risk that laboratory tests could under or over predict effects in the wild, it is generally reasonable to interpret effects from laboratory tests as applicable to field situations where criteria are applied.

- Biochemical - 1 μg/L (NR) for 1 day;
- Behavioral - 400 μg/L (NR) for 4.8 hours
- Cellular - 300 μg/L (NR) for 120 days
- Physiological - 230 μg/L (NR) for 42 days

The expected concentration at the edge of the chronic mixing zone is 38 μg/L, which is below these effects thresholds except for the potential for biochemical effects after exposure for one day. However, the life stages used in the chronic tests were not reported, creating uncertainty as to their relevance to the effects of the action. In light of these uncertainties, concentrations of ammonia shown to have biochemical effects could be present within the 3,080-ft^2 chronic mixing zone.[10]

Chlorine (Total Residual Halogen). Acute toxicities (LC50) for salmon and trout (n=54) ranged from 40 μg/L (fry) at an exposure duration of 96 hours to 179 μg/L (juveniles) at an exposure duration of 96 hours. The 95th percentile concentration in the effluent at the point of discharge is 100 μg/L, which is diluted to 11.111 μg/L at a distance of 31 feet downstream at the edge of the acute mixing zone. Therefore, concentrations of chlorine shown to reduce the survival of salmonid fry after a 96-hour exposure could be present within the 31-ft^2 acute mixing zone.

We did not find any chronic toxicity data for salmon or trout. The minimum concentration for chronic toxicity for the fathead minnow ("early life stage") was 11.2 μg/L (exposure duration NR). The expected concentration at the edge of the chronic mixing zone is 1.075 μg/L, which is below this minimum effects threshold.

Chromium VI. The geomean of exposure concentrations for the LC50 was 68,333 μg/L (range = 12,079 to 74,239 μg/L, n = 6; NMFS 2012). The 95th percentile concentration of chromium VI in the effluent at the point of discharge is 2.32 μg/L, which is below these thresholds, and which is diluted at the edge of the acute mixing zone, 31 feet downstream, to 1.498 μg/L.

The minimum concentration and exposure duration for a chronic effect on growth were 9.6 μg/L (eggs-juveniles) for 7 months (NMFS 2012). The expected concentration of chromium VI at the edge of the chronic mixing zone is 1.409 μg/L, which is below this minimum effects threshold.

Copper. The geomean of exposure concentrations for the LC50 was 96 μg/L (range = 5.70 to 1,160.10 μg/L, n = 178; NMFS 2012). The 95th percentile concentration of copper in the effluent at the point of discharge is 19.5 μg/L, which is diluted 31 feet downstream at the edge of the acute mixing zone to 3.401 μg/L. Therefore, concentrations of copper shown to reduce the survival of yolk-sac fry and large juveniles after some 96-hour exposures could be present within the 31-ft^2 acute mixing zone.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Growth - 1.1 μg/L (embryo) for 96 hours; 2.2 μg/L (fry) for 10 days

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[10] The area of the chronic mixing zone was calculated as (base*height)/2 where the base of the chronic mixing zone is 20 feet across and the height is 308 feet (see Figure 3 in EFSEC 2014).

- NOEC for growth - 9.5 µg/L for a mix of life stages from eggs through yearlings at an exposure duration of 8 months
- Behavioral - 65.8 µg/L (yolk sac fry) for 15 days
- Olfaction - 0.18 µg/L (juveniles) for 3 hours
- Cellular - 29.2 µg/L (yearlings) for 15 days
- Physiological - 1.3 µg/L (200-250 gram juveniles) for 24 hours
- Reproductive - 3.5 µg/L (yearlings) for 8 months

Expected concentrations between the point of discharge (19.5 µg/L) and edge of chronic mixing zone (1.142 µg/L) are above the minimum observed levels with effects on growth, olfaction, physiology, and reproductive biology for a variety of juvenile life stages over exposure periods ranging from 24 hours to 8 months.

Zinc. The geomean of exposure concentrations for the LC50 was 1,190 µg/L (range = 238 to 9,784 µg/L, n = 73; NMFS 2012). The 95th percentile concentration of zinc in the effluent at the point of discharge is 33.94 µg/L, which is diluted to 5.80 µg/L at a distance 31 feet downstream at the edge of the acute mixing zone.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Mortality - 11 µg/L (eggs) for 18 months; 320 µg/L (fingerlings) for 21 months
- Growth - 104 µg/L (NR) for 4 days
- NOEC for mortality/reproduction - 98 µg/L (NR) for 1 month
- Cellular - 91 µg/L (6-18 months) for 3.15 hours
- Physiological - 1,360 µg/L (yearlings) for 96 hours
- Reproductive - 30 µg/L (NR) for 0.67 hours

Expected concentrations between the point of discharge (33.94 g/L) and the edge of the chronic mixing zone (2.639 g/L) are above minimum observed levels with effects on egg survival after 18 months and reproductive biology (life stage not reported) after 0.67 hours.

Bromoform. Bromoform, is a halomethane and a bromine by-product. Bromine reacts with natural organic substances leads to the production of brominated organic compounds. There are many possible organo-brominated by-products, but toxicological data is either scarce or non-existent. The State of Washington has not set aquatic life criteria for bromoform, but regulates the maximum concentration at the edge of the chronic mixing zone for the protection of human health.

We reviewed the available data for effects on rainbow trout, a species closely related to steelhead. For acute effects (LC50), the minimum exposure concentration for bromine was 68 µg/L (life stage NR) for 96 hours (Lewis *et al*. 1997). In water, hypobromous acid can react rapidly with ammonia or other organics to form bromamines and brominated organics. From the available data for bromamines and brominated organics, the minimum concentration for an LC50 was 400 µg/L for 96 hours (Lewis *et al*. 1997). The lowest test concentration causing 100%

mortality (LC100) was 1,000 µg/L for 96 hours (life stage NR). In comparison, the 95th percentile concentration in the effluent at the point of discharge is 1.43 µg/L, which is below these effects thresholds.

For chronic toxicity, the minimum NOEC was 100 µg/L (NR) for 96 hours. The expected concentration of bromoform at the edge of the chronic mixing zone is 0.019 µg/L, which is below the chronic effects threshold.

<u>Antimony.</u> Antimony exists in three valence states (-3, +3, and +5), but the -3 state is not stable in oxygenated water and the +3 state, antimony trioxide, is not very soluble in water. On the other hand, antimony trichloride is very soluble, but it will form the insoluble antimony oxychloride. The +3 state also forms water soluble complexes with some acids, such as in potassium antimony tartrate. Little seems to be known about the aqueous chemistry of the +5 valence state. The State of Washington has not set aquatic life criteria for antimony, but regulates the maximum concentration at the edge of the chronic mixing zone for the protection of human health.

There are insufficient data on salmonids to determine whether exposure to antimony is likely to cause adverse effects. Acute toxicity data for freshwater fishes is limited to two studies, one used the fathead minnow (*Pimephales proelas*) and reported an LC50 concentration of 21,900 µg/L and one used the bluegill (*Lepomis macrochirus*) and reported an LC50 concentration of 530,000 µg/L (EPA 1980). Chronic toxicity for the fathead minnow (embryo-larval) was reported at a concentration of 1,600 µg/L (EPA 1980). These studies suggest that the expected concentration of antinomy at the point of discharge (3.51 µg/L) and 31 feet downstream at edge of the acute mixing zone (0.045 µg/L; Table 8) is not likely have negative effects the listed salmonids. The expected concentrations at the downstream edge of the chronic mixing zone would be even lower.

<u>Arsenic.</u> The geomean of exposure concentrations for the LC50 was 62,625 µg/L (range = 35,000 to 145,000 µg/L, n = 6; NMFS 2012). The 95th percentile concentration of arsenic in the effluent at the point of discharge is 6.8 µg/L, which is diluted to 2.226 µg/L at a distance of 31 feet downstream at the edge of the acute mixing zone.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Mortality–35,000 µg/L (5-6 weeks)
- Growth–3,510 µg/L (fry) for 11 weeks
- Behavioral–17,800 µg/L (adults) for 8 weeks
- Physiological–21,900 µg/L (7-11 weeks) for 24 hours

The expected concentration of arsenic at the edge of the chronic mixing zone is 0.219 µg/L, which is below these effects thresholds.

<u>Lead.</u> The geomean exposure concentration for the LC50 was 14,675 µg/L (range = 320 to 224,000 µg/L, n = 14; NMFS 2012). The 95th percentile concentration in the effluent at the point

of discharge is 0.74 μg/L, which is diluted to 0.204 μg/L at a distance of 31 feet downstream at the edge of the acute mixing zone.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Growth−1 μg/L (NR) for 19 minutes; 6 μg/L (sexually maturing males and females) for 12 days
- NOEC for mortality/growth−18 μg/L (eggs) for 19 minutes
- Behavioral−3 μg/L (NR) for 20 minutes; 6 μg/L (eggs) for 210 days
- Biochemical−9 μg/L (6-18 months) for 2 weeks
- Cellular−6 μg/L (sexually maturing males and females) for 12 days
- Physiological−3 μg/L (NR) for 191 days
- Reproductive−751 μg/L (embryo-adult spawning) for 2.25 years

The expected concentration of lead at the edge of the chronic mixing zone is 0.110 μg/L, which is below these effects thresholds.

