US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.1 INTRODUCTION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 4 - CUMULATIVE EFFECTS

SECTION 4.1, CUMULATIVE EFFECTS, INTRODUCTION,
HAS BEEN REVISED IN FORMAT FROM THE DEIS
INSERTION OF LARGE AMOUNTS OF TEXT IS IDENTIFIED; MINOR EDITS ARE NOT DENOTED

Summary of changes from the DEIS:

- **DEIS information on additive, interactive, and countervailing cumulative effects has been deleted because this level of detail is not necessary to understand the cumulative effects analyses and will not help to inform a decision.**
- **Information on the analysis area for each resource has been modified for clarity and to reflect FEIS content (FEIS Section 4.1.1, Geographic and Temporal Scope).**
- **Additional information on past actions has been added to FEIS Section 4.1.2.1, Past Actions.**
- **Detail regarding non-U.S. Army Corps of Engineers-managed dams in the Willamette River Basin has been incorporated into FEIS Section 4.1.2.1, Past Actions.**
- **Information on dam safety as an ongoing and future action has been modified for clarity in FEIS Section 4.1.2.2, Ongoing and Present Actions, Dam Safety Actions.**
- **Each of the reasonably foreseeable future action descriptions has been updated for accuracy and consistency with other EIS content in FEIS Section 4.1.2.4. The FEIS section provides an overview of each RFFA with general information on related effects from WVS operations.**
- **Identification of resources that would be affected by each RFFA has been removed from the RFFA descriptions in FEIS Section 4.1.2.4 (i.e., DEIS text stating "this RFFA interacts cumulatively with…"). Interactions with, and effects to, a given resource by an RFFA are more accurately described under each resource analysis, some of which have been modified since publication of the DEIS. DEIS Table 4.1-1, Reasonably Foreseeable Future Actions and Potentially Affected Resources, has also been removed for the same reasons. Further, this table would not inform decision making because nearly every RFFA interacts with nearly every resource (e.g., population growth, climate change, wildlife, and lands management).**
- **DEIS RFFA 2 – Reduced Agricultural Production, has been revised to Agricultural Production. Although croplands will likely decrease over the 30-year implementation timeframe, agricultural production will continue in the Willamette River Basin.**

Summary of changes from the DEIS, continued:

- **Additional information on Federally co-managed reservoirs and on Oregon Department of Parks and Recreation management has been added to FEIS Section 4.1.2.4, RFFA 5, Federal and State Wildlife and Lands Management.**
- **Information on Southern Resident killer whales has been updated to reflect best available information at the time the alternatives were analyzed in FEIS Section 4.1.2.4, RFFA 6, Southern Resident Killer Whale Management.**
- **Additional information on environmental organizations and watershed councils have been added to FEIS Section 4.1.3.4, RFFA 7, State, Tribal, and Local Fish and Wildlife Improvement.**

4.1 Introduction

Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) require an assessment of cumulative effects.

What is a cumulative effect?

"The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7).

CEQ recommends that cumulative effects analyses be narrowed to focus on important issues at a national, regional, or local level (CEQ 1997). The analysis of cumulative effects was conducted by the following steps:

1. Identification of past, present, and reasonably foreseeable future (RFFA) cumulative actions.
2. Identification of how each RFFA would affect a given resource, such as water quality, fish habitat, etc.
3. Analyses of overall effects of the alternatives on a given resource by combining results of direct and indirect analyses with RFFA effects. This outcome is the cumulative effects analysis.

This chapter considers the direct and indirect effects on each resource under each alternative *together* with the past, present, and RFFAs. For example, the existing and projected future climate of the Willamette River Basin can be considered a direct and/or indirect effect of past, present, and future actions, all of which may result in further cumulative effects on certain resources in the Basin.

Direct and indirect effects are analyzed in Chapter 3, Affected Environment and Environmental Consequences.

4.1.1 Geographical and Temporal Scope

THE DEIS HAS BEEN MODIFIED TO REVISE THE FOLLOWING INFORMATION IN THE FEIS

Geographic Scope (Analysis Areas)

Descriptions of the cumulative effects analysis areas (geographic scope) are presented under each resource analysis. Analysis areas may differ among resources because boundaries depend on the environmental condition being analyzed. For example, the analysis area for greenhouse gas emissions encompasses a larger scope than the area for water quality, which is primarily localized. Figures of each of the six primary analysis area subbasins are provided in Chapter 11, Analysis Area Subbasins.

Temporal Scope (Timeframes)

The temporal boundaries for cumulative effects in this analysis have three components: past, present, and future timeframes. Past cumulative effects are considered under the Affected Environment descriptions for each resource (Chapter 3, Affected Environment and Environmental Consequences). This is because past actions and their effects have contributed to, or fully resulted in, the current condition of a resource.

A brief description of relevant past actions is provided below. This description includes past cumulative effects dating back to approximately the year 1969 when all 13 Willamette Valley System (WVS) dams and reservoirs were completed. All resource analysis areas encompass the WVS.

Present and RFFAs are included in this chapter if they are expected to overlap during the 30-year implementation timeframe with the scope of this NEPA review, which, unless otherwise noted, is approximately the year 2050.

END REVISED TEXT

4.1.2 Cumulative Actions

4.1.2.1 Past Actions

According to CEQ, a cumulative effects analysis may assess past actions in an analysis area by focusing on the “current aggregate effects of past actions without delving into the historical details of individual past actions” (CEQ 2005). While all past actions do not need to be identified for the cumulative effects analysis, this section presents a brief catalogue and description of the effects from past actions on the existing condition of the Willamette River Basin to the extent they are relevant and useful in analyzing cumulative effects (i.e., within the scope of this NEPA review).

Human actions and development have substantially influenced all resources in the Basin. The history of the WVS and its component dams, reservoirs, bank protection, fish hatcheries, and other facilities is discussed in Chapter 1, Introduction.

Willamette Valley System and Other Dams and Reservoirs in the Willamette River Basin

THE DEIS HAS BEEN MODIFIED TO REVISE THE FOLLOWING INFORMATION IN THE FEIS

Within the Willamette River Basin, aquatic, riparian, and floodplain habitat have changed continuously throughout history through habitat loss, modification, degradation, and restoration. These effects result from combined natural forces and events and human activities. Central to these changes is alteration of Basin hydrology, or how water movement has changed over time (Section 3.2, Hydrologic Processes). Before dams existed in the Basin, the Willamette River was a natural, free-flowing riverine system. River flows, naturally augmented by rainfall and snowmelt, were historically high in winter months and low in summer months.

Several miles of free-flowing, riverine habitat in Willamette River tributaries have been converted by construction of 13 WVS dams and reservoirs. These dams have changed Basin flows and currents and function to moderate overall Basin flows.

WVS operations result in winter flows that are lower on average than historical flows because WVS reservoirs reduce high flows by capturing runoff and releasing it gradually. Average summer flows are now higher than historical summer flows because of intentional releases of stored water from reservoirs.

Additionally, dam and reservoir construction interfered with sediment transport, altered seasonal hydrology, changed vegetation composition in the Willamette Valley floor, and permanently converted flowing riverine habitat and forested riparian areas to open water and seasonal mudflat habitat.

In addition to the 13 USACE-managed dams in the Willamette River Basin, there are 247 other dams dispersed throughout the Basin managed by other entities (USACE 2020h) (Chapter 1, Introduction, Section 1.8, Non-U.S. Army Corps of Engineers'-managed Dams and Structures in the Willamette River Basin).

Of the 247 non-USACE dams in the Willamette River Basin in its entirety, only 38 dams are in Willamette River Basin subbasins containing WVS dams/reservoirs. Many are in tributary headwaters. Operation of these facilities support increasing population and economic activity in the Basin by supplying water for both agricultural irrigation and municipal/industrial users, generating electricity, and providing water-based and land-based recreational opportunities for residents and visitors.

Along with USACE-managed dams and reservoirs, these widely dispersed impoundments affect Basin hydrology and salmon runs by obstructing migration and submerging spawning and rearing habitat in the Willamette River Basin. Adverse effects also include direct mortality to species and habitat loss and degradation. Examples of the various ways that habitat can be lost or degraded include the creation of barriers to fish passage both upstream and downstream, overharvest of aquatic species, introduction of invasive and predatory species, modification of flow and water temperature to suboptimal conditions, and water pollution.

Relevant past cumulative actions also include the voluntary and Federal- and state-mandated actions of private and public stakeholders to benefit and offset adverse impacts on salmonids, other aquatic species, and wildlife. These offsetting actions include, but are not limited to, managing hatcheries and fisheries, water quality improvements, and land conservation management fish and wildlife habitat.

USACE, Bonneville Power Administration (BPA), and the U.S. Bureau of Reclamation (BOR) with partnering Federal, tribal, and state agencies and non-governmental organizations continue to collaborate to conserve and manage fish and wildlife and to mitigate adverse effects of WVS operations.

Additionally, the 2008 National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) Biological Opinions obligate USACE, BPA, and BOR to develop and implement procedures and measures to protect Endangered Species Act (ESA)-listed species (Chapter 1, Introduction, Section 1.1.3, Willamette Valley System Endangered Species Act and National Environmental Policy Act History Since 2008). These measures must be concurrent with continued operations and maintenance of the WVS in accordance with WVS Congressionally authorized purposes (Chapter 1, Introduction, Section 1.10, Congressionally Authorized Purposes).

END REVISED TEXT

Willamette River Basin Population Growth and Development

The Willamette River Basin had experienced substantial population growth and development around the time the alternatives were analyzed (Figure 4.1-1). This growth occurred primarily in the lower elevations of the Basin in close proximity to the Mainstem Willamette River and its major tributaries. Other past cumulative actions related to Willamette River Basin population growth and development include:

- Agricultural, urban, and transportation corridor development
- Water withdrawals for irrigation, municipal, and industrial uses to support development in the Willamette Valley
- Floodplain development
- Logging and mining

- Dredging and sediment management
- Commercial and recreational fish harvesting
- Increased recreational use and visitation of public lands
- Proliferation of invasive species (both plants and animals)
- Point and non-point source water pollution

Figure 4.1-1. Population and Urban Development in Eugene, Oregon.

Growth and development have resulted in adverse effects to resources within the Willamette River Basin, including salmonids, other aquatic organisms, and other wildlife and their habitats.

There are 10 counties within nearly all of the Willamette River Basin boundary. According to data from the Natural Resources Conservation Service National Resources Inventory, in the 35-year span between 1982 and 2017, the area of developed land in these 10 counties grew from 519,800 acres (812 square miles) to 747,100 acres (1,167 square miles), an increase of 44 percent (Table 4.1-1) (NRCS 2020). During the same period, the combined populations of these 10 counties grew by 59 percent (USCB 1992; USCB 2020b).

Cropland in the 10 Basin counties decreased by 12 percent from 1982 to 2017, from 1,085,200 acres (1,696 square miles) to 955,300 acres (1,493 square miles) (Table 4.1-2). This decrease is primarily a result of population growth and associated demand for additional developed land.

Table 4.1-1. Increase in Developed Land in Willamette River Basin Counties, 1982 to 2017.

County	1982 Developed Land Area (1,000 acres)	2017 Developed Land Area (1,000 acres)	Percentage Change 1982 to 2017 (%)
Benton	24.4	30.2	24
Clackamas	70.4	114.3	62
Douglas	57.5	72.8	27
Lane	110.7	141.7	28
Linn	40.2	60.5	50
Marion	58.2	92.3	59
Multnomah	70.7	92.5	31
Polk	17.4	26.2	51
Washington	52.9	90.9	72
Yamhill	17.4	25.7	48
Total	**519.8**	**747.1**	**44[1]**

Source: NRCS 2020

[1] Percent average change

Table 4.1-2. Cropland Change in Willamette River Basin Counties, 1982 to 2017.

County	1982 Cropland Area (1,000 acres)	2017 Cropland Area (1,000 acres)	Percentage Change 1982 to 2017[1] (%)
Benton	68.5	63.7	-7
Clackamas	85.3	52.4	-39
Douglas	29.6	31.2	5
Lane	114.4	82.3	-28
Linn	210.3	214.5	2
Marion	244.0	223.6	-8
Multnomah	16.0	11.3	-29
Polk	114.5	112.9	-1
Washington	76.4	57.8	-24
Yamhill	126.2	105.6	-16
Total	**1,085.2**	**955.3**	**-12[1]**

Source: NRCS 2020

[1] Percent average change

4.1.2.2 Ongoing and Present Actions

Court-ordered Injunction Actions

USACE is undergoing planning to address an order from the U.S. District Court for the District of Oregon (Chapter 1, Introduction, Section 1.12.3, Court-ordered Injunction Measures). The order requires USACE to implement interim actions intended to improve conditions for fish passage and water quality in the WVS to avoid irreparable harm to ESA-listed salmonids. These actions are to remain in effect until the completion of the reinitiated Section 7 ESA consultation with NMFS and USFWS.

These interim actions include Interim Operations that require changes to how one or more of the WVS dams are currently operated. Interim Operations are included under each of the action alternatives, except Alternative 1 (Chapter 2, Alternatives). Direct and indirect effects of these measures are assessed in Chapter 3, Affected Environment and Environmental Consequences.

Three structural modification actions are required by the court order. These modifications have undergone, or are currently undergoing, separate site-specific NEPA processes to assess the direct, indirect, and cumulative impacts of their effects on the human environment. Consequently, these future actions are not included in the direct and indirect effects analyses (Chapter 3, Affected Environment and Environmental Consequence).

Modification Actions

- Dexter Dam – Design and construct upgrades to the existing Dexter Dam Adult Fish Facility.
- Big Cliff Dam – Determine whether operational measures alone are sufficient to maintain acceptable total dissolved gas (TDG) levels below Big Cliff Dam. If not, design and construct a structural solution for mitigating excess TDG levels during spill operations.
- Cougar Dam – Determine whether structural improvements/modifications are needed to the regulating outlet to ensure safer fish passage and to reduce TDG levels. If so, design and construct a structural solution.

THE DEIS HAS BEEN MODIFIED TO REVISE THE FOLLOWING INFORMATION IN THE FEIS

Dam Safety Actions

As part of its comprehensive dam safety program, USACE continuously monitors, inspects, and assesses dams to assess safety risks and to inform future management actions (Appendix H, Dam Safety). Annual dam safety inspections and periodic inspections are performed every 5 years to monitor and document dam conditions and performance.

Risk assessments are part of an ongoing dam safety program necessary to prioritize Federal investments for aging infrastructure (Appendix H, Dam Safety). Risk assessments evaluate life safety risks associated with dams to determine if risk reduction actions are needed. At the time the alternatives were analyzed, USACE had conducted advanced risk assessments, called Issue Evaluation Studies, at several WVS dams. Short-term targeted measures, or Interim Risk Reduction Measures, or long-term modifications may be necessary to reduce risk depending on study results.

Detailed analyses of seismic risk at Detroit Dam in 2021, Lookout Point Dam in 2020, and Hills Creek Dam in 2020 concluded that immediate action to mitigate risks at these dams was necessary. Per USACE Engineering Regulation (ER) 1110-2-1156, USACE has specific public safety responsibility, when a dam has known safety issues, to take appropriate interim risk reduction measures, including reservoir releases. USACE statutory responsibilities require operations to reduce probabilities of failure when there are known issues with the integrity of a dam or reservoir.

Consequently, Interim Risk Reduction Measures at these dams required maximum conservation pool elevation reduction. USACE must operate so that the maximum elevation of associated reservoirs each summer is lower than the authorized maximum elevation.

Actions in Addition to USACE Management included in the Analyses

- ✓ Operation of hydroelectric dams
- ✓ Developed and undeveloped recreation opportunities
- ✓ Timber and logging operations
- ✓ Mining operations
- ✓ Ongoing non-point source pollution
- ✓ Natural resources management, conservation, and protection by other Federal, state, and local agencies

Effects from these measures were assessed in NEPA Environmental Assessments. However, the measures proposed under the action alternatives do not require these reservoirs to reach the authorized maximum conservation pool elevation and, would generally further restrict maximum elevations below the Interim Risk Reduction Measure restrictions. Consequently, effects of the Interim Risk Reduction Measures combined with other measures under the action alternatives are not additive and are not assessed in the cumulative effects analyses.

4.1.2.3 Ongoing Regulatory and Policy Initiatives

To assess cumulative effects, it was assumed that existing laws, policies, agency jurisdictions, rulings, Biological Opinions, and other elements of the regulatory environment would remain in effect for stated durations.

Similarly, while the adequacy and status of existing regional coordination, alignment, and planning actions are not assessed, they are discussed for context. For example, efforts are underway to create more integrated and regional approaches to salmon and steelhead challenges that require collaboration across Federal, state, and tribal government jurisdictions (e.g., efforts by the Willamette Action Team for Ecosystem Restoration, Willamette Fish

Passage Operations and Maintenance coordination team, Flow Management and Water Quality Team). Anticipated future effects of these initiatives are included where applicable.

END REVISED TEXT

4.1.2.4 Reasonably Foreseeable Future Actions

RFFAs are anticipated future environmental trends or specific proposed activities that could cause effects in the same space and time as effects from implementation of any alternative. RFFAs described below are proposed by or involve outside entities such as other Federal, state, or local agencies, or private sector interests. RFFAs can also be trends or activities not yet implemented but anticipated.

Specifically, RFFAs considered were those in formation and not speculative in planning or concept at the time the alternatives were analyzed. For example, RFFAs included in the scope of analysis are those with budgets and included under formal proposals or decisions. RFFAs affecting the WVS and Willamette River Basin have been grouped into 11 categories and numbered for reference (Table 4.1-3). Each RFFA is described below.

Table 4.1-3. Reasonably Foreseeable Future Actions Affecting the Willamette Valley System and Willamette River Basin.

RFFA Number	RFFA Title
RFFA 1	Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
RFFA 2	Agricultural Production
RFFA 3	Water Withdrawals for Municipal, Industrial, and Agricultural uses
RFFA 4	Decarbonizing the Energy Sector with Renewable Energy Sources
RFFA 5	Federal and State Wildlife and Lands Management
RFFA 6	Southern Resident Killer Whale Management
RFFA 7	Tribal, State, and Local Fish and Wildlife Improvement
RFFA 8	Invasive Species Management
RFFA 9	Climate Change
RFFA 10	Mining Operations
RFFA 11	Timber and Logging Industry Operations

RFFA = Reasonably Foreseeable Future Action

THE DEIS HAS BEEN MODIFIED TO REVISE THE FOLLOWING INFORMATION IN THE FEIS

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Populations are continuing to increase within the counties that compose the Willamette River Basin. At the time the alternatives were analyzed, this growth was occurring primarily in urban metropolitan areas with smaller increases in rural areas (State of Oregon 2013). The State of Oregon Office of Economic Analysis, responsible for making official demographic projections for Oregon, anticipates this increase to continue at least through 2050 (State of Oregon 2013) (Table 4.1-4).

Table 4.1-4. Population Projections for Willamette River Basin Counties, 2020 to 2050.

County	2020 Population Estimate	2050 Population Estimate	Percentage Increase 2020 to 2050 (%)
Benton	91,379	111,666	22
Clackamas	422,576	583,814	38
Douglas	116,113	139,675	20
Lane	378,335	464,839	23
Linn	128,454	168,189	31
Marion	331,643	498,624	50
Multnomah	807,198	982,504	22
Polk	88,081	135,877	54
Washington	570,672	915,979	61
Yamhill	113,611	167,300	47
Total	**3,048,061**	**4,168,466**	**37[1]**

Source: State of Oregon 2013

[1] Percent average increase

Land developed in the Basin from 2020 to 2050 would be estimated to increase by 28 percent, or approximately 206,150 acres (322 square miles) if the relationship between the increase in population and the increase in developed land mirrors the trend between 1982 and 2017 (USCB 1992; USCB 2020b).

Increasing population in the Willamette River Basin would cause several cumulative effects throughout the Basin regardless of WVS operations. However, municipal water demands would likely increase, which may be met by increased withdrawals from the WVS. Additionally, after use and treatment, municipal and industrial water demands would be returned to rivers in the Basin through increased permitted point source discharges, potentially increasing base flow of degraded water quality into Basin waterways.

RFFA 2—Agricultural Production

Farmland/Agricultural Land Categories

- ✓ Cropland includes cultivated row crops and orchards.
- ✓ Range and pasture lands are vegetated primarily by herbaceous plants and shrubs, which provide forage for domestic livestock.
- ✓ Farmland converted to developed land to accommodate population growth.

Population growth and related development have contributed to decline of agricultural lands within the Willamette River Basin. The Natural Resources Conservation Service identifies and inventories three categories of farmland or agricultural land: cropland, pastureland, and rangeland. Cropland in the 10 counties that compose most of the geographic area of the Willamette River Basin declined by 12 percent from 1982 to 2017 (Table 4.1-2) (Figure 4.1-2).

Figure 4.1-2. Willamette Valley Cropland.

Photo by jim.choate59 licensed under CC BY-NC-ND 2.0

Given population projections for strong growth within each of the 10 counties, land conversion and development pressures are likely to continue; the area of cropland within the Willamette River Basin will likely continue to decrease (Table 4.1-4). Regardless, agricultural production will continue to occur in the Basin over the 30-year implementation timeframe requiring demand for water supply from the WVS (Section 3.13, Water Supply). Less cropland could result in less soil erosion from wind and rain and less pollutant, nutrient, and bacteria runoff in localized areas.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

Water use within the Willamette River Basin is forecasted to increase in the future, especially as population growth, associated development, and climate change continue to affect water availability and scarcity in the region (Section 3.13, Water Supply, Table 3.13-2). The Willamette Water 2100 Project[1] identifies and quantifies linkages and feedbacks among human, hydrological, and ecological dimensions within the Basin, and makes predictions about where and when human activities and climate change would impact future water scarcities (Figure 4.1-3).

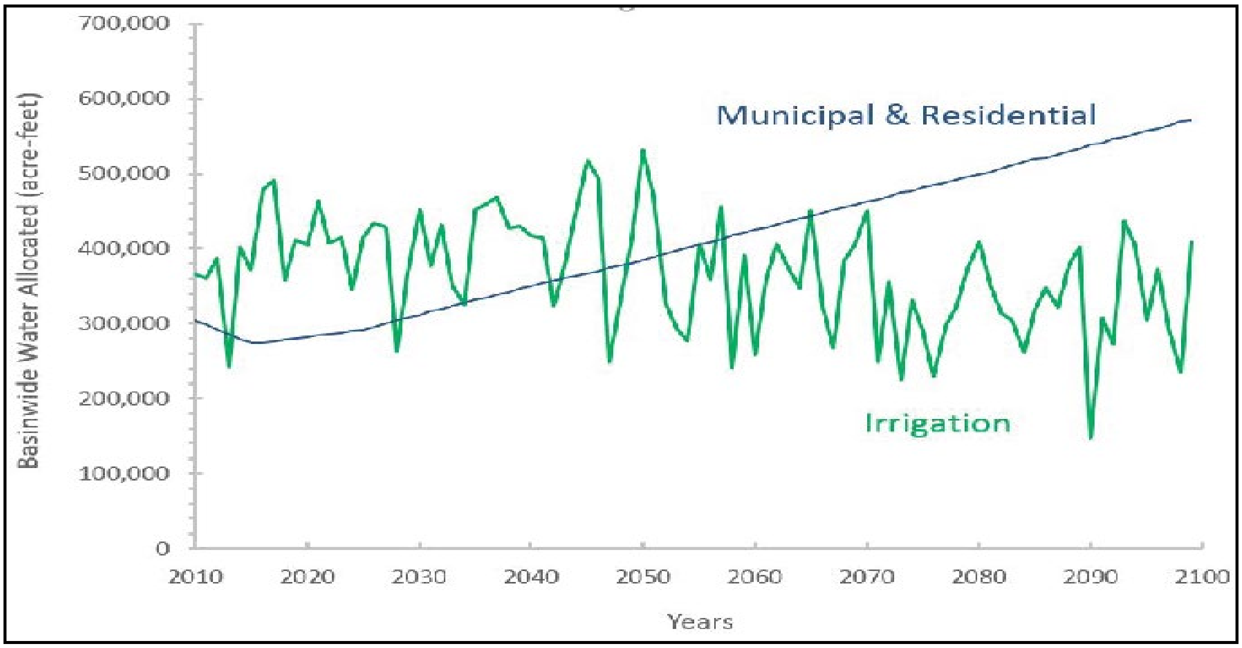

Figure 4.1-3. Willamette River Basin Water Usage Dams, 2010–2100.
Source: WW2100 No Date

Water 2100 Project information suggests water demand for municipal and residential use would increase (Figure 4.1-3, blue line), which is consistent with Willamette Basin Review Feasibility Study results (USACE 2019a). In addition to future demands for agricultural water use, at the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). This need was one of the factors that led to the Willamette Basin Review Feasibility Study (USACE 2019a), which resulted in a total of 159,750 acre-feet of conservation storage reallocated to the purpose of municipal and industrial water supply.

[1] The Willamette Water 2100 project was a collaborative effort of faculty from Oregon State University, the University of Oregon, Portland State University, and the University of California - Santa Barbara. It was funded primarily by grants from the National Science Foundation with additional support from the National Oceanic and Atmospheric Administration.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

By reducing the amount of water flowing through the WVS, increased withdrawals could have implications for instream flow, water quality parameters, recreation opportunities, and for maintenance of riparian and aquatic habitats for fish and wildlife.

RFFA 4—Decarbonizing the Energy Sector with Renewable Energy Sources

Decarbonization of the energy sector is a national trend. Oregon's Renewable Portfolio Standard sets the requirement for how much of the state's electricity must come from renewable sources. In March 2016, this standard was set to require 50 percent of Oregon's electricity to come from renewable sources by 2040 (ODOE No Date-b).

Coal no longer supplies any in-state generation because Oregon's only coal-fired power plant in Morrow County closed in October 2020. There are also no commercial nuclear power plants in the state (EIA 2021) and no new natural gas plants have been proposed within the counties of the Willamette River Basin. Oregon has only minor fossil energy reserves (EIA 2021), which would likely reduce the propensity for the fuel source into the future.

Renewable energy infrastructure and projects such as wind turbines and solar arrays are expanding in Oregon as throughout the nation. Federal and state wind energy incentives, including state tax credits and large cash rebates, for installing wind turbines and generators are available for projects in Oregon (Dasolar Energy 2021; Energy Trust 2014; ODOE No Date-c).

Sources of Energy in Oregon

- ✓ Hydropower facilities typically provide more than half the electricity generated in Oregon.
- ✓ Natural gas fuels the second-largest share of Oregon's electricity generation.
- ✓ Non-hydroelectric renewable resources, including wind, biomass, solar, and geothermal power, provide almost the rest of Oregon's generation.

The Willamette River Basin has the greatest and fastest growing electricity demand in the state (Poehler 2020). Electricity generated by renewable sources at locations outside the Basin could also potentially help meet some of the region's growing energy needs (Musial et al. 2019). However, other land use planning and regulations make it difficult to site utility-scale solar projects in the densely populated Willamette Valley.

While multiple renewable energy projects are proposed throughout Oregon, there are currently no proposed renewable energy projects within the counties representing the Basin (ODOE No Date-a).

RFFA 5—Federal and State Wildlife and Lands Management

Federal, state, and local management practices within the Willamette River Basin can have cumulative effects when added to the actions proposed under the alternatives. For example, water, soil, vegetation, and fire management can have important additive, adverse, or beneficial environmental effects on a given resource. Management practices relevant to the cumulative analyses are described below.

Federal Land Management

U.S. Forest Service-managed Lands

Under U.S. Forest Service (USFS) management, the 1.7-million-acre Willamette National Forest contains eight Congressionally-designated national wilderness areas and stretches for 110 miles along the eastern edge of the Willamette River Basin and western slopes of the Cascade Range (Figure 4.1-4). The forest extends from the upper reaches of the Santiam River in the north and past the McKenzie River, to the Middle and North Forks of the Willamette River and the 8,743-ft. Diamond Peak in the south of the Basin.

Among other functions, the wooded slopes of the National Forest protect soils from erosion, thereby helping with water quality conditions for water provided to the cities of Salem, Eugene, and Springfield, and other communities in the Basin (USFS No Date-b).

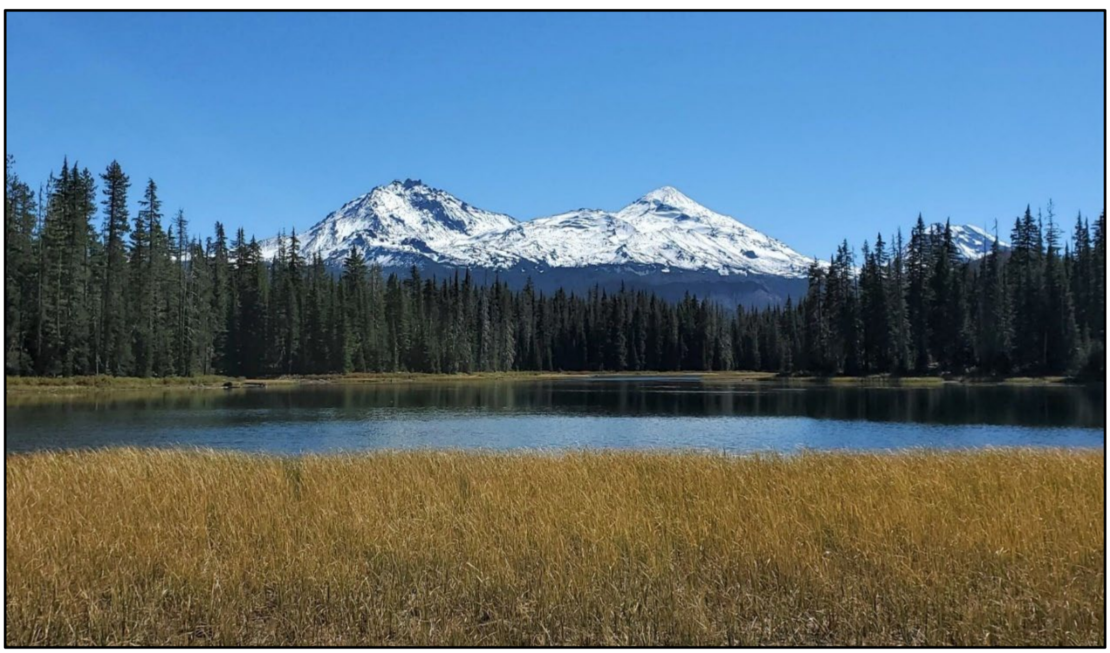

Figure 4.1-4. Willamette National Forest.

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

USACE and the USFS co-manage five WVS reservoirs (Detroit, Cougar, Blue River, Hills Creek, and half of Lookout Point Reservoirs) under construction-era Memoranda of Understandings, on U.S. Department of Agriculture[2]-withdrawn lands. Generally, the USFS manages lands in the WVS for wildlife habitat and developed and undeveloped recreation opportunities, including boat launches. USACE manages all reservoir activities.