Mercury. In the environment, virtually all mercury exposure to fish is from dietary sources. Because the elimination of methylmercury from the tissues of fish is very slow, the older and larger fish within a species tend to have the highest mercury tissue burdens. And because mercury biomagnifies within food chains, fish that eat other fish (e.g., bass and pikeminnow) generally accumulate more mercury than those that feed on plant material, insects, or crustaceans. Because juvenile spring-run Chinook salmon and steelhead feed on invertebrates (especially insects) within the action area, they are probably at relatively low risk of mercury toxicity.

Nickel. The geomean exposure concentration for the LC50 is 18,793 μg/L (range = 107 to 561,339 μg/L, n = 18; NMFS 2012). The 95th percentile concentration in the effluent at the point of discharge is 3.65 μg/L, which is diluted to 1.124 μg/L at a distance of 31 feet downstream at the edge of the acute mixing zone.

For chronic effects (growth), the minimum concentrations were 60 μg/L (eggs, 4 hours post-fertilization) for 85 days and 672 μg/L (8 months) for 75 days (NMFS 2012). The expected concentration of nickel at the edge of the chronic mixing zone is 0.117 μg/L, which is below these effects thresholds.

Selenium. Selenium is a metalloid that exists in three oxidation states in water: selenide (-2), selenite (+4) and selenate (+6). The toxicity of selenium varies with its chemical species; inorganic selenium is the predominant form in aquatic environments. The geomean of exposure concentrations for the LC50 was 2,850 μg/L (range = 0.4 to 1,000,000 μg/L, n = 176; NMFS 2012). The 95th percentile effluent concentration at the point of discharge is 1.94 μg/L, which is diluted to 0.647 μg/L at a distance of 31 feet downstream at the edge of the acute mixing zone. Thus, expected concentrations between the point of discharge and the edge of acute mixing zone 31 feet downstream could exceed the lowest LC50s reported with exposures up to 96 hours. The life stages used in these tests were not reported. The minimum concentration for an LC50 for a test where the life stage was identified was 3.78 µg/L for tests using salmonid fry, which is higher than the expected concentration at the point of discharge.

For chronic effects, the minimum effects concentrations and exposure durations (NMFS 2012) were:

- Mortality–40 µg/L (eggs) for 12 months; 47.3 µg/L (yolk sac fry) for 5 days; 1,100 µg/L (60 mm fry) for 16 days
- NOEC for mortality–40 µg/L (eggs) for 12 months; 40 µg/L (eggs and fry) for 12 months
- Growth–1 µg/L (NR) for 21 days; 7,000 µg/L (60 mm fry) for 30 hours
- Cellular–100 µg/L (eggs) for 21 days; 11,400 µg/L (fry) for 21 hours

Expected concentrations between the point of discharge (1.94 µg/L) and the edge of the chronic mixing zone (0.063 µg/L) could be above the minimum observed level with effects on growth (life stage not reported) in a 21-day exposure.

Summary: Salmonid Responses to Concentrations of Individual Toxic Constituents from the Effluent Discharge

Based on toxicity testing data from the EPA's ECOTOX database, the concentrations of most of the chemical constituents in the effluent discharge, as expected within the acute and chronic mixing zones, are below the thresholds for negative effects for most of the life stages of spring-run Chinook salmon and steelhead that occupy the action area (Table 9).

Exceptions are the following:

- Ammonia: expected concentrations between the point of discharge and the edge of the chronic mixing zone (308 feet downstream) could have biochemical effects after 24 hour exposures, although the life stages used in testing were not reported.
- Chlorine: expected concentrations between the point of discharge and the edge of the acute mixing zone could reduce the survival of fry exposed for 96 hours.
- Copper: expected concentrations between the point of discharge and the edge of the acute mixing zone could reduce the survival of yolk-sac fry and yearling juveniles exposed for 96 hours. Expected concentrations between the point of discharge and the edge of the chronic mixing zone could reduce growth, olfaction, physiology, or reproductive biology for a variety of juvenile life stages over exposure periods ranging from 24 hours to 8 months.
- Zinc: expected concentrations between the point of discharge and the edge of the chronic mixing zone could be above minimum levels at which effects were observed on egg survival after 18 months and reproductive biology (life stage not reported) after 0.67 hours.
- Selenium: Expected concentrations between the point of discharge and the edge of the acute mixing zone could reduce the survival of salmon and steelhead over exposure periods of up to 96 hours, although the life stages used in these tests were not reported. Expected concentrations between the point of discharge and the edge of the

chronic mixing zone could be above the minimum observed level with effects on growth after 21 days (life stages used in testing were not reported).

Table 9. Expected concentrations of chemical constituents from the effluent discharge within the acute and chronic mixing zones compared to minimum levels indicating toxicity in the ECOTOX database. End points for chronic effects tests include growth, behavior, and cellular, physiological, biochemical, and reproductive changes.

Legend:
"–" Expected concentrations within the acute or chronic mixing zone are below all minimum levels with observed effects
"+" Expected concentrations are above some minimum levels with observed effects indicating potential negative effects on the survival or condition of individual salmonids

Stressor	**Acute effects (LC50)**	**Chronic Effects**
Compound		
Ammonia[(a)]	-	+
Chlorine[(b)]	+	-
Chromium (VI)	-	-
Copper	+	+
Zinc[(c)]	-	+
Bromoform	-	-
Antimony	-	-
Arsenic	-	-
Lead	-	-
Mercury	-	-
Nickel	-	-
Selenium[(d)]	+	+

a Life stages used in testing were not reported for chronic toxicity tests with ammonia.
b The test organism for chronic toxicity testing with chlorine was the fathead minnow, which could respond differently to similar exposures to chlorine than spring-run Chinook salmon or steelhead.
c Life stages used in some chronic toxicity tests with zinc were not reported.
d Life stages used in acute and chronic toxicity tests with selenium were not reported.

2.5.3.2.2 Effects of Chemical Mixtures in the Effluent

In the preceding section, we compare the concentrations of each chemical constituent in isolation, as expected at various points within the action area, to toxicity endpoints. However, the overall toxicity of a chemical mixture can be equal to the sum of each substance's individual toxicity (additivity), less than the sum (antagonism), or greater than the sum (synergism).

Various models can be used to estimate the toxicity of chemical mixtures (NMFS 2012). For this analysis, we use a concentration addition analysis to assess whether exposure to multiple substances under the renewed license is likely to pose a greater risk of mortality to listed spring-run Chinook salmon and steelhead than exposure to any of the individual substances. For example, if the assessment effects concentration (i.e., the denominator of the analytical equation) is 50% mortality, a sum across all the constituents of 1 would predict a 50% mortality rate for organisms exposed to the mixture. Assuming additivity, a result of < 1 would predict less than 50% mortality and a result of > 1 would predict more that 50% mortality. The concentration addition analysis is based on an assumption of a similar mechanism of action for each set of compounds, e.g., metals or organic compounds (which include ammonia even though it does not have a C-H bond). The effect of the mixture (expected mortality rate) is represented by:

$$\sum_{i=1}^{n} \frac{C_i}{EC_{xi}}$$

where:

n = the number of compounds in the mixture
C_i = the assessment exposure concentration for each constituent[11]
EC_{xi} = the assessment effects concentration (the geometric mean of the compound-specific toxicity data)[12]

The results of the concentration addition analyses for metals and organic compounds are provided in Table 10. We did not consider mercury in the mixtures analysis because mercury concerns for aquatic organisms focus on bioaccumulation through food chain effects rather than mortality.

Table 10. Results of the effluent concentration addition analysis for the mixtures of metals and organic compounds discharged at Outfall 001 under the renewed license.

Metal Compounds	**Endpoint**	**Mixture Prediction**
Cr (VI), Cu, Zn, Sb, As, Pb, Ni, Se	Acute	0.25
Cr (VI), Cu, Zn, Sb, As, Pb, Ni, Se	Chronic	0.54
Organic Compounds	**Endpoint**	**Mixture Prediction**
Ammonia, chlorine, bromoform	Acute	0.03
Ammonia, chlorine, bromoform	Chronic	0.04

The results of this analysis indicate that fish exposed to the mixtures of metals and organic compounds in the effluent are unlikely to experience effects greater than the individual assessment effect concentrations.

[11] C_i are the maximum or 95th percentile effluent concentrations used to determine the reasonable potential that effluent concentrations could exceed the State of Washington's numerical criteria for the protection of aquatic life at the edge of the mixing zone for the NPDES permit (Appendix D in EFSEC 2014).
[12] NMFS (2012)

2.5.3.2.3 Effect of Effluent Constituents Mixed with Constituents from Other Sources

Once in the Columbia River, pollutants discharged from CGS also mix with those from anthropogenic non-point (e.g., stormwater runoff) and natural sources (erosion of native minerals) at rates that are affected by river discharge. Background concentrations of contaminants from the mainstem Columbia River upstream of Outfall 001 that were used in the reasonable potential analysis for the NPDES permit are shown in Table 2 (ambient background data) in EFSEC (2014). Using the concentration addition analysis to evaluate the potential for additive, antagonistic, or synergistic toxicities of the effluent when combined with ambient concentrations of metals and organic compounds indicates antagonistic relationships for chromium VI, copper, and zinc and for the organic compounds (Table 11). We did not include the metals antimony, arsenic, nickel, or selenium in this analysis because ambient concentrations were below the analytical detection limits.

Table 11. Results of the ambient concentration addition analysis for the mixtures of metals and organic compounds discharged at Outfall 001 under the renewed license.

Metal Compounds	**Endpoint**	**Mixture Prediction**
Cr (VI), Cu, Zn	Acute	0.004
Cr (VI), Cu, Zn	Chronic	0.011
Organic Compounds	**Endpoint**	**Mixture Prediction**
Ammonia, chlorine, bromoform	Acute	0.012
Ammonia, chlorine, bromoform	Chronic	0.061

2.5.3.2.4 Risk of Exposure to Toxic Constituents in the Effluent by Species and Life Stage

Adults. The expected concentrations of most effluent constituents within the acute and chronic mixing zones are below the effects thresholds for this life stage. Exceptions could be ammonia (chronic effects), zinc (chronic effects), and selenium (acute and chronic effects) because the life stages used in those tests were not reported. However, many adults could migrate through (or in the case of steelhead, hold within) the action area without encountering the 31-ft^2 area of the acute mixing zone or the 3,080-ft^2 area of the chronic mixing zone, minimizing the risk of exposure to toxic constituents. The same is true of any adult steelhead that spawn within the action area. The risk of reductions in abundance, productivity, diversity, or spatial structure at the population level is very small for both species.

Eggs and Yolk-sac Fry. Upper Columbia River spring-run Chinook salmon spawn far upstream of the action area in the Wenatchee, Entiat, and Methow subbasins. There is no pathway for eggs or yolk-sac fry of this species to be exposed to toxic contaminants as a result of operations under the renewed license.

No steelhead redds have been identified within the mixing zone for Outfall 001. However, assuming a spawning distribution of 3.22 redds per mile (less than 1 redd within the 308-ft long footprint of the mixing zone) and the conversion rates in Table 6, we estimate that up to 1,442 eggs and yolk-sac fry could be present in this area and affected by chemical constituents in the effluent. The potential losses of these eggs and yolk-sac fry would be too small to affect numbers or productivity at the population level, which is based on assessments of adult returns to the core steelhead spawning areas in the Wentatchee, Entiat, Methow, and Okanogan subbasins, or to affect the diversity or spatial structure of the DPS.

Fry and Parr. There is no pathway for eggs or yolk-sac fry of UCR spring-run Chinook salmon fry or parr to be exposed to toxic contaminants as a result of operations under the renewed license.

Steelhead fry and parr rearing within the mixing zone could be exposed to concentrations of chlorine, copper, and potentially selenium (although the life stages used in toxicity tests with the latter were not reported) shown to affect survival after 96-hour exposures. Similarly, fry and parr could be exposed to concentrations of ammonia, copper, zinc, and selenium in the 3,080-ft^2 chronic mixing zone with negative effects on various biological processes after 24-hour exposures. However, these small fish are more likely to rear in shallow areas along the banks than in the mixing zone where even summer low flows exceed 30,000 cfs. And individuals that are out in the mainstem are not likely to maintain their position for 24 to 96 hours or more. Therefore, the risk that toxic concentrations of effluent constituents will reduce the condition or survival of steelhead fry and parr is very small.

Smolts. Juvenile UCR spring-run Chinook and steelhead from the core production areas in the Wenatchee, Entiat, Methow, and for steelhead, the Okanogan subbasin, migrate through the action area each spring. The expected concentrations of most effluent constituents within the acute and chronic mixing zones are below the effects thresholds for this life stage. Further, 96-hour residence times within the mixing zone are extremely unlikely because smolts are migrating under spring flow conditions of 130,000 cfs or more. Thus, the likelihood of adverse effects on condition or survival is very small.

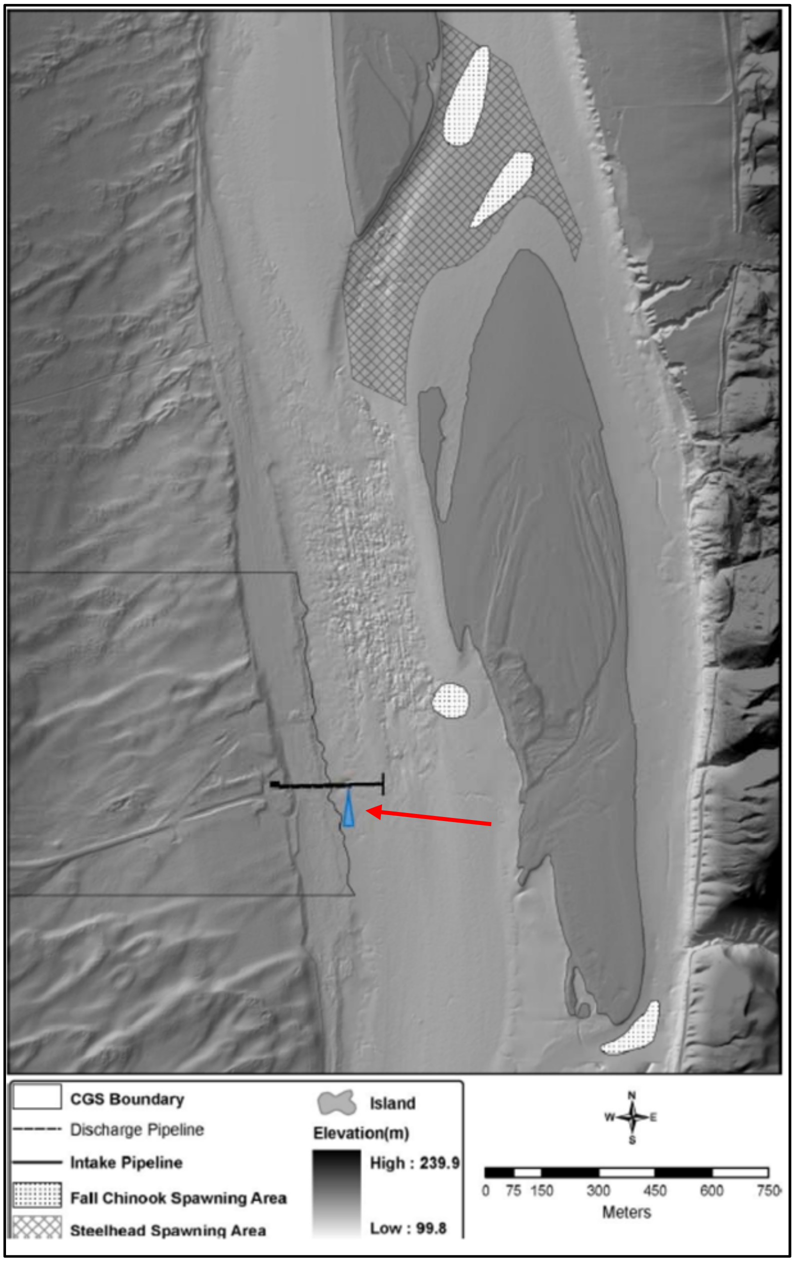

Figure 14. Plan view of the location of the discharge port and cooling water intake system with the footprint of the chronic mixing zone (blue triangle to left of red arrow). The action area extends one mile south of the discharge port. Sources: NRC (2012b) and EFSEC (2014)

2.5.3.2.5 Effects of Toxic Constituents in the Effluent on the Functioning of Critical Habitat

Concentrations of ammonia, chlorine, copper, zinc, and selenium from the effluent discharge could exceed acute and/or chronic effects thresholds for the smaller life stages of UCR steelhead within a small portion of the action area. This is likely to have a minor negative effect on the physical feature of water quality based on the small aerial extent of the affected area and the short expected duration of exposure and is not expected to reduce the conservation value of water quality in designated critical habitat for UCR spring-run Chinook or UCR steelhead.

2.5.3.3 Effects of the Effluent Discharged from Outfall 001 on Sediment Quality

EFSEC (2014) reviewed the physical characteristics of the discharge and the chemical characteristics of the effluent and determined that the discharge had no reasonable potential (i.e., was not likely) to violate the sediment management standards (i.e., WA DOE 2013 and RSET 2016). The EFSEC determination was based on low concentrations of total dissolved solids in the discharge and the velocity of the Columbia River in the vicinity of the outfall, which is high enough to inhibit deposition. EFSEC (2014) also considered the results of an October 2006 outfall evaluation where sediment deposition was found to be “minimal if not non-existent” downstream of the outfall. We agree with this assessment; the effluent discharged from Outfall 001 is not likely to affect sediment quality.

2.5.3.4 Effects of a Thermal Plume Discharged from Outfall 001

The major waste stream discharged at Outfall 001, in terms of volume, is “blowdown” from the non-contact circulating cooling water system for the steam condenser and associated machinery. This water is circulated at about 600,000 gallons per minute, cooled by evaporative processes in the six mechanical draft cooling towers, and then recycled (EFSEC 2014). The physical location of the discharge to Outfall 001 is at the point of the lowest temperature of the circulating cooling water system. This point is located downstream of the cooling towers with no additional sources of heat located between the cooling towers and the discharge location.

Studies in 1985 evaluated seasonal effects of the thermal plume (WPPSS 1986). Two parallel rows of six buoys were deployed in the mixing zone about 20 feet to either side of the plume centerline. The downstream distances were about 50, 100, 150, 200, 250, and 300 feet below the outfall. Four thermistors, each on a 25-ft lead, were attached at various positions on a cable carried underwater. During all four tests, the plant was either at 100% power or the condition was simulated by reducing the performance of the cooling tower.