U.S. Bureau of Land Management-managed Lands

The U.S. Bureau of Land Management (BLM) manages Federally owned lands in the Willamette River Basin for multiple uses, including outdoor recreation, energy production, timber production, grazing, and wildlife. USACE and the BLM co-manage sites on Department of Interior[3]-withdrawn lands at Green Peter, Fall Creek, and Fern Ridge Reservoirs in the WVS. Developed and undeveloped recreation opportunities and wildlife habitat are managed by the BLM adjacent to these reservoirs. USACE manages all reservoir activities.

END NEW TEXT

U.S. Fish and Wildlife Service-managed Lands

The USFWS would continue to implement management activities at the Willamette Valley National Wildlife Refuge Complex. The three refuges in the complex provide protection for historically abundant oak savanna, native prairie, riparian forest, and wetland habitats. These protected areas support habitat for special status plants and wildlife and are important habitat for wintering waterfowl.

Refuges are grouped and managed as a “complex” because they occur in a similar ecological region, such as a watershed or specific habitat type (USFWS 2014b). In addition to conserving and managing wildlife habitats and populations, national wildlife refuges support six priority public uses: hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

Refuges in the Willamette Valley National Wildlife Refuge Complex

- ✓ William L. Finley National Wildlife Refuge, Benton County
- ✓ Ankeny National Wildlife Refuge, Marion County
- ✓ Baskett Slough National Wildlife Refuge, Polk County

[2] The U. S. Forest Service is an agency within the U.S. Department of Agriculture that administers the nation’s 154 national forests and 20 national grasslands covering 193 million acres of land.

[3] The U.S. Bureau of Land Management is an agency within the U. S. Department of the Interior responsible for administering Federal lands. The U.S. Bureau of Land Management oversees more than 247.3 million acres of land, or one-eighth of the United States’s total landmass.

Federally Listed Species

The Willamette River Basin supports species currently listed as threatened or endangered as well as critical habitat designations under the ESA (Section 3.9, Wildlife). Candidate species, species petitioned for listing, and species of concern also inhabit the Basin.

Species formally listed under the ESA and afforded additional protections (such as critical habitat designation) are integral to development of each of the alternatives because of known effects on habitat and populations. Direct and indirect effects on ESA-listed or candidate species are analyzed in Chapter 3, Affected Environment and Environmental Consequences. Cumulative effects are addressed in this chapter under applicable resource analyses.

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

State Land Management

Public lands in Oregon continue to be managed to balance economic interest with wildlife conservation and land preservation. Oregon's Department of Land Conservation and Development (ODLCD) guides these decisions through the Oregon Statewide Planning Goals and Guidelines, which were amended in July 2019. This most recent revision includes goals to:

- Preserve forest lands, agricultural lands, scenic and historic areas.
- Maintain air, water, and land resource quality.
- Protect urban growth boundaries for future urbanization growth.
- Create a 300-mile Willamette Greenway that protects the Willamette River.
- Classify 22 major estuaries based on their biological, economic, recreational, and aesthetic benefits to better inform future developments or alterations.

Local city and county land use plans must be consistent with the statewide planning goals. Consequently, land use plans guide development of Oregon lands (ODLCD 2019).

The Willamette River Basin contains abundant public lands, especially in the headwaters and higher elevations. These lands would continue to be managed for multiple purposes, such as watershed protection, wildlife and habitat conservation, recreation, livestock grazing, resource extraction (e.g., logging, mining), and other public uses.

The Oregon Department of Parks and Recreation manages many developed and undeveloped campgrounds and boat launches along the Willamette River and tributaries as well as WVS real estate leases. The Department manages predominantly developed campgrounds within the WVS.

END NEW TEXT

RFFA 6—Southern Resident Killer Whale Management

Southern Resident Killer Whales

Southern Resident killer whales compose the smallest of the three "resident" populations of killer whales in the eastern North Pacific Ocean (Figure 4.1-5). They are listed as endangered. As of September 2020, they numbered just 74 individuals in three pods, a decrease from 96 to 98 individuals in the mid-1990s.

Southern Resident killer whales are found mostly off the coasts of British Columbia, Washington, and Oregon, but also travel to forage widely along the outer coast. Southern Residents specialize in preying on Chinook salmon. They feed on Chinook salmon year-round; this species is their main prey in the spring and summer when they occupy inland waters (MMC 2021).

The majority of Chinook salmon prey for Southern Residents in the vicinity of the WVS is from the Columbia River. This is likely attributed to (1) the large amount of time Southern Residents spend near the Columbia River, (2) the seasonal increase in fish aggregations associated with Chinook salmon spawning, and (3) the relatively large number of Chinook salmon returning to the Columbia River system (Hansen et al. 2021). Studies on Chinook salmon prey sourced from the Willamette River Basin were not found; however, the contribution as a prey source is assumed to be low in comparison to Columbia River Chinook salmon prey availability.

Figure 4.1-5. Pod of Killer Whales (*Orcinus orca*).

Pacific Fishery Management Council

Management of Southern Resident killer whales and the fisheries they depend on are expected to continue based on efforts taken by the Pacific Fishery Management Council (PFMC) and other stakeholders. The PFMC, one of eight regional fishery management councils established by Congress in 1976, manages ocean populations of Upper Willamette River (UWR) Chinook salmon, which are the focus of multi-agency endangered species preservation efforts.

The PFMC prepares fisheries harvest plans known as Pacific Salmon Fishery Management Plans for Chinook salmon (including UWR Chinook), coho, and pink salmon; these plans are implemented and enforced by NMFS in Federal offshore waters (i.e., 3 miles to 200 miles offshore). NMFS promulgates regulations for how many salmon can be caught offshore based on PFMC plans.

Overall, PFMC and NMFS continue to study improvements in the catch of salmon in offshore ocean waters.

Southern Resident Killer Whale Workgroup

PFMC established the Southern Resident Killer Whale Workgroup to reassess effects of Federal ocean salmon fisheries on this whale population. The SRKW Workgroup is composed of representatives from west coast tribes; the states of California, Idaho, Oregon, and Washington; PFMC; and NMFS.

The goal of the Workgroup was to recommend conservation measures or management protocols to limit effects on Chinook salmon in Federal waters and thereby indirectly help to ensure survival of the highly endangered Southern Resident killer whales. In November 2020, the Workgroup provided recommendations for ocean salmon fisheries management via a final report to PFMC members (PFMC 2020).

Under recommendations adopted by PFMC, the management threshold was set as the arithmetic mean of the seven lowest years of pre-fishing Chinook salmon abundance in the area north of Cape Falcon, Oregon (1994 to 1996, 1998 to 2000, and 2007) (estimated at 966,000 fish). Several management actions (time and area fishery closures) are implemented through annual regulations when pre-season Chinook salmon abundance projections fall below the established threshold of 966,000. These management efforts interact cumulatively with the number of UWR Chinook salmon able to return each year to spawn in Willamette River tributaries via the Columbia River and the Mainstem Willamette River.

Fisheries and Fish Production

Ocean fisheries have an effect (a reduction) on adult salmon returns because of fish harvest. However, this reduction effect on UWR Chinook salmon in PFMC fisheries is minimal as evidenced by an average exploitation rate[4] in PFMC fisheries of less than 0.5 percent (PFMC 2021).

[4] Exploitation rate is the percentage of a fish population that is caught by fishing.

Actions in the PFMC ocean fishery management areas have very low effects on the return abundance of UWR Chinook salmon. Therefore, the magnitude of effect on Southern Residents of ocean fishery actions on UWR Chinook salmon is also very small.

In contrast to low harvest effects, improved production of the salmon stock in freshwater areas can have a potentially large, beneficial effect on the strength of salmon returns. UWR Chinook salmon are important to Southern Resident killer whales due to the timing of salmon returns to the mouth of the Columbia River correlating to Southern Resident energetic needs in the same timeframe. Consequently, increased production actions may accrue larger benefits to Southern Residents than harvest management actions. However, prey from the Willamette River is not a substantial source for Southern Resident killer whales.

In the absence of substantial improvements in smolt-to-adult ratios of natural-origin fish, any reductions in Willamette Valley hatchery production would cause minor decreases in a key food resources available to Southern Resident killer whales. The contribution of Willamette River Chinook salmon as a prey source is assumed to be low, particularly in comparison to Columbia River sources.

<u>RFFA 7—Tribal, State, and Local Fish and Wildlife Improvement</u>

Tribes, state, and local agencies; environmental organizations; and private communities are expected to continue non-Federal habitat activities and projects focused on improving general habitat and ecosystem function or species-specific conservation objectives in western Oregon.

Tribes

The Confederated Tribes of Grand Ronde Community of Oregon collaborates with USACE to improve fish habitat and populations in Reservation streams, in part for subsistence fishing purposes. Members of the Confederated Tribes of Warm Springs harvest Pacific lamprey at Willamette Falls and work with USACE to ensure that cumulative effects from other ongoing projects or mitigation efforts in the Willamette River Basin are recognized and addressed. Members also coordinate with USACE to consider potential effects of the WVS on water quality, climate change, streamflow for fish and wildlife, and tribal cultural resources, in particular on Pacific salmon and Pacific lamprey.

Oregon Department of Fish and Wildlife

ODFW implemented a Strategic Plan in February 2018 to establish long-term goals of managing and protecting the state’s fish and wildlife resources, both game and nongame. A primary goal is to expand stewardship and to support Oregon’s fish, wildlife, and their habitats. Effective stewardship is being addressed by developing science-based actions, targeting constituents’ needs, providing leadership on five focal fish and wildlife issues with progress reports and solutions by 2022, aligning budgets with ODFW conservation and management priorities, and expanding ODFW overall funding efforts (ODFW 2018).

Environmental Organizations

The Nature Conservancy oversees several projects in the Willamette River Basin aimed at protecting imperiled species, managing habitats and ecosystems, and adapting to climate change. For example, restoration of the Willamette River was completed at the confluence of the Middle Fork of the Willamette River and the Coastal Fork River, east of Eugene, Oregon.

Restoration included removal of a series of gravel pits and barriers acting as levees and allowed the river to return to its natural, free-flowing state, which provided crucial resting spots for salmon, wetland habitat for wildlife, and fertile floodplains for trees, shrubs, and other plants. The McKenzie River Trust owns and manages the property at the confluence and continues to collaborate with The Nature Conservancy regarding preservation projects and ecotourism programs (TNC 2021).

The Nature Conservancy also purchases lands worldwide, and works to promote conservation of lands with public and private partners to meet its mission of conserving open space and wildlife preserves (Wikipedia 2024).

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Willamette Riverkeeper is an environmental organization founded in 1996. Its mission is to protect and restore the Willamette River, one characterized by good water quality and abundant natural habitat (Willamette Riverkeeper No Date).

Watershed Councils

Oregon watershed councils are community-based organizations that date back to 1997 when the state legislature encouraged local governments to form these groups. Councils are led by natural resources experts and guided by boards composed of local community members (Oregon Watersheds No Date). In the Willamette River Basin, 17 watershed councils are involved in stream restoration and fish and wildlife habitat improvement efforts.

END NEW TEXT

RFFA 8—Invasive Species Management

Non-native and invasive plants and animals are damaging biological diversity and ecosystem integrity across the Willamette River Basin. Aquatic invasive species can spread rapidly and quickly alter the function of an ecosystem.

Within the Willamette Valley National Wildlife Refuge Complex, several invasive species pose a serious threat to native species through competition and predation. Specifically, reed canary grass out-competes native wetland emergent plants; Himalayan blackberry thickets alter upland prairies and woodlands, nutria degrade aquatic habitats and displace native species; and bullfrogs, bass, and bluegill fish disrupt aquatic ecosystems by preying on native fish, amphibians, and reptiles (USFWS No Date).

Throughout the Willamette River Basin, USACE, BPA, and BOR, USFWS, USFS, BLM, and the Oregon Department of Agriculture cooperate on weed management, invasive species prevention and eradication, and vegetation treatments. To the extent that these efforts are successful, they improve habitats for, and the survival of, native plants and animals.

Several other planning efforts and regulations are underway to provide a comprehensive framework for addressing invasive species in Oregon (Oregon Conservation Strategy No Date). These include:

- Oregon Statewide Strategic Plan for Invasive Species, 2017–2027
- ODFW Wildlife Integrity Administrative Rules
- ODFW Aquatic Invasive Species Prevention Plan
- Oregon Department of Agriculture Noxious Weed Strategic Plan
- Oregon Aquatic Nuisance Species Management Plan
- Ballast Water Management Administrative Rules

In general, USACE anticipates that invasive species management efforts will increase in the Willamette River Basin generally and within the WVS specifically over the 30-year implementation timeframe. This increase will be due to changes in climatic conditions that may favor invasive species, particularly early colonizers after disturbance, species resistant to climate perturbations, and species favored by emerging climate regimes (such as flora and fauna migrating northward).

RFFA 9—Climate Change

Climate change continues to be an evolving, complex phenomena that is causing multiple, and at times intersecting, environmental effects that are occurring within the Willamette River Basin, the State of Oregon, and the planet. Climate change contributes to direct, indirect, and cumulative effects to all resources analyzed in the EIS. Direct and indirect effects are analyzed in Chapter 3, Affected Environment and Environmental Consequences. However, climate change can also impact resources as an RFFA when combined with other RFFAs identified in this chapter.

Appendix F2, Supplemental Climate Change Information, provides a detailed assessment of the potential effects of climate change on the Basin and WVS using the most recent available science and modeling at the time the alternatives were analyzed. Appendix F2 includes results of a 4-year research project completed by the University of Washington and Oregon State University, with resource support and technical expertise provided by the River Management Joint Operating Committee (RMJOC) agencies (USACE, BPA, BOR). The RMJOC-II Committee reports the following for the 2020 to 2049 time period (RMJOC 2018):

- Temperatures in the region have already warmed about 1.5 degrees Fahrenheit (°F) since the 1970s. Temperatures are expected to warm another 1°F to 4°F by the 2030s.
- Future precipitation trends are more uncertain, but higher precipitation is likely for the rest of the 21st century, particularly in the winter months. Already dry summers could become drier.
- Average winter snowpacks in the mountains surrounding the Willamette Valley are very likely to decline over time as more winter precipitation falls as rain instead of snow.
- By the 2030s, higher average fall and winter flows on Willamette River Basin streams and rivers, earlier peak spring runoff, and longer periods of low summer flows are very likely.
- The incidence of large forest fires has increased since the early 1980s and is projected to continue increasing through the 21st century as air surface temperatures continue to rise. Wildfire alters the land surface and can have strong influences on runoff, vegetation dynamics, erosion and sediment transport, and ecosystem processes. Seasonality regime and spring snowmelt dependencies position the Willamette River Basin to be at risk for increased fires due to effects of climate change (Figure 4.1-6).

Figure 4.1-6. 2022 Cedar Creek Fire on the Willamette National Forest.

RFFA 10—Mining Operations

Mining operations within the Willamette River Basin continue to be of growing interest due to the area's diverse mineral resources and the large number of identified mines and active mining claims. The BLM is responsible for a wide variety of activities within the Federal minerals program, including decision-making regarding mining claims and providing guidance for surface use management and use and occupancy under mining laws (BLM No Date-b).

As of 2021, the Basin has a total of 462 identified mines, most of which are located within Lane, Douglas, Linn, and Clackamas Counties (Table 4.1-5). Of those mines, 171 (37 percent) are in production, and another 199 (43 percent) are prospect mines, meaning there has been some degree of development such as surface trenching, shafts, drill holes, or geophysical, geochemical, or geological surveys to estimate grade and tonnage (The Diggings 2022). These are likely indications of future mining activities in these counties.

Table 4.1-5. Mining Sites in Willamette River Basin Counties, 2021.

County	Identified Mines	Production Mines	Prospect Mines	Active Claims
Benton	1	0	0	0
Clackamas	52	22	21	3
Douglas	111	53	39	351
Lane	170	58	90	233
Linn	88	37	35	53
Marion	15	0	7	49
Multnomah	13	1	4	0
Polk	5	0	0	0
Washington	3	0	0	0
Yamhill	4	0	3	2
Total	462	171	199	691

Source: The Diggings 2022

Minerals in Willamette River Basin Mines (not an inclusive list)

gold	antimony
silver	barium-barite
copper	silica
zinc	manganese
lead	clary
mercury	construction sand and gravel

Furthermore, there are 691 active mining claims within the Willamette River Basin, which are parcels of land where the claimant has asserted a right of possession, and the right to develop and extract a discovered, valuable, mineral deposit (The Diggings 2022). The majority of these sites are in Douglas and Lane Counties.

Claimants are required to maintain sites by paying an annual maintenance fee to continue to hold mining claims, or must perform assessment work such as drilling, excavations, driving shafts and tunnels, or geophysical, geochemical, or geological surveys (BLM No Date-b). While there is no guarantee the active claims will transition into production mines, these ongoing maintenance requirements do indicate the probability that these sites could transition to production mines in the future.

Mining operations have the potential to introduce chemicals and minerals into nearby water sources and to adversely affect vegetation and wildlife habitat.

RFFA 11—Timber and Logging Industry Operations

Western Oregon is classified as one of the primary timber regions of the country. Of western Oregon's 19.2 million acres, 15.3 million acres are forested, or 80 percent. At the time the alternatives were analyzed, forests in this region supported approximately 78 billion cubic feet of standing timber. About 71 percent of this volume is in Federal ownership, but not all timber is available for production due to the expansion of riparian and wildlife preserves and forest conservation efforts. The other 29 percent is in non-Federal ownership, including state ownership and private industry (Campbell, Azuma, and Weyermann 2002).

Oregon's soils and climate provide ideal conditions for growing commercially viable trees, which can be made into products such as paper, lumber, particle board, firewood, and oak barrels. However, timber harvests have fluctuated from 1990 to 2020 and have decreased overall.

From 1990 to 2020, annual timber harvests declined from 6.2 billion board feet to 3.6 billion board feet. Jobs from 1990 to 2019 declined by almost 41 percent from 15,774 statewide to 9,353. Projections for the Oregon logging industry predict a relatively stable but gradual decline of the industry, losing about 100 jobs, or 2 percent, between 2020 and 2030 (Rooney 2021).

The Willamette Valley would not likely be the focus of timber and logging operations into the foreseeable future. It has a low percentage of forest lands (35 percent) and a high concentration of urban areas (Campbell, Azuma, and Weyermann 2002). However, logging operations would not be precluded entirely in the Willamette Valley over the 30-year implementation timeframe. Consequently, logging operations would impact natural resources in nearby vicinities and in downstream areas by adversely impacting vegetation and wildlife habitat and increasing potential erosion and sediment into water sources. Oregon State forest practices regulations provide protections for riparian areas, streams, and wetlands.

US Army Corps of Engineers®
Portland District

Willamette Valley
SYSTEM OPERATIONS AND MAINTENANCE
ENVIRONMENTAL IMPACT STATEMENT

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.2 HYDROLOGIC PROCESSES

TABLE OF CONTENTS

4.2 Hydrologic Processes

THE HYDROLOGIC PROCESSES CUMULATIVE ANALYSES HAVE BEEN REVISED FROM THE DEIS. INSERTION OF LARGE AMOUNTS OF TEXT IS IDENTIFIED; MINOR EDITS ARE NOT DENOTED.

Summary of changes from the DEIS:

- **The analyses have been modified to more clearly combine direct and indirect effects analyzed in Section 3.2, Hydrologic Processes, with Reasonably Foreseeable Future Actions. Conclusions have been added to address expected cumulative effects outcomes.**
- **Information has been added to clarify specific causes of effects (e.g., increased rainfall).**
- **The analysis of cumulative effects in the Mainstem Willamette River Basin has been correlated to upstream effects and combinations of effects.**
- **Information has been supported by references and by cross-reference to Appendix F1, Qualitative Assessment of Climate Change Impacts, and Appendix F2, Supplemental Climate Change Information.**
- **Information on the Implementation and Adaptive Management Plan has been added.**

4.2.1 Cumulative Actions Applicable to Hydrologic Processes and Analysis Area

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.2.1, Cumulative Actions. RFFAs that would have cumulative effects on hydrologic processes when considered together with actions under all alternatives and past actions are listed below. RFFAs not listed below would not interact with the hydrology of the Willamette River Basin or only negligibly alter the WVS dam and reservoir operations.

- WVS and other Dams and Reservoirs in the Willamette River Basin: Construction and past operations and maintenance
- WVS Dams and Reservoirs: Ongoing operations and maintenance
- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate Change

4.2.2 Hydrologic Processes Cumulative Effects Analysis Area

The analysis area to assess cumulative effects on hydrologic processes is the Willamette River Basin. The temporal scope of the analysis is the 30-year planning timeframe unless otherwise noted.

4.2.2.1 Analysis Area Overview and Ongoing Actions

The existing regulated hydrology is changed from the natural condition by the construction and operation of the WVS and other dams and reservoirs. The imposition of regulated hydrology moderated the natural hydrology in the Willamette River Basin. Regulated peak flows are lower in the winter due to flood risk management operations. Flows are also lower during spring while the reservoirs store water, and higher during the summer and fall when they release that stored water. The volume and height of each reservoir and dam or system of dams and reservoirs generally determines its potential cumulative effect on the hydrology of the Willamette River Basin.

Past Willamette River Basin population growth and development has altered land use in the Basin and next to the rivers that the WVS dams and reservoirs regulate. This development has affected construction and operation of the WVS dams and reservoirs, with USACE historically seeking to maximize its net benefits to the downstream population.

The WVS dams and reservoirs are currently authorized for flood risk management, hydropower, fish and wildlife, recreation, navigation, municipal and industrial water supply, irrigation, and water quality (Chapter 1, Introduction, Section 1.10, Congressionally Authorized Purposes). The revetments are typically designed for riverbank stabilization, though features and functions vary by location (Chapter 1, Introduction, Section 1.7.2, Revetments and Other Structures for Bank Protection).

The typical operations of USACE-managed dams within the WVS have changed since their construction and continue to change with ongoing operations and actions (Chapter 1, Introduction, Section 1.7.1, Dams and Reservoirs). Additionally, there are 38 non-USACE-managed dams in the Willamette River Basin (Chapter 1, Introduction, Section 1.8, Non-USACE-managed Dams and Reservoirs in the Willamette River Basin). While each individual water year may have a minor effect on basin-wide hydrology, ongoing changes by USACE and other dam operators will alter the Willamette River Basin hydrology permanently.

Reasonably Foreseeable Future Action Effects

USACE and others commonly use the term hydrology and hydraulics to discuss the quantity, movement, or behavior of water. The direct and indirect analyses demonstrate how water would move through the system, both within and downstream of the WVS dams and reservoirs, given a specific set of operational measures and within an observed period of record (Section 3.2, Hydrologic Processes, Environmental Consequences). The cumulative effects analyses also focus on water movement through the Willamette River Basin.

The cumulative effects of past, present, and RFFAs on Willamette River Basin hydrologic processes are described as additive outcomes. Subsequent effects would occur on various operations, such as water supply, flood risk management, etc., and on resources, such as water quality and fish. However, those related effects are not analyzed below but are addressed in the cumulative effects analyses for each resource as applicable.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Future population growth and accompanying urban, industrial, and commercial development would increase local inflow into river reaches downstream of the WVS dams due to increased impervious area and, therefore, runoff. Growth and development would also increase demand for water withdrawals for consumptive uses (see RFFA 3 analysis below).

The increased demand for water withdrawals would occur across all seasons. Total flow in the Willamette River Basin is lowest in the summer. Consequently, increased demand for withdrawals will have the greatest impact on flow availability during the summer months. The combination of flood risk management challenges and the increased demand for consumptive withdrawals would result in additive effects on total Willamette River Basin flow.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

Water withdrawals for municipal, industrial, and agricultural uses would decrease water availability and operational adaptability across many reaches in the Willamette River Basin. Increased demand would have the synergistic effect of either decreasing reservoir water surface elevation, decreasing instream flows, or a combination of both. Overall, water withdrawals would have additive effects on water availability throughout the Willamette River Basin.

RFFA 5—Federal and State Wildlife and Lands Management

Federal and state wildlife and lands management refers to areas both upstream and downstream of the WVS reservoirs. Future land management changes are unlikely upstream of the reservoirs that would appreciably alter inflow to the reservoirs. Consequently, there would not likely be upstream hydrologic process cumulative effects in the Willamette River Basin from RFFA 5.

Downstream of the dams, any floodplain restoration projects would likely lead to minor increases in floodplain storage, potentially altering the local inflows. This would potentially alter flood risk management operations and the effect would be additive within the Willamette River Basin.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvement

Tribal, state, and local fish and wildlife improvement would primarily alter the Willamette River Basin hydrology because of fish flow targets downstream of the WVS dams and combined targets on the Mainstem Willamette River. All action alternatives contain measures that would redefine these targets (Chapter 2, Alternatives). The spring and summer regulated hydrology of the Willamette River, particularly in dry years, is defined by these flow operations; any changes would be immediately noticeable. These hydrologic process effects would be additive.

RFFA 9—Climate Change

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Climate change would increase Willamette River Basin winter inflows due to increased basin-wide temperatures (U.S. Global Change Research Program 2017; RMJOC 2018), increased precipitation (RMJOC 2018), and conversion of snow to rainfall (RMJOC 2018) both upstream and downstream of the WVS dams and reservoirs (Appendix F1, Qualitative Assessment of Climate Change Impacts; Appendix F2, Supplemental Climate Change Information, Chapter 3.2, Climate Change in the Willamette Subbasins). Inflow increases would alter flood risk management operations during the winter and generally increase instream flows regardless of any alternative implemented. In late spring, basin-wide flows would drop earlier (RMJOC 2018), leading to lower reservoir water surface elevations to meet ongoing and increasing flow demands (Section 3.2, Hydrologic Processes, Environmental Consequences). Effects on hydrologic processes would be additive with the other RFFAs in respective seasons.

In general, the combination of the RFFAs with effects on hydrologic processes would increase overall flow and reservoir water surface elevations in the winter. The RFFAs would also decrease available instream flows and reservoir water surface elevations starting in the late spring through the summer and fall.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year planning timeframe (Appendix N, Implementation and Adaptive Management Plan).

END NEW TEXT

4.2.3 No-action Alternative

Although measures under the No-action Alternative (NAA) would maintain the Willamette River Basin hydrology consistent with existing conditions (Section 3.2., Hydrologic Processes, No-action Alternative), there could be substantial changes to these conditions under the NAA from the cumulative effects discussed above. The combined cumulative effects in the Basin would mean higher reservoir water surface elevations and an increase in flows across all river reaches in the winter and early spring. During late spring and summer, there would be lower reservoir water surfaces and lower flow in dry years as compared to existing conditions. Overall, the changes would be moderate as compared to the existing conditions.

The analyses under the action alternatives in this section are compared to the NAA, inclusive of the cumulative effects of the RFFAs, unless otherwise indicated.

4.2.3.1 Santiam River Subbasin

Cumulative actions would decrease water surface elevations and outflows at Detroit and Green Peter Dams during the conservation season. Major changes would be expected in dry years and moderate changes during wetter periods. Because both reservoirs reach minimum conservation pool during the driest years under existing operational conditions, this would happen earlier in the year and more often. Outflows from the dams would be proportionally reduced per the water-year-type scheme.

During the winter, there would be both increased inflows and average reservoir water surface elevations in the Santiam River Subbasin, particularly at Detroit Dam compared to existing conditions. This would be the cumulative result of higher-than-average expected increases in inflow from climate change conditions (RFFA 9) because terrain upstream of Detroit Reservoir is higher and more rugged than terrain upstream of Green Peter and Foster Reservoirs.

4.2.3.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flows would moderately decrease during the conservation season (spring to early fall) and increase during the flood season (winter) compared to the existing conditions as a result of cumulative effects from RFFAs, including climate change conditions and future population growth.

4.2.3.3 McKenzie River Subbasin

The cumulative impacts from RFFAs, particularly climate change, would result in operational decreases in water surface elevations and outflows at Cougar and Blue River Dams during the conservation season. These decreases would be major and largest at Cougar Reservoir because this reservoir already reaches minimum conservation elevation during the driest years under existing conditions, has an immediate downstream flow target (Blue River Reservoir does not have an equivalent biological target), and greater snowpack declines are expected in its subbasin.

During the winter, there would be both moderately increased instream flows and increased reservoir water surface elevations in the McKenzie River Subbasin, particularly at Cougar Dam as compared to existing conditions. This would be the cumulative result of higher-than-average expected increases in inflow from climate change conditions (RFFA 9).

4.2.3.4 Middle Fork Willamette River Subbasin

Hills Creek Reservoir would have the largest cumulative impacts from RFFAs in the Middle Fork Willamette River Subbasin due to its high upstream elevation and because it drafts near minimum conservation elevation relatively frequently under existing operational conditions. A major reduction of inflows, particularly due to the effects of climate change, would result in reduced outflows and lower pool elevations throughout the conservation season.

Conservation season impacts from decreased inflows due to climate change conditions at Lookout Point Reservoir would be moderate and more like existing conditions because of the large basin size and lower average elevation than that of Hills Creek Reservoir. Fall Creek Reservoir water surface elevations and downstream flows would moderately decrease during the conservation season due the same decreased inflows.

During the winter, there would be both increased instream flows and increased reservoir water surface elevations in the subbasin, particularly at Hills Creek Dam as compared to existing conditions. This would be the cumulative result of higher-than-average expected increases in inflow from climate change conditions. While larger inflows are also expected into Lookout Point Reservoir, it has considerably more storage capacity than Hills Creek Reservoir; therefore, the impacts (more releases and higher average storage volumes) would not be as substantial.

4.2.3.5 Coast Fork Willamette River Subbasin

Both Dorena and Cottage Grove Reservoirs would have lower water surface elevations and outflows in the conservation season due to the cumulative impacts of the RFFAs as compared to the existing conditions. Both reservoirs reach minimum conservation pool elevation in the driest years, and the Coast Fork Subbasin is lower in elevation than most other subbasins in the Willamette River Basin; therefore, the changes would be more moderate.

During the winter, there would be both increased instream flows and increased water surface elevations in the subbasin compared to existing conditions. The impacts from RFFAs would also be more moderate in the winter in the Coast Fork Willamette River Subbasin than in other subbasins in the Willamette River Basin.

4.2.3.6 Mainstem Willamette River

Instream flows under the NAA would decrease during the conservation season from late spring through early fall as compared to existing conditions. This decrease would result from RFFA cumulative effects, including climate change and flow demands. Flow targets at Albany and Salem, Oregon would be missed more often during the summer and fall because of the combined cumulative effect of the NAA and RFFAs. Consequently, cumulative actions would exacerbate instream flow demand while decreasing availability.

Under the NAA, winter flows would increase as compared to existing conditions in the Mainstem Willamette River in all except the driest years due to climate change conditions and population growth RFFAs. USACE may be able to increase average reservoir elevations during flood risk management operations to limit this increased flow. However, the potential for winter reservoir management to offset increasing flows would be very limited because most of the tributary area to the Mainstem Willamette River is unregulated, and increased inflows to the Willamette River Basin reservoirs would likely be coincident with the increased downstream flows.

4.2.4 Alternative 1—Improve Fish Passage through Storage-focused Measures

The cumulative effects to hydrologic processes under Alternative 1 are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes under Alternative 1 and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

Under Alternative 1, USACE would continue to store more water in the spring and release in the fall as compared to the NAA. Combined with the cumulative effects of the RFFAs, there would be less instream flows during the spring as compared to flow conditions under the NAA and more during summer and fall.