The highest temperature differentials between the centerline of the plume and the ambient water column are shown for several depths during four sampling periods: March, April, August, and November, 1985, in Figures 15a-15d. During each sampling period, the “near bottom” measurements were taken 1 foot from the bottom although the distance to the surface varied from 6 feet during April (estimated river flow = 68,000 cfs) to 12 feet during November (estimated flow = 110,000 cfs).

Figure 15a-15d. Temperatures (ambient shown in graph titles) at the surface and several depths (Z) along the centerline of the effluent plume below Outfall 001. Data are shown for four sampling periods during 1985. X- and Y-axis scales are different between graphs. Source: WPPSS (1986)

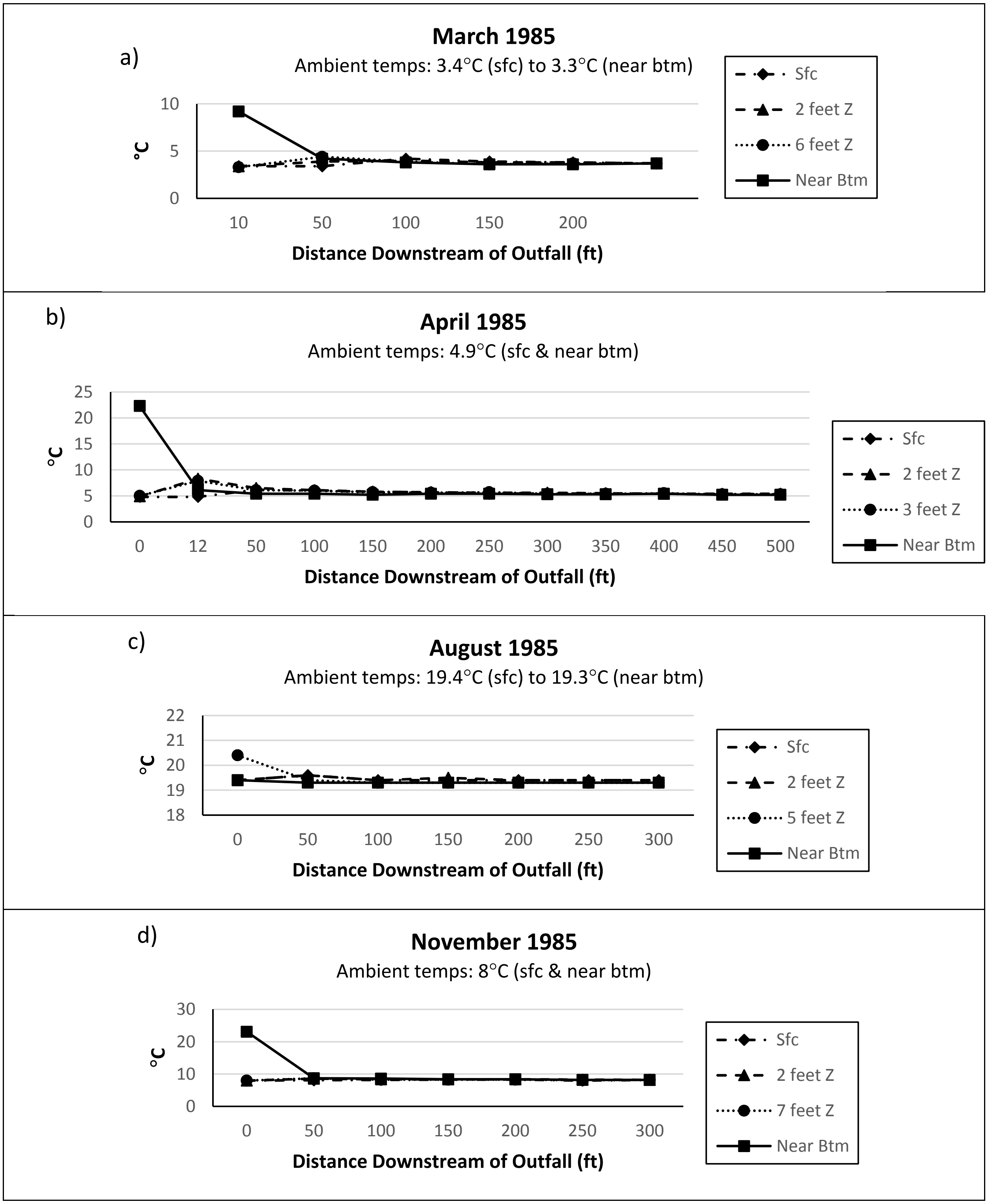

Figure 15 shows the temperature profile along the plume centerline during each sampling period. The effluent temperature was about 26°C at the point of discharge along the bottom in each case. Although ambient temperatures differed by month, the plume contributed little to the river's thermal load.

- March (Figure 15a): ambient temperatures were less than 4°C at all depths and thermistor readings that could be associated with the plume added no more than 1.1°C at all depths for 300 feet downstream.
- April (Figure 15b): ambient temperatures were less than 5°C at all depths. The only thermistor reading associated with the plume that exceeded 13°C was near the bottom next to the outfall (i.e., the actual reading on the bottom next to the outfall was 22.3°C, exceeding 18°C in this very limited area).
- August (Figure 15c): ambient temperatures exceeded 18°C at all depths. The only thermistor reading associated with the plume that added more than 0.2°C was at the 5-foot depth next to the outfall (actual reading 20.4°).
- November (Figure 15d): ambient temperatures were less than 13°C at all depths. The only thermistor reading that added enough heat to exceed 13°C was on the bottom next to the outfall (the actual reading was 22.3°C, exceeding 18°C in this very limited area).

In addition, the plume appeared to become well mixed with the ambient water at all depths within 10 to 50 feet downstream of the outfall.

2.5.3.4.1 Salmonid Responses and Risk of Exposure to a Thermal Plume Discharged from Outfall 001 by Species and Life Stage

NMFS has determined that a water temperature of 13°C during February through early June protects steelhead gametes before spawning and provides protective temperatures for egg incubation. Steelhead spawn within the Hanford Reach during February through early June, peaking in mid-May (Nugent and Cranna 2015). Eggs hatch within 2 months assuming that temperatures along the bottom range from 5°C to 14°C during that period combined with the incubation times for rainbow trout shown in Quinn (2005; see Table 8-1). Based on the 1985 thermistor readings (Figure 15), temperatures along the bottom exceed 13°C only next to Outfall 001 except during August when ambient temperatures exceed 19°C at all depths. Thus, the thermal plume does not expose any steelhead redds within the action area to temperatures that could have a negative effect on spawning or incubation.

A water temperature of 18°C protects against lethal conditions for juveniles and adults, prevents migration blockages for adults, provides sub-optimal growth conditions during summer under limited food conditions and optimal conditions during the other months of the year, and minimizes the exposure time of adults and juveniles to temperatures associated with a high risk of disease. The thermal plume exceeded 18°C near the bottom at the station next to the outfall, but became completely mixed with the water column, resulting in temperatures less than 18°C, within 10 to 50 feet downstream. The only exception was during August 1985 when ambient conditions exceeded 18°C at all depths; the plume added only another 1°C of temperature load and only within 10 feet of the outfall. Thus, the thermal plume is not responsible for exposing any juvenile or adult steelhead or spring-run Chinook salmon to temperatures that exceed 18°C.

2.5.3.4.2 Effects of a Thermal Plume Discharged from Outfall 001 on the Functioning of Critical Habitat

The presence of a very small thermal plume from Outfall 001 is not expected to have a negative effect on the physical feature of water quality within the action area (RM 351-354) and therefore is not likely to affect the conservation value of critical habitat for UCR spring-run Chinook salmon or UCR steelhead.

2.5.3.5 Effects of Biological Monitoring Activities

2.5.3.5.1 Effects of the Radiological Environmental Monitoring Program

To determine the risk to humans of consuming fishes that occupy the mainstem near CGS as well as DOE's Hanford Site, the REMP requires annual analyses of edible flesh from anadromous and resident fish for gamma isotopes. The collection methods specified by the REMP are described in section 1.3.4.1. Anadromous fish will be obtained from hatcheries. Methods for collecting resident fish include angling (hook-and-line fishing) from the shoreline and from a small boat and, if angling is not successful, electrofishing from a small boat. We describe the effects of these methods on the listed species in the following sections.

<u>Angling (Hook-and-Release).</u> Anadromous salmonids hooked during angling for resident fish would be released immediately. However, the act of capturing and handling fish causes stress—primary contributing factors are water temperatures above 18°C, dissolved oxygen concentrations below saturation, the amount of time that fish are held out of water, and physical trauma. Programs that use standard protocols such as keeping fish in the water to the maximum extent possible can limit mortality to less than 5%.

With respect to hooking trauma, the available data indicate that hook-and-release mortality of adult steelhead is low during cold conditions (Hooton 1987, Reingold 1975, Pettit 1977, and Bruesewitz 1995). In a study on steelhead in a California river, more than 80% of the observed mortalities occurred at stream temperatures greater than 21°C (Taylor and Barnhart 1999). Fish hooked in the jaw or tongue suffered lower mortality (2.3% and 17.8% in Lindsay *et al*. 2004) than fish hooked in the gills or esophagus (81.6% and 67.3%). A large portion of the mortality in this study was related to deep hooking by anglers using prawns or sand shrimp for bait on two-hook terminal tackle; other baits and lures produced higher rates of jaw hooking.

The proposed angling for resident fish for gamma isotope analysis would take place during July through December. If a radiological impact is identified in those samples, a second sampling event will take place at least 2-3 months after the first by hook and line or electrofishing, probably during January-early March. Anglers are therefore unlikely to encounter UCR spring-run Chinook salmon migrating through the action area (mid-April through mid-June) or spawning steelhead (February through early June; see Table 3). However, adult UCR steelhead migrate through the Hanford Reach to the core populations areas during mid-April through mid-November, a period that overlaps with the proposed angling activities. Adults of this species are therefore likely to be in the action area during angling and vulnerable to capture/handling and hook-and-release mortality. For the purpose of this analysis, we conservatively assume that up to two adult UCR spring-run Chinook salmon and up to ten adult UCR steelhead would be handled during angling activities between RM 351-354 during July through March each year. Of these, we anticipate that one adult of each species would die as a result of its injuries.

Boat Electrofishing. Only if unable to capture the resident fish needed for gamma isotope analysis by angling, Energy Northwest would use boat electrofishing equipment in water less than 10 feet deep. The seasonal timing (September to December and potentially January through early March) would be the same as for angling so that few UCR spring-run Chinook salmon are likely to be affected, but adult UCR steelhead could be vulnerable as would fry and parr rearing in the action area. If electrofishing during late winter when steelhead have begun spawning, Energy Northwest proposes to stay at least 300 feet from any active redds. However, we expect that this condition would be difficult to implement because steelhead spawn under high water conditions when the bottom is not visible.

The amount of unintentional injury and mortality during electrofishing varies depending on the equipment used, the settings on the equipment, and the expertise of the technician. Potential effects include the mechanical and physiological effects of exposure to an electrical field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river. For example, spinal injuries from forced muscle contraction have been documented in adult salmonids. Sharber and Carothers (1988) reported that electrofishing killed 50% of the adult rainbow trout in their study.

We assume that if one individual of either species is seen moving away from the electrical field, Energy Northwest will cease electrofishing and move to another location. If a second individual of either listed species is seen moving away, or one individual of either species is collected and handled with this equipment, electrofishing will cease for that calendar year. Thus, we assume that up to one adult of each species would die each year as a result of electrofishing activities.

Juvenile UCR spring-run Chinook salmon migrate through the action area during April - June and thus are not likely to be affected by the proposed electrofishing activities. Juvenile UCR steelhead from the upstream core populations migrate through during April - May, but fry and parr produced within the Hanford Reach are likely to be present throughout the year. These small juveniles are likely to stay close to the shorelines with overhanging and submerged vegetation, but also occupy shallow gravel bars (USDOE 2015). Based on the calculations in Table 6, a maximum of between 108,000 and 163,000 fry could be present in the action area each year, but only a small portion of these would be present during the proposed electrofishing activities. For the purpose of this analysis, we conservatively assume that up to 1,000 steelhead fry or parr would be killed during electrofishing for resident fish.

2.5.3.5.2 Effects of the Entrainment Study

As described in section 1.3.5, entrainment sampling will take place weekly during mid-March through mid-June and biweekly from mid-July through September, a total of 21 weekly 24-hr sampling periods during each of 2 years. In addition, two sequential 12-hour samples will be taken during normal sampling weeks when more than 20 fish appear in the entrainment samples; for the purpose of this analysis of effects we assume that this will occur two times each year, an additional 48 sampling hours. Thus, we assume that the total period for entrainment sampling will be 552 hours,[13] which is 6.3% of each 365-day operational year.

In section 2.5.2.1, we estimated that a maximum of between 540 and 815 UCR steelhead fry could be in the vicinity of the screens each year and could be entrained or impinged during normal operations. The steelhead fry that potentially will be killed during the study are a subset (6.3%) of these 540 to 815 fry. That is, the entrainment study will have no additional effects on the listed species beyond those associated with normal operations.

Implementation of the entrainment study will not affect the functioning of any of the physical or biological features of critical habitat designated for UCR spring-run Chinook salmon or UCR steelhead.

2.5.3.5.3 Effects of Monitoring for Risk of Impingement

The observations to determine the risk of impingement at the water intake structure, described in section 1.3.5, are passive and will not affect the survival or condition of any life stage of UCR spring-run Chinook salmon or UCR steelhead.

These observations also will not affect the functioning of any of the physical or biological features of critical habitat designated for UCR spring-run Chinook salmon or UCR steelhead.

2.5.4 Summary: Effects of the Action on UCR Spring-run Chinook Salmon and UCR Steelhead and the Functioning of Critical Habitat

2.5.4.1 Effects of Water Withdrawals from the Columbia River

Even under several potential worst-case flow scenarios involving low ambient flows and withdrawal rates up to pumphouse capacity, mainstem flows are likely to be continued to be reduced by less than 0.2%. This is an ongoing effect that has probably not elicited a biological response from adult UCR spring-run Chinook salmon or steelhead or from yearling smolts of either species. Nor have flow changes of this magnitude affected the ability of steelhead fry and parr that emerge from redds within the Hanford Reach upstream of the water intake to find suitable microhabitat. Even if some fry and parr are negatively affected, these individuals are not from the core population areas in the Wenatchee, Entiat, Methow, or Okanogan rivers and any reduction in individual fitness or survival would not affect our estimates of numbers or productivity at the population level. Losses would have a very small effect on the diversity and spatial structure of the DPS.

The continuation of these water withdrawals is also likely to have a very small effect on the water quantity PBF within the action area, which is within designated critical habitat for both UCR spring-run Chinook salmon and UCR steelhead.

[13] The estimate of 552 hours assumes a total of 21 24-hour sampling events (14 during mid-March through mid-June and 7 during July through September) with an additional two 24-hour sampling events to characterize diel rates of entrainment.

2.5.4.2 Effects of the Water Intake Screens

Upper Columbia River spring-run Chinook salmon spawn far upstream of the action area and there is no pathway for their fry to be exposed to entrainment or impingement at the water intake screens. However, small steelhead fry emerging from mainstem redds within or upstream of the action area each year are vulnerable to injury and mortality. Fewer than 900 steelhead fry are at risk each year. Because these individuals are not from the core population areas, reductions in individual fitness or survival would not affect our estimates of numbers or productivity at the population level. Losses would have a very small effect on the diversity and spatial structure of the DPS.

The risk of entrainment and impingement also would have a very small negative effect on the safe passage PBF within the action area, which is within designated critical habitat for both UCR spring-run Chinook salmon and UCR steelhead.

2.5.4.3 Effects of Radionuclides Discharged at Outfall 001

Energy Northwest has not made a radioactive liquid effluent discharge at Outfall 001 since 1998. Based on the analytical results for samples collected in 2014 and 2015, no radioactive materials in water, sediment, or the edible tissue of anadromous fish returning to Ringold Fish Hatchery could be attributed to past operations at CGS. Therefore, no effects of discharged radionuclides on fish survival or condition for either species, or on the functioning of water or sediment quality in designated critical habitat, are expected as a result of ongoing operations under the action.

2.5.4.4 Effects of Chemical Constituents Discharged at Outfall 001

Our analysis indicates that neither adult UCR spring-run Chinook salmon and steelhead nor smolts migrating through the Hanford Reach from upstream core population areas are at risk of exposure to toxic levels of effluent constituents in the water column. Although no redds have been identified in the action area downstream of the outfall, if one steelhead redd was present within this reach, an estimated 1,442 eggs and yolk-sac fry could be exposed to toxic levels of ammonia, chlorine, copper, zinc, and/or selenium each year. Fry and parr from mainstem redds upstream of the action area could be exposed to concentrations of these constituents with acute and chronic effects. However, the risk for this life stage is very small due because individuals are more likely to rear along the banks of the river than in the mixing zone where even summer low flows exceed 50,000 cfs.

Because incubating steelhead eggs, yolk-sac fry, and mobile fry and parr within the Hanford Reach are not from the core population areas for the DPS, losses would not affect abundance or productivity at the population level. Effects on the diversity and spatial structure of the DPS would be very small.

Concentrations of ammonia, chlorine, copper, zinc, and selenium within the action area from the effluent discharge are likely to have a very small effect on the water quality PBF in designated critical habitat.

2.5.4.5 Effects of a Thermal Plume Discharged from Outfall 001

The very small thermal plume discharged from Outfall 001 is not likely to affect the condition of the listed species within the action area or the water quality PBF within designated critical habitat.

2.5.4.6 Effects of Discharge to Dry Wells

There is no evidence from dry well sampling that radionuclides from CGS operations have been discharged to groundwater at the site. Therefore there is no evidence of a contamination pathway that could affect the listed salmonid species.

2.5.4.7 Effects of Biological Monitoring Activities

We conservatively anticipate that up to two adult UCR spring-run Chinook salmon and up to ten adult UCR steelhead would be captured and handled during angling activities for resident fish each year and, of these, one adult of each species would die as a result of its injuries. If electrofishing is necessary, we conservatively anticipate that up to one adult of each species and up to 1,000 steelhead fry from redds within the Hanford Reach would be killed each year. These losses only affect juveniles from redds within the Hanford Reach and therefore are not likely to affect any of the viability parameters (abundance, productivity, diversity, or spatial structure) for the Entiat, Wenatchee, Methow, or for steelhead, Okanogan population.

We do not anticipate that angling or electrofishing will have negative effects on PBFs within designated critical habitat.