4.2.4.1 Santiam River Subbasin

The cumulative actions would decrease reservoir elevations at Detroit Dam and Green Peter Dam in the conservation season. Summer downstream flows would remain above NAA flows even with cumulative actions such as increased downstream flow demands because Alternative 1 would result in increased total stored water at these dams as compared the NAA.

During the winter, reservoir water surface elevations and downstream flows resulting from cumulative actions would be the same as described under the NAA.

4.2.4.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flows resulting from cumulative actions would be the same as described under the NAA.

4.2.4.3 McKenzie River Subbasin

Conservation season reservoir water surface elevation increases at Cougar Reservoir and Blue River Reservoir under Alternative 1 would be offset by cumulative actions, including climate change and flow demands, but available net storage would remain above the net storage anticipated under NAA operations. Flow releases would decrease in the spring of dry years but remain above the NAA flows in summer and fall when combining cumulative effects from RFFAs and implementation of Alternative 1.

During the winter, reservoir water surface elevations and downstream flows resulting from cumulative actions would be the same as described under the NAA.

4.2.4.4 Middle Fork Willamette River Subbasin

Under Alternative 1, USACE would release minimum flows for longer periods in the spring at Lookout Point Dam and Hills Creek Dam as compared to operations under the NAA. Due to cumulative effects of the RFFAs, conservation season stored water under Alternative 1 would be decreased, but total flow releases would remain greater than the flows under the NAA in summer and fall. Both reservoirs would reach their minimum storage elevations earlier in the year as a result of RFFAs and other cumulative actions, though less frequently than under the NAA operations, while supplying water to meet the Mainstem Willamette River flow targets.

Fall Creek Reservoir water surface elevations and releases resulting from cumulative actions would be somewhat above the NAA elevations and releases.

During the winter, reservoir water surface elevations and downstream flows would be nearly the same as elevations and flows under the NAA. At Hills Creek Reservoir, some additional storage capacity as compared to the NAA may be available at the beginning of winter after the driest summers, but the ability to reduce flood flows would be substantially limited as climate change conditions increase both reservoir inflows and flows downstream.

4.2.4.5 Coast Fork Willamette River Subbasin

Water surface elevations at both Dorena and Cottage Grove Reservoirs would decrease during the conservation season as a result of cumulative effects of RFFAs but would remain above the NAA water surface elevations. Downstream flows would remain similar to NAA flows even with cumulative actions such as increased downstream flow demands because Alternative 1 would result in increased total stored water at these dams as compared to the NAA.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be nearly the same as the NAA, with very small additional storage available only after very dry fall seasons.

4.2.4.6 Mainstem Willamette River

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Instream flows under Alternative 1 would decrease for longer and to lower levels during spring as compared to conditions under the NAA as USACE prioritizes reservoir refill. Regardless of impacts to flows from the RFFAs, USACE would release stored water from upstream reservoirs; therefore, flows would be higher in the summer and fall than flows under the NAA.

During the winter, flows on the Mainstem Willamette River would be the same under Alternative 1 as under the NAA. The occasional small additional storage available from a dry fall (e.g., at Hills Creek Reservoir) would be negligible on the Mainstem Willamette River because of the distance from the reservoir and inflows downstream of the reservoirs.

END NEW TEXT

4.2.5 Alternative 2A—Integrated Water Management Flexibility and ESA-listed Fish Alternative

The cumulative effects to hydrologic processes under Alternative 2A are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes under Alternative 2A and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

Under Alternative 2A, USACE would continue to store more water in the spring and release in the summer and fall as compared to the NAA. Combined with the cumulative effects of the RFFAs, there would be less instream flows during the spring as compared to flow conditions under the NAA and more during summer and fall.

4.2.5.1 Santiam River Subbasin

The cumulative actions would decrease reservoir elevations at Detroit and Green Peter Reservoirs in the conservation season under Alternative 2A. Detroit Reservoir would remain above the NAA water surface elevations while Green Peter Reservoir would fall further below.

Summer downstream flows would remain above NAA flows even with cumulative actions such as increased downstream flow demands because Alternative 2A would result in increased peak stored water at these dams as compared to the NAA while modifying the downstream flow targets. Outflow durations, but not flow rates, from the fall drawdown at Green Peter Reservoir would be somewhat reduced but still notably above NAA flows during the fall months.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA at Detroit Reservoir. The cumulative effects would reduce any additional winter flexibility after the fall drawdown at Green Peter Reservoir by increasing inflows, although outflows would remain below the NAA.

4.2.5.2 Long Tom River Subbasin

Cumulative effects to Fern Ridge Reservoir water surface elevations and downstream flows would be the same as described under the NAA.

4.2.5.3 McKenzie River Subbasin

Conservation season reservoir water surface elevation increases at Cougar and Blue River Reservoirs under Alternative 2A would be offset by cumulative effects from RFFAs, including climate change and flow demands. Peak stored water in early summer would remain above the peak stored water anticipated under NAA operations with cumulative effects such as decreased and earlier inflow. USACE would release more stored water in the summer and fall under Alternative 2A than under the NAA in all except the driest years. During these rare years as a result of cumulative actions, releases would be a function of inflow under Alternative 2A, occasionally falling below flow releases under the NAA.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.5.4 Middle Fork Willamette River Subbasin

USACE would release minimum flows for longer periods in the spring at Lookout Point Dam and Hills Creek Dam as compared to operations under the NAA due to cumulative effects of the RFFAs. Conservation season stored water under Alternative 2A would be decreased, but total flow releases would remain greater than the flows under the NAA in summer and fall.

Both reservoirs would reach their minimum storage elevations earlier in the year under Alternative 2A than under the NAA operations while supplying water to meet the Mainstem Willamette River flow targets. Hills Creek Reservoir would reach lower water surface elevations more often than under the NAA, and Lookout Point would do so less often as reservoir inflows are reduced from spring through fall due to climate change conditions.

Fall Creek reservoir water surface elevations and releases would be only marginally different than under the NAA due to cumulative effects.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be nearly the same as elevations and flows under the NAA. At Hills Creek Reservoir, some additional storage capacity under Alternative 2A as compared to the NAA may be available at the beginning of winter after drier-than-average summers, but the ability to reduce flood flows would be substantially limited.

4.2.5.5 Coast Fork Willamette River Subbasin

The water surface elevations in both Dorena and Cottage Grove Reservoirs would decrease during the conservation season as a result of cumulative effects of RFFAs under Alternative 2A such as downstream flow demands but would remain above the NAA water surface elevations. Regardless of cumulative actions, downstream flows would remain below the NAA flows in the spring due to downstream targets but above the NAA flow into the summer and fall.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.5.6 Mainstem Willamette River

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Regardless of cumulative actions, instream flows in the Mainstem Willamette River under Alternative 2A would decrease for longer during spring as compared to conditions under the NAA because USACE would operate to meet the lower flow targets of the integrated temperature and habitat flow regime. Lower spring flows would occur more frequently as climate change decreases spring flow and shifts flow earlier in the year. Regardless of climate change effects, flows would be higher in the summer and fall than flows under the NAA as

USACE releases stored water from reservoirs upstream. Furthermore, summer flow variability would further decrease in comparison to the NAA as summers dry out due to climate change conditions in the Willamette River Basin and population growth increases flow demands.

During the winter, flows on the Mainstem Willamette River would be the same under Alternative 2A as under the NAA. In combination with increased inflows due to climate change conditions, the occasional small additional available storage from the fall reservoir drawdowns (e.g., at Hills Creek Reservoir) would be negligible on the Mainstem Willamette River flows due to the distance from the reservoirs and additional uncontrolled instream flow.

END OF NEW TEXT

4.2.6 Alternative 2B—Integrated Water Management Flexibility and ESA-listed Fish Alternative

The cumulative effects to hydrologic processes under Alternative 2B are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes under Alternative 2B and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

Alternative 2B would be similar to Alternative 2A except that increasingly dry conditions due to climate change would further reduce the water stored during summer at Cougar Reservoir. Furthermore, USACE would operate other reservoirs in the WVS differently as a result of the reduced water stored at Cougar Reservoir during the conservation season.

4.2.6.1 Santiam River Subbasin

Water surface elevations and downstream flow cumulative effects under Alternative 2B at Detroit, Green Peter, and Foster Reservoirs would be the same as described under Alternative 2A.

4.2.6.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.6.3 McKenzie River Subbasin

Cougar Reservoir would lose the minimal conservation season stored water realized under Alternative 2B because of cumulative actions as climate change shifts inflows to before the Alternative 2B refill period. Water surface elevations at Blue River Reservoir would remain above the elevations under the NAA in all except very dry years when stored water would fall further below operations under the NAA because USACE would release stored water to make up for larger decreases at Cougar Reservoir.

Summer and fall flows downstream would decrease compared to the NAA as stored water in Cougar Reservoir decreases. The total stored water would decrease in the subbasin relative to under the NAA because Cougar Reservoir has a higher storage capacity than Blue River Reservoir.

Although there would be additional storage capacity at Cougar Reservoir after the deeper fall drawdown, winter flows would only be below the NAA flows during average and drier years under Alternative 2B. Cougar Reservoir is expected to see higher-than-average increases in inflow. Therefore, winter flows would return to the same conditions as under the NAA during wet winters, which would see increased frequency from climate change.

4.2.6.4 Middle Fork Willamette River Subbasin

At Lookout Point and Hills Creek Reservoirs, cumulative actions would decrease conservation season stored water under Alternative 2B as compared to the NAA because USACE would release water to meet the Mainstem flow targets. The reservoirs would reach their minimum water surface elevations more often and earlier in the year to compensate for the lack of stored water at Cougar Reservoir.

Cumulative effects to Fall Creek Reservoir would be the same as under Alternative 2A.

Winter reservoir water surface elevations and flow cumulative effects in the Middle Fork Willamette River Subbasin would be the same as described under Alternative 2A.

4.2.6.5 Coast Fork Willamette River Subbasin

Under Alternative 2B, water surface elevations and flow cumulative effects below Dorena and Cottage Grove Reservoirs would be the same as described under Alternative 2A.

4.2.6.6 Mainstem Willamette River

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Instream flows in the Mainstem Willamette River would be the same as described under Alternative 2A except that earlier inflow and drier springs would exacerbate effects of the delayed refill at Cougar Reservoir. Therefore, peak conservation season system stored water would decrease under Alternative 2B relative to Alternative 2A.

Combined with the drier summers due to climate change, the operation would have the effect of missing flow targets at Albany more often in the driest Septembers and Octobers. This would further exacerbate instream flow availability.

END OF NEW TEXT

4.2.7 Alternative 3A—Improve Fish Passage through Operations-focused Measures

The cumulative effects to hydrologic processes under Alternative 3A are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes under Alternative 3A and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

The expected shifts in rainfall toward earlier in the year would increase the differences in the WVS under Alternative 3A as compared to the NAA, with particular impacts in and downstream of Detroit, Cougar, and Lookout Point Reservoirs.

4.2.7.1 Santiam River Subbasin

Detroit Reservoir water surface elevations would be even lower throughout the conservation season under Alternative 3A due to cumulative actions as drier conditions under climate change decrease spring inflow. Typical instream flows below Detroit Dam would be comparable to the NAA in only the wettest years.

Below Green Peter Dam, summer downstream flows would remain above NAA flows even with cumulative actions such as increased downstream flow demands. This would result from increased peak stored water in Green Peter Reservoir under Alternative 3A as compared the NAA.

During the winter, reservoir water surface elevations and downstream flows would be nearly the same as elevations and flows under the NAA. At Detroit and Green Peter Reservoirs, some additional storage capacity as compared to the NAA may be available at the beginning of winter after the deeper fall drawdowns, but the ability to reduce flood flows would be substantially limited under Alternative 3A as climate change would increase winter inflows.

4.2.7.2 Long Tom River Subbasin

Under Alternative 3A, cumulative effects to Fern Ridge Reservoir water surface elevations and downstream flows would be the same as described under the NAA.

4.2.7.3 McKenzie River Subbasin

Cougar Reservoir would lose the minimal stored water realized during the conservation season under Alternative 3A because of cumulative actions, including climate change and flow demands. The differences in stored water under the NAA would be larger and more frequent.

Blue River Reservoir water surface elevations would remain higher than under the NAA until the deeper fall drawdown. Summer and fall flows downstream under Alternative 3A would be less variable than under the NAA, largely reflecting the reduced stored water available in Cougar Reservoir due to higher-than-average inflow decreases from climate change conditions.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.7.4 Middle Fork Willamette River Subbasin

The spring drawdown at Lookout Point Reservoir ends in June. Therefore, decreasing inflows would mean lower peak stored water in the conservation season, increasing the differences between Alternative 3A and the NAA. Hills Creek Reservoir water surface elevation would remain higher under Alternative 3A than under the NAA during the refill period (i.e., until May), but the pool would decrease faster than under the NAA as inflows decrease due to climate change conditions. Downstream flows and flow variability would further decrease as compared to flows under the NAA as total peak stored water in the subbasin decreases due to decreased inflows.

Cumulative effects to Fall Creek Reservoir water surface elevations and releases would be the same as under Alternative 2A.

During the winter, reservoir water surface elevations and downstream flows would be similar to elevations and flows under the NAA. The additional storage capacity below minimum conservation elevation at Hills Creek and Lookout Point Reservoirs would only persist in drier-than-average winters, which would become increasingly uncommon with climate change conditions. USACE would operate the dams the same as under the NAA when expecting higher inflows.

4.2.7.5 Coast Fork Willamette River Subbasin

Water surface elevations at both Dorena and Cottage Grove Reservoirs under Alternative 3A would peak above elevations under the NAA. Because both reservoirs would contribute more water to the Mainstem flow targets than under the NAA, USACE would release more water from these reservoirs due do cumulative actions such as climate change and flow demands. Stored water would decrease below levels under the NAA by late summer.

Cumulative effect winter conditions in the Coast Fork Willamette River Subbasin would be the same as under Alternative 3A as described under Alternative 1.

4.2.7.6 Mainstem Willamette River

THE DEIS HAS BEEN MODIFIED TO INCLUDE THE FOLLOWING INFORMATION IN THE FEIS

Instream flows in the Mainstem Willamette River would decrease during the conservation season as compared to the NAA—from late spring through early fall—from already minimum levels because of cumulative actions, including reduced summer flows due to climate change and flow demands. USACE would rarely, if ever, meet the Albany flow target under Alternative 3A from July through September because of the reduced peak conservation season WVS stored water. While minimum observed flows under Alternative 3A would be slightly less than under the NAA, those minimum flows would occur for a longer duration and more frequently with increasingly dry summers. The limited and decreasing stored water at Detroit Reservoir would mean that long summer and fall periods below the Salem flow target would be inevitable.

During the winter, cumulative effects to flows on the Mainstem Willamette River would be the same for Alternative 3A as under the NAA. The occasional additional storage available from the deeper fall reservoir drawdowns (e.g., at Detroit and Lookout Point Reservoirs) would be negligible on the Mainstem Willamette River flows due to the distance from the reservoirs and additional uncontrolled instream flow.

4.2.8 Alternative 3B—Improve Fish Passage through Operations-focused Measures

The cumulative effects to hydrologic processes under Alternative 3B are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes under Alternative 3B and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

The expected shifts in rainfall toward earlier in the year will increase the differences in the WVS under Alternative 3B as compared to under the NAA, with particular impacts in and downstream of Green Peter, Foster, Cougar, and Hills Creek Reservoirs.

4.2.8.1 Santiam River Subbasin

The cumulative actions would decrease water surface elevations at Detroit and Green Peter Reservoirs in the conservation season. Detroit Reservoir would remain above the NAA water surface elevations until the start of the fall drawdown, after which reservoir water surface elevations would fall below those under the NAA. Green Peter Reservoir water surface elevations would fall further below operations under the NAA, rarely filling to minimum conservation pool.

As stored water in Green Peter Reservoir decreases further due to climate change conditions, USACE would draft Foster Reservoir more often than under the NAA. Under Alternative 3B, downstream of Foster Dam, USACE would meet the flow target only in the wettest years. Instream flows would be a fraction of those under the NAA and decrease more with increasingly dry summers. Consequently, cumulative actions would exacerbate decreasing instream flow availability.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA at Detroit Reservoir. The cumulative effects would reduce any additional winter flexibility after the fall drawdown at Green Peter Reservoir by increasing inflows.

4.2.8.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.8.3 McKenzie River Subbasin

Water surface elevations and downstream flow cumulative effects at Cougar and Blue River Reservoirs would be the same as described under Alternative 2B.

4.2.8.4 Middle Fork Willamette River Subbasin

The spring drawdown at Hills Creek Reservoir ends in June. Therefore, decreasing inflows would mean lower peak water storage in the conservation season, increasing the differences between Alternative 3B and the NAA. While peak conservation storage volumes at Lookout Point Reservoir would be higher than under the NAA, the reservoir would also draft faster than the NAA to maintain downstream flow targets as summer inflows decrease. Fall Creek Reservoir water surface elevations and releases would be the same as described under Alternative 2A.

Winter season cumulative effects conditions would be the same as described under Alternative 3A.

4.2.8.5 Coast Fork Willamette River Subbasin

Water surface elevations at both Dorena and Cottage Grove Reservoirs under Alternative 3B would peak above elevations under the NAA. Because both reservoirs would contribute more water than under the NAA to the Mainstem flow targets, the reservoirs would release more water due do cumulative actions such as climate change and flow demands. Stored water would decrease to about the same levels as under the NAA by late summer.

The Coast Fork Willamette River Subbasin cumulative effects conditions would be the same as described under Alternative 1 in the winter.

4.2.8.6 Mainstem Willamette River

Instream flows at the Albany and Salem control points would decrease as compared to the NAA during the conservation season. From late spring through early fall, drier conditions from climate change would combine with the lower peak conservation season WVS stored water to reduce total flow, miss the Mainstem flow targets more often, and exacerbate decreasing flow availability.

During the winter, flows on the Mainstem Willamette River would be the same as under Alternative 3B as described under the NAA. The occasional additional storage available from the fall reservoir drawdowns (e.g., at Detroit and Lookout Point Reservoirs) would be negligible on the Mainstem Willamette River flows because of the distance from the reservoirs and additional uncontrolled instream flow.

END OF NEW TEXT

4.2.9 Alternative 4—Improve Fish Passage with Structures-based Approach

The cumulative effects to hydrologic processes under Alternative 4 are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes from Alternative 4 and the identified RFFAs combined with past and present actions would be major when compared to the NAA. Reservoir elevation and instream flow would be the same as described under Alternative 2A except for the effects of the deeper fall drawdowns.

4.2.9.1 Santiam River Subbasin

Water surface elevations and downstream flow cumulative effects at Detroit, Green Peter, and Foster Reservoirs would be the same as described under Alternative 2A except that Green Peter Reservoir would not have a deeper fall drawdown; therefore, effects would the same as described under the NAA for this period.

4.2.9.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.9.3 McKenzie River Subbasin

Cumulative effects from water surface elevations and downstream flows at Cougar and Blue River Reservoirs would be the same as described under Alternative 2A.

4.2.9.4 Middle Fork Willamette River Subbasin

Cumulative effects from water surface elevations and downstream flows at Hills Creek, Lookout Point, and Fall Creek Reservoirs would be the same as described under Alternative 2A.

4.2.9.5 Coast Fork Willamette River Subbasin

Cumulative effects from water surface elevations and downstream flows at Cottage Grove and Dorena Reservoirs would be the same as described under Alternative 2A, with one exception. USACE would draft both reservoirs below the minimum conservation elevation in late fall of dry years, whereas USACE would hold that elevation under Alternative 2A and the NAA. This operation would increase in frequency with decreased inflow in the summer and fall due to climate change conditions.

4.2.9.6 Mainstem Willamette River

Cumulative effects on instream flows in the Mainstem Willamette River would be the same as described under Alternative 2A.

4.2.10 Alternative 5—Preferred Alternative—Revised Integrated Water Management Flexibility and ESA-listed Fish Alternative

The cumulative effects to hydrologic processes under Alternative 5 are divided by Willamette River subbasin based on the effects described above. Overall, cumulative effects to hydrologic processes from Alternative 5 and the identified RFFAs combined with past and present actions would be major when compared to the NAA.

Alternative 5 would be similar to Alternative 2B, except flows in the Mainstem Willamette River would be higher in spring and lower in summer, mainly due to operational changes in the Middle Fork and Coast Fork Willamette River Subbasins.

4.2.10.1 Santiam River Subbasin

Cumulative effects from water surface elevations and downstream flows at Detroit, Green Peter, and Foster Reservoirs would be the same as described under Alternative 2B.

4.2.10.2 Long Tom River Subbasin

Fern Ridge Reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.10.3 McKenzie River Subbasin

Water surface elevations and downstream flow cumulative effects at Cougar and Blue River Reservoirs would be the same as described under Alternative 2B.

4.2.10.4 Middle Fork Willamette River Subbasin

Water surface elevations and downstream flow cumulative effects at Lookout Point and Fall Creek Reservoirs would be the same as described under Alternative 2B. Hills Creek Reservoir water surface elevations would fall further below those under the NAA because of decreased inflow from climate change conditions and because USACE would release water to meet downstream flow targets during the conservation season.

Winter reservoir water surface elevations and flow cumulative effects in the Middle Fork Willamette River Subbasin would be the same as under Alternative 2A.

4.2.10.5 Coast Fork Willamette River Subbasin

Water surface elevations would decrease at both Dorena and Cottage Grove Reservoirs during the conservation season as a result of cumulative effects of RFFAs such as downstream flow demands but would be similar to the NAA water surface elevations. Downstream flows would remain below the NAA flows in the spring due to downstream targets but above the NAA flow into the summer and fall.

During the winter, reservoir water surface elevations and downstream flow cumulative effects would be the same as described under the NAA.

4.2.10.6 Mainstem Willamette River

Instream flows in the Mainstem Willamette River would be the same as described under Alternative 2A except that USACE would release more water in the spring of dry years, although flows would still be lower than under the NAA during dry springs. As a result of the lower accumulated stored water in the system and drier summers due to climate change conditions, flows under Alternative 5 would be lower in the summer and fall of dry years than under Alternative 2A. Instream flow would miss the flow targets more often than under Alternative 2A, though summer and fall flows under Alternative 5 would still be higher than flows under the NAA.

US Army Corps
of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.3 RIVER MECHANICS AND GEOMORPHOLOGY

4.3 River Mechanics and Geomorphology

THE DEIS RIVER MECHANICS AND GEOMORPHOLOGY SECTION HAS BEEN DELETED IN THE FEIS

Summary of changes from the DEIS:

- **After considering analyses in the DEIS, there is no potential for a significant impact to occur to river mechanics and geomorphology under any of the alternatives, including the No-action Alternative, over the 30-year implementation timeframe. Information on river mechanics and geomorphology existing conditions is needed to understand effects to other resources such as water quality, fish, vegetation, and cultural resources.**
- **Assessing direct, indirect, and cumulative impacts to this resource alone would not provide a comprehensive assessment of effects to the human environment, which are more appropriately analyzed by combining existing conditions regarding shoreline sediment exposure, mobilization, trap efficiency, and supply with potential effects to other resources, such as the turbidity analyses in Section 3.5, Water Quality.**
- **DEIS Section 3.3, River Mechanics and Geomorphology, Affected Environment, has been moved to Appendix C, River Mechanics and Geomorphology Technical Information. Other data and analyses in Appendix C have also been updated in the FEIS to inform resource analyses in Chapter 3, Affected Environment and Environmental Consequences, as applicable.**
- **See 40 CFR 1500.1(b) (NEPA documents should not "amass needless detail"), id. at (d) ("NEPA's purpose is not to generate paperwork – even excellent paperwork – but to foster excellent action"), 1502.1 (Agencies…shall reduce paperwork and the accumulation of extraneous background data), 1503.4(c) (changes to a DEIS are to be circulated in the FEIS).**

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.4 GEOLOGY AND SOILS

TABLE OF CONTENTS

4.4 Geology and Soils

4.4.1 Cumulative Actions Applicable to Geology and Soils

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.2, Cumulative Actions. RFFAs that would that, when considered together with the Proposed Action and alternatives, would have cumulative effects on Geology and Soils, include:

- WVS and Other Dams and Reservoirs in the Willamette River Basin: construction and past operations and maintenance
- WVS Dams and Reservoirs: ongoing operations and maintenance
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 8: Tribal, State, and Local Fish and Wildlife Improvements
- RFFA 10: Climate Change
- RFFA 11: Mining Operations
- RFFA 12: Timber and Logging Industry Operations.

4.4.2 Geologic Analysis Area

The analysis area for geology includes WVS dam foundations, the areas around dams and reservoirs, and all relevant features described in periodic inspections of each dam by USACE. It also includes the active channel of the Willamette River up to the 1 percent and 0.2 percent annual exceedance probability flood elevation (100- and 500-year flood zones, respectively) for all reaches in the Willamette Valley that contain levees and bank protection works (Section 3.4, Soils and Geology).

4.4.3 Cumulative Effects to Geology and Soils by Alternative

Construction of the Willamette Valley projects altered local geology because several necessary tasks for dam construction require removal of geologic materials. Foundation preparation at many locations involved stripping of overburden and unsuitable rock until competent rock was reached. Construction of the dam spillway and core trench often require blasting and excavation.

Additionally, materials for the dam embankments are often excavated from local borrow areas. Initial filling and drawdown of the reservoir and activities associated with construction of the dam sometimes initiate landslides or steepen slopes so that rockfall and landslides are more likely. For example, at Lookout Point relocation of the highway and railroad during construction reactivated the Minnow slide deposit and the first drawdown of the reservoir formed the Voss slide (Section 3.4, Geology and Soils).

Activities related to construction and the first fill and drawdown cycle of the reservoir-initiated soil creep and landslides at Cougar, Detroit, Dorena, Fall Creek, Green Peter, Hills Creek, Lookout Point Reservoirs. These landslides are likely to continue to occur during periods of very wet weather or reduction of the reservoir stage. Construction of other dams and reservoirs in the Willamette River Basin are unlikely to directly affect the formation of landslides at the Willamette Valley dams and reservoirs.

As discussed in Section 3.4, Soils and Geology, Interim Operations related to the injunction that are expected to require deep drawdown of the reservoir that could result in moderate landslide effects at Lookout Point and Cougar Dams, minor landslide effects at Green Peter Dam, and negligible effects to landslides at Fall Creek Dam. There are also dam operations that may result in excavation of geologic materials. These effects would be additive.

An increase to water withdrawals to meet municipal, industrial, and agricultural demand (RFFA 3) would result in more stored water being released from the reservoir to meet downstream flow targets, which may mean that in dry years reservoir levels will decrease more quickly to minimal pool elevations in order to meet flow targets. Water withdrawals would be additive effect on landslide formation.

The alternatives include measures that would alter the flow targets downstream of the WVS dams to meet tribal, state, and local fish and wildlife improvement goals (RFFA 7). Under some alternatives during spring and summer of dry years reservoirs would need to be lowered more rapidly and would be drawn down deeper than the current minimum elevation in order to meet these targets. This effect would be additive for landslide formation.

Climate change (RFFA 9) is anticipated to reduce the amount of precipitation that falls as snow in the winter, which would cause basin-wide flows to be reduced earlier in spring than when it has historically occurred. This leads to an earlier reduction in reservoir water surface elevations starting in late spring through summer and fall. This increases the probability that the reservoir will be drawn down to its minimum elevation during dry years. This increases shoreline exposure and is an additive effect for landslide formation. Additionally, climate change is anticipated to increase the risk of forest fire. Because tree roots bind soil together, loss of trees due to forest fires increases the erodibility of soils and reduces the strength of slopes, allowing for otherwise stable slopes to initiate failure.

Removal of material associated with mining (RFFA 10) can result in over steepened slopes. Mining in areas where landslides are already present exacerbates existing slope stability issues. Green Peter and Lookout Point Dams have mining claims located on mapped landslide areas that would have an additive effect on the environmental consequences of Interim Operations and proposed alternatives.

The roots of trees have a stabilizing effect on soils and removing trees during timber and logging industry operations (RFFA 11) kills the roots, which can result in slope instability, especially in areas that have existing landslides and are already prone to slope failure. Cougar and Lookout Point have historic logging operations in areas containing landslides that would have an additive synergistic effect to landslide formation.

4.4.3.1 No-action Alternative

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under the No-action Alternative (NAA) due to landslide formation. As discussed in Section 3.4, Geology and Soils, the effects of the NAA do not appreciably change the geomorphology and sediment processes, or the closely related hydrology and hydraulics, of the WVS from the existing conditions. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under the NAA, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River Subbasin analyzed in Section 3.4, Geology and Soils.

Coast Fork Willamette River Subbasin

Under the NAA, no Coast Fork Willamette River Subbasin operations are expected to have environmental consequences due to landslides or removal of geologic materials.

Long Tom River Subbasin

There are no landslides in contact with the Fern Ridge Reservoir; therefore, no environmental consequences due to landslides are expected under any alternative.

McKenzie River Subbasin

In the McKenzie River Subbasin, several RFFAs would have an additive effect on environmental consequences under the NAA. Construction associated with Cougar Dam initiated landslides that are in contact with the reservoir. No differential effects on landslide formation from fish and wildlife improvement are expected to occur because no operations are proposed under the NAA that would cause a reduction in reservoir elevation at Cougar Dam.

Timber harvesting has occurred in areas with landslides at Cougar Dam (ODF 2022), which would reduce slope stability. Both increased water withdrawals due to demand and climate change have effects for at Cougar Dam. In summary, cumulative effects due to past, current, and future actions under the NAA are anticipated for Cougar Dam operations, but not at Blue River Dam, since it does not have existing landslide areas and, therefore, no environmental consequences due to landslides are expected under any alternative.

Middle Fork Willamette River Subbasin

In the Middle Fork Willamette River Subbasin, several RFFAs would have an additive effect on environmental consequences under the NAA. Construction associated with Hills Creek and Lookout Point Dams initiated landslides that are in contact with the reservoirs. Interim Operations at Hills Creek and Lookout Point Dams would influence landslide formation. No differential effects on landslide formation from fish and wildlife improvement are expected to occur because no operations are proposed under the NAA that would cause a reduction in reservoir elevation at Hills Creek and Lookout Point Dams.

Mining claim activity and timber harvesting at Lookout Point Dam have occurred in areas with landslides (Causey, J.D. 2011; DOGAMI 2022; ODF 2022). Both increased water withdrawals due to demand and climate change have synergistic additive effects for environmental consequences at Hills Creek and Lookout Point Dams. In summary, cumulative effects due to past, current, and future actions under the NAA are anticipated at Hills Creek and Lookout Point Dams, but not at Dexter or Fall Creek Dams, since they do not have existing landslide areas and, therefore, no environmental consequences due to landslides are expected under any alternative.

North and South Santiam River Subbasins

In the North and South Santiam River Subbasins several RFFAs have an additive effect on environmental consequences under the NAA. Construction associated with Green Peter Dam initiated landslides that are in contact with the reservoir. Interim Operations at Detroit and Green Peter Dams would cause deeper drawdowns and increase the probability of landslide formation. No differential effects on landslide formation from fish and wildlife improvement are expected to occur because no operations are proposed to meet flow targets that would cause a reduction in reservoir elevations at the North and South Santiam River Subbasins reservoirs.

Mining claim activity at Green Peter (Causey, J.D. 2011; DOGAMI 2022) and timber harvesting at Detroit (ODF 2022) have occurred in areas with landslides, which would potentially destabilize slopes. Both increased water withdrawals due to demand and climate change have additive effects for Detroit and Green Peter Dams.

In summary, cumulative effects due to past, current, and future actions under the NAA are anticipated for Detroit and Green Peter Dams, but not at Big Cliff or Foster Dams. This is because Big Cliff Reservoir does not have existing landslide areas and Foster Reservoir is not anticipated to have increased shoreline exposure, and therefore no environmental consequences due to landslides are expected under any alternative.

4.4.3.2 Alternative 1—Improve Fish Passage through Storage-focused Measures

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 1 due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 1, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 1 in the Coast Fork Willamette River Subbasin would be the same as those described under the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 1 in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

Cumulative effects under Alternative 1 in the McKenzie River Subbasin would be the same as those described under the NAA.

Middle Fork Willamette River Subbasin

Cumulative effects under Alternative 1 in the Middle Fork Willamette River Subbasin would be the same as those described under the NAA.

North and South Santiam River Subbasins

Cumulative effects under Alternative 1 in the North and South Santiam River Subbasins would be the same as those described under the NAA.

4.4.3.3 Alternative 2A—Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 2A due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 2A, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 2A in the Coast Fork Willamette River Subbasin would be the same as those described the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 2A in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

Cumulative effects under Alternative 2A in the McKenzie River Subbasin would be the same as those described under the NAA.

Middle Fork Willamette River Subbasin

Impacts to geologic resources from landslide activity under Alternative 2A in the Middle Fork Willamette River Subbasin would be the same as those described under the NAA.

North and South Santiam River Subbasins

In the North and South Santiam River Subbasins several RFFAs have an additive effect on environmental consequences under Alternative 2A. Construction associated with Green Peter Dam initiated landslides that are in contact with the reservoir. Operations at Green Peter Dam under Alternative 2A would cause deep drawdowns and increase the probability of landslide formation. Because all measures that cause a reduction in reservoir elevation at Green Peter are directly related to meeting flow targets, no differential effects on landslide formation are expected to occur.

Mining claim activity at Green Peter Dam (Causey, J.D. 2011; DOGAMI 2022) have occurred in areas with landslides. Both increased water withdrawals due to demand and climate change would have effects at Green Peter Dam.

In summary, cumulative effects due to past, current, and future actions under Alternative 2A are anticipated for Green Peter, but not at Big Cliff, Detroit, or Foster Dams. Big Cliff Dam and Reservoir does not have existing landslide areas, and Detroit and Foster Dams are not anticipated to have increased shoreline exposure; therefore, no environmental consequences due to landslides are expected under any alternative.

4.4.3.4 Alternative 2B—Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 2B due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 2B, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 2B in the Coast Fork Willamette River Subbasin would be the same as those described under the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 2B in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

In the McKenzie River Subbasin several RFFAs have an additive effect on environmental consequences under the Alternative 2B. Construction associated with Cougar Dam initiated landslides that are in contact with the reservoir. Deep drawdowns at Cougar Reservoir related to operations under Alternative 2B are anticipated to increase shoreline exposure and may decrease slope stability due to erosion and small-scale slope failures in areas that have existing landslides.

Timber harvesting has occurred in areas with landslides at Cougar Dam (ODF 2022), which would further destabilize slopes. Both increased water withdrawals due to demand and climate change have synergistic additive effects for environmental consequences at Cougar Dam.

In summary, cumulative effects due to past, current, and future actions under Alternative 2B are anticipated for Cougar Dam, but not at Blue River Dam because it does not have existing landslide areas and, therefore, no environmental consequences due to landslides are expected under any alternative.

Middle Fork Willamette River Subbasin

Impacts to geologic resources from landslide activity under Alternative 2B in the Middle Fork Willamette River Subbasin would be the same as those described under the NAA.

North and South Santiam River Subbasins

Cumulative effects under Alternative 2B in the North and South Santiam River Subbasins would be the same as those described under the Alternative 2A.

4.4.3.5 Alternative 3A—Improve Fish Passage through Operations-focused Measures

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 3A due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 3A, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 3A in the Coast Fork Willamette River Subbasin would be the same as those described under the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 3A in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

Cumulative effects under Alternative 3A in the McKenzie River Subbasin would be the same as those described under Alternative 2B.

Middle Fork Willamette River Subbasin

In the Middle Fork Willamette River Subbasin several RFFAs have an additive effect on environmental consequences under Alternative 3A. Construction associated with Hills Creek and Lookout Point Dams initiated landslides that are in contact with the reservoirs. Deep drawdowns at Lookout Point Reservoir under Alternative 3A are anticipated to increase shoreline exposure and may decrease slope stability due to erosion and small-scale slope failures in areas that have existing landslides.

Mining claim activity and timber harvesting at Lookout Point Dam have occurred in areas with landslides (Causey, J.D. 2011; DOGAMI 2022; ODF 2022). Both increased water withdrawals due to demand and climate change have synergistic additive effects for environmental consequences at Lookout Point Dam.

Based on the cumulative effects of past, current, and future actions under Alternative 3A are anticipated for Lookout Point Dam, but not at Dexter or Fall Creek Dams, since they do not have existing landslide areas, or Hills Creek Dam because deep drawdowns of the reservoir are not anticipated under Alternative 3A and, therefore, no environmental consequences due to landslides are expected under this alternative.

North and South Santiam River Subbasins

In the North and South Santiam River Subbasins several RFFAs have an additive effect on environmental consequences under Alternative 3A. Construction associated with Green Peter Dam initiated landslides that are in contact with the reservoir. Operations at Detroit and Green Peter Dams under Alternative 3A would cause deep drawdowns and increase the probability of landslide formation. No differential effects on landslide formation are expected to occur because all measures that cause a reduction in reservoir elevation at Detroit and Green Peter Dams are directly related to meeting flow targets.

Mining claim activity at Green Peter (Causey, J.D. 2011; DOGAMI 2022) and timber harvesting at Detroit (ODF 2022) have occurred in areas with landslides. Both increased water withdrawals due to demand and climate change would have effects at Detroit and Green Peter Dams.

In summary, cumulative effects due to past, current, and future actions under Alternative 3A are anticipated at Detroit and Green Peter Dams, but not at Big Cliff or Foster Dams. Big Cliff Dam does not have existing landslide areas, and Foster Dam is not anticipated to have increased shoreline exposure and, therefore, no environmental consequences due to landslides are expected under any alternative.

4.4.3.6 Alternative 3B—Improve Fish Passage through Operations-focused Measures

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 3B due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 3B, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 3B in the Coast Fork Willamette River Subbasin would be the same as those described under the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 3B in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

Cumulative effects under Alternative 3B in the McKenzie River Subbasin would be the same as those described under Alternative 2B.

Middle Fork Willamette River Subbasin

Cumulative effects under Alternative 3B in the Middle Fork Willamette River Subbasin would be the same as those described under Alternative 3A.

North and South Santiam River Subbasins

Cumulative effects under Alternative 3B in the North and South Santiam River Subbasins would be the same as those described under the Alternative 3A.

4.4.3.7 Alternative 4—Improve Fish Passage with Structures-based Approach

Combined with the effects of the RFFAs including climate change, there would likely be additional effects to geology (changes from existing condition) under Alternative 4 due to conditions that increase the probability of landslide formation occurring. For all subbasins that are expected to have cumulative effects on the probability of landslides occurring due to past, current, and future actions under Alternative 4, the expected cumulative effect is additive, synergistic, indirect, and of unknown magnitude. However, any cumulative effect that increases the probability of landslide formation is not expected to change the scale of the effect from activation of landslides within the Santiam River basin based on the criteria in Section 3.4, Soils and Geology.

Coast Fork Willamette River Subbasin

Cumulative effects under Alternative 1 in the Coast Fork Willamette River Subbasin would be the same as those described under the NAA.

Long Tom River Subbasin

Cumulative effects under Alternative 4 in the Long Tom River Subbasin would be the same as those described under the NAA.

McKenzie River Subbasin

Cumulative effects under Alternative 4 in the McKenzie River Subbasin would be the same as described under the NAA.

Middle Fork Willamette River Subbasin

Impacts to geologic resources from landslide activity under Alternative 4 in the Middle Fork Willamette River Subbasin would be the same as those described under the NAA.

North and South Santiam River Subbasins

Cumulative effects under Alternative 4 in the North and South Santiam River Subbasins would be the same as those described under the NAA.

4.4.3.8 Alternative 5—Preferred Alternative—Refined Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Operations in all subbasins under Alternative 5 would be similar to those under Alternative 2A with respect to potential drawdown-related and construction-related effects on geologic resources. Consequently, cumulative effects under Alternative 5 in all subbasins would be the same as those described under the Alternative 2A.

US Army Corps
of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.5 WATER QUALITY

TABLE OF CONTENTS

4.5 Water Quality

THE WATER QUALITY CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.5.1 Cumulative Actions Applicable to Water Quality

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on water quality when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on water quality in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 2: Agricultural Production
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvements
- RFFA 8: Invasive Species Management
- RFFA 9: Climate Change
- RFFA 10: Mining Operations
- RFFA 11: Timber and Logging Operations

4.5.2 Water Quality Cumulative Effects Analysis Area

The water quality analysis area is the same as the area analyzed for direct and indirect effects in Section 3.5, Water Quality. The analysis area encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). It is not anticipated that water quality effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

4.5.3 Cumulative Effects on Water Quality

A summary of RFFA impacts that would affect water quality is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.5.6, Water Quality, Summary of Effects, provides parameter summaries of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.5.3.1 Overview

Construction of the WVS dams has changed downstream water temperatures to be unnaturally cool in the spring to summer and warm in fall to winter. Water released through non-power-generating outlets creates total dissolved gas (TDG), which can be detrimental to aquatic species. Additionally, increased turbidity levels typically occur from reservoir drawdown operations or high flow events due to precipitation.

At the time the alternatives were analyzed, water quality standards in the State of Oregon were listed for pH, bacteria, dissolved oxygen, temperature, TDG, total dissolved solids, turbidity, nuisance phytoplankton, and toxic substances.

Implementation of any alternative would result in continued direct, adverse effects on water quality. However, the degree of adverse effect would vary depending on alternative and temperature, TDG, turbidity, harmful algal blooms, and mercury parameters (Section 3.5, Figure 3.5-59 through Figure 3.5-63). Some parameters may be less adverse as compared to the No-action Alternative (NAA). For example, WVS reservoirs can trap sediment from the upstream watershed during high-flow events, which can moderate adverse effects by reducing turbidity downstream of the dams. Trapping sediment would be a beneficial effect on water quality under all alternatives.

4.5.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on water quality are described below.

<u>RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development</u>

Population in the analysis area is expected to increase over the 30-year implementation timeframe. Increases in population result in increased urban development and associated water quality impacts from urban runoff, pollution, and in-water uses.

Stormwater would continue to be discharged from residential, commercial, industrial, and agricultural land uses. In-water recreation at WVS reservoirs and in the Willamette River and its tributaries is also likely to increase with population growth. An increase in runoff and in-water use from population growth may introduce non-point and point source pollution into the analysis area, which would continue to adversely affect water quality.

Increased nutrient inputs (i.e., wastewater, stormwater, or seepage from unincorporated suburban areas) may facilitate continued adverse water quality effects from harmful algal blooms, which would be localized but possibly recurring seasonally.

RFFA 2—Agricultural Production

Although agricultural production in the analysis area had been decreasing at the time the alternatives were analyzed, water demand for agricultural use will continue over the 30-year implementation timeframe. Agricultural practices will, therefore, continue to adversely affect water quality in the analysis area from pollutant, nutrient, and bacteria runoff and soil erosion in localized areas.

WVS conservation storage totals approximately 1,590,000 acre-feet. As of September 2024, of this total, only 84,349 acre-feet of stored water (less than 5 percent of the WVS conservation storage volume) was contracted through U.S. Bureau of Reclamation for agricultural irrigation use on 45,715 acres in the analysis area (Section 3.13, Water Supply).

Future demands for agricultural water use would need to be met with stored water from the WVS because most water systems in the Willamette River Basin have limited availability for river flow water rights (Section 3.13, Water Supply). A total of 327,650 acre-feet was reallocated to the specific use of agricultural irrigation in the Water Resources Development Act of 2020 (USACE 2019a) based on the forecasted demand[1] for stored water for agricultural irrigation use to the year 2070.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

In addition to future demands for agricultural water use, at the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). This need was one of the factors that led to the Willamette Basin Review Feasibility Study (USACE 2019a), which resulted in a total of 159,750 acre-feet of conservation storage reallocated to the purpose of municipal and industrial water supply.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

Adverse effects to water quality in the analysis area could occur from increased volumes of water withdrawals for municipal, industrial, and agricultural uses over the 30-year implementation timeframe. An increase in water withdrawals would likely adversely affect water quality because of warmer water temperatures and increased pollutant, nutrient, and bacteria concentrations during the summer as less water would be available downstream of the WVS dams for dilution.

After use and treatment, municipal and industrial water demands would be returned to rivers in the Basin through increased permitted point source discharges, potentially increasing base flow of degraded water quality in the system.

[1] The Willamette Basin Review Feasibility Study period was 50 years (USACE 2019a).

RFFA 5—Federal and State Wildlife and Lands Management

Federal lands management objectives in the analysis area can align with preservation of water quality conditions through land conservation practices. Conserving forested and other natural landscapes can aid in preservation of water quality conditions by preventing soil erosion or chemical uses that pollute water systems.

State lands management in analysis area headwaters would continue to be managed to protect water quality and for watershed protection as required under the Oregon Statewide Planning Goals and Guidelines (ODLCD 2019).

However, some water quality impairment is likely to occur over the 30-year implementation timeframe from Federal and state management practices that include logging, road development and use, recreation near water sources, livestock grazing, resource extraction, and other uses.

RFFA 6—Southern Resident Killer Whale Management

Increased production of Chinook salmon may accrue larger benefits to Southern Resident killer whales than harvest management actions (PFMC 2021). In the absence of substantial improvements in smolt-to-adult ratios of natural-origin fish, any reductions in Willamette Valley hatchery production would cause minor decreases in a key food resource available to Southern Residents. Prey from the Willamette River is not documented as a substantial source for Southern Resident killer whales (Hansen et al. 2021). Water quality conditions have the potential to adversely affect survival of hatchery-origin fish and the quality of fish from contaminants.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvements

Watershed protection and conservation projects aimed at improvements in fish and aquatic habitat would necessarily preserve or improve water quality parameters needed to support habitat over the 30-year implementation timeframe. Water quality parameters, such as water temperature, may also benefit depending on upland-focused wildlife and land management strategies. For example, modifications to riparian management could result in stable streambank conditions minimizing turbidity and runoff. Additionally, retention of riparian timber would maintain or improve localized instream temperatures in the analysis area.

These management actions could result in long-term, permanent water quality benefits; however, some actions may result in short-term, adverse effects such as instream riprap or beaver analog work, culvert placement, bank stabilization projects, etc. that would temporarily increase turbidity during construction. Such impacts would be localized in stream areas and would not adversely affect the entire analysis area.

RFFA 8—Invasive Species Management

Management of analysis area aquatic and upland invasive plants will continue over the 30-year implementation timeframe. Management will include use of herbicides to control growth.

Wetter winters and drier summers related to climate change would be expected to lead to changes in vegetation community composition and distribution over time, as drought-tolerant species become more predominant and invasive plants potentially encroach further into communities of native species. The quantity of pesticides used to control invasive species would be expected to increase proportionally as invasive species proliferate throughout the WVS over time because of climate change-related conditions (Section 3.16, Hazardous Materials).

Herbicides and insecticides are types of pesticides (Section 3.16, Hazardous Materials). These chemicals are applied as spot treatments on a small scale as part of routine maintenance to prevent the establishment of new invasive species, manage/control existing populations, and to enhance habitat for native species.

The continued and increased use of herbicides can adversely affect reservoir water quality through pollutant overspray, soil erosion, or if suspended in water runoff.

RFFA 9—Climate Change

Studies on the effects of climate change on water quality demonstrate and project increases in average annual temperatures in the analysis area from 1950 to 2100 (Appendix F2, Supplemental Climate Change Information). Precipitation is also anticipated to increase in winter months and decrease during the spring and summer months. Such impacts could be expected in the analysis area over the 30-year implementation timeframe under any alternative. Moreover, these effects would likely be long-term, affecting stream reaches above and below all WVS dams.

Climate change would affect water quality due to an increase in air temperature, which would increase water temperatures in the analysis area, including reservoir and instream temperatures. Increased water temperatures in reservoirs will likely increase ongoing adverse, localized, and seasonal effects from harmful algal blooms in the WVS.

Increased air temperatures will also continue to foster wildfires in the Willamette River Basin. Wildfire alters the land surface and can have strong influences on runoff, erosion, toxin concentrations (i.e., volatile organic compounds, heavy metals), and sediment transport into water systems. This will contribute adverse effects to ongoing turbidity effects downstream of WVS dams.

Climate change-related temperature increases coupled with increased analysis area population will also likely result in increased in-water recreation uses. Increased uses in WVS reservoirs and the Mainstem Willamette River will cause increases in water pollution and bacteria, adding to existing direct, adverse water quality conditions.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 10—Mining Operations

Mining operations have the potential to adversely affect water quality by introducing minerals and contaminants into streams and reservoirs from runoff upstream and downstream of WVS dams. Localized water quality impairment could occur from runoff associated with drilling, excavation, and survey work in the analysis area over the 30-year implementation timeframe.

RFFA 11—Timber and Logging Operations

Similar to mining operations, timber and logging operations in the analysis area have the potential for localized water quality impacts from soil erosion into water sources near operations. Although logging operations had decreased in the analysis area at the time the alternatives were analyzed, some operations will continue upstream of streams in the Willamette River Basin over the 30-year implementation timeframe.

4.5.3.3 Cumulative Effects under All Alternatives

Direct, adverse effects on water quality in the analysis area would continue under any alternative to varying degrees with some parameter improvements depending on the alternative. The combined RFFA impacts on water quality in the analysis area added to anticipated ongoing direct, adverse impacts could result in adverse effects ranging from those similar to direct effects to more substantial, adverse effects.

Water Temperature

The combined impacts of ongoing, adverse effects on water temperature with climate change-related and water supply demand effects could lead to substantial, adverse effects on water quality. However, while moderate, adverse water temperatures would continue under the NAA, they would improve under the action alternatives (except for Alternative 3A) in varying locations below dams. Further, temperature impacts would be localized to stream reaches immediately below dams.

Consequently, climate change-related and water supply demand impacts would be somewhat moderated by operations under the action alternatives. Combined RFFA effects on water temperature would likely be most moderated under Alternative 2B and Alternative 5 because operations would result in the most improvements from adverse water temperature conditions system-wide over the 30-year implementation timeframe (Section 3.5, Water Quality, Figure 3.5-59).

Total Dissolved Gas

Direct effects on water quality from TDG would range from slightly to moderately adverse under the NAA. Increases in adverse conditions would occur in some locations below dams under all alternatives except Alternative 1 and Alternative 4 where the most improvements would occur (Section 3.5, Water Quality, Figure 3.5-60). However, RFFAs would not likely add to TDG conditions below WVS dams over the 30-year implementation timeframe because the RFFA actions themselves would not produce TDG.

Turbidity

Conservation land management would continue to moderate water quality effects in the analysis area. However, it is not likely that these RFFAs would measurably contribute to stabilizing or to improving water quality conditions immediately below dams resulting from operations under any alternative. This is because of the localized effects of land management and of dam operations. Regardless, overall water quality conditions in the Willamette River Basin would continue to benefit from conservation land management.

Conversely, erosion from some land management practices in the analysis area would continue to adversely affect water quality downstream of WVS dams. This impact may be combined with ongoing direct, adverse effects of turbidity in downstream reaches under all alternatives. Additionally, these cumulative effects would worsen with erosion and sediment entering Willamette River Basin streams from wildfire landscape alterations, which are expected to be an increasing risk from climate change effects.

Harmful Algal Blooms and Mercury

A predominant, combined effect of RFFAs on water quality would be effects from runoff containing pollutants, nutrients, and bacteria. These adverse conditions would be combined with slight, adverse, direct effects from harmful algal blooms and mercury under the NAA and increases in these adverse conditions under all action alternatives. Direct and cumulative, adverse effects would be greatest under Alternative 3A and Alternative 3B (Section 3.5, Water Quality, Figure 3.5-62 and Figure 3.5-63).

Consequently, water quality conditions from anticipated ongoing effects combined with RFFA effects would result in increased impaired water quality over the 30-year implementation timeframe. It is anticipated that these effects would be localized and possibly seasonal when combined with harmful algal blooms under any alternative.

Hatchery Production of Chinook Salmon

Water quality associated with hatchery production can potentially affect the Chinook salmon prey source for Southern Resident killer whales. USACE funds the operation and maintenance of five hatcheries for mitigation and conservation within the WVS. However, while hatcheries can result in effects on localized and downstream water quality near the WVS hatcheries, none of the alternatives would alter management affecting water quality at hatcheries as compared to the NAA (Section 3.5, Water Quality). Consequently, there are no anticipated cumulative effects on Southern Resident primary prey source produced in the WVS hatcheries from direct water quality conditions under any alternative.

Best Management Practices at WVS hatcheries to minimize impacts on Chinook salmon and other ESA-listed fish include adequately screening hatchery intake water supplies to prevent fish loss, ensuring hatcheries are operated in compliance with National Pollutant Discharge Elimination System permits, and outplanting surplus carcasses from the hatchery for nutrient enhancement in the ecosystem where appropriate (IHOT 1995; HSRG 2004; Mobrand et al. 2005) (Section 3.8, Fish and Aquatic Habitat).

Water Quality Contaminants

A limiting factor to Southern Resident killer whales is emerging contaminants (NMFS 2008). Contaminants can adversely affect fish that are prey for Southern Residents. Mercury is known to be a legacy contaminant in the Willamette River Basin and can accumulate in fish tissue (Section 3.18, Hazardous, Radioactive, and Toxic Waste). However, mercury contamination has not been identified as a specific limiting factor on Southern Residents (NMFS 2008). Consistent with the NMFS Biological Opinion, there would be no adverse effect on Southern Residents from water quality conditions in the analysis area under any alternative (NMFS 2024). However, cumulative effects are considered below.

Under the State of Oregon Administrative Rules (OAR) 340-041, the Oregon Department of Environmental Quality (ODEQ) implements the Water Quality Standards and Total Maximum Daily Loads (TMDLs) for Oregon waters (Section 3.5, Water Quality).

A TMDL is a load allocation of a pollutant implemented to reduce the pollutant impairment of a waterbody and to meet water quality standards. Water quality standards in the State of Oregon are listed for pH, bacteria, dissolved oxygen, temperature, TDG, total dissolved solids, turbidity, nuisance phytoplankton, and toxic substances (i.e., contaminants).

ODEQ and EPA addressed water quality impairments in the Willamette Basin in 2006 by finalizing the Willamette Basin TMDLs for temperature, mercury, and bacteria. In 2019, ODEQ issued the Final Revised Willamette Basin Mercury TMDL (ODEQ 2019a). These TMDLs highlight impaired rivers and streams of the Willamette River Basin and set guidelines designed to restore water quality by establishing limits on pollutants to meet water quality standards.

All Willamette River Basin subbasins and the Mainstem Willamette River have TMDL load allocations set by the state for mercury. USACE-operated dams are in 6 of the 12 subbasins within the Willamette River Basin. At the time the alternatives were analyzed, there were no other toxic substance TMDLs for the Willamette River Basin (Section 3.5, Water Quality). However, increased air temperatures from climate change-related conditions will also continue to foster wildfires in the Willamette River Basin. Wildfire alters the land surface and can have strong influences on toxin concentrations (i.e., volatile organic compounds, heavy metals), and sediment transport into water systems. Such concentrations could adversely affect the quality of the small amount of Southern Resident prey comprised of Upper Willamette River Chinook salmon and Upper Willamette River steelhead during the 30-year implementation timeframe (NMFS 2024).

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.6 VEGETATION AND WETLANDS

TABLE OF CONTENTS

4.6 Vegetation and Wetlands

THE VEGETATION CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS
THE FEIS WETLANDS ANALYSIS IS COMBINED WITH THE VEGETATION ANALYSIS

4.6.1 Cumulative Actions Applicable to Vegetation and Wetlands

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on vegetation and wetlands when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on vegetation and wetlands in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 2: Agricultural Production
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 8: Invasive Species Management
- RFFA 9: Climate change
- RFFA 10: Mining Operations
- RFFA 11: Timber and Logging Industry Operations

4.6.2 Vegetation and Wetlands Cumulative Effects Analysis Area

The vegetation and wetlands analysis area is expanded from the area analyzed for direct and indirect effects in Section 3.6, Vegetation and Section 3.7, Wetlands. The RFFAs will impact vegetation and wetlands beyond the 1-mile maximum pool elevation. Therefore, the analysis area for cumulative effects encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). It is not anticipated that vegetation or wetlands effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

4.6.3 Cumulative Effects on Vegetation and Wetlands

A summary of RFFA impacts that would affect vegetation and wetlands is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.6, Vegetation, Table 3.6-4, and Section 3.7, Wetlands, Table 3.7-3, provides summaries of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.6.3.1 Overview

USACE manages water levels in the reservoirs by typically maintaining low water in the winter and re-filling reservoirs in spring, holding water over the summer at full pool. These operations result in vegetation communities composed of species suited to higher downstream flows in the fall/winter and lower downstream flows in the spring/summer.

Drawdown zones support areas around the reservoir perimeter where soil saturation is affected by water level fluctuations, creating opportunities for invasive disturbance-tolerant species to rapidly spread and to colonize in new locations. High reservoir water levels in the spring and summer growing season saturate soils and provide benefits to overall plant growth and facilitate biomass accumulation for reservoir-adjacent communities.

The hydrologic regime from reservoir operations allows for disturbance-tolerant wetlands to form around many reservoirs despite winter drawdowns (Section 3.7, Wetlands). Wetlands support vegetation communities composed of native and invasive species and provide habitat for wildlife and aquatic species around WVS reservoirs. The ecosystem services provided by these wetlands are limited, however, because species assemblages are dominated by disturbance-tolerant vegetation.

In recent years, around the time the alternatives were analyzed, reservoirs had not been filled because of drought, early drawdowns (required by the 2008 National Marine Fisheries Service (NMFS) Biological Opinion), and summer low water. This reservoir condition has fostered establishment of novel communities of disturbance-tolerant plants in the analysis area.

Wetlands in the analysis area also include those located along channels of slow-moving, low-gradient stream reaches downstream of the dams where the floodplain and the channel migration zone broaden.

Backwater sloughs and oxbow lakes are formed when a stream channel migrates across the floodplain over time. This process shifts primary stream flows from previously used channels, now backwater sloughs, and completely isolates other portions, which become oxbow lakes.

These wetlands are part of the riverine and palustrine systems within the analysis area. In these areas, large floodplain wetland complexes sometimes form over time, particularly in lower gradient areas.

Wetlands in the analysis area are more abundant within lower elevation reservoirs (Cottage Grove, Dorena, and Fern Ridge Reservoirs), within the Willamette Valley in areas adjacent to the Mainstem Willamette River, and in the lower sections of tributaries to the Willamette River. Wetlands in the analysis area are capable of high productivity and will accumulate biomass and store carbon. However, disturbed reservoir-adjacent wetlands dominated by non-native and invasive vegetation do not provide optimal wetland function and quality because of low species diversity. Conversely, less-disturbed wetland habitat downstream of dams has greater potential to support native plant diversity and, therefore, high ecosystem quality and function.

4.6.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on vegetation and wetlands are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. As the population increases throughout the Willamette River Basin, adverse impacts on vegetation and wetlands, including special status plants, may increase as lands are converted to urban or industrial uses or plant communities are adversely impacted from increases in human mediated ecosystem disturbance.

Impacts would include substantial loss of native plant communities, disturbance to seed banks, and loss of wetland ecosystems. Population-related impacts can also result in increases in invasive plant species introduction, colonization and establishment onto newly disturbed sites throughout the Basin.

RFFA 2—Agricultural Production

Agricultural production in the analysis area had been decreasing at the time the alternatives were analyzed. In particular, cropland management in the Willamette River Basin had been decreasing with likely conversions to urban or industrial uses. Although decreasing, agricultural practices would continue in the analysis area over the 30-year implementation timeframe.

Impacts on vegetation and wetlands in the analysis area would be similar to those related to population growth. Additional, site-specific adverse effects may also occur from the interrelationship of cropland management and adjacent vegetation or wetland ecosystems.

For example, irrigation adjacent to undisturbed or undeveloped land can promote establishment of adjacent plant communities. Adverse impacts on this interrelationship could occur from less irrigation and land conversion that may impact the Basin-wide ecosystem depending on the magnitude of cropland management decline.

Continued agricultural runoff from fertilizers used to manage cropland have the potential for adverse effects to vegetation and wetlands within the Basin. Eutrophication as a result of additional nutrient inputs can lead to harmful algal blooms in aquatic and wetland systems.

Additionally, high nutrient inputs from agricultural runoff facilitate colonization by invasive species that are often able to utilize additional nutrient inputs to outcompete native plant species.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

At the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

Frequent water fluctuations in reservoirs to address water withdrawals may prohibit plant establishment and succession, which may increase the potential for the establishment of invasive-dominated plant communities. Additionally, increases in plant growth from high reservoir levels during the growing season can result in biomass accumulation. Vegetation and wetlands can also be adversely impacted from water fluctuations that induce localized landslides.

Open water habitat for floating, unrooted plants such as dotted watermeal and Columbia watermeal is directly influenced by the existing hydrologic regime (Section 3.6, Vegetation). Due to the unique growth form of floating, unrooted plants, they are entirely reliant upon a water medium for survival. If water levels are lowered, these plants either remain floating on the water surface and are relocated or are desiccated on exposed reservoir substrates.

Flow operations can benefit or adversely impact downstream vegetation and wetlands composed of species suited to higher downstream flows in the fall/winter and lower downstream flows in the spring/summer. Flow operations can also impact downstream vegetation communities by altering floodplain connectivity, which can create new wetland habitat or disconnect existing wetland habitats.

RFFA 5—Federal and State Wildlife and Lands Management

Federal lands management objectives in the analysis area can align with preservation of Willamette River Basin-wide vegetation and wetland communities and special status plant species through land conservation practices. Conserving forested and other natural landscapes can aid in preservation of vegetation and special status plant species by preventing land disturbances and fostering ecological conditions conducive to vegetation and wetland ecosystem health.

For example, the USFWS would continue to implement management activities at the Willamette Valley National Wildlife Refuge Complex. The three refuges in the complex provide protection for historically abundant oak savanna, native prairie, riparian forest, and wetland habitats. These protected areas would continue to support habitat for special status plants.