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 consultation (50 CFR 402.02). Future Federal actions that are unrelated to the action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

There are few non-federal actions that constitute cumulative effects within the action area for this consultation. Activities within the Hanford Reach that affect conditions within the action area include chemical and radiological contamination from past and some ongoing activities at the DOE's Hanford Site, but these activities have a federal nexus and are not "cumulative effects." Land use in Franklin County, across the Columbia River, primarily consists of agriculture lands with small urban areas. Agriculture has converted the native shrub-steppe ecosystem to dry-land and irrigated farming and livestock production (NRC 2012b). We did not identify any new non-federal activities in the action area that would adversely affect habitat conditions. To the extent activities described in the environmental baseline are ongoing, their negative effects are likely to continue.

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 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 action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

Upper Columbia River Spring-run Chinook Salmon

Our updated status review indicates that the viability rating for the UCR spring-run Chinook salmon ESU remains at high risk of extinction. The species' status does not meet the viability criteria recommended by the ICTRT and adopted in the 2007 Recovery Plan. Improvements have been made in operations and fish passage at tributary dams and at the FCRPS dams, and numerous habitat restoration projects have been completed in many upper Columbia River tributaries. However, habitat problems are still common throughout the species' range and many more improvements are likely needed to achieve viability. Harvest rates remain relatively low and stable, but changes in hatchery management are needed to reduce the number of hatchery-origin fish used as broodstock and to reduce the number of hatchery fish allowed to spawn naturally. In addition, increased predation rates by pinnipeds and significant effects of avian predation in the estuary remain concerns, as do the impacts that climate change poses to the species' long-term recovery.

Habitat use by UCR spring-run Chinook salmon within the action area is limited to the adult and smolt migrations. Factors affecting survival and habitat quality within the action area, which is limited to 1 mile downstream and 2 miles upstream of the water intake and outfall structures (RM 351-354), include:

- Hydrologic conditions and the availability of water in upstream reservoirs to provide minimum flows for the protection of anadromous fish;
- Potential contamination of water and sediment from past activities at the DOE's Hanford Site and in the case of copper, past operations of CGS's main steam condenser;
- Other activities including irrigation return water; groundwater seepage associated with extensive irrigation of lands north and east of the Columbia River; and effluent from upstream industrial, agricultural, and mining activities that are likely to have contaminated water and sediment in the action area; and
- Air temperatures and hydrologic conditions affecting water temperatures in the action area, which have been within the preferred ranges for anadromous salmonids over the last decade except for exceedances of 18°C during mid-July through September; the frequency and severity of these temperature exceedances and risks to the listed species are expected to increase as air temperatures increase

and snow packs diminish under climate change scenarios for the Pacific Northwest.

With the exception of concerns about air temperatures and hydrologic conditions affecting water temperatures in the action area, these factors are not exacerbating those identified as limiting the viability of the UCR spring-run Chinook salmon ESU in section 2.2.

We did not identify any new non-federal activities in the action area or in the Hanford Reach that would adversely affect habitat conditions between RM 351-354. To the extent that non-federal activities described in the environmental baseline are ongoing, their negative effects are likely to continue.

We conservatively estimate that up to two adult UCR spring-run Chinook salmon are likely to be captured and handled and one is likely to be killed during REMP sampling for resident fish. We did not identify any other negative effects of the action that would affect individuals from this ESU. The loss of one adult is not likely to affect any of the viability parameters (abundance, productivity, diversity, or spatial structure) at the population level. Therefore, the renewal of the operating license for CGS will not reduce the viability of any of the UCR spring-run Chinook salmon populations or increase the likelihood of extinction or reduce the likelihood of recovery for the ESU.

Upper Columbia River Steelhead

Our updated status review indicates that the viability rating for the UCR steelhead DPS remains at high risk of extinction. The species' status does not meet the viability criteria recommended by the ICTRT and adopted in the 2007 Recovery Plan. Improvements have been made in operations and fish passage at tributary dams and at the FCRPS dams, and numerous habitat restoration projects have been completed in many upper Columbia River tributaries. However, habitat problems are still common throughout the species' range and many more improvements are needed to achieve viability. Harvest rates remain relatively low and stable, but changes in hatchery management are needed to reduce the number of hatchery-origin fish used as broodstock and to reduce the number of hatchery fish allowed to spawn naturally. In addition, increased predation rates by pinnipeds in the estuary and significant effects of avian predation at inland sites and in the estuary remain concerns, as do the impacts that climate change poses to the species' long-term recovery.

Habitat use by UCR steelhead within the action area includes the adult and smolt migrations, but also the potential for small amounts of spawning (one or more redds) and for rearing by fry and parr emerging from redds within the 35-mile mainstem reach upstream of the action area. Factors affecting survival and habitat quality within the action area include:

- Hydrologic conditions and the availability of water in upstream reservoirs to provide minimum flows for the protection of anadromous fish;
- Potential contamination of water and sediment from past activities at the DOE's Hanford Site and in the case of copper, past operations of CGS's main steam condenser;

- Other activities including irrigation return water; groundwater seepage associated with extensive irrigation of lands north and east of the Columbia River; and effluent from upstream industrial, agricultural, and mining activities that are likely to have contaminated water and sediment in the action area; and
- Air temperatures and hydrologic conditions affecting water temperatures in the action area, which have been within the preferred ranges for anadromous salmonids over the last decade except for exceedances of 18°C during mid-July through September; the frequency and severity of these temperature exceedances and risks to the listed species are expected to increase as air temperatures increase and snow packs diminish under climate change scenarios for the Pacific Northwest.

With the exception of concerns about air temperatures and hydrologic conditions affecting water temperatures in the action area, these factors are not exacerbating those identified as limiting the viability of the UCR steelhead DPS in section 2.2.

We did not identify any new non-federal activities in the action area or in the Hanford Reach that would adversely affect habitat conditions between RM 351-354. To the extent that non-federal activities described in the environmental baseline are ongoing, their negative effects are likely to continue.

In our analysis of effects, we found the following potential negative effects of the action on individual UCR steelhead:

- Ongoing water withdrawals could have a very small negative effect on the amount and quality of habitat available to fry or parr rearing within the action area;
- A maximum of 540 to 815 steelhead fry are at risk of entrainment and impingement at the water intake screens each year;
- A maximum of 1,442 eggs and yolk-sac fry per year could be exposed to concentrations of ammonia, chlorine, copper, zinc, and/or chromium in effluent discharged at Outfall 001 that could affect survival or condition; and
- Up to ten adult steelhead are likely to be captured and handled and one is likely to be killed during REMP sampling (angling) for resident fish each year. Up to 1 adult steelhead and 1,000 steelhead fry from redds within the Hanford Reach are likely to be killed during REMP sampling, if electrofishing is needed, for resident fish.

The loss of one adult UCR steelhead from a core spawning area and small numbers of eggs, yolk-sac fry, and mobile fry and parr from redds within the Hanford Reach would not affect numbers or productivity at the population level. These losses are too small to have more than a very small effect on the diversity and spatial structure of the DPS. Therefore, the renewal of the operating license for CGS will not reduce the viability of any of the UCR steelhead populations or increase the likelihood of extinction or reduce the likelihood of recovery for the DPS.

Designated Critical Habitat

We found a very small negative effect of ongoing water withdrawals on the functioning of the water quantity PBF for UCR spring-run Chinook salmon; the action will not reduce the conservation value of critical habitat for UCR spring-run Chinook salmon.

We did find the following potential negative effects on water quantity and quality and the functioning of safe passage for early life stages of UCR steelhead:

- Ongoing water withdrawals are likely to have a very small effect on the water quantity PBF;
- The risk of entrainment and impingement at the water intake screens is likely to have a very small effect on the passage PBF; and
- Concentrations of ammonia, chlorine, copper, and selenium from the effluent discharge are likely to have a very small effect on the water quality PBF

These very small negative effects, restricted to the 3-mile long action area, are not exacerbating any of the factors identified in section 2.2 as limiting the conservation value of critical habitat and would not meaningfully reduce its conservation value at the designation level for the UCR steelhead DPS.

2.8 Conclusion

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

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 ITS.

2.9.1 Amount or Extent of Take

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

- Take of UCR steelhead in the form of entrainment and impingement at the water intake screens, including the portion of those operations that are monitored with pumphouse cages;
- Take of UCR steelhead in the form of exposure to concentrations of chlorine, copper, zinc, and selenium shown to affect survival; and
- Take of UCR spring-run Chinook salmon and UCR steelhead during angling and, if needed, electrofishing for resident fish (REMP sampling).

Because all of the anticipated take results from, but is not the purpose of, operation of CGS, it is considered “incidental take” for purposes of this Opinion (see 50 CFR §402.02). When we exempt incidental take, we must issue Reasonable and Prudent Measures (RPMs) and Terms and Conditions. These RPMs and Terms and Conditions minimize (either the amount or the effect of that take, that is, the RPMs could reduce the number of takes or could minimize the potential for mortality of captured animals) and monitor take.

2.9.1.1 Entrainment and Impingement at the Water Intake Structure

The applicant for the renewed license, Energy Northwest, is required to conduct visual or remote monitoring for impingement when the cooling water intake structure is operational and is required to conduct an entrainment study. Both are conditions of NPDES Permit No. WA002515-1 (EFSEC 2016). The entrainment study will be conducted as described in Energy Northwest (2015a), documenting all life stages of the affected fish species including threatened or endangered species. Results of the impingement monitoring and of the entrainment study will be submitted to EFSEC by May 1, 2019. The extent of take for our analysis is limited to no more than 900 steelhead fry per year.