Oregon State public lands in the Basin would continue to be managed to preserve forested land, to maintain land resource quality, to protect resources in the Willamette River Greenway, and to plan for developments affecting estuaries. These land management goals will help to preserve existing vegetation and wetland communities.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvements

Watershed protection and conservation projects aimed at improvements in fish and wildlife habitat would necessarily preserve or improve riparian, wetland, and upland habitat over the 30-year implementation timeframe. Floodplain restoration projects may include native plant preservation, invasive plant removal, and native species plantings.

These management actions could result in long-term, permanent vegetation and wetland benefits; however, some actions may result in short-term, adverse effects on localized plant communities such as beaver analog work, culvert placement, bank stabilization projects, etc. that would temporarily disturb these communities. Such impacts would be localized and would not adversely affect the entire analysis area.

RFFA 8—Invasive Species Management

Management of analysis area aquatic and upland invasive plants will continue over the 30-year implementation timeframe. Reservoir fluctuations have the potential to promote invasive species growth. Management will include use of herbicides to control growth.

Wetter winters and drier summers related to climate change would be expected to lead to changes in vegetation community composition and distribution over time, as drought-tolerant species become more predominant and invasive plants potentially encroach further into communities of native species. The quantity of pesticides used to control invasive species would be expected to increase proportionally as invasive species proliferate throughout the WVS over time because of climate change-related conditions and continued human-mediated disturbance and introduction (Section 3.16, Hazardous Materials). This is also likely throughout the Willamette River Basin where invasive species management is undertaken by Federal, state, local agencies and private organizations.

Herbicides and insecticides are types of pesticides (Section 3.16, Hazardous Materials). These chemicals are applied as spot treatments on a small scale as part of routine maintenance to prevent the establishment of new invasive species, manage/control existing populations, and to enhance habitat for native species.

RFFA 9—Climate Change

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the Willamette River Basin as compared to existing conditions over the 30-year implementation timeframe (Climate Impacts Group 2010; RMJOC 2020) (Appendix F1, Qualitative Assessment of

Climate Change Impacts, Chapter 4, Projected Trends in Future Climate and Climate Change; Appendix F2, Supplemental Climate Change Information, Chapter 3, Supplemental Data Sources, Section 3.1, Overview of RMJOC II Climate Change Projections). Increased wildfires throughout the Basin would change the composition of vegetative communities and adversely affect wetlands and hydrologic conditions needed to support wetland ecosystems.

Reservoir levels under all alternatives may fall more frequently and refill would be more difficult than under existing or proposed operations with climate-related conditions and subsequent operational adjustments. Reservoir fluctuations coupled with drought conditions will favor invasive plants suited to these environments throughout the analysis area and at the local, reservoir-adjacent level.

Specifically, wetland plant communities in the analysis area would likely change in composition with more drought-tolerant and fire-adapted vegetation species becoming increasingly predominant throughout the region. As the wetland community changes, invasive plant species are anticipated to establish in areas where native vegetative communities have diminished.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

<u>RFFA 10—Mining Operations</u>

Mining operations have the potential to adversely affect vegetation from ground disturbance activities such transportation access, drilling, excavation, and survey work in the analysis area over the 30-year implementation timeframe.

<u>RFFA 11—Timber and Logging Operations</u>

Similar to mining operations, timber and logging operations in the analysis area have the potential for localized vegetation impacts from ground disturbance activities such as road development and use, culvert placement, and logging operations. Additionally, removal of soil-stabilizing vegetation has the potential to increase sedimentation into wetland and stream habitats leading to detrimental effects to vegetation and wetland habitats. However, these effects may be mitigated as Oregon State forest regulations provide protections for riparian areas and wetlands.

Although logging operations had decreased in the analysis area at the time the alternatives were analyzed, some operations will continue in the Willamette River Basin over the 30-year implementation timeframe.

4.6.3.3 Cumulative Effects under All Alternatives

Population Increases and Cropland Conversion

Direct, adverse effects on reservoir-adjacent vegetation and wetlands could be worsened by increased population and climate change-related effects. As populations and temperatures increase, visitor use will increase at WVS reservoirs, which may adversely impact plant communities through direct disturbance and invasive species introduction.

Although localized to reservoirs as a result of alternative implementation, the cumulative effect could be Basin-wide over the 30-year implementation timeframe. Impacts at the local level could be combined with Basin impacts from population growth and ecosystem and cropland conversions to urban and industrial development that would include substantial loss of native plant communities, disturbance to seed banks, and loss of wetland ecosystems. Population-related impacts can also result in cumulative increases in invasive plant species introduction, colonization, and establishment onto newly disturbed sites at WVS reservoirs and throughout the Basin.

Water Withdrawals and Land Conservation Management

Direct, negligible, minor, and moderate, adverse effects on vegetation and wetlands, including special status plants and open water habitat for floating plants, from reservoir fluctuations would not worsen or improve from the combined effects of the RFFAs. RFFA effects related to water supply forecasted demand, including agricultural production, were incorporated into the analyses of direct and indirect effects on vegetation and wetlands. No additional, cumulative effects would occur since all withdrawal effects were analyzed as direct and indirect effects.

Floodplain connectivity would continue to have localized, adverse effects on vegetation and wetland habitat under all alternatives. However, habitat connectivity improvements from gravel bars and the potential for seed bank establishment from revetment improvements under the action alternatives combined with Federal, state, tribal, and organizational land conservation management would benefit vegetation and wetlands Basin-wide. Although these improvements would not occur under the NAA, conservation management by other agencies and organizations will continue to benefit vegetation and wetland habitat in the Basin.

Similarly, direct, negligible to minor, adverse effects and some beneficial effects to vegetation and wetlands from downstream flows would occur under all alternatives. Cumulative, beneficial effects from conservation land management would be expected Basin-wide.

Invasive Species Management

Effects from invasive species management would likely be the same as anticipated direct and indirect effects. Direct, major, adverse effects to vegetation and wetlands from invasive species presence in reservoirs from frequent water elevation changes would occur under all alternatives. Minor benefits would occur under most alternatives from spring refills. The RFFA of increased invasive species management will be responsive to these conditions, assisting in invasive species control but would not likely prevent invasive species establishment at reservoirs.

Cumulatively, establishment of invasive species would continue Basin-wide as populations increase site-specific disturbance and as climate change conditions favor invasive species establishment.

Climate Change

The analyses of direct and indirect effects on vegetation and wetlands from climate change incorporate this RFFA.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

Vegetation

Adverse effects to vegetation, including special-status plant species and wapato, under all alternatives would increase in degree of intensity because of increased frequency of wildfires destroying available habitat and lower plant survival rates due to drought.

Effects from climate change in the analysis area are likely to decrease plant species diversity (i.e., homogeneity), but this may not result in increased listed species. The criteria for listed species may change over the 30-year implementation timeframe, prompted by climate change effects. Survey efforts may also change. Consequently, it is uncertain how climate change will impact species listings. Regardless, plant communities will persist within the analysis area but would likely change in composition with less species diversity and supported by more drought-tolerant and fire-adapted species than under existing conditions.

Wetlands

Wetland plant communities in the analysis area would likely change in composition with more drought-tolerant and fire-adapted vegetation species becoming increasingly predominant throughout the region. As the wetland community changes, invasive plant species are anticipated to establish in areas where native vegetative communities have diminished.

Adverse effects to wetlands under all alternatives will increase in degree of intensity because of increased frequency of wildfires destroying available habitat and lower plant survival rates due to drought. Wetland habitat will persist within the analysis area but would likely change in composition with more drought-tolerant and fire-adapted species becoming increasingly predominant throughout the analysis area. Consequently, wetland habitat function and quality are likely to diminish as a result of climate change.

Mining and Logging Operations

There would be no localized, cumulative effects on reservoir-adjacent vegetation or wetlands from mining or logging operations in the Willamette River Basin combined with alternative implementation. Cumulative effects could occur in areas downstream of WVS dams if operations impact vegetation or wetlands also impacted by flow operations.

Additionally, removal of soil-stabilizing vegetation has the potential increase sedimentation into wetland and stream habitats leading to detrimental effects to these habitats.

However, mining and logging operations are not likely located adjacent to stream reaches downstream of WVS dams. Therefore, impacts on vegetation and wetlands in these reaches would not likely occur from mining and logging operational disturbances. Further, Oregon State forest practices would continue to provide riparian and wetland protections, thereby minimizing the potential for adverse, cumulative effects below WVS dams.

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.7 WETLANDS

4.7 Wetlands

THE WETLANDS CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS
AND COMBINED WITH SECTION 4.6, VEGETATION

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.8 FISH AND AQUATIC HABITAT

TABLE OF CONTENTS

LIST OF TABLES

4.8 Fish and Aquatic Habitat

4.8.1 Geographic Scope

The system study area for cumulative effects on aquatic species and ESA-listed resources is defined broadly as the geographic boundaries of the Willamette River basin. The Willamette River basin is located entirely within the state of Oregon, beginning south of Cottage Grove and extending approximately 187 miles to the north where it flows into the Columbia River. The Willamette River is the 13th largest river in the conterminous U.S. in terms of streamflow and produces more runoff per unit area than any of the 12 larger rivers (USEPA, 2013). The basin averages 75 miles in width and encompasses approximately 12 percent of the total area of the state. The basin is bound by three mountain ranges: The Cascade Range to the east, the Coast Range to the west, and the Calapooya Mountains to the south. Maximum elevations exceed 10,000 feet in the Cascade Range, 4,000 feet in the Coast Range, and 6,000 feet in the Calapooya Mountains.

In the upper reaches, Willamette River tributaries flow in narrow valleys with steep gradients. Major Cascade Range tributaries include the Santiam, McKenzie, Middle Fork of the Willamette, Molalla, and Clackamas rivers. The Willamette River is also fed by major tributaries from the Coast Range, including the Long Tom, Marys, Luckiamute, Yamhill, and Tualatin rivers. At the south end of the basin, the Coast Fork of the Willamette River emerges from the Calapooya Mountains and joins the mainstem Willamette River near the City of Springfield. Annual precipitation in the Willamette River basin ranges from 40 to 200 inches depending on location. The average annual flow at Salem (river mile 84, drainage area of 7,280 square miles) for the water years 1910-2015 was 23,300 cubic feet per second (cfs) or about 16.9 million acre-feet per year (USACE, 2017).

Forested land covers approximately 70 percent of the watershed and dominates the foothills and mountains of the Coast and Cascade Ranges (USEPA, 2013). Agricultural land (mostly cropland) comprises approximately 22 percent of the basin and is located predominantly in the Willamette Valley (USEPA, 2013). About one-third of the agricultural land is irrigated, and most of this irrigated agricultural land is adjacent to the main stem Willamette River in the southern portion of the basin or scattered throughout the northern valley. Urban land comprises approximately six percent of the basin and is located primarily in the valley along the mainstem Willamette River (USEPA, 2013).

4.8.2 Past Actions

Prior to the start of WS dam construction in sub-basins where spring Chinook salmon populations occurred, the count of wild spring Chinook salmon returning to Willamette Falls was about 55,000 in 1946 and 47,000 in 1947. WS dams and revetments were constructed mostly in eastside tributaries of the Willamette Basin during the 1950s and 1960s. Although runs were already in decline due to fishing and land use practices, runs continued to diminish as WS dams were constructed in the Santiam, McKenzie, and Middle Fork sub-basins, to less than 20,000 wild Chinook after 1960. Willamette System projects block access to critical habitat for

ESA-listed species. While fish passage at high head dams continues to be evaluated, Congress approved authority for the Willamette Hatchery Mitigation Program (Corps 1948).

4.8.3 Present Actions

Actions have been completed as part of the 2007 BA/2008 RPA implementation, which include construction of three new adult fish facilities in various stages of planning (Cougar, Detroit, Minto, Fall Creek) for collection and transport to upstream habitats. Fall Creek and Minto have been completed while Foster is in planning stages for an updated weir with improved dam passage efficiency. Ongoing efforts include operations for downstream fish passage and temperature improvement implemented at several dams, improvements to adult fish release sites at spawning grounds above the dams, and ongoing research to fill data gaps supporting alternative selection and design. While it is generally accepted that upstream passage can be accomplished through appropriate infrastructure and best management practices, downstream passage effectiveness is less certain and potential solutions are complicated by large elevation fluctuations for flood control. Therefore, the WS Project impacts are less certain with respect to the feasibility of juvenile downstream survival.

4.8.4 Cumulative Effects to Fish and Aquatic Habitat from Reasonably Foreseeable Future Actions

4.8.4.1 RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Within the counties that comprise the WRB, human populations are continuing to increase. This growth is occurring primarily in urban metropolitan areas with smaller increases in rural areas.

If the relationship between the increase in population and the increase in developed land continues into the future, and mirrors the trend that existed from 1982 to 2017, developed land area of the WRB from 2020 to 2050 would be estimated to increase by 28 percent.

Municipal water demands may increase, which may be met by increased withdrawals from the WVS.

Increased urban development would decrease upland habitat and increase impervious surface in the area, changing the physical, chemical, hydrological, and ecological characteristics of stream ecosystems. In most cases, such changes are detrimental to native fish and wildlife.

The rate of exurban (area just beyond denser suburbs) development also appears to be increasing. Exurban development is generally associated with direct habitat conversion and loss for fish and wildlife species. Human population growth and development often leads to increased discharges of non-point source pollutants in stormwater runoff from residential, commercial, industrial, agricultural, recreational, and transportation land uses.

Projects to deepen channels or modify ports in Portland, OR may necessitate increasing numbers of ships and cargo tonnage on the lower Willamette and increasing rail freight and truck traffic on transportation corridors in the WRB that are linked to that port. Increased volumes of materials such as hazardous products and fuels that power trains, vessels, and trucks will likely move through the WRB in response to the demands of a growing population.

With increased movement of raw materials and manufactured goods via all three modes, more accidents and spills would be likely. Mining, logging, trade, and transportation projects also influence the hydrology, water quality, and land use in the WRB and WVS. Overall, this RFFA interacts cumulatively with all of the resources listed in Table 4.2-6.

Future population growth and accompanying urban, industrial, and commercial development (RFFA 1) would increase local inflow in winter into river reaches downstream of the WVS dams during and increase demand for water withdrawals in consumptive uses (see RFFA 3 analysis below). The increased runoff could increase non-point source pollutants affecting fish health, behavior and survival. Increased winter flows could increase inundation of off-channel river features and the flood plain, which may provide additional habitat for rearing native fish. Increased demand for water withdrawals associated with population growth and development would increase summer water temperatures where they decrease instream flow. Fish habitat availability could increase or decrease depending on the timing and magnitude of instream flow changes, river reach affected, and the fish species life history and life stage.

4.8.4.2 RFFA 2—Future Agricultural Development

Human population growth and related development have contributed to the decline of agricultural lands within the WRB.

Population projections show strong growth for each of the 10 counties, land conversion and development pressures are likely to continue and the area of cropland within the WRB will likely continue to diminish. Reduced cropland acreage may reduce demands for agricultural irrigation water withdrawn from the WRB. Less cropland could also result in less soil erosion from wind and rain. Overall, this RFFA interacts cumulatively with most of the resources listed in Table 4.2-6, including but not limited to land use, soils, wetlands, listed species and critical habitat, socioeconomics, water supply, and visual resources.

Agricultural land conversion and development pressures from population growth are projected to continue, and thus the area of cropland within the WRB will likely continue to diminish. Reduced cropland acreage may reduce demands for agricultural irrigation water withdrawn from the WRB. Decreased water demand would reduce water withdrawals for croplands from streams, and reduce exposure to agricultural pollutants from converted croplands. Negative effects from croplands on water quality and instream flow would be reduced, potentially improving habitat and survival of fish.

4.8.4.3 RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

Water usage within the WRB is likely to increase in the future, especially as human population growth, associated development, and climate change continue to affect water availability and scarcity in the region.

Water demand for irrigation usage (as seen in green) is predicted to remain relatively stable over the course of the 21st century; whereas water demand for municipal and residential usage (as seen in blue) would increase, likely linked to factors such as increasing human population projections and the evolving effects of climate change (WW2100, No Date).

By reducing the amount of water flowing through the WVS, increased withdrawals have implications for instream flow and for maintenance of riparian and aquatic habitats for fish and wildlife. New water withdrawals are typically subject to regulatory restrictions which might partially offset their negative effects. In the model's scenario, urban areas in general would be able to meet water needs with existing water rights, which would also include maintaining important water sources from outside the basin, such as the Bull Run watershed that supplies the City of Portland (WW2100, No Date). Overall, this RFFA interacts cumulatively with most of the resources listed in Table 4.2-6, including but not limited to water supply, socioeconomics, listed species and critical habitat, water quality, and hydrological processes.

Increased water demands are expected to increase water withdrawals, particularly in the mainstem Willamette River downstream of Salem, OR (see WBR EA/BA). Increases in water withdrawals downstream from WVS dams in the 30 year period after the ROD (until ~2050) were accounted for when assessing the effects of the alternatives in the Environmental Consequences section, but not for streams in the WRB not regulated by the WVS, or beyond 2030. The effect of increased water withdrawals in these other streams, and in the WBR at large beyond 2030, would be to increase water temperatures in the WRB streams and rivers, potentially increase the concentration of toxic pollutants, and change habitat availability. The effect of increased water withdrawals on fish depends on the location, magnitude, timing and duration of the withdrawals and associated return flows. Because most of the increase in withdrawals are expected to occur during summer months downstream of Salem OR, the effect on ESA-listed fish (spring Chinook, winter steelhead and bull trout) will be limited since very few adults or juveniles are present in the mainstem during summer months. Increasing stored water releases from WVS reservoirs to meet new water withdrawals on the mainstem will increase flows in Willamette River tributaries, where both adult and juveniles are present in the summer. In these tributaries, increased flows would reduce peak summer water temperatures, however habitat availability could either increase or decrease depending on river reach, and species/life stage.

4.8.4.4 RFFA 4—Decarbonizing the Energy Sector with Renewable Energy Sources

Oregon's Renewable Portfolio Standard sets the requirement for how much of the state's electricity must come from renewable sources. In March 2016, this standard was set to require 50 percent of Oregon's electricity to come from renewables by 2040 (ODEQ, No Date-e).

Hydropower facilities typically provide more than half of the electricity generated in Oregon; natural gas fuels the second-largest share of Oregon's electricity generation, while non-hydroelectric renewable resources, including wind, biomass, solar, and geothermal power, provide almost the rest of Oregon's generation.

Decarbonizing the energy sector with renewable energy sources (RFFA 4) could have a number of conflicting impacts. Increasing development of wind and solar generation could reduce the demand for hydropower generation. Alternatively, the increase in solar and wind projects may increase the demand for hydropower due to its baseload and flexibility capabilities.

If decarbonizing the energy sector with renewable energy sources reduces the demand for hydropower generation, this could benefit fish and aquatic habitat downstream by increasing operational flexibility of WVS dams and reservoirs to meet non-hydropower missions, including fish passage and water temperature operations. Conversely if decarbonizing the energy sector with renewable energy sources increases the demand for hydropower leading to increased power peaking operations or use of turbines at WVS dams, then these changes could decrease fish passage rates or survival and could affect water temperature management.

4.8.4.5 RFFA 6—Federal and State Wildlife and Lands Management

The WRB contains abundant public lands, especially in the headwaters and higher elevations. These lands would continue to be managed for multiple purposes, such as watershed protection, wildlife and habitat conservation, recreation, livestock grazing, resource extraction (e.g., logging, mining), and other public uses.

The Oregon Department of Fish and Wildlife (ODFW) and the U.S. Fish and Wildlife Service (USFWS) would continue to implement management activities at the Willamette Valley National Wildlife Refuge Complex.

The way that these lands are managed within the WRB can have cumulative effects when added to the actions proposed in this Draft EIS. In particular, water management, soil management, vegetation management, and fire management can have important additive effects that could be either beneficial or adverse depending on the nature of the management action. Overall, this RFFA interacts cumulatively with most resources, including but not limited to land use, water and air quality, socioeconomics, flood risk management, water supply, recreation, listed species and critical habitat, hazardous algal blooms, tribal and cultural resources, and environmental justice.

Baker et al. (2004) discuss alternative futures for land use in the WRB in 2050. Likely actions included those that converted agricultural to urban land use and higher prioritization on wildlife and conservation initiatives. The suite of actions analyzed under theEIS are intended to be compatible with multiple land use approaches and conservation obligations. With the exception of future water availability, it is expected that conservation initiatives would improve the population status of endangered fish in the WRB.

It is expected that with the implementation of passage and conservation initiatives, the state's hatchery program could result in competing objectives for recreational angling and conservation. The original intent of the authorization for game fish hatcheries did not consider the recreational benefits to the State from reservoir inundation, nor the increasing budget needed to maintain services for an expanding recreational fishing industry.

Retail sales for sport fishing in 2016 generated $680M in revenue and provided 11,000 jobs in the State of Oregon (Testimony of the Northwest Sportfishing Industry Association 2015 to Congress). Despite this, the State has encountered budget shortfalls as mission areas expand for conservation and ESA requirements but available spending for these programs remains the same or has declined. In 2014, ODFW expressed concerns of shrinking budgets, expanding conservation responsibilities, and increasing reliance on fishing and hunting licenses to support program missions (ODFW 2014). The popularity and revenue generation from recreational angling is particularly dependent on active stocking of game fish, Chinook salmon, and summer steelhead hatchery production.

Although the Corps has continued to contribute to game fish stocking and hatchery programs to meet harvest missions, the magnitude of angling activity in Oregon has expanded beyond the stream angling experience of the late 1930s. It is expected that the hatchery program will need to be adjusted to accommodate improved habitat and passage conditions.

It is also expected that the USFWS Willamette Valley Wildlife Refuge Complex, which includes Ankeny, William L. Finley, and Baskett Slough would continue to be managed into the future.

4.8.4.6 RFFA 7—Pacific Ocean Fishery Management

Commercial and recreational fishing of Pacific salmon is multi-jurisdictional and multi-national. The evaluation of oceanic fishing is overseen by many agencies. However, the most robust analyses come from the Pacific Salmon Commission. The Pacific Salmon Commission relies on observers, fishermen, and information from PIT, clipped, and coded wire tagged fish to inform harvest modeling. Much of this information can be used to forecast appropriate harvest management in the future. Alternative hatchery management and production schedules could impact hatchery produced fish available to harvest. However, it is expected that improved conservation initiatives could enhance overall abundance available to ocean fisheries. Wild fish are assumed to be natural more productive than their hatchery counterparts which would naturally favor a larger wild population if hatchery fish made up a smaller component and adequate downstream passage was implemented. Alternatively, changing ocean conditions and ocean survival can outstrip the benefits of passage and reduced hatchery pressure in a given year (see Appendix E). Therefore, it is expected that fishing performance in the future would be at least as variable as it is at present.

4.8.4.7 RFFA 8—Tribal, State, and Local Fish and Wildlife Improvement

Tribal, state, and local governments work independently or collaboratively on initiatives geared toward conservation, restoration, and public access to wildlife resources. Tribal actions are related to restoration and access to wildlife resources. Initiatives to preserve cultural resources is ongoing and expected to continue.

The state has several programs focused on conservation and habitat restoration. The 2010 memorandum of understanding details a wildlife mitigation program run jointly with Bonneville Power Administration and funded by Bonneville Power Administration. The program is intended to mitigate for the effects of inundation and construction of the Willamette Valley Project by acquiring land for purposes of habitat restoration. This program is expected to continue under the terms and deadlines of that memorandum and that the effects will result in an improvement to endangered fish and aquatic wildlife.

The state also operates several wildlife conservation, research, internship, and public outreach programs with local and private conservation entities. These programs will directly positively impact fish and wildlife through habitat restoration and mitigation actions and indirectly positively impact fish in wildlife through public education on wildlife resource management.

4.8.4.8 RFFA 9—Invasive Species Management

The state of Oregon with funding from BPA manages invasive species removal. Several local agencies also surveil for invasive species and evaluate invasive species risk. Many of these local efforts are also integrated with habitat restoration. It is expected that with changes to water availability, future urbanization and withdrawals, the risk for invasive species to colonize in the Willamette in the future will be greater. Invasive species management may need to be increased to avoid detrimental effects in the future. Invasive species may have direct impacts through competition or predation, or indirect effects through reduction of critical habitat attributes.

4.8.4.9 RFFA 10—Climate Change

The RMJOC-II report (2018) found the following for the 2020 to 2049 time period:

- Temperatures in the region have already warmed about 1.5 degrees Fahrenheit (°F) since the 1970s. Temperatures are expected to warm another 1 to 4°F by the 2030s.
- Future precipitation trends are more uncertain, but higher precipitation is likely for the rest of the 21st century, particularly in the winter months. Already-dry summers could become drier.
- The incidence of large forest fires as seen in Figure 4.2-6 has increased since the early 1980s and is projected to continue increasing through the 21st century as air surface temperatures continue to rise. Wildfire alters the land surface and can have strong influences on runoff, vegetation dynamics, erosion and sediment transport, and ecosystem processes. Strong seasonality and dependence on spring snowmelt positions the WRB to be at risk for increased fires due to the effects of climate change.
- Average winter snowpacks in the mountains surrounding the Willamette Valley are very likely to decline over time as more winter precipitation falls as rain instead of snow.

- By the 2030s, higher average fall and winter flows on WRB streams and rivers, earlier peak spring runoff, and longer periods of low summer flows are very likely.

Effects of climate change were accounted for when assessing the effects of the alternatives in the Environmental Consequences section to 2050 including assumptions (Table 4.8-1).

Table 4.8-1. Climate Change Assumptions.

	Increasing winter flow, decreasing summer flow and reservoir levels	Increasing water temperatures in streams and reservoirs
Adult Holding and Spawning	Decrease in available habitat	Increase in pre-spawn mortality
Incubation	Mortality from redd dewatering or scouring	Earlier emergence and earlier ocean entry
Rearing and Emigration	Increased frequency of displacement or mortality during flooding. Decrease or elimination of summer habitat; particularly for bull trout at decreasing elevations	Decrease or elimination of summer habitat; particularly for bull trout at decreasing elevations. Earlier emigration timing and earlier ocean entry of salmon and steelhead.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

Below dams, effects of climate change on fish will vary depending on WVS dams and reservoir operations. During the conservation storage and delivery seasons (Feb 1 to Sep 31) stored water can supplement natural flows in later spring to fall downstream of WVS dams. Discharged water temperatures from each dam can influence downstream river reaches to near each tributary confluence with the mainstem Willamette River. WVS stored water releases in later spring to fall can also influence water temperatures in the mainstem Willamette River. These effects will help reduce some of the negative effects of higher temperatures (increase in adult pre-spawn mortality from higher temperatures, increase in egg or juvenile displacement from higher winter flows, decrease in rearing habitat from higher water temperatures). The extent dams and reservoirs influence below dam flows and water temperatures depends on the measures included in each WVS PEIS alternative.

Most future mining activities would be expected in either Clackamas or Douglas Counties. Very little of the WRB exists in Douglas County, therefore any effects from mining on WRB fish would be largely expected within the Clackamas County in the Clackamas River Subbasin. These effects could include water quality degradation from sedimentation or release of hazardous materials into natural water bodies or those connected with natural water bodies within the Clackamas River Sub-basin. Poor water quality could decrease fish health and survival (Table 4.8-2).

Table 4.8-2. Summation of Effects of RFFAs on Fish and Aquatic Habitat.

RFFA	RFFA Title	Summary effects on fish and aquatic habitat
RFFA 1	Future population growth and accompanying urban, industrial, and commercial development	Increased runoff leading to non-point source pollutants affecting fish health, behavior and survival; increased winter flows leading to increased off-channel or floodplain habitat for rearing fish; increased summer water temperatures where withdrawals decrease instream flow leading to changes in fish habitat availability, particularly in the mainstem Willamette River.
RFFA 2	Future agricultural development	Conversion/development of croplands will decrease water demand and water pollutants from croplands, improving aquatic habitat for fish.
RFFA 3	Water withdrawals for municipal, industrial, and agricultural uses	Increased water demands, particularly below Salem, leading to increased water temperatures, pollutant concentrations, and change aquatic habitat availability. Limited negative effect on ESA-listed fish expected (spring Chinook, winter steelhead and bull trout) since very few adults or juveniles are present in the mainstem during summer months, and some positive effects may occur within tributaries from increasing stored water releases from WVS reservoirs on tributaries to meet new water withdrawals on the mainstem.
RFFA 4	Decarbonizing the energy sector with renewable energy sources	If the demand for hydropower generation decreases, this could benefit fish and aquatic habitat downstream by increasing operational flexibility of WVS dams and reservoirs to meet non-hydropower missions, included those for fish passage and water temperature. Conversely if the demand for hydropower increases leading to increased power peaking operations or use of turbines at WVS dams, then these changes could decrease fish passage rates or survival and could affect water temperature management.
RFFA 6	Federal and state wildlife and lands management	Adjustments to fish hatchery programs to accommodate for improved fish passage conditions at dams and reduce effects on conservation of wild fish; continued operation and maintenance of the USFWS Willamette Valley Wildlife Refuge Complex
RFFA 7	Pacific Ocean fishery management	Fishing performance in the future would be at least as variable as it is at present due to variability in ocean conditions and fish survival in the ocean, and changes in salmon hatchery production.
RFFA 8	Tribal, state, and local fish and wildlife improvement	Positively impact on fish through habitat restoration and mitigation actions and indirectly positive impacts on fish through public education on resource management. Locations and magnitude of impacts uncertain.

RFFA	RFFA Title	Summary effects on fish and aquatic habitat
RFFA 9	Invasive species management	Increased negative effects (primarily competition and predation) on native fish and aquatic habitat availability from invasive species.
RFFA 10	Climate change	Decrease in habitat available for spawning and rearing. Increase in adult pre-spawn mortality, change in incubation and emergence timing and decrease in summer habitat availability and quality

4.8.4.10 No-action Alternative

Negative impacts from the RFFAs include those from increased winter runoff, increased water temperatures from water withdrawals, and non-point source pollutants from population growth and development degrading aquatic habitat conditions and reducing fish health and survival. Water withdrawals for municipal and industrial (M&I) uses will also decease flows downstream of Salem, however since very few are present in the mainstem during summer months, limited negative effects on ESA-listed fish (spring Chinook, winter steelhead and bull trout) are expected from these M&I withdrawals. Effects of decarbonizing the energy sector with renewable energy sources is difficult to predict, however if the demand for hydropower increases leading to increased power peaking operations or use of turbines at WVS dams, then these changes could decrease fish passage rates or survival and could affect water temperature management. Increased negative effects from invasive species on native fish (primarily competition and predation) is also expected to increase, in particular due to climate change effects favoring invasive species.

Some positive effects of RFFAs on fish and aquatic habitat in the WRB can also be expected. Conversion/development of croplands will decrease water demand and water pollutants, improving aquatic habitat conditions for fish. If the demand for hydropower generation decreases, this could benefit fish and aquatic habitat downstream by increasing operational flexibility of WVS dams and reservoirs to meet non-hydropower missions, included those for fish passage and water temperature. Fishing performance in the future would be at least as variable as it is at present due to variability in ocean conditions and fish survival in the ocean, and changes in salmon hatchery production. Ongoing and future aquatic and riparian habitat restoration and mitigation actions would also be expected to directly and indirectly have positive impacts on fish. HGMP outplant numbers of Chinook salmon are not expected to change under any alternative. Anadromous hatchery origin Chinook salmon that return from sea to freshwater collection facilities will continue to be outplanted above WVS dams as regulated through HGMPs. Supplementation of anadromous salmon above dams, may deliver marine-derived nutrients and organic matter to freshwater and riparian environments (Rex and Petticrew 2008). Analytical analyses of marine origin nutrients, such as, Carbon, Nitrogen, Phosphorus, and Sulfur, have found that post-spawn salmon are a major contributor of marine nutrient deposition to the surrounding stream, lake, and/or riparian zones (Naiman et al. 2002, Rex & Petticrew 2008). Abundance of natural origin fish populations is expected to be less under the NAA when compared to the other alternatives. Therefore, the amount of marine derived nutrients above dams is expected to be less under the NAA.

RFFAs are expected to infer a net negative impact in addition to the effects accounted for in the Environmental Consequences section. Poor fish passage conditions at WVS dams will continue to significantly constrain population viability of ESA-listed salmon and steelhead, and effects of RFFAs on habitat conditions below dams will further reduce population viability. Similarly, RFFAs also will infer a net negative impact for bull trout, stemming primarily from climate change-related contraction of existing habitat occupied above WVS dams (increased winter flows, decreased summer low flows, increased water temperatures) in high elevation areas. Under the NAA, bull trout do not have effective access to below dam habitat, however stream reaches below dams will further degraded in the future and not be expected to provide any suitable spawning areas, experience a reduction and degradation in available rearing habitat, and survival rates of bull trout below dams would be expected to decline due to increases in recognized risk factors.

4.8.4.11 Alternative 1—Improve Fish Passage through Storage-focused Measures

Alternative 1 is a storage themed alternative with the intent to store water for multiple uses across the Corps' authorizations. Under Alternative 1, at-dam structures proposed for Detroit, Green Peter, Foster and Lookout Point dams provided for fish passage and water temperature management while promoting storage, integration with hydropower, and downstream water uses nearest communities that are expected to increase in population and likely water demand downstream. Minimum flows for fish as included are designed to adjust with real-time water availability, supporting downstream fish passage measures, and habitat and water temperature needs for fish below dams.

With respect to future population growth, urbanization, industrial, and commercial development, demand for this storage would increase and specific allocation would need to be forecasted with respect to fish and wildlife needs. While there may be greater public demand for access to stored water, fish and wildlife needs would also need to be prioritized. Given the uncertainty of water availability in the future and the expected increase in wildfire frequency with ongoing climate change, the ability to store more water earlier in the year may become a very valuable resiliency strategy. It is expected that as demand for agricultural use becomes less frequent with conversion to urban uses, negative impacts from effluent and agricultural runoff will positively affect fish and wildlife resources. Increased municipal water demand would likely compete with endangered fish and aquatic species needs such that stored water would likely need to be prioritized among interests. Increased urbanization expected in the future would likely mean a greater need for decarbonization and possibly greater demand for hydropower. This could indicate a need for stored water and a greater emphasis on at dam structural fish passage that is integrated with turbine operations. Federal and state land management downstream of project may be directly impacted by water storage practices, however, conservation efforts above project where the majority of quality habitat for endangered fish is expected to be, would likely be improved under Alternative 1. Pacific Ocean harvest management is unlikely to be directly affected but may be indirectly affected by the percentage of hatchery fish that make up total catch. It is expected that water storage would most likely support above dam populations of natural origin endangered fish, which are assumed to be more productive than their hatchery counterparts. While the catchability of hatchery origin fish may decrease, the catch of natural origin fish is expected to increase. HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 1 is similarly expected to be better than under the NAA. Tribal, state, and local land management may be negatively impacted downstream of project depending on the allocation and water year type experienced in any given year. However, it is expected that the opportunity for improvement, on average, would be better than the NAA. Invasive species management may become more complex under Alternative 1. However, this complexity may well be buffered by the ability to allocate stored water such that negative impacts to endangered fish and aquatic species would be mitigated through adequate planning of stored water use. With respect to climate change, water storage is likely to be a more resilient planning strategy due to the fact that precipitation patterns and snowpack are expected to be more variable (and less predictable). While water availability forecasting is relatively limited, water storage early in the year allows for a buffer against unexpected climatic events that may occur later in the year (i.e., flows needed for fish later in the year). Overall, while Alternative 1 may not perform the best over other alternatives, it does provide some resiliency for fish and wildlife given the uncertainties with respect to urbanization, land use, climate change, and water use needs predicted in the future.

4.8.4.12 Alternative 2A—Integrated Water Management Flexibility and ESA-listed Fish Alternative

Alternative 2A is an integrated water management alternative that balances practical public need with operational flexibility that may better reflect the historic hydrograph with respect to endangered fish and aquatic species. This alternative integrates a mixture of at-dam downstream passage solutions with operational solutions. At-dam structural solutions to downstream fish passage are proposed at Detroit Dam, Foster Dam, and Lookout Point Dam. Operational downstream passage is proposed at Green Peter Dam and Cougar Dam. Future population growth under this alternative will likely have lesser impact to endangered fish and aquatic species due to implementation at projects where storage is prioritized over operational passage.

Under Alternative 2A, an at-dam structure proposed for Detroit and Lookout Point dams promote storage, integration with hydropower, and downstream water uses nearest communities that are expected to increase in population and likely water demand downstream. Operational measures for downstream fish passage are proposed for Green Peter and Cougar dams. Given the uncertainty of water availability in the future and the expected increase in wildfire frequency with ongoing climate change, the ability to store more water earlier in the year may become a very valuable resiliency strategy. Minimum flow targets proposed are responsive to water storage availability in the spring. Minimum flows for fish as included are designed to adjust with real-time water availability, supporting downstream fish passage measures, and habitat and water temperature needs for fish below dams. However, the reservoir drawdown to the regulating outlet at Cougar Dam in spring proposed at Cougar Dam for downstream fish passage will eliminate much of the ability to store water in Cougar Reservoir specifically.

It is expected that agricultural demand will decrease over time as use shifts to urban expansion and municipal uses. Water withdrawals are expected to increase which will impact endangered fish and aquatic species below project negatively. Demand for hydropower may increase which will likely show positive responses for endangered fish and aquatic species where at-dam/turbine friendly solutions are prioritized, a slightly positive effect on endangered fish and aquatic species where operational downstream passage is prioritized, and a detrimental effect from decarbonization leads to increased hydropower operations where operational downstream fish passage is prioritized. Federal and state wildlife and land management would likely be less affected in terms of direct and indirect effects. Where there are opportunities for storage at large projects such as Detroit where water availability would be more variable, agencies could incorporate adaptive planning. Where operational downstream fish passage is implemented, planning would be adaptive to endangered fish and aquatic species needs without sacrificing critical habitat. HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative (2A) is similarly expected to be better than under the NAA. Pacific Ocean harvest would likely reflect outcomes described under Alternative 1. Tribal, state, and local wildlife management would likely reflect outcomes described under Alternative 1. Invasive species management would likely be complicated by the combination of at-dam storage and operational downstream passage approaches. This could result in management plans that are more reactive given that such operations have not yet been observed and monitored.

4.8.4.13 Alternative 2B—Integrated Water Management Flexibility and ESA-listed Fish Alternative

Alternative 2B is also an integrated water management alternative. Downstream fish passage at Cougar Dam is proposed as a spring and fall reservoir drawdown to the diversion tunnel in Alternative 2B, otherwise fish passage and water quality measures are the same in Alternative 2A and 2B. Operational fish passage at Cougar Dam proposed for this Alternative is estimated to be more effective that that proposed for Alternative 2A at Cougar Dam.

Future population growth under this alternative will likely have lesser impact to endangered fish and aquatic species due to implementation at projects where storage is prioritized over operational passage. Under Alternative 2B, an at-dam structure proposed for Detroit and Lookout Point dams promote storage, integration with hydropower, and downstream water uses nearest communities that are expected to increase in population and likely water demand downstream. Operational downstream passage is proposed at Green Peter and Cougar dams where urbanization downstream is unlikely to increase and effects on the public are expected to be less impactful.

Minimum flow targets proposed are responsive to water storage availability in the spring. Minimum flows for fish as included are designed to adjust with real-time water availability, supporting downstream fish passage measures, and habitat and water temperature needs for fish below dams. However, the reservoir drawdown to the regulating outlet at Cougar Dam in spring proposed at Cougar Dam for downstream fish passage will eliminate much of the ability to store water in Cougar Reservoir specifically.

It is expected that agricultural demand will decrease over time as use shifts to urban expansion and municipal uses. Water withdrawals are expected to increase which will impact endangered fish and aquatic species below project negatively. Demand for hydropower will likely increase which will likely show positive responses for endangered fish and aquatic species where at-dam/turbine friendly solutions are prioritized, a slightly positive effect on endangered fish and aquatic species where operational downstream passage is prioritized, and a detrimental effect on decarbonization where operational downstream passage is prioritized. Federal and state wildlife and land management would likely be less affected in terms of direct and indirect effects. Where there are opportunities for storage at large projects such as Detroit where water availability would be more variable, agencies could incorporate adaptive planning. Where operational downstream fish passage is implemented, planning would be adaptive to endangered fish and aquatic species needs without sacrificing critical habitat. HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 2B is similarly expected to be better than under the NAA. Pacific Ocean harvest would likely reflect outcomes described under Alternative 1. Tribal, state, and local wildlife management would likely reflect outcomes described under Alternative 1. Invasive species management would likely be complicated by the combination of at-dam storage and operational downstream passage approaches. This could result in management plans that are more reactive given that such operations have not yet been observed and monitored.

4.8.4.14 Alternative 3A—Improve Fish Passage through Operations-focused Measures

Alternative 3A is focused on operational measures at WVS dams for fish passage and water quality. Operational measures for fish passage and water quality are less resilient to changes associated with RFFAs, when compared to structural measures, since structural measures are designed to be effective at a range of reservoir pool elevations and discharge rates, whereas operational measures effectiveness varies with reservoir elevation/volume, discharge outlets available, and discharge rates.

Minimum flows for fish as included are designed to adjust with real-time water availability in spring, supporting downstream fish passage measures, and habitat and water temperature needs for fish below dams. Given the uncertainty of water availability in the future and the expected increase in wildfire frequency with ongoing climate change, the ability to store more water earlier in the year may become a very valuable resiliency strategy.

Spring reservoir drawdowns for fish significantly decrease resiliency since the availability of storage water is substantially reduced. Spring drawdowns will reduce water available for supplementing naturally low flows in summer and fall, managing summer and fall water temperatures, and reduce reservoir habitat for fish remaining above dams. Spring drawdowns to regulating outlets occur at Detroit, Lookout Point, and Cougar dams in Alternative 3A.

Lower stream flows below dams resulting for spring drawdowns of reservoirs in the North Santiam, McKenzie and Middle Fork will be further negatively impacted by population growth and development, municipal and industrial (M&I) uses which increase water temperatures from water withdrawals, and non-point source pollutants reducing fish health and survival. However, since very few adults or juveniles are present in the mainstem during summer months, limited negative effects on ESA-listed fish (spring Chinook, winter steelhead and bull trout) are expected from M&I withdrawals in particular since most are predicted to occur downstream of Salem. If the demand for hydropower increases leading to increased power peaking operations or use of turbines at WVS dams, then these changes could decrease fish passage rates or survival and could affect water temperature management. Increased negative effects from invasive species on native fish (primarily competition and predation) is also expected to increase, in particular due to climate change effects favoring invasive species. Fishing performance in the future would be at least as variable as it is at present due to variability in ocean conditions and fish survival in the ocean, and changes in salmon hatchery production. HGMP outplant numbers above dam are not expected to differ under this alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 3A is similarly expected to be better than under the NAA.

Some positive effects of RFFAs on fish and aquatic habitat in the WRB may counter-balance some of the negative effects. Conversion/development of croplands will decrease water demand and associated water pollutants. Adjustments to fish hatchery programs would be expected to accommodate for improved fish passage conditions at dams and reduce effects on wild fish conservation. If the demand for hydropower generation decreases, this could benefit fish and aquatic habitat downstream by increasing operational flexibility of WVS dams and reservoirs to meet non-hydropower missions, included those for fish passage and water temperature. Ongoing and future aquatic and riparian habitat restoration and mitigation actions would also be expected to directly and indirectly have positive impacts on fish.

4.8.4.15 Alternative 3B—Improve Fish Passage through Operations-focused Measures

Alternative 3B is also focused on operational measures at WVS dams for fish passage and water quality. As described for 3A, operational measures for fish passage and water quality are less resilient to changes associated with RFFAs, when compared to structural measures. Spring drawdowns, in particular where they occur, significantly decrease resiliency. Spring drawdowns to regulating outlets occur at Green Peter and Hills Creek, and to the diversion tunnel at Cougar Dam in Alternative 3A.

Lower stream flows below dams resulting for spring drawdowns of reservoirs in the South Santiam, McKenzie and Middle Fork will be further negatively impacted by population growth and development, municipal and industrial (M&I) uses which increase water temperatures from water withdrawals, and non-point source pollutants reducing fish health and survival. However, since very few adults or juveniles are present in the mainstem during summer months, limited negative effects on ESA-listed fish (spring Chinook, winter steelhead and bull trout) are expected from M&I withdrawals in particular since most are predicted to occur downstream of Salem.

Bull trout relying on Cougar Reservoir for rearing will likely re-distribute upstream into the South Fork McKenzie watershed or below Cougar Dam, which could lead to density dependent effects from habitat and food limitations and exposure to poorer habitat conditions lower in the McKenzie Sub-basin. If the demand for hydropower increases leading to increased power peaking operations or use of turbines at WVS dams, then these changes could decrease fish passage rates or survival and could affect water temperature management. Increased negative effects from invasive species on native fish (primarily competition and predation) is also expected to increase, in particular due to climate change effects favoring invasive species.

Fishing performance in the future would be at least as variable as it is at present due to variability in ocean conditions and fish survival in the ocean, and changes in salmon hatchery production. HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 3B is similarly expected to be better than under the NAA.

As for Alternative 3B, some positive effects of RFFAs on fish and aquatic habitat in the WRB may counter-balance some of the negative effects. Conversion/development of croplands will decrease water demand and associated water pollutants. Adjustments to fish hatchery programs would be expected to accommodate for improved fish passage conditions at dams and reduce effects on wild fish conservation. If the demand for hydropower generation decreases, this could benefit fish and aquatic habitat downstream by increasing operational flexibility of WVS dams and reservoirs to meet non-hydropower missions, included those for fish passage and water temperature. Ongoing and future aquatic and riparian habitat restoration and mitigation actions would also be expected to directly and indirectly have positive impacts on fish.

4.8.4.16 Alternative 4—Improve Fish Passage with Structures-based Approach

Alternative 4 is a structural downstream passage themed alternative with the intent to prioritize and operate with a focus on ESA-listed fish species. Proposed downstream fish passage structures are proposed for Detroit, Foster, Cougar, Hills Creek and Lookout Point dams.

Minimum flows for fish as included are designed to adjust with real-time water availability in spring, supporting downstream fish passage measures, and habitat and water temperature needs for fish below dams. Given the uncertainty of water availability in the future and the expected increase in wildfire frequency with ongoing climate change, the ability to store more water earlier in the year may become a very valuable resiliency strategy.

With respect to future population growth, urbanization, industrial, and commercial development, demand for this storage would increase and specific allocation would need to be forecasted with respect to fish and wildlife needs. While there may be greater public demand for access to stored water, fish and wildlife needs would also need to be prioritized. It is expected that as demand for agricultural use becomes less frequent with conversion to urban uses, negative impacts from effluent and agricultural runoff will positively affect fish and wildlife resources.

Increased municipal water demand would likely compete with endangered fish and aquatic species needs such that stored water would likely need to be prioritized among interests. Increased urbanization expected in the future would likely mean a greater need for decarbonization and possibly greater demand for hydropower. This could indicate a need for stored water and a greater emphasis on at dam structural fish passage that is integrated with turbine operations. Federal and state land management downstream of project may be directly impacted by water storage practices, however, conservation efforts above project where the majority of quality habitat for endangered fish is expected to be, would likely be improved under Alternative 4.

Pacific Ocean harvest management is unlikely to be directly affected but may be indirectly affected by the percentage of hatchery fish that make up total catch. It is expected that water storage would most likely support above dam populations of natural origin endangered fish, which are assumed to be more productive than their hatchery counterparts. While the catchability of hatchery origin fish may decrease, the catch of natural origin fish is expected to increase. HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 4 is similarly expected to be better than under the NAA.

Tribal, state, and local land management may be negatively impacted downstream of project depending on the allocation and water year type experienced in any given year. However, it is expected that the opportunity for improvement, on average, would be better than the No Action Alternative. Invasive species management success is expected to be similar or better given the implementation of biological downstream flows.

With respect to climate change, water storage is likely to be a more resilient planning strategy due to the fact that precipitation patterns and snowpack are expected to be more variable (and less predictable). While water availability forecasting is relatively limited, water storage early in the year allows a for a buffer against unexpected climatic events that may occur later in the year (i.e., flows needed for fish later in the year). Alternative 4 provides some resiliency for fish and wildlife given the uncertainties with respect to urbanization, land use, climate change, and water use needs predicted in the future.

4.8.4.17 Alternative 5—Preferred Alternative—Refined Integrated Water Management Flexibility and ESA-listed Fish Alternative

Alternative 5 is functionally similar to Alternative 2B and it is anticipated that the cumulative effects under Alternative 5 will be indistinguishable from cumulative effects under Alternative 2B. Alternative 5, similar to alternatives 2A and 2B, is integrated water management alternative with small hydrological differences noted in Chapter 4 Hydrologic Processes. Downstream minimum flows are different below Big Cliff, Foster, Cougar and Dexter dams, otherwise fish passage and water quality measures are the same in alternatives 5 and 2B. Operational fish passage at Cougar Dam proposed for this Alternative is estimated to be more effective that that proposed for Alternative 2A at Cougar Dam.

Future population growth under this alternative will likely have lesser impact to endangered fish and aquatic species due to implementation at projects where storage is prioritized over operational passage. Under Alternative 5, at-dam structures for fish passage proposed for Detroit and Lookout Point dams promote storage, integration with hydropower, and downstream water uses nearest communities that are expected to increase in population and likely water demand downstream.

Minimum flow targets proposed are responsive to water storage availability in the spring. Minimum flows for fish included are designed to adjust with real-time water availability Downstream fish passage operations at Green Peter Dam will utilize surface spill, promoting storage of water in the reservoir for fish other needs during the spring and summer. The reservoir drawdown to the regulating outlet at Cougar Dam in spring proposed at Cougar Dam for downstream fish passage will eliminate much of the ability to store water in Cougar Reservoir specifically. where urbanization downstream is unlikely to increase and effects on the public are expected to be less impactful.

It is expected that agricultural demand will decrease over time as use shifts to urban expansion and municipal uses. Water withdrawals are expected to increase which will impact endangered fish and aquatic species below project negatively. Demand for hydropower will likely increase which will likely show positive responses for endangered fish and aquatic species where at-dam/turbine friendly solutions are prioritized, a slightly positive effect on endangered fish and aquatic species where operational downstream passage is prioritized, and a detrimental effect on decarbonization where operational downstream passage is prioritized.

Federal and state wildlife and land management would likely be less affected in terms of direct and indirect effects. Where there are opportunities for storage at large projects such as Detroit where water availability would be more variable, agencies could incorporate adaptive planning.

Where operational downstream fish passage is implemented, planning would be adaptive to endangered fish and aquatic species needs without sacrificing critical habitat.

HGMP outplant numbers above dam are not expected to differ under any alternative in the short-term. Abundance of natural origin fish populations is expected to increase under all alternatives compared to the NAA. Therefore, the amount of marine derived nutrients above dams under Alternative 5 is similarly expected to be better than under the NAA.

Pacific Ocean harvest would likely reflect outcomes described under Alternative 1. Tribal, state, and local wildlife management would likely reflect outcomes described under Alternative 1. Invasive species management would likely be complicated by the combination of at-dam storage and operational downstream passage approaches. This could result in management plans that are more reactive given that such operations have not yet been observed and monitored.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.9 WILDLIFE AND HABITAT

TABLE OF CONTENTS

4.9 Wildlife and Habitat

THE WILDLIFE CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.9.1 Cumulative Actions Applicable to Wildlife and Habitat

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on wildlife and habitat when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on wildlife and habitat in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 6: Southern Resident Killer Whale Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate change
- RFFA 10: Mining Operations
- RFFA 11: Timber and Logging Industry Operations

4.9.2 Wildlife and Habitat Cumulative Effects Analysis Area

The wildlife and habitat analysis area is expanded from the area analyzed for direct and indirect effects in Section 3.9, Wildlife and Habitat. The RFFAs will impact wildlife and habitat beyond the Willamette Valley System (WVS) reservoirs. Therefore, the analysis area for cumulative effects encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). It is not anticipated that wildlife and habitat effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

4.9.3 Cumulative Effects on Wildlife and Habitat

A summary of RFFA impacts that would affect wildlife and habitat is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.9, Wildlife and Habitat, Table 3.9-4, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.9.3.1 Overview

The Willamette River Basin supports a multitude of aquatic and terrestrial habitat types that sustain rich assemblages of wildlife species. These assemblages include species that live year-round in its waters and associated floodplains, migratory species using seasonal habitat (e.g., breeding, wintering), wildlife movement corridors, and non-breeding/foraging habitats.

Direct and indirect analyses addressed aquatic habitats including open water (i.e., reservoir, main channel, secondary channels, backwaters, oxbows, and lakes/ponds) of varying depths. Terrestrial habitat analyses included wetlands, forests, oak savannas, grasslands, and shrublands (Section 3.9, Wildlife and Habitat).

The method used to assess direct effects to wildlife, birds, and associated habitat was a qualitative analysis based on species presence or absence or suitable habitat present in the analysis area.

Potential effects to wildlife and associated habitats within the analysis area are also the result of indirect effects related to hydrology, water quality, and fish passage measures proposed under each alternative.

At the time the alternatives were analyzed, Endangered Species Act-listed species in the analysis area included northern spotted owls, streaked horn larks, and Southern Resident killer whales. Northwestern pond turtles were candidate species for listing.

4.9.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on wildlife and habitat are described below. Water quality is a key component of wildlife and habitat health. Effects on analysis area water quality are addressed in Section 4.5, Water Quality.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. As the population increases throughout the Willamette River Basin, impacts on wildlife and habitat, including listed species, may increase as lands are converted to urban or industrial uses or wildlife and habitat adversely impacted from increases in human disturbance.

Impacts would include direct harm to individual wildlife and the eradication of habitat and habitat connectivity. Disturbances from noise, night lighting, pollution, and human presence can have substantial, adverse effects on wildlife. Habitat effects will continue in the Basin from decreased water availability, increased human presence, wetland and other specialized habitat losses, and increases in road mortality.

Population-related impacts can also result in increases in species that outcompete existing species throughout the Basin through introduction or habitat conversions that displace species and favor other species.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

At the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

Sustained water sources provided by reservoirs and downstream flows from withdrawal operations may be adverse or beneficial to species depending on habitat requirements. For example, sustained water would consistently provide aquatic prey for some wildlife species but may inundate eggs for other species. Downstream flows affect habitat connectivity, migration, and wetland and riparian habitat.

RFFA 5—Federal and State Wildlife and Lands Management

Federal lands management objectives in the analysis area can align with preservation of Willamette River Basin-wide wildlife habitat through land conservation practices. Wildlife management is a primary requirement for Federal and state lands management in the Basin. Additionally, conserving forested and other natural landscapes through Federal and state lands management can aid in preservation of wildlife habitat by preventing land disturbances and fostering ecological conditions conducive to habitat health.

For example, the USFWS would continue to implement management activities at the Willamette Valley National Wildlife Refuge Complex. The three refuges in the complex provide protection for historically abundant oak savanna, native prairie, riparian forest, and wetland habitats. These protected areas would continue to support habitat for wildlife in the Basin, including winter migration habitat for waterfowl.

Oregon State public lands in the Basin would continue to be managed to balance economic interest with wildlife conservation and land preservation. Public lands in headwaters areas would continue to be managed for wildlife and habitat conservation.

RFFA 6—Southern Resident Killer Whale Management

Increased production of Chinook salmon may accrue larger benefits to Southern Resident killer whales than harvest management actions (PFMC 2021). In the absence of substantial improvements in smolt-to-adult ratios of natural-origin fish, any reductions in Willamette Valley hatchery production would cause minor decreases in a key food resource available to Southern Residents. Prey from the Willamette River is not documented as a substantial source for Southern Resident killer whales (Hansen et al. 2021).

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvements

Watershed protection and conservation projects aimed at improvements in fish and wildlife habitat would necessarily preserve or improve riparian, wetland, and upland wildlife habitat over the 30-year implementation timeframe. Floodplain restoration projects will continue to promote improved habitat and habitat connectivity, thereby improving species abundance and species and habitat diversity.

These management actions could result in long-term, permanent wildlife benefits; however, some actions may result in short-term, adverse effects on localized habitat and species disturbances such as beaver analog work, culvert placement, bank stabilization projects, etc. that would temporarily disturb these habitats. Such impacts would be localized and would not adversely affect the entire analysis area.

RFFA 9—Climate Change

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the Willamette River Basin as compared to existing conditions and independent of the WVS operations and maintenance activities over the 30-year implementation timeframe (Climate Impacts Group 2010; RMJOC 2020)(Appendix F1, Qualitative Assessment of Climate Change Impacts, Chapter 4, Projected Trends in Future Climate and Climate Change; Appendix F2, Supplemental Climate Change Information, Chapter 3, Supplemental Data Sources: Section 3.1 Overview of RMJOC II Climate Change Projections).

Effects from climate change including, but not limited to, increased water temperatures in the Willamette River and more frequent and intense wildfires in the Willamette River Basin have negatively impacted wildlife habitat within the analysis area at the time the alternatives were analyzed (Halofsky et al. 2020; Talke et al. 2023). Changes to habitat in the analysis area from increased wildfires, drought, and low summer flows, for example, will likely increase stress on wildlife species to find suitable habitat.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 10—Mining Operations

Mining operations have the potential to adversely affect wildlife and habitat by disturbing individuals from activities such transportation, drilling, excavation, and surveys. Habitat fragmentation may also occur for some species in landscapes altered by mining operations.

RFFA 11: Timber and Logging Industry Operations

Timber and logging industry operations can affect wildlife and wildlife habitat by disturbing individuals, particularly during breeding periods, and by destroying and fragmenting habitat.

4.9.3.3 Cumulative Effects under All Alternatives

Population Increases

Direct, adverse effects on species present in the analysis area and on reservoir-adjacent habitat could be worsened by increased population and climate change-related effects. As populations and temperatures increase, visitor use will increase at WVS reservoirs, which may adversely impact species from increased direct disturbances and human mediated habitat degradation.

Although localized to reservoirs as a result of alternative implementation, the cumulative effect could be Basin-wide over the 30-year implementation timeframe. Impacts at the local level could be combined with Basin impacts from population growth and ecosystem conversions to urban and industrial development that would include eradication of wildlife habitat and specialized ecosystems. Population-related impacts can also result in cumulative increases in invasive plant species that alter wildlife habitat and outcompete existing native species at WVS reservoirs and throughout the Basin.

Water Withdrawals and Land Conservation Management

Direct, minor and moderate, adverse effects on wildlife habitat from summer and winter reservoir elevations would not worsen or improve from the combined effects of the RFFAs. Similarly, moderate beneficial effects from summer water surface elevations under some alternatives would not worsen or improve from the combined effects of the RFFAs.

RFFA effects related to water supply forecasted demand were incorporated into the analyses of direct and indirect effects on wildlife and habitat. No additional, cumulative effects would occur since all withdrawal effects were analyzed as direct and indirect effects.

Floodplain connectivity would continue to have localized, adverse effects on wildlife habitat under all alternatives due to flood operations/revetments causing floodplain disconnection, habitat fragmentation, and migration limitations. However, minor beneficial effects would occur from increased summer flows, gravel augmentation, and prey and forage availability from passage measures depending on the alternative.

Conversely, adverse effects would occur to northwestern pond turtle eggs from gravel augmentation and from high flows and sediment releases dislodging amphibian egg masses and burying mussel beds and aquatic invertebrates under some alternatives.

Habitat connectivity improvements from gravel bars and revetment improvements under the action alternatives combined with Federal, state, tribal, and organizational land conservation management would benefit vegetation and wetland habitat supporting some wildlife Basin-wide. Although these improvements would not occur under the NAA, conservation management by other agencies and organizations will continue to benefit vegetation and wetland habitat in the Basin important to many wildlife species.

Northwestern Pond Turtle

Direct, moderate, adverse effects would occur to northwestern pond turtles under all alternatives from reservoir elevations forcing turtles to travel farther from the aquatic environment to terrestrial overwintering habitat and increasing competition for resources. This adverse effect could be worsened by cumulative effects of land disturbances from increased visitor use; climate change-related effects that may alter terrestrial ecosystems; and land management favoring recreation, hunting, and grazing.

Northern Spotted Owl

Although nesting and roosting habitat likely exists in forested areas surrounding the WVS dams and reservoirs, there would be no direct, beneficial or adverse effects on northern spotted owls under NAA operations because changes in reservoir elevations or downstream instream flows would not impact habitat necessary for this species. Consequently, no cumulative, adverse effects are anticipated from operations under any alternative combined with RFFAs over the 30-year implementation timeframe.

Streaked Horned Lark

There would be no direct, beneficial or adverse effects on streaked horned larks under the NAA because changes in reservoir elevations or downstream instream flows would not impact habitat necessary for this species. Consequently, no cumulative, adverse effects are anticipated from operations under any alternative combined with RFFAs over the 30-year implementation timeframe.

<u>Southern Resident Killer Whale Management</u>

Direct, minor, adverse effects would occur to Southern Resident killer whales from any alternative implementation. USACE funds the operation and maintenance of five hatcheries for mitigation and conservation within the WVS, which would continue to produce salmon as Southern Resident prey.

While the RFFAs would likely continue to adversely impact Chinook salmon abundance in the Willamette River Basin, most prey is sourced from the Columbia River. Consequently, cumulative effects on Southern Residents from prey impacts would be negligible.

Climate Change

Climate change-related impacts on the environment will continue to adversely affect species and habitat in the Willamette River Basin over the 30-year implementation timeframe. For example, amphibian breeding success will be adversely affected, reptile foraging will be altered, and raptor prey base will be diminished Basin-wide. These climate change-related effects will worsen adverse effects on wildlife in the analysis area when combined with adverse effects from alternative implementation such as increased distances to over-wintering habitat, egg and muscle bed burial, dislodged amphibian egg masses, and negligible effects on Southern Resident killer whale prey.

Additionally, climate change is anticipated to continue to increase water temperature over time as ambient temperatures increase and snowmelt contributes less runoff or earlier runoff within the Basin. Such temperature increases will adversely affect wildlife prey species, such as fish, important to fish-eating species, and other aquatic species. These adverse effects would be combined with adverse effects anticipated on fish and aquatic species under all alternatives.