2.9.1.2 Water Quality

2.9.1.2.1 Discharge of Chemical Constituents at Outfall 001

Up to 1,442 UCR steelhead eggs and yolk-sac fry per year could be exposed to concentrations of chlorine, copper, zinc, and/or selenium shown to affect survival or other biological processes in some toxicity tests. However, it is not practical to detect or monitor affected eggs or fry within the action area. NMFS has therefore elected to use a surrogate for identifying an exceedance of take that considers the extent of potentially occupied habitat where the action could cause increases in chemical concentrations to levels that could affect the survival of ESA-listed species.

The action is likely to cause ongoing elevated concentrations of some chemical constituents within the mainstem reach of the Columbia River between RM 351-352. The potential for adverse effects is greatest within the acute and chronic mixing zones with effects decreasing with distance downstream; the maximum size of the plume where concentrations are high enough to elicit adverse effects is 20 feet wide at a distance 308 feet from the outfall. Based on this information, the total area of potentially occupied habitat that may experience ongoing elevated concentrations of contaminants due to the action is estimated to be about 3,080 ft^2.

Because the surrogate is based on the area likely to be affected, NMFS will use the chemical concentrations in the effluent as sampled at the pumphouse before discharge and ambient flow conditions within the 3,080-ft^2 mixing zone as the basis for an exceedance of take. That is, the 95^{th} percentile effluent concentrations of the chemical constituents in Table 8 in the Opinion, combined with a 7-day average low flow with a recurrence interval of 10 years (a rolling 7Q10) of 52,700 cfs, will represent the worst-case conditions attributable to the action within the mixing zone for CGS's Outfall 001. Thus, for the water quality take pathway, the extent of take is limited to the 95^{th} percentile concentrations of the constituents in Table 8 within the 3,080-ft^2 mixing zone under 7Q10 low flow conditions.

2.9.1.4 Monitoring Activities

2.9.1.4.1 Fish Sampling for the Radiological Environmental Monitoring Program

The extent of take for biological sampling related to the REMP program will be exceeded if any of the following occur:

- More than two adult UCR spring-run Chinook salmon or more than ten adult UCR steelhead are captured and handled or more than one adult of each species is killed during angling for resident fish per year.
- More than one additional adult of each species is captured and handled or more than one is killed during electrofishing for resident fish per year.
- More than 1,000 steelhead fry are estimated to be killed during electrofishing for resident fish per year.

Control samples of resident fish species will be obtained from other researchers and/or commercial samplers, facilities (e.g., dams), state sponsored fishing programs, private anglers, or commercial fishermen.

2.9.1.4.2 Entrainment and Impingement Studies

We estimate that up to 815 UCR steelhead fry could be killed due to entrainment and impingement at the water intake screens during normal operations each year. The steelhead fry likely to be killed during the entrainment study are a subset (6.3%) of those entrained during normal operations. That is, the entrainment study will have no additional effects on the listed species beyond those associated with normal operations.

Only passive observations will be used to characterize the risk of impingement and these are not expected to kill, injure, or harm any individual of a listed species.

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

1. Minimize the potential for incidental take of ESA-listed species as a result of elevated concentrations of chemical constituents in the mainstem Columbia River by implementing the action as described in section 1.3.

2. Minimize the potential for incidental take of ESA-listed species as a result of entrainment and impingement associated with the cooling water intake structure for CGS.

3. Minimize the potential for incidental take of ESA-listed species as a result of biological monitoring.

4. Ensure completion of a monitoring and reporting program to confirm that the terms and conditions in this ITS were effective in avoiding and minimizing incidental take from permitted activities and ensuring incidental take is not exceeded.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the licensee (Energy Northwest) must make compliance with them a requirement of its renewed license for CGS in order to implement the RPMs (50 CFR 402.14). Energy Northwest must monitor the impacts of its incidental take and report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If Energy Northwest does not comply with the following terms and conditions, protective coverage for the action would likely lapse.

1. The following terms and conditions implement RPM 1 (effluent discharge monitoring):
    a. To ensure that effluent water quality controls are functioning as intended and that the assumptions forming the basis of the water quality predictions relied upon in this Opinion remain valid, the NRC and Energy Northwest (the license applicant) shall ensure that the ongoing physical and chemical monitoring of the effluent prior to discharge, as specified in NPDES Permit No. WA002515-1 (EFSEC 2016), continues throughout the term of the operating license (December 20, 2043).

2. The following terms and conditions implement RPM 2 (entrainment and impingement studies):[14]
   a. Pursuant to NPDES Permit No. WA002515-1 (EFSEC 2016), Energy Northwest must prepare and conduct an entrainment study consistent with the content requirements in 40 CFR 122.21(r)(9).
   b. Pursuant to NPDES Permit No. WA002515-1 (EFSEC 2016), if the final entrainment study report, or any other monitoring, indicates significant entrainment of listed species, Energy Northwest must prepare an engineering analysis, including costs and benefits associated with replacement of the intake structure consistent with approvable design criteria.
   c. Impingement study: provide a study design for development of a numerical model of the expected flow field around the CWIS screens for NMFS's comment; complete the study; and submit the report by December, 2018. The study may include the physical characteristics of the screens in the expected flow field and relevant information on the behavior of vulnerable life stages of listed species.
   d. Energy Northwest and NRC shall meet with NMFS within 12 months of finalizing the report for each study to discuss the findings and any potential recommendations for the next NPDES permit, if needed.

3. The following terms and conditions implement RPM 3 (biological monitoring):
   a. Handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When using gear that captures a mix of species (e.g., electrofishing), process listed fish first to minimize handling stress.
   b. Stop angling if the water temperature exceeds 21°C at the capture site. Electrofishing is not permitted if water temperatures exceed 18°C.
   c. If Energy Northwest unintentionally captures any listed adult salmon or steelhead while angling for resident fish, the listed fish must be released without further handling and such take must be reported in the annual report to NMFS.
   d. Electrofishing is not permitted when listed adult salmon or steelhead or steelhead redds are observed at the site. Any listed adult salmon or steelhead encountered while electrofishing are considered take and must be reported in the annual report to NMFS.
   e. Energy Northwest must obtain approval from NMFS before changing field sampling locations or methods.
   f. Energy Northwest must notify NMFS as soon as possible, but no later than two days after any authorized level of take is exceeded or if such an event is likely. Energy Northwest must submit a written report to NMFS detailing why the authorized take level was exceeded or is likely to be exceeded.
   g. The person(s) actually doing the research must carry a copy of this ITS while conducting the authorized activities.

[14] These are one-time studies designed to resolve uncertainties about risk to the listed species.

h. Energy Northwest must allow any NMFS employee or representative to accompany field personnel while they conduct the biological monitoring activities.
i. Energy Northwest must allow any NMFS employee or representative to inspect any records or facilities related to the biological monitoring activities.
j. Energy Northwest must obtain all other Federal, state, and local permits and authorizations needed for the biological monitoring activities.
k. If Energy Northwest or its representative (e.g., a contractor performing field monitoring) violates any condition of this ITS, they will be subject to any and all penalties provided by the ESA. NMFS may revoke this authorization if activities are not conducted in compliance with this ITS and the requirements of the ESA.

4. The following terms and conditions implement RPM 4 (monitoring and reporting):
    a. On or before February 28th of each year, Energy Northwest shall submit to NMFS, and copy to NRC, a post-season report describing the biological monitoring activities, the number of listed fish taken and the location, the type of take, the number unintentionally killed, and the take dates. This report must also summarize any changes to CGS operations that affected the effluent discharge taken during the course of the year with the potential to affect ESA-listed resources and confirm that the amount and extent of incidental take (section 2.9.1) authorized by this statement was not exceeded. Energy Northwest shall also submit to NMFS, and copy to NRC, on or before February 28th of each year, either a copy of the reports it submitted to EFSEC pursuant to NPDES Permit WA002515-1 for the previous year or a report condensing this information into a single document.
    b. Energy Northwest shall provide a copy to NMFS, and NRC, of the final report for the entrainment study required by NPDES Permit No. WA002515-1 (EFSEC 2016).
    c. Reports prepared in accordance with the above terms and conditions shall be submitted to NMFS and copied to NRC at:

Ritchie Graves@noaa.gov
Columbia Hydropower Branch
National Marine Fisheries Service
1201 NE Lloyd Blvd, Suite 1100
Portland, Oregon 97232

Briana.Grange@nrc.gov
U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001
and
EndangeredSpecies.Resource@nrc.gov

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 an action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

The following conservation recommendation would further the recovery of UCR steelhead and increase the value of designated critical habitat for the species' recovery. Considering the results of the proposed entrainment study (NPDES permit condition) and the impingement study described as Terms and Conditions in the preceding Incidental Take Statement, consider installing new water withdrawal structures that meet NMFS's anadromous salmonid passage facility design criteria (NMFS 2011) when the existing structures need to be replaced.

2.11 Reinitiation of Consultation

This concludes formal consultation for the renewal of the operating license for CGS.