Increased water temperatures would also cause a greater frequency of algal blooms[1], which can introduce toxins both to prey species (e.g., fish) as well as species higher up the food chain that ingest these toxins (Section 3.5.4, Water Quality, Climate Change under All Alternatives). Algal blooms are anticipated to increase under all alternatives, making the combined effect from climate change-related impacts more severe.

The seasonality of wildlife species' life histories[2] will be forced to adapt to the changing climate patterns (e.g., birds, reptiles, insects, etc.), which is anticipated to have a number of adverse effects to species, interactions between species, interactions with their habitats, and likely, overall survival of species that cannot adapt to changing conditions such as air and water temperature increases or loss of suitable habitat. RFFA cumulative effects would be combined

---

[1] USACE contracted Portland State University to produce a CE-QUAL-W2 model utilizing physical parameters and potential algae bloom response within Dexter Reservoir (Cervarich et al. 2020). Analyses included scenarios for climate change and structural changes (i.e., power intake, Lowell Covered Bridge, and the curtain weir at the bridge). Results showed the simulated algae bloom was eliminated with structural changes and intensified with climate change scenarios (Cervarich et al. 2020).

[2] The life history of an organism is its pattern of survival and reproduction along with the traits that directly affect survival and the timing or amount of reproduction (Oxford Bibliographies 2013).

with this climate change-related impact as well as with anticipated adverse effects on some species life histories, such as habitat connectivity, under all alternatives.

Land conservation management practices would help to moderate the effects of climate change on Basin species. Additionally, the USACE Implementation and Adaptive Management Plan incorporates climate change monitoring and potential operations and maintenance adaptations to address effects as they develop (Appendix N, Implementation and Adaptive Management Plan).

Mining and Logging Operations

There would be no localized, cumulative effects on reservoir-adjacent vegetation or wetlands from mining or logging operations in the Willamette River Basin combined with alternative implementation. Consequently, there would be no cumulative effect on these wildlife habitats. Cumulative effects could occur in areas downstream of WVS dams if mining or logging operations impact wildlife habitat also impacted by flow operations.

However, mining and logging operations are not likely located adjacent to stream reaches downstream of WVS dams. Therefore, impacts on wildlife habitat in these reaches would not likely occur from mining and logging operational disturbances. Further, Oregon State forest practices would continue to provide riparian and wetland protections, thereby minimizing the potential for adverse, cumulative effects on these wildlife habitats below WVS dams.

Disturbances to individuals from noise and human activity related to dam operations, maintenance, and reservoir recreation would be combined with noise and disturbances from mining and logging operations in the analysis area. This combined effect could be adverse to species sensitive to noise, particularly during nesting seasons, over the 30-year implementation timeframe. This would adversely impact individuals in close proximity to reservoirs during the recreation season and to dam, mining, and logging operations, but may also be more far-reaching depending on noise levels and species-specific sensitivity.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.10 AIR QUALITY AND GREENHOUSE GAS EMISSIONS

TABLE OF CONTENTS

4.10 Air Quality and Greenhouse Gas Emissions

THIS SECTION HAS BEEN REVISED IN FORMAT FROM THE DEIS
REPEATED INFORMATION HAS BEEN DELETED

Summary of changes from the DEIS:

- **Additional information has been added regarding greenhouse gas emissions.**
- **Additional information has been added on reasonably foreseeable future actions and anticipated effects from these actions.**
- **The analysis area has been enlarged beyond the three-county direct and indirect analysis area.**

4.10.1 Cumulative Actions Applicable to Air Quality and Analysis Area

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.2, Cumulative Actions. RFFAs that would have cumulative effects on air quality when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on air quality in the analysis area would not result from other RFFAs identified in Section 4.1.2, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 4: Decarbonizing the Energy Sector with Renewable Energy Sources
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate Change

4.10.2 Air Quality Analysis Area

The analysis area for direct and indirect effects on air quality was the Willamette Valley System (WVS) dams within Lane, Linn, and Marion Counties, Oregon (Section 3.10, Air Quality). Within these counties, USACE operates and maintains 13 dams and reservoirs, 5 adult fish facilities, 5 fish hatcheries, and trap-and-haul fish trucking operations that transport fish above and below existing reservoirs.

The analysis area for air quality and greenhouse gas emissions, however, is broader than the three-county area assessed for direct and indirect effects. The identified RFFAs in combination with WVS operations and maintenance have the potential to affect air quality and greenhouse gas emissions beyond the WVS location.

4.10.2.1 Cumulative Effects to Air Quality by Alternative

A summary of RFFA impacts that would affect air pollutant and greenhouse gas emission risk under all alternatives is provided below. This is followed by analyses of cumulative effects under each alternative. For context, Table 3.10-6 and Table 3.10-7 Summary of Effects on Air Quality and Greenhouse Gas Emissions, respectively, provides summaries of anticipated direct and indirect effects on air quality and greenhouse gas emissions under the alternatives. Section 2.4, Alternatives Considered in Detail, provides information on measures incorporated under each alternative.

4.10.2.2 Overview

Air quality is the measure of the atmospheric concentration of defined pollutants in a specific area. Air quality is affected by pollutant emission sources as well as the movement of pollutants in the air via wind and other weather patterns. An air pollutant is any substance in the air that can cause harm to humans or the environment. Pollutants may be natural or human-made and may take the form of solid particles, liquid droplets, or gases (UCAR 2025).

Natural sources of air pollution in the cumulative effects analysis area include smoke from wildfires, dust, and wind erosion. Human-made sources of air pollution include emissions from vehicles, dust from unpaved roads or construction sites, facilities, and prescribed fires.

Greenhouse gases trap heat in the Earth's atmosphere, contributing to the warming of the planet and shifting climate patterns. Some greenhouse gases occur naturally in the atmosphere, such as water vapor, carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), though human activities (such as the burning of fossil fuels for energy) increase their abundance. Other greenhouse gases, such as fluorocarbons, are synthetic. Greenhouse gases are often measured in terms of their relative global warming potential (GWP), which is a common unit of measure that allows comparisons of the potential climate change impacts of different greenhouse gases.[1]

[1] It is a measure of the radiative forcing of a GHG relative to CO_2 (IPCC 2014). Radiative forcing properties of GHGs are due to their absorption and reflection of infrared radiation back to the Earth's surface. The GWP of CO_2 is one and GWPs of non-CO_2 GHGs are calculated relative to CO_2 (EPA No Date-a). The GWP of CH_4 ranges from 27 to 30 over 100 years and NO_2 is 273 times that of CO2 over 100 years (EPA No Date-a). Some fluorinated gases have GWPs in the thousands. The range in GWPs relates to uncertainty regarding climate carbon feedback, which is the effect that changing climate has on the carbon lifecycle (IPCC 2014). As described by their relative GWPs, GHGs vary in their radiative intensity. Some GHGs persist longer in the atmosphere than others and some have more of a radiative effect (IPCC 2014).

In the United States, most of the emissions of human-caused greenhouse gases are from CO2, which comes primarily from burning fossil fuels—coal, natural gas, and petroleum—for energy use (EIA 2023a). Economic growth (with short-term fluctuations in growth rate) and weather patterns that affect heating and cooling needs are the main factors that drive the amount of energy consumed (EIA 2023b). Human-caused CH_4 comes from landfills, coal mines, agriculture, and oil and natural gas operations, whereas N_2O comes from using nitrogen fertilizers and burning fossil fuels and certain industrial and waste management processes (EIA 2023a).

Air quality from USACE operations and maintenance in the analysis area would primarily be affected by air emissions generated from diesel trucks during fish trucking operations and diesel-powered generator use at dam locations. Air quality would also be affected by construction or maintenance activities including operation of vehicles, machinery, and other heavy equipment (Section 3.10.2.1, Air Emissions from U.S. Army Corps of Engineers Operations and Maintenance Activities). Greenhouse gas emissions would also be affected by these activities, as well as by power generation.

4.10.3 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects to air quality and greenhouse gas emissions are described below. It is anticipated that all private and public entities, including USACE, would continue to comply with all Federal and state air emissions standards during the 30-year implementation timeframe, which would minimize or prevent the potential for long-term effects from RFFA activities when combined with USACE operations and maintenance activities (Section 3.10.2.2, Federal and State Regulations).

The State of Oregon current incentivizes businesses, governments, and equipment owners to reduce diesel emissions by providing grants and programs to replace older and more polluting diesel engines with new, cleaner technologies and exhaust control retrofits (Section 3.10.2.2, Federal and State Regulations, Oregon Diesel Reduction Programs). The Diesel Emissions Mitigation Fund is a program that provides funding to public, private, and tribal diesel equipment owners to replace current diesel vehicles or equipment with equivalent, cleaner burning engines or power sources (ODEQ No Date-e). It is anticipated that these programs would continue in the cumulative effects analysis area to help minimize cumulative air quality and greenhouse gas emissions adverse effects during the 30-year implementation timeframe.

Further, the USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population growth in the cumulative effects analysis area would result in continued and additional development, which would additively contribute to an increase in air emissions.

These contributions would come from increased construction activities, additional paved roadways, and urban sprawl as compared to existing conditions and would lead to more vehicle miles traveled, increased construction vehicle and equipment use, and increased commercial transportation throughout the WRB.

Natural, spaces benefit air quality conditions and greenhouse gas emissions through plant photosynthesis and provide urban uses that do not adversely impact air quality (Nowak et al. 2014). Urban development would substantially reduce natural spaces in the cumulative effects analysis area.

> Trees remove air pollution by the interception of particulate matter on plant surfaces and the absorption of gaseous pollutants through the leaf stomata… Computer simulations with local environmental data reveal that trees and forests in the conterminous United States removed 17.4 million tonnes (t) of air pollution in 2010 (range: 9.0-23.2 million t), with human health effects valued at 6.8 billion U.S. dollars (range: $1.5-13.0 billion). This pollution removal equated to an average air quality improvement of less than one percent. Most of the pollution removal occurred in rural areas, while most of the health impacts and values were within urban areas. Health impacts included the avoidance of more than 850 incidences of human mortality and 670,000 incidences of acute respiratory symptoms (Nowak et al. 2014).

RFFA 4—Decarbonizing the Energy Sector with Renewable Energy Sources

Renewable energy sources, such as wind turbines, solar arrays, and geothermal power, could potentially offset or counteract adverse cumulative effects on air quality and greenhouse gas emissions by producing clean energy that emits few if any pollutants and greenhouse gases into the atmosphere.

RFFA 9—Climate Change

Climate change would potentially have direct, indirect, and cumulative effects air quality and greenhouse gas emissions within the analysis area. Ambient air temperature changes, such as the 1° F to 2° F warming experienced in the Pacific Northwest, could increase ground-level ozone and make wildfires more common due to drier conditions from higher evapotranspiration rates (Appendix F1, Qualitative Assessment of Climate Change Impacts; Appendix F2, Supplemental Climate Change Information).

As a result, more intense and frequent wildfires are anticipated over the 30-year implementation timeframe as compared to current conditions. Wildfires in and around the analysis area would affect emissions in the surrounding area and beyond by releasing air pollutants (e.g., particulate matter, carbon monoxide, etc.), aerosols (black carbon and brown carbon), and greenhouse gases (e.g., CO2, etc.) into the air (NASA 2021; UCR 2023) and by contributing to the production of ozone, a greenhouse gas (NOAA 2022a; Farmiloe 2023).

Wildfire emitted greenhouse gases and inputs to ozone production would continue to contribute to climate change, while particulate matter and ozone could create smog that blocks sunlight and could be harmful to human health (C2ES No Date; NASA 2015, 2017; NOAA 2022a).

Climate change would amplify the effects to air quality already occurring in the analysis area for short durations while fires are occurring. During wildfire events, there could be an air quality change that would exceed 50 percent of a Federal or state standard. Further, as climate change increases the risk of natural disasters over the 30-year implementation timeframe, air quality from the number and magnitude of wildfires in and surrounding the cumulative effects analysis area could exceed Federal or state standards.

Increases in greenhouse emissions would make it more difficult to achieve state greenhouse gas reduction targets. However, the exceedances of Federal or state standards and increases in greenhouse gas emissions would be temporary; air quality and greenhouse gas emissions would return to ambient levels in the analysis area after fires are controlled.

Effects from climate change on air quality and greenhouse gas emissions in the analysis area would be long-term in duration because climate change continues to evolve. Effects would also be large in extent depending on the size of wildfires and the distance wildfire generated air pollutants and greenhouse gases would travel.

It is anticipated that all private and public entities, including USACE, would continue to comply with all Federal and state air emissions standards during the 30-year implementation timeframe, which would minimize or prevent the potential for long-term effects. Public land management agencies would continue with fire management strategies such as prescribed burns and burn bans throughout the analysis area. Further, the USACE Implementation and Adaptive Management Plan incorporates climate change monitoring and potential operations and maintenance adaptations to address effects as they develop (Appendix N, Implementation and Adaptive Management Plan).

4.10.4 Cumulative Effects under All Alternatives

Air quality and greenhouse gas emissions in the direct and indirect analysis area is relatively good (Section 3.10.2.1, Air Emissions from U.S. Army Corps of Engineers Operations and Maintenance Activities, Additional Sources of Emissions Reported as National and State Inventory Data; Section 3.10.2.2, Federal and State Regulations, Attainment Status in Lane, Linn, and Marion Counties). The potential to adversely affect air quality within the broader cumulative analysis area under any alternative would be a result of measures that include increases in diesel truck mileage and the use of diesel-powered generators and fugitive dust emissions from construction and maintenance activities.

Greenhouse gas emissions would also be adversely affected by diesel increases in diesel truck mileage and the use of diesel-powered generators associated with construction and maintenance activities. In combination with RFFA 1 and RFFA 9, these activities would result in minor adverse effects to air quality in the broad cumulative effects analysis area.

Since greenhouse gases can travel far from their source, stay in the atmosphere for extended periods, and increases would temporarily reduce Oregon's ability to meet greenhouse gas reduction targets, the magnitude of adverse effects to greenhouse gas emissions would be minor to moderate adverse.

Under the No-action Alternative (NAA), adverse effects to air quality would be negligible or undetectable because there would be few changes in existing operations and maintenance activities that would increase potential pollutant emissions over the 30-year implementation timeframe.

While increases in similar pollution sources are expected under some of the RFFAs, USACE-generated emissions would not exceed 50 percent of a Federal or state air emissions standard and would likely be undetectable when combined with other sources (Section 3.10.2.2, Federal and State Regulations). Further, USACE-generated emissions would not cause an existing attainment[2] area to be designated as a nonattainment[3] area although it is possible that other, unknown sources could be developed in the analysis area during the 30-year implementation timeframe. Such sources could contribute to cumulative nonattainment designations under any alternative.

Several USACE dams produce hydropower, a form of renewable, clean energy that does not emit greenhouse gases itself, but the amount of hydropower generated affects the fuel mix (i.e., relative contribution of generation from fossil fuels, hydropower, and other renewables) and, therefore, would affect Oregon electricity-sector greenhouse gas emissions. Even with population growth under RFFA 1, greenhouse gas emissions in Oregon would most likely reduce relative to current levels under the NAA and Alternatives 1 and 4 as a result of current trends toward decarbonization included under RFFA 4.

Changes in the fuel mix over time are most likely to favor low-carbon resources, such as hydropower, solar and wind, as well as demand-response measures. As for the other alternatives (Alt 2A, 2B, 3A, 3B, and 5), there are slight to large decreases in hydropower generation compared to the NAA thereby increasing the need for fossil fuel generation.

Given that policy and legislative decisions in Oregon are targeting large reductions in greenhouse emissions, increases in greenhouse emissions makes this goal more difficult to achieve. However, if the region is able to replace the reduction in hydropower with zero-carbon resources instead of with natural gas (i.e., effects could be reduced commensurate with the amount of natural gas that would be displaced by zero-carbon resources).

---

[2] Attainment areas are those Federally designated as areas with pollution levels below the National Ambient Air Quality Standards.

[3] Nonattainment areas are those Federally designated as areas with pollution levels above, and in violation of, the National Ambient Air Quality Standards.

Smaller increases in greenhouse gas emissions relative to the NAA would result in minor to moderate adverse effects on greenhouse gas emissions under Alternatives 2A, 2B, and 5 and larger increases would result in moderate to major adverse effects under Alternatives 3A and 3B.

RFFA 5 and RFFA 7 would likely result in beneficial effects to air quality and greenhouse gas emissions in the analysis area and could offset some effects from RFFA 1 and RFFA 9 in combination with minor effects from USACE operations and maintenance under any alternative. Ongoing natural areas protections through land use designations or public and private ownership would likely continue during the 30-year implementation timeframe. These areas would include parks, recreation sites, wildlife refuges, natural preserves, national forests, and other wildlife habitats in the cumulative effects analysis area.

Management of natural areas would continue to preserve natural vegetation that contribute to air quality and greenhouse gas emissions benefits through photosynthesis. These area designations would also benefit air quality and greenhouse gas emissions by preventing development (RFFA 1), which would avoid air pollutant and greenhouse gas emissions that would occur from construction of new developments in the short term and through ongoing emissions from ongoing emissions development uses in the long term.

US Army Corps of Engineers®
Portland District

SYSTEM OPERATIONS AND MAINTENANCE
Willamette Valley
ENVIRONMENTAL IMPACT STATEMENT

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.11 SOCIOECONOMICS

TABLE OF CONTENTS

4.11 Socioeconomics

THE SOCIOECONOMICS CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.11.1 Cumulative Actions Applicable to Socioeconomics

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on socioeconomic conditions when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on socioeconomic conditions in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 9: Climate Change

4.11.2 Socioeconomics Cumulative Effects Analysis Area

The socioeconomics analysis area is the same as the area analyzed for direct and indirect effects in Section 3.11, Socioeconomics. It is not anticipated that socioeconomic effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

The analysis area encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). County and multi-county areas are also included in this analysis area and represent local conditions as described below. MSAs were defined to capture WVS dams and reservoirs, or industry activities associated with analysis area metropolitan communities.

4.11.2.1 Analysis Area Communities

The analysis area to assess existing socioeconomic conditions and potential effects is the Salem, Albany, and Eugene, Oregon Metropolitan Statistical Areas (MSAs). MSAs are defined in the USACE Regional Economic System (RECONS) model as Core-based Statistical Areas (CBSAs). CBSAs are based on population and labor force commuting patterns.

The MSAs for this EIS analysis are Salem, Eugene, and Albany, Oregon. Metropolitan areas contain at least 50,000 people and include numerous cities, towns, and unincorporated communities. Additionally, counties surrounding the CBSAs are included in the MSA/CBSA analysis area. Populations within the corresponding counties for the MSAs include Lane, Linn, Benton, Marion, and Polk Counties (Section 3.11, Socioeconomics, Figure 3.11-1).

Counties were included in the analysis area because direct and indirect effects from alternative implementation would occur in these MSA locations. Counties outside of the analysis area are not anticipated to experience measurable adverse or beneficial effects from alternative implementation and, therefore, were not included in the analysis area. Each relevant factor affecting existing economic conditions in the analysis area is described below.

Several small communities with economic and social associations with WVS operations are also in the analysis area but are not considered metropolitan areas. An example of this community relationship with the WVS is the City of Detroit located within Marion County and the Salem MSA. Detroit Reservoir operations are integrally tied to the City of Detroit. All-season recreation is a large part of the community identity and includes the Detroit Oregon Rocks scavenger hunts and annual traditions of summer fireworks on the reservoir and the spring fishing derby.

Another example of this community relationship is the City of Oakridge located within Lane County and the Eugene MSA. The City of Oakridge economy is supported by recreation and tourism, which can be adversely affected by power generation loss. Additionally, the City is reliant on emergency power transmission from the WVS hydroelectric dam capability to operate isolated from the rest of the power system (Section 3.12, Power Generation and Transmission).

4.11.3 Cumulative Effects on Socioeconomics

A summary of RFFA impacts that would affect socioeconomics is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.11, Socioeconomics, Table 3.11-8 , provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.11.3.1 Overview

The direct and indirect effects analyses of socioeconomic conditions address how economic conditions under each alternative would affect communities in the analysis area. Economic activity is described in Section 3.11, Socioeconomics, as both impacts and contributions to an economy from construction-related activities to alternative implementation. This activity is measured as economic output from sales, annual average of jobs available monthly, income earned, and value added[1].

The relevance of economic conditions pertains to the economic influence on analysis area communities over the 30-year implementation timeframe under any alternative. Community effects are important in assessing the social aspect of the human environment. These effects are realized from economic conditions but also from the relationship of economic conditions with other community impacts such as water quality, drinking water quality, greenhouse gas emissions, hydropower transmission, water supply, and recreation opportunities. This relationship was analyzed in Section 3.11, Socioeconomics. The cumulative effects analyzed under each of these resources would also apply to socioeconomic conditions in the analysis area.

4.11.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on socioeconomic conditions are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. Increases in populations will result in increased demands on water-based and land-based recreation. These demands would impact employment through opportunity supply and natural resource management.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

Water demand for industrial and residential uses is expected to increase over the 30-year implementation timeframe, consistent with expected increases in population growth. Consequently, WVS operations would need to be managed in response to demand through Congressionally authorized purposes (Chapter 1, Introduction, Section 1.10, Congressionally Authorized Purposes). Water supply management could result in cumulative effects on drinking water supply and the quality of water that is subsequently treated for drinking water. Recreation-related revenue may be affected by operational responses to water demands; reservoir levels impact the availability of water-based recreation opportunities during the peak recreation season.

RFFA 5—Federal and State Wildlife and Lands Management

Federal and state management of public recreation lands within the analysis area can be cumulatively impacted by water-based and land-based recreation opportunities at each of the WVS reservoirs over the 30-year implementation timeframe. Alterations in these opportunities based on reservoir operations would affect managing agency resources from lack of use, lack of

[1] Value added is an estimate of gross regional product. It is a combination of employee compensation, business owner income, industry profits, and indirect business taxes.

revenue, or increased use and revenue from displaced visitor uses. Lack of use could also result in impacts on natural resources from visitor displacement to undeveloped or dispersed recreation areas. Agency effects could include staffing and financial resource requirements and site-specific land use planning modifications.

RFFA 9—Climate Change

Climate change will affect socioeconomic conditions primarily through effects on other resources such as air quality, hydropower and transmission, water supply, drinking water, water quality, and recreation opportunities. Increased temperatures, dry conditions, and related wildfire events will continue to alter resources in the analysis area with direct and indirect effects on communities.

4.11.3.3 Cumulative Effects under All Alternatives

No measurable direct or indirect effects would be experienced by the Arts, Entertainment, and Recreation industry, labor force, or to unemployment at the local, MSA level under any alternative over the 30-year implementation timeframe (Section 3.11, Socioeconomics). Additionally, implementation of any alternative would not directly or indirectly impact population growth or housing.

Slight economic benefits at the local, MSA level would be realized from operations and maintenance and construction spending, but these would not measurably affect any economic sector or socioeconomic factor under any alternative. Consequently, no cumulative effects related to these socioeconomic factors at the local level are anticipated in combination with the RFFAs.

Direct and indirect effects on analysis area socioeconomics would occur at the local level from recreation-related employment and revenue and water supply needed for industrial and agricultural uses. Cumulative socioeconomic effects in the analysis area would occur from increases in population affecting demands for recreation opportunities, and thereby affecting recreation-related employment and local community revenue, and water supply.

Water supply would be affected by operational responses in dry years. Federal and state management of analysis area lands, including employment, would also be impacted by cumulative effects from population growth, recreation opportunities, and climate change.

Alternative 3A and Alternative 3B would result in the most substantial, adverse effects on local recreation-related employment and revenue from deep drawdowns during the peak recreation season, which would prohibit recreation water-based use. Additionally, substantial, direct, adverse effects on water users dependent on stored water would also occur under these alternatives.

Combined with increases in population, ongoing climate change impacts, and climate-related adverse effects on water supply in the analysis area, Alternative 3A and Alternative 3B would have the most substantial, adverse, cumulative effects on local economies and communities from reduced recreation-related employment and revenue opportunities and industrial and residential water supplies.

Cumulative effects from these RFFAs under Alternative 3A and Alternative 3B would also occur on recreation resource management agencies. Visitor displacement from lack of water-based recreation opportunities could adversely impact management resources throughout the analysis area to respond to changes in visitor use.

These impacts would also be cumulatively added to wildfire-related impacts on recreation opportunities and subsequent visitor displacement. Cumulative impacts on managing agencies would include employment adjustments and possible decreases in revenue from recreation site closers. However, localized decreased revenue may be moderated by increased revenue at other recreation sites depending on demand and opportunity supply (e.g., campground availability to meet demand).

Implementation of all other action alternatives and the No-action Alternative (NAA) would not result in substantial, direct or indirect, adverse effects on local recreation-related employment, community revenue, or water supply over the 30-year implementation timeframe. Beneficial effects on local, reservoir-level economies would occur under the NAA and all other action alternatives with some variations in degree of benefit.

Stored water under the NAA, Alternative 1, and Alternative 4 would be substantially beneficial and moderately beneficial under Alternatives 2A, 2B, and 5.

However, cumulative effects from population growth combined with climate change may adversely affect recreation employment and community revenue at the local level if water supply is adjusted in dry years under any alternative regardless of direct and indirect benefits. This could result in limitations on water-based recreation and related employment and revenue and on water supply for industrial and residential uses in analysis area communities. Impacts on managing agencies would be similar to those described under Alternative 3A and Alternative 3B.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.12 POWER GENERATION AND TRANSMISSION

TABLE OF CONTENTS

LIST OF TABLES

4.12 Power Generation and Transmission

4.12.1 Cumulative Actions Applicable to Power Generation and Transmission

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on vegetation and wetlands when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on vegetation and wetlands in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 4: Decarbonizing the Energy Sector with Renewable Energy Sources
- RFFA 5: Vehicle Emissions Reductions
- RFFA 10: Climate Change

4.12.2 Power Generation and Transmission Cumulative Effects Analysis Area

The power generation and transmission analysis area is the same as the direct and indirect effects analysis area in Section 3.12, Power and Transmission. The hydropower generation analysis area is broader than the Willamette River Basin because it includes regional power supply and marketing. Power-generating capacity within the analysis area includes the Western Interconnection, the Pacific Northwest, all of Bonneville Power Administration's (BPA) marketable resources, and WVS dams.

4.12.3 Cumulative Effects on Power Generation and Transmission

For context, Section 3.12, Power Generation and Transmission, Table 3.12-23 and Table 3.12-25 provides summaries of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.12.3.1 Overview

Hydropower generation and transmission in the Willamette Valley exists as a result of construction and operation of the WVS dams and reservoirs for flood risk management. Hydropower generation from the WVS dams is integrated into the Federal Columbia River Power System (FCRPS), which is marketed as a system by BPA.

WVS dams are integrated into the regional transmission system, and provide islanded service to the nearby communities Oakridge and Blue River, Oregon in weather or wildfire incidents, as well as during system maintenance. Hydropower generation from the WVS does not specifically supply nearby communities, instead communities served by BPA wholesale power receive their power from the entire FCRPS. Specific releases for hydropower generation occur only after operations for other project purposes are optimized, both at the specific reservoir and in coordination among the entire WVS. Consequently, hydropower generation should be viewed as a residual benefit after other benefits are provided for.

Cumulative effects on power generation and transmission encompass the entire WVS under each alternative analysis. Summary tables of cumulative effects are provided at the end of each alternative analysis.

4.12.3.2 Cumulative Effects under Each Alternative

No-action Alternative

The cumulative effects of past, present, and reasonably foreseeable future actions combined with the No-action Alternative (NAA) would result in major, long-term, cumulative, adverse impacts to power generation (Table 4.12-1).

Under the NAA, generation for the WVS projects would be 171 aMW. This translates to roughly enough to power 136,416 household customers. The loss of load probability (LOLP) refers to the probability that a system demand will exceed capacity during a given period.

The LOLP would be 6.5 percent, which is within the current range of the Pacific Northwest Power System recent reliability assessments, but above the 5 percent standard established by the Northwest Power and Conservation Council. This suggests a risk of blackouts approximately once every 15 years.

The Net Present Value (NPV) for the combined WVS projects would be $356 million. The estimated levelized cost of generation (LCOG)—which refers to the average cost of power generation for a given plant or system—would be $30.03/MWh.

Under the NAA and Interim Operations, power generation would decrease by 52 aMW, resulting in a NPV of -$213 million, and would increase the LCOG to $48.95/MWh from $30.03/MWh for WVS projects.

Under climate change-related conditions, stream flows are expected to increase in the Willamette River Basin in the winter, which may lead to increased generation. However, the level of future demand for hydropower is uncertain.

There is a potential for a decrease in demand in power generation during the 30-year implementation timeframe because of increasing temperatures. However, there is also a potential for an increase in Pacific Northwest regional demand during the winter from increased electrification of various sectors (e.g., transportation and use of water/space heaters due to population growth), and load spikes due to temperature fluctuations from extreme weather. Decreasing flows and lower reservoir elevations expected in the spring and summer would negatively impact generation going into a high demand summer season, with demand expected to increase as temperatures increase.

Overall, cumulative effects on hydropower generation would increase the severity of the expected direct and indirect adverse impacts to the economic viability of power generation. Unless energy prices substantially increase at the same time, producing power at WVS projects—given the other cumulative actions discussed above—would not be cost effective during the 30-year implementation timeframe.

The creation of the dams and past population growth in the region led to the need to develop the transmission system. Under the NAA, the Cross Cascades South (CCS) and South of Allston (SOA) transmission paths are congested, but operational. Hills Creek and Cougar Dams are capable of islanded operations to provide some isolated communities with power during emergencies such as wildfires.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not be able to operate islanded during deep drawdowns.

Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. These potential changes could be considerably large, but since the changes to WVS hydropower generation would be considerably small in comparison, the availability of these resources would not substantially impact long-term transmission planning.

The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek Dams to operate islanded could affect service to the communities of Blue River and Oakridge, Oregon.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

Table 4.12-1. Summary of Cumulative Effects for Power and Transmission under the No-Action Alternative.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Power	Construction and operation of the WVS Dams and Reservoirs for flood risk management enabled creation of the Willamette Valley hydropower system. The past WVS Population Growth and Development has contributed to existing regional power demand that is met by the FCRPS.	Interim Operations have a **n**egligible impact on power system reliability, blackouts, and LOLP. It would decrease generation by about 52 aMW and would have long-term major impacts on the economic viability of power generation at the combined WVS projects including a Net Present Value of -$213 million and a levelized cost of generation of $48.95/MWh, which is a decrease of $569M in Net Present Value and increase of $18.92/MWh in the levelized cost of generation over the existing condition. Costs of Interim Operations structural measures are currently unknown but would be expected to reduce the NPV and increase the levelized cost of generation.	Same or similar to the affected environment. WVS Projects 73-Year average generation is estimated to be 171 aMW for the system and the Loss of Load Probability is 6.5%. Under the No-action Alternative, the NPV for the combined WVS projects is estimated to be $356 million and the levelized cost of generation is estimated to be $30.03/MWh.	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons, especially in the summer.	The cumulative effect of past, present, future actions, as well as the No-action Alternative, would likely be major long-term adverse impacts to power.
Transmission	The creation of the WVS Dams and Reservoirs for flood risk management required transmission lines to be built to service the dams. The past WVS Population Growth and Development has contributed created demand for transmission in the area.	Interim Operations mwould have long-term moderate adverse effects on the transmission system. Deep fall and spring drawdowns would compromise the ability of Cougar Dam to operate islanded and serve the community of Blue River under temporary weather or wildfire-related outage conditions. Interim Operations structural measure would not affect transmission.	Same or similar to the affected environment. Some transmission lines are currently congested and would remain so. Cougar and Hills Creek would remain able to operate islanded and service Blue River and Oakridge communities, respectively, during power system outages due to, especially, weather events or wildfires.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar to operate islanded could affect service to the community of Blue River.	The cumulative effect of past, present, future actions, as well as the No-action Alternative, would likely have long-term, moderate adverse impacts on transmission.