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 habitat in a manner or to an extent not considered in this Opinion (for example, the results of the entrainment and impingement studies in term and condition #2 in the accompanying incidental take statement), (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect" Determination

On November 18, 2005, NMFS listed the Southern Resident killer whale (SRKW) DPS as endangered under the ESA (70 FR 69903). The SRKW DPS (*O. orca*) is composed of a single population that ranges as far south as central California and as far north as Southeast Alaska. Although the entire DPS has the potential to occur along the outer coast at any time during the year, occurrence along the outer coast is more likely from late autumn to early spring. SRKWs have been observed feeding off the Columbia River plume during the spring Chinook salmon run (Krahn *et al*. 2004; Zamon *et al*. 2007; Hanson *et al*. 2008, 2010). Due to potential impacts on the whale's prey base, we consider the SRKW to be a species that could potentially be adversely affected by the action.

The final listing rule identified several potential factors that may have resulted in the decline or may be limiting recovery of SRKW including: quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessel traffic. The rule further identified oil spills as a potential risk factor for the small population of SRKW. The final recovery plan includes more information on these potential threats (73 FR 4176).

NMFS designated critical habitat for the SRKW DPS on November 29, 2006 (71 FR 69054). Designated critical habitat includes about 2,560 square miles of Puget Sound, except areas with water less than 20 feet deep relative to extreme high water. NMFS did not designate critical habitat for SRKW within the action area for this consultation—all marine waters where they would typically feed on prey affected by the action.

The SRKWs spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and then move south into Puget Sound in early autumn (NMFS 2008). Although these are the typical seasonal patterns, SRKW have the potential to occur throughout their range (from Central California north to the Queen Charlotte Islands) at any time during the year.

The SRKW consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their primary prey (NMFS 2008). Diet studies of SRKW have sampled inland waters of Washington State and British Columbia during the spring, summer, and fall months (i.e., Ford and Ellis 2006; Hanson *et al*. 2010). Less is known about the diet of SRKW elsewhere off the Pacific Coast; however, chemical analyses support the importance of salmon in the year-round diet (Krahn *et al*. 2002; Krahn *et al*. 2004). The predominance of Chinook salmon in the diet when in inland waters, even when other species are more abundant (Ford and Ellis 2006), combined with information indicating that the killer whales consume salmon year round, makes it reasonable to expect that SRKW also consume Chinook salmon when available in coastal waters. Their switch to chum salmon in Puget Sound during fall makes it reasonable to expect that SRKW consume other species when Chinook salmon are not available (Hilborn *et al*. 2012).

The action will not have any direct effects on SRKWs, but may indirectly affect the quantity of prey available to them. As described in the above Opinion and ITS, the action is likely to result in the loss of Chinook salmon. The ocean range of UCR spring-run Chinook salmon (Weitkamp 2010) overlaps with the known range of SRKWs. The loss of some Chinook salmon from various brood years could reduce the SRKWs available prey base when the affected broods would otherwise have been present in the Pacific Ocean.

A few adult UCR spring-run Chinook salmon could be taken each year from the continued operation of CGS under the renewed license that would otherwise be available as prey for SRKWs. Given the total quantity of Chinook salmon available to SRKWs, the reduction in prey due to ongoing operations at CGS will be extremely small in any given year. The above Opinion does not identify any potential for the action to influence the quality (fish size) and/or quality (contaminant levels) of Chinook salmon. NMFS finds that the action will not have anything more than minimal effects on the abundance, productivity, diversity, or spatial structure of listed Chinook salmon, and therefore the effects to the quantity of prey available to the whales in the long term across their vast range is expected to be very small. For these reasons, the action will have an insignificant effect on SRKW, and therefore, NMFS concludes that the action may affect, but is not likely to adversely affect SRKW.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect 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 EFH assessment provided by the NRC (2012b) and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.[15]

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[15] On May 3, 2010, the NRC requested information from the NMFS on EFH designated within the vicinity of CGC. NMFS replied to this request by letter dated June 23, 2010. NMFS indicated that the Upper Columbia River Chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) have EFH in the Columbia River and that NRC should analyze potential adverse impacts of the proposed license renewal on these species' EFH. The NRC evaluated the potential impacts to designated EFH and documented its findings in a combined biological assessment and EFH Assessment, which appears in Appendix D-1 of the final Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 47, Regarding Columbia Generating Station (SEIS) (NRC 2012b). In the EFH Assessment portion of the SEIS, the NRC considered Upper Columbia River Chinook salmon (spring, summer, and fall runs) and coho salmon EFH and concluded that license renewal would have minimal adverse effects on the EFH of these species.

The NRC forwarded its draft SEIS containing the combined biological assessment and EFH Assessment to the NMFS by letter dated August 23, 2011. The NRC requested that the NMFS respond in writing to the EFH Assessment within 30 days per the abbreviated EFH Consultation requirements at 50 CFR 600.920(h)(4). Abbreviated consultation is appropriate when the Federal action does not have the potential to cause substantial adverse effects on EFH (50 CFR 600.920(h)(1)). In response to such a request, the NMFS must either (1) notify the Federal agency either informally or in writing that the action would not adversely affect EFH and that no EFH Conservation Recommendations are needed; (2) request in writing that the Federal agency initiate expanded consultation if NMFS believes that that the action may result in substantial adverse effects on EFH or that additional analysis is needed to assess the effects of the action; or (3) provide the Federal agency with EFH Conservation Recommendations, if appropriate, pursuant to section 305(b)(4)(A) of the MSA (50 CFR 600.920(h)(3)) if expanded consultation is not necessary. The Federal agency must submit its EFH Assessment to NMFS as soon as practicable, but at least 60 days prior to a final decision on the action, and NMFS must respond in writing within 30 days (50 CFR 600.920(h)(4)).

The NRC issued a renewed license to Energy Northwest for CGS on May 22, 2012. At that time, NMFS had neither sent NRC EFH Conservation Recommendations nor sent NRC a written request for expanded EFH consultation. Because the NMFS did not provide the NRC with EFH Conservation Recommendations or a request for expanded EFH consultation within the 30-day timeframe established at 50 CFR 600.920(h)(4), the NRC considered its obligations under the MSA fulfilled and the EFH consultation concluded for the proposed CGS license renewal. The NRC documented this view on page 4-11 of the SEIS (NRC 2012b).

3.1 Essential Fish Habitat Affected by the Project

The action area for this consultation includes areas of designated EFH in the Columbia River for Chinook salmon (PFMC 1999) and for coho salmon (50 CFR 660), and habitats of particular concern (HAPCs; 50 CFR 600.815(a)(8)) including thermal refugia, spawning habitat, and complex channel and floodplain habitats.

The population of UCR fall Chinook salmon that spawns in the Hanford Reach of the Columbia River is the largest wild stock of salmon remaining in the Pacific Northwest. Coho salmon and UCR spring-run Chinook salmon also use the Hanford Reach for migration. The Hanford Reach contains islands, riffles, gravel bars, oxbow ponds, and backwater sloughs that support productive spawning areas. The loss of other spawning grounds on the Columbia and its tributaries has increased the importance of habitat in the Hanford Reach including the action area.

3.2 Adverse Effects on Essential Fish Habitat

Based on the information provided in NRC (2012b) and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the action, ongoing operations at CGS under the renewed license, will have the following adverse effects on EFH designated for Chinook and coho salmon:

- <u>Water Quality</u>. The action will continue to cause minor increases in ammonia, chlorine, copper, zinc, and selenium to levels that may be harmful to early life stages of salmonids incubating or rearing in the Columbia River downstream of the outfall.
- <u>Water Quantity</u>. The action will continue to cause a minor increase in the amount of water (up to 56 cfs) taken from the Columbia River. These withdrawals will continue to reduce the amount of habitat available for rearing fish. The additional water uses are small and not likely to substantially affect the cold water refugia HAPC.
- <u>Artificial Obstructions.</u> The action will continue to create an artificial obstruction to UCR fall Chinook salmon fry rearing in the action area based on the risk of entrainment through or impingement on the screens on the water withdrawal structures.

3.3 Essential Fish Habitat Conservation Recommendations

Consistent with section 305(b) of the MSA, because NMFS has determined that the action of renewing the operating license for the CGS would adversely affect EFH for Chinook and coho salmon, NMFS is recommending that the NRC amend the renewed operating license for the CGS, as requested by the license applicant (Energy Northwest), to require compliance with the terms and conditions of the above ITS (section 2.9.4). The following two conservation recommendations are necessary to avoid, mitigate, or offset the impact of the action on EFH. These conservation recommendations are a subset of the ESA terms and conditions.

- Water Quality. Minimize adverse effects on water quality by monitoring and reporting as stated in term and condition #1 in the accompanying opinion.
- Artificial Obstructions. Minimize the risk of artificial obstruction by conducting the entrainment and impingement studies as stated in term and condition #2 in the accompanying opinion.

Fully implementing these conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 170 acres (0.266 mi^2) of designated EFH for Pacific Coast salmon, equivalent to an area of the mainstem Columbia River that is 1,400 feet wide by 1 mile long.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, NRC must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. 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 NRC’s statutory reply to the EFH portion of this consultation, it clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The NRC must reinitiate EFH consultation with NMFS if the action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS’s 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 NRC. Other interested users could include its licensee, Energy Northwest, and state and Tribal fisheries managers and others interested in the conservation of UCR spring-run Chinook salmon and UCR steelhead. Individual copies of this Opinion were provided to the NRC. This Opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by 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 U.S. Fish and Wildlife Service and NMFS's 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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