Alternative 1—Improve Fish Passage through Storage-focused Measures

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 1 would result in major, long-term, adverse impacts to the economic viability of power generation at WVS projects (Table 4.12-2). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

The direct and indirect impacts on power associated with Alternative 1 would be primarily a result of the costs associated with implementing the alternative as there are positive impacts to generation. Generation at the projects as a whole would increase by 8 aMW under Alternative 1, an increase of 4.7 percent.

The LOLP metric would decrease by 0.1 percent to 6.4 percent due to the increase in generation. Due to the costs of the alternative, the NPV for the Willamette Valley would decrease by $1.76 billion to -$1.4 billion million. The LCOG would increase by $48.63 to $78.66/MWh.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 1 would be the same as those described under the NAA.

Long-term, moderate, adverse impacts on the transmission system would occur from the cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 1.

The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

The direct and indirect effects of Alternative 1 would be less than 10MW of increased load on the CCS and SOA paths in all seasons. Hills Creek and Cougar Dams would continue to be able to operate islanded under Alternative 1.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 1 would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-2. Summary of Cumulative Effects for Power and Transmission under Alternative 1—Improve Fish Passage through Storage-focused Measures.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Power	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.		Alternative 1 would have negligible impacts on power system reliability and long-term major impacts to the economic viability of power generation in the WVS. Average annual generation would increase by 8 aMW and LOLP decreases by 0.1 percent. Alternative 1 would result in a $1.75 billion reduction of NPV to -$1.4 billion and a $48.63 increase in the LCOG to $78.66/MWh.	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	Overall, there would be long-term, major, adverse effects on power given cumulative effects of past, present, future actions, and Alternative 1. This alternative would create a situation where power in the Willamette Valley would no longer be cost effective at many of the dams. Other factors unrelated to Alternative 1 itself would have the potential to further adversely impact power.
Transmission	The creation of the WVS Dams and Reservoirs for flood risk management required transmission lines to be built to service the dams. The population growth in the area also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep fall and spring drawdowns would also compromise the ability of Cougar Dam to operate islanded and serve the community of Blue River under temporary weather or wildfire-related outage conditions.	Alternative 1 would have long-term, minor adverse effects on the transmission system including some increased loading on already congested transmission paths.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	Overall, there would be long-term, moderate adverse effects on transmission given cumulative effects of past, present, future actions, and Alternative 1. Other factors unrelated to Alternative 1 itself would have the potential to further adversely impact transmission.

Alternative 2A—Integrated Water Management Flexibility and ESA-listed Fish Alternative

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 2A would result in major, long-term, adverse impacts to the economic viability of power generation at WVS projects (Table 4.12-3). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$196 million, and would increase the LCOG to $38.35/MWh from $26.70 for Willamette Valley projects. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations are currently unknown, but would be expected to further reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 2A would primarily result in the costs associated with implementing the alternative as well as a decrease in generation. Generation at the projects would decrease by 4 aMW under Alternative 2A, a decrease of 2.3 percent. LOLP would not change from 6.5 percent. Due to the costs of the alternative, the NPV for the Willamette Valley would decrease by $1.25 billion to -$891 million.

The LCOG would increase by $35.71 to $65.74/MWh. Note that Interim Operations and Alternative 2A were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 2A would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 2A would result in long-term, moderate, impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of deep drawdowns.

The direct and indirect effects of Alternative 2A would be increased loading on the CCS path (18.4 MW) in the winter and on both SOA (11.8 MW) and CCS (61.3 MW) in spring.

Hills Creek and Cougar Dams would continue to be able to operate islanded under Alternative 2A. However, if Interim Operations were implemented in conjunction with Alternative 2A, Cougar Dam would have a compromised ability to do so. Note that Interim Operations and Alternative 2A were analyzed separately, so metrics associated with each one are not additive.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 2A would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-3. Summary of Cumulative Effects for Power and Transmission under Alternative 2A—Integrated Water Management Flexibility and ESA-listed Fish Alternative.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -$213 and a levelized cost of generation to $48.95/MWh (an increase of $18.92/MWh over the existing condition) for the system.	Alternative 2A would have negligible impacts on power system reliability and long-term major adverse impacts on the economic viability of power generations. Average annual generation decreases by 4 aMW and LOLP remains the same as the No-action Alternative. Alternative 2A would result in a $1.25 billion reduction of NPV to -$891 million and a $35.71 increase in the LCOG to $65.74/MWh.	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	Overall, there would be long-term, major, adverse effects on power given cumulative effects of past, present, future actions, and Alternative 2A. This alternative would create a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. Other factors unrelated to Alternative 2A itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the area also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep fall and spring drawdowns would also compromise the ability of Cougar Dam to operate islanded and serve the community of Blue River under temporary weather or wildfire-related outage conditions.	Alternative 2A would have long-term, moderate adverse effects of the transmission system due to increased loading on some of the transmission paths, though Cougar and Hills Creek would remain able to operate islanded.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	Overall, there would be moderate long-term adverse impacts to transmission given cumulative effects of past, present, future actions, and Alternative 2A. Other factors unrelated to Alternative 2A itself would have the potential to further adversely impact transmission.

Alternative 2B—Integrated Water Management Flexibility and ESA-listed Fish Alternative

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 2B would result in major, long-term, adverse impacts to the economic viability of power generation at WVS projects (Table 4.12-4). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$213 million, and would increase the LCOG to $48.95/MWh from $30.03/MWh for Willamette Valley dams. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations are currently unknown, but would be expected to further reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 2B would be primarily a result of the costs associated with implementing the alternative as well as a decrease in generation. Generation at the projects would decrease by 18 aMW under Alternative 2B, a decrease of 10.5 percent.

LOLP would increase to 6.6 percent. Due to the costs of the alternative, the NPV for the Willamette Valley would decrease by $1.33 million to -$970 million. The LCOG would increase by $40.67 to $70.70/MWh. Interim Operations and Alternative 2B were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts under Alternative 2B to the economic viability of power would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 2B would result in long-term, moderate, adverse, impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system.

Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of drawdowns.

The direct and indirect effects of Alternative 2B would be increased loading on the CCS path (21.9 MW) in the winter and on both SOA (5.1 MW) and CCS (25.1 MW) in spring.

Hills Creek Dam would continue to be able to operate islanded under Alternative 2B. However, the drawdowns at Cougar Dam under both Interim Operations and Alternative 2B would compromise the ability to operate Cougar Dam islanded under temporary weather or wildfire-related outage conditions.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 2B would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-4. Summary of Cumulative Effects for Power and Transmission under Alternative 2B—Integrated Water Management Flexibility and ESA-listed Fish AlternativeCumulative Effects under Each Alternative.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -$213 and a levelized cost of generation to $48.90/MWh (an increase of $18.92/MWh over the existing condition) for the system.	Alternative 2B would have negligible impacts on power system reliability and long-term major adverse impacts on the economic viability of power generation. Average annual generation would decrease by 18 aMW from the No-action Alternative. Alternative 2B would result in a $1.33 billion reduction of NPV to -$970 million and a $40.67 increase in the LCOG to $70.70/MWh	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	Overall, there would be long-term, major, adverse effects on power given cumulative effects of past, present, future actions, and Alternative 2B. This alternative would create a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. Other factors unrelated to Alternative 2B itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the + also created demand for transmission in the area.	Interim Operations have would long-term moderate adverse effects on the transmission system. Deep drawdowns would also compromise the ability of Cougar Dam to operate islanded and serve the Blue River community with power under temporary weather or wildfire-related outage conditions.	Alternative 2B would have long-term, moderate adverse effects on the transmission system. There would be increased loading on already congested transmission paths and deep drawdowns at Cougar would make operating islanded difficult under temporary weather or wildfire-related outage conditions.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	The cumulative effects of past, present, future actions, and Alternative 2B on transmission would be moderate, long-term adverse impacts to transmission. The other factors unrelated to Alternative 2B itself would have the potential to further adversely impact transmission.

Alternative 3A—Improve Fish Passage through Operations-focused Measures

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 3A would result in long-term, moderate, adverse impacts to the economic viability of power generation at WVS dams (Table 4.12-5). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$213 million, and would increase LCOG to $48.90/MWh from $30.03 for WVS projects. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations are currently unknown, but would be expected to reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 3A would primarily result in the costs associated with implementing the alternative as well as a large decrease in generation. Generation at the projects would decrease by 87 aMW under Alternative 3A, a decrease of 50.9 percent.

LOLP would increase to 7 percent. The NPV for the Willamette Valley would decrease by $1.15 billion to -$789 million. The LCOG would increase by $61.45 to $91.48/MWh. Note that Interim Operations and Alternative 3A were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 3A would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 3A would result in long-term, moderate, adverse impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of deep drawdowns under Interim Operations.

The direct and indirect effects of Alternative 3A would be increased loading on the CCS (37.2 MW) and SOA (13.6 MW) paths in the winter. It would also lead to increased loading on both paths in spring.

Drawdowns at Hills Creek and Cougar Dams under Alternative 3A would compromise abilities to operate islanded under temporary weather or wildfire-related outage conditions.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 3A would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-5. Summary of Cumulative Effects for Power and Transmission under Alternative 3A—Improve Fish Passage through Operations-focused Measures.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -\$213 and a levelized cost of generation to \$48.90/MWh (an increase of \$18.92/MWh over the existing condition) for the system.	Alternative 3A would have negligible impacts on power system reliability and long-term, major effects on the economic viability of power generation. Average annual generation would decrease by 87 aMW and LOLP would increase by 0.5 percent. Alternative 3A would result in a \$1.15 billion reduction of NPV to -\$789 million and a \$61.45 increase in the LCOG to 91.48 /MWh.	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	Overall, there would be long-term, major, adverse effects on power given cumulative effects of past, present, future actions, and Alternative 3A. This alternative would create a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. Other factors unrelated to Alternative 3A itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the area also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep drawdowns would also compromise the ability of Cougar Dam to operate islanded under temporary weather or wildfire-related outage conditions.	Alternative 3A would have long-term, moderate adverse effects on the transmission system. There would be increased loading on existing systems and the ability to operate islanded at Hills Creek and Cougar under temporary weather or wildfire- related outage conditions would be compromised.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	The cumulative effects of past, present, future actions, and Alternative 3A on transmission would be moderate, long-term adverse impacts to transmission. The other factors unrelated to Alternative 3A itself would have the potential to further adversely impact transmission.

Alternative 3B— Improve Fish Passage through Operations-focused Measures

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 3B would result in major, long-term, adverse impacts to the economic viability of power generation at WVS dams (Table 4.12-6). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$213 million, and would increase the LCOG to $48.90 /MWh from $30.03 for Willamette Valley projects. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations construction are currently unknown, but would be expected to reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 3B would be primarily a result of the costs associated with implementing the alternative as well as large decreases in generation. Generation at the projects would decrease by 79 aMW under Alternative 3B, a decrease of 46.2 percent.

LOLP would increase to 7 percent. The NPV for the Willamette Valley would decrease by $1.13 billion to -$771 million. The LCOG would increase by $53.81 to $83.84 /MWh. Note that Interim Operations and Alternative 3B were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 3B would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 3B would result in long-term, moderate, adverse impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of deep drawdowns.

The direct and indirect effects of Alternative 3B would be increased loading on the CCS and SOA paths in all seasons. Drawdowns at Hills Creek and Cougar Dams under Alternative 3B would compromise abilities to operate islanded under temporary weather or wildfire-related outage conditions.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-6. Summary of Cumulative Effects for Power and Transmission under Alternative 3B— Improve Fish Passage through Operations-focused Measures.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -$213 and a levelized cost of generation to $48.90/MWh (an increase of $18.92/MWh over the existing condition) for the system.	Alternative 3B would have negligible impacts on power system reliability and long-term, major effects on the economic viability of power generation. Generation would decrease by 79 aMW and LOLP decreases by 0.5 percent. NPV for the system would be reduced by $1.13 billion to -$771 million. LCOG would increase to $83.84/MWh	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	The cumulative effects of past, present, future actions, and Alternative 3B on hydropower would be major, long-term adverse impacts to hydropower. Choosing this alternative creates a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. The other factors unrelated to Alternative 3B itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the area also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep drawdowns would also compromise the ability of Cougar Dam to operate islanded under temporary weather or wildfire-related outage conditions	Alternative 3B would have long-term moderate adverse effects on the transmission system. This alternative would increase loading on existing transmission systems and compromise the ability of Hills Creek and Cougar to operate islanded under temporary weather or wildfire-related outage conditions.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	The cumulative effects of past, present, future actions, and Alternative 3B on transmission would be moderate, long-term adverse impacts to transmission. The other factors unrelated to Alternative 3B itself would have the potential to further adversely impact transmission.

Alternative 4—Improve Fish Passage with Structures-based Approach

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 4, would result in major, long-term, adverse impacts to the economic viability of power generation at WVS dams (Table 4.12-7). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$213 million, and would increase LCOG to $48.95/MWh from $30.03 for Willamette Valley projects. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations construction are currently unknown, but would be expected to reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 4 would be primarily a result of the costs associated with implementing the alternative as there are minor increases in generation. Generation at the projects would increase by 1 aMW under Alternative 4, an increase of 0.6 percent.

LOLP would remain 6.5 percent under Alternative 4. Again, due to the costs of the alternative, the NPV for the Willamette Valley would decrease by $1.61 billion to -$1.26 billion. The LCOG would increase by $46.31 to $76.34/MWh. Note that Interim Operations and Alternative 4 were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 4 would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 4 would result in long-term, minor, adverse impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide some isolated communities with power during emergencies such as wildfires.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of deep drawdowns.

The direct and indirect effects of Alternative 4 would be less than 10MW of increased load on the CCS and SOA paths in all seasons, except an increase of 15MW on the CCS path in spring. Hills Creek and Cougar Dams would continue to operate islanded under Alternative 4. However, if Interim Operations were implemented in conjunction with Alternative 4, Cougar Dam would have a compromised ability to do so.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 4 would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-7. Summary of Cumulative Effects for Power and Transmission under Alternative 4—Improve Fish Passage with Structures-based Approach.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -$213 and a levelized cost of generation to $48.95/MWh (an increase of $18.92/MWh over the existing condition) for the system.	Alternative 4 would have negligible impacts on power system reliability and long-term adverse effects on the economic viability of power generation. Generation would slightly increase by 1 aMW and LOLP remains the same as the No-action Alternative. However, due to the high cost associated with Alternative 4, the NPV estimate would be reduced by $1.61billion to -$1.26 billion; and the LCOG would increase by $46.31/MWh to $76.34/MWh.	Climate change would likely increase demand for power while reducing generation capability during high demand seasons.	The cumulative effects of past, present, future actions, and Alternative 4 on hydropower would be minor, long-term adverse impacts to hydropower. Choosing this alternative would create a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. The other factors unrelated to Alternative 4 itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the area also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep drawdowns would also compromise the ability of Cougar Dam to operate islanded in cases of emergency.	Alternative 4 would have long-term, minor effects on the transmission system increased loading on already congested transmission paths. Cougar and Hills Creek would remain able to operate islanded under temporary weather or wildfire-related outage conditions.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	The cumulative effects of past, present, future actions, and Alternative 4 on transmission would be moderate, long-term adverse impacts to transmission. The other factors unrelated to Alternative 4 itself would have the potential to further adversely impact transmission.

Alternative 5—Preferred Alternative—Refined Integrated Water Management Flexibility and ESA-listed Fish Alternative

Cumulative effects under Alternative 5 would be similar to those under Alternative 2B. The small flow changes under Alternative 5 as compared to Alternative 2B could possibly lead to lower power generation at Green Peter, Foster, and Hills Creek Dams, as detailed below.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 5 would result in major, long-term, adverse impacts to the economic viability of power generation at WVS dams (Table 4.12-8). The creation of the system and population growth in the past created the ability to generate power and a demand for that power.

Interim Operations would decrease power generation by 52 aMW, resulting in a NPV of -$213 million, and would increase the LCOG to $48.95/MWh from $30.03/MWh for Willamette Valley projects. There are no costs associated with Interim Operations, so these estimated changes are due solely to a decrease in generation. Costs of Interim Operations construction are currently unknown, but would be expected to further reduce the NPV and increase the levelized cost of generation.

The direct and indirect impacts on power associated with Alternative 5 would be primarily a result of the costs associated with implementing the alternative as well as a decrease in generation. Generation at the projects would decrease by 18 aMW under Alternative 5, a decrease of 10.5 percent.

LOLP would increase to 6.6 percent. Due to the costs of the alternative, the NPV for the Willamette Valley would decrease by $1.34 billion to -$986 million. The LCOG would increase by $41.19 to $71.22/MWh. Note that Interim Operations and Alternative 5 were analyzed separately, so metrics associated with each one are not necessarily additive. Changes to hydropower generation resulting from the various cumulative effects would further impact the expected adverse impacts to the economic viability of power.

Adverse climate change-related effects and impacts to the economic viability of power under Alternative 5 would be the same as those described under the NAA.

The cumulative effects of past, present, and reasonably foreseeable future actions in combination with Alternative 5 would result in long-term, moderate, adverse impacts on the transmission system. The creation of the dams and past population growth in the region led to the need to develop the transmission system. Currently, the CCS and SOA transmission paths are congested, but operational. Hills Creek and Cougar Dams are able to operate islanded to provide Oakridge and Blue River communities, respectively, with power under temporary weather or wildfire-related outage conditions.

Interim Operations would increase loading on the CCS path in both spring (47.0 MW) and winter (59.8 MW). Hills Creek Dam would continue to be able to operate islanded, but Cougar Dam may not because of deep drawdowns.

The direct and indirect effects of Alternative 5 would be increased loading on the CCS path (21.9 MW) in the winter and on both SOA (5.1 MW) and CCS (25.1 MW) in spring.

Hills Creek Dam would continue to be able to operate islanded under Alternative 5. However, the drawdowns at Cougar Dam under both Interim Operations and Alternative 5 would compromise the ability to operate islanded under temporary weather or wildfire-related outage conditions.

Combined effects from population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions under Alternative 5 would be the same as those described under the NAA. Additionally, islanding operations during extreme weather events would also be the same as described under the NAA.

Table 4.12-8. Summary of Cumulative Effects for Power and Transmission under Alternative 5— Preferred Alternative—Refined Integrated Water Management Flexibility and ESA-listed Fish Alternative.

Resource	Past Actions	Present Actions	Direct and Indirect Effects	Future Actions	Cumulative Effect
Hydropower	The construction and operation of the WVS dams and reservoirs created the Willamette Valley hydropower system. The population growth and the economic development in the region has led to the current demand for power that exists.	Interim Operations have a negligible impact on power system reliability, blackouts, and LOLP, but does decrease generation by about 52 aMW. It also would have long-term major impacts on the economic viability of power generation at WVS projects, resulting in a Net Present Value of -$213 and a levelized cost of generation to $48.95/MWh (an increase of $18.92/MWh over the existing condition) for the system.	Alternative 5 would have negligible impacts on power system reliability and long-term major adverse impacts on the economic viability of power generation. Average annual generation would decrease by 18 aMW from the No-action Alternative. Alternative 5 would result in a $1.34 billion reduction of NPV to -$986 million and a $41.19 increase in the LCOG to $71.22/MWh	Climate change may increase or decrease power demand while reducing generation capability during high demand seasons.	Overall, there would be long-term, major, adverse effects on power given cumulative effects of past, present, future actions, and Alternative 5. This alternative would create a situation where hydropower in the Willamette Valley would no longer be cost effective at many of the dams. Other factors unrelated to Alternative 5 itself would have the potential to further adversely impact hydropower.
Transmission	The creation of the dams required transmission lines to be built to service the dams. The population growth in the + also created demand for transmission in the area.	Interim Operations would have long-term moderate adverse effects on the transmission system. Deep drawdowns would also compromise the ability of Cougar Dam to operate islanded and serve the Blue River community with power under temporary weather or wildfire-related outage conditions.	Alternative 5 would have long-term, moderate adverse effects on the transmission system. There would be increased loading on already congested transmission paths and deep drawdowns at Cougar would make operating islanded difficult under temporary weather or wildfire-related outage conditions.	Population growth and development, decarbonization of the energy sector, and targeted reduction in vehicle emissions could conceivably add loading on the regional transmission system. The increased potential of extreme weather events and wildfires due to climate change could also affect how frequently transmission lines may temporarily be de-energized. During these events, the diminished ability of Cougar and Hills Creek to operate islanded could affect service to the communities of Blue River and Oakridge.	The cumulative effects of past, present, future actions, and Alternative 5 on transmission would be moderate, long-term adverse impacts to transmission. The other factors unrelated to Alternative 5 itself would have the potential to further adversely impact transmission.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.13 WATER SUPPLY

TABLE OF CONTENTS

4.13 Water Supply

THE WATER SUPPLY CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.13.1 Cumulative Actions Applicable to Water Supply

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on water supply when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on water supply in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 2: Agricultural Production
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate change

4.13.2 Water Supply Cumulative Effects Analysis Area

The water supply analysis area is the same as the area analyzed for direct and indirect effects in Section 3.13, Water Supply. The analysis area encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). It is not anticipated that water supply effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

4.13.3 Cumulative Effects on Water Supply

A summary of RFFA impacts that would affect water supply is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.13, Water Supply, Table 3.13-4, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.13.3.1 Overview

Water is critical for the sustenance and continued growth of the Willamette Valley, where more than 70 percent of the Oregon population resides. Water users in the Willamette River Basin rely on river flow, groundwater wells, and stored water released from reservoirs to satisfy state-issued water rights for many types of uses. The two main consumptive uses of water from basin rivers are municipal and industrial water supply and agricultural irrigation.

Municipal and industrial water needs are not limited to domestic drinking water, but include water used for other domestic functions, landscape management, and industrial uses such as manufacturing and processing.

USACE has not identified any groundwater wells that are hydrologically connected to WVS reservoirs. There was no documented impact on groundwater wells in areas adjacent to WVS reservoirs during the 2024 deep drawdown operations.

Groundwater wells that are hydrologically connected to rivers downstream of USACE reservoirs benefit from augmented streamflows, especially during dry years, which helps to maintain the water table at levels accessible by groundwater wells. There was no documented impact on groundwater wells in areas downstream of WVS reservoirs during the 2024 deep drawdown operations. Consequently, there are no anticipated cumulative effects on groundwater wells in the analysis area from implementation of any alternative.

4.13.3.2 Reasonable and Foreseeable Future Actions

RFFAs that could result in cumulative effects on water supply are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. As the population increases throughout the Willamette River Basin, municipal and industrial needs will increase, putting pressure on existing water supplies. Increased water supply demands will also result in decreased in-stream water in the Basin.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water over the 30-year implementation timeframe are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

RFFA 2—Agricultural Production

Although agricultural production in the analysis area had been decreasing at the time the alternatives were analyzed, water demand for agricultural use will continue over the 30-year implementation timeframe (Section 3.13, Water Supply, Table 3.13-2).

WVS conservation storage totals approximately 1,590,000 acre-feet. As of September 2024, of this total, only 84,349 acre-feet of stored water (less than 5 percent of the WVS conservation storage volume) was contracted through U.S. Bureau of Reclamation for agricultural irrigation use on 45,715 acres in the analysis area (Section 3.13, Water Supply).

The expansion of agricultural irrigation in the Willamette River Basin was slow until the 1940s, when irrigated acres increased during the post-World War II decades, from 27,000 irrigated acres in 1940 to approximately 194,000 irrigated acres in 1964 (OWRB 1967). Irrigated acreage increased to about 300,000 acres by 2007 and was 276,000 acres in 2017 (USDA 2019). Unlike in other basins in Oregon, there are limited irrigation districts in the Willamette River Basin, with most irrigation diversions installed by individual users (USACE 2019a).

Future demands for agricultural water use would need to be met with stored water from the WVS because most waterways in the Willamette River Basin have limited availability for river flow water rights (Section 3.13, Water Supply). A total of 327,650 acre-feet was reallocated to the specific use of agricultural irrigation in the Water Resources Development Act of 2020 (USACE 2019a) based on the forecasted demand[1] for stored water for agricultural irrigation use to the year 2070.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

In addition to future demands for agricultural water use, at the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). This need was one of the factors that led to the Willamette Basin Review Feasibility Study (USACE 2019a), which resulted in a total of 159,750 acre-feet of conservation storage reallocated to the purpose of municipal and industrial water supply.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvement

Tribes, state, and local agencies, environmental organizations, and private communities are expected to continue non-Federal habitat activities and projects focused on improving general habitat and ecosystem function or species-specific conservation objectives in Oregon. Improvements could result in conversion of minimum perennial streamflows to instream water

[1] The Willamette Basin Review Feasibility Study period was 50 years (USACE 2019a).

rights, giving protections to instream flows and seniority against out-of-stream uses. This could result in the need for alternative sources of municipal, industrial, and agricultural water supply for users during the 30-year implementation timeframe.

This scenario was considered as part of the Willamette Basin Review Feasibility Study (USACE 2019a) resulting in reallocation of the conservation storage to the authorized purposes of municipal and industrial water supply, irrigation, and fish and wildlife.

RFFA 9—Climate Change

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the Willamette River Basin as compared to existing conditions and independent of the WVS operations and maintenance activities over the 30-year implementation timeframe (Appendix F1, Qualitative Assessment of Climate Change Impacts, Chapter 4, Projected Trends in Future Climate and Climate Change; Appendix F2, Supplemental Climate Change Information, Chapter 3, Supplemental Data Sources, Section 3.1, Overview of RMJOC II Climate Change Projections).

Climate change would have an adverse effect on water supply and to municipal and industrial water and agricultural irrigation users under any alternative. Increased climate variability in the spring shoulder months, drier hotter summers, and lower summer baseflow are the most impactful climate change factors affecting conservation season water supply operations. Consequently, water supply from water stored in analysis area reservoirs and groundwater wells and from river flow may be adversely affected in the long term under any alternative. Additionally, decreased summer baseflows would adversely affect water users under any alternative as there may not be adequate water in the rivers to satisfy existing water rights.

The Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N).

4.13.3.3 Cumulative Effects under All Alternatives

Effects of the RFFAs on water supply were incorporated into the direct and indirect analyses in Section 3.13, Water Supply. For example, results of the Willamette Basin Review Feasibility Study (USACE 2019a) were used to assess future water supply demands and subsequent impacts on these demands under each alternative, including impacts during dry years. Subsequently, effects on water supply during dry years under each alternative were analyzed in Subsection 3.13.5, Climate Change under All Alternatives.

No additional, cumulative effects on water supply would occur when combining the anticipated RFFA impacts with direct and indirect effects. This includes the combined effect of all RFFAs over the 30-year implementation timeframe because the impact of population increases and other RFFA demands on water supply were incorporated into forecasted water demands used for the alternatives analyses of direct and indirect effects.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.14 RECREATION RESOURCES

TABLE OF CONTENTS

4.14 Recreation Resources

THE RECREATION RESOURCES CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.14.1 Cumulative Actions Applicable to Recreation Resources

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on recreation resources when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on recreation resources in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

Cumulative effects on sport fishing are analyzed in Section 4.8, Fish and Aquatic Habitat. Cumulative effects on recreation-related socioeconomics are analyzed in Section 4.11, Socioeconomics.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate Change

4.14.2 Recreation Resources Cumulative Effects Analysis Area

The recreation resources analysis area is the same as the area analyzed for direct and indirect effects in Section 3.14, Recreation Resources. It is not anticipated that recreation opportunity effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

The analysis area encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS).

4.14.3 Cumulative Effects on Recreation by Alternative

For context, Section 3.14, Recreation Resources, Table 3.14-29, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.14.3.1 Overview

Cumulative effects on recreation resources would occur from impacts to either land-based or water-based recreation opportunities in the analysis area when combining direct and indirect effects with effects from RFFAs over the 30-year implementation timeframe.

Cumulative effects were analyzed by assessing the additive effect of the RFFAs on:

- Alterations in land-based, water-based, or river-based recreation opportunities.
- Subsequent effects on visitor use associated with the three types of opportunities.
- Overuse or over-demand of alternate recreation sites if a recreation opportunity is limited or prohibited at a given reservoir.
- Stress on other resources from use of alternate recreation sites such as reservoir-adjacent vegetation.

Direct effects were assessed relative to visitation, which is considered qualitatively as related to cumulative effects.

4.14.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on recreation resources are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. Increases in populations will result in increased demands on water-based and land-based recreation. These demands would impact opportunity supply, recreation-related employment, natural resource integrity, and natural resource management.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses

Water demand for industrial and residential uses is expected to increase over the 30-year implementation timeframe, consistent with expected increases in population growth. Consequently, WVS operations would need to be managed in response to demand as a Congressionally authorized purpose (Chapter 1, Introduction, Section 1.10, Congressionally Authorized Purposes). Recreation opportunities may be affected by operational responses to water demands; reservoir levels impact the availability of water-based recreation opportunities during the peak recreation season.

RFFA 5—Federal and State Wildlife and Lands Management

Federal and state management of lands for public recreation uses within the analysis area would not likely impact reservoir-related recreation opportunities over the 30-year implementation timeframe either directly, indirectly, or cumulatively. Conversely, public recreation lands management can be cumulatively impacted by water-based and land-based recreation opportunities at each of the WVS reservoirs over the 30-year implementation timeframe.

Alterations in recreation opportunities based on reservoir operations would affect managing agency resources from lack of use at one or more reservoirs, or increased use from displaced visitors. Lack of use at one or more reservoirs could also result in impacts on natural resources in undeveloped or dispersed recreation areas from displaced visitors. Agency effects could include staffing and financial resource requirements and site-specific land use planning modifications.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvement

Habitat and ecosystem function improvements in the analysis area will include managing and protecting game and nongame fish and wildlife resources. Additionally, land conservation efforts will preserve open spaces and wildlife habitat in the analysis area. These management efforts will likely result in continuation of recreation opportunities related to habitat improvements such as hunting, wildlife viewing, and hiking within the analysis area over the 30-year implementation timeframe.

RFFA 9—Climate Change

Climate change will likely affect recreation resources from increased temperatures during the peak recreation season, thereby, increasing visitor demand at WVS reservoirs. Climate change-related wildfire events could continue to alter recreation resources in the analysis area with direct and indirect effects on area closures and displacement to other areas for recreation opportunities.

Precipitation and temperature trends would decrease water quantity, which are anticipated to have a direct, adverse effect on reservoir levels necessary for water-based recreation opportunities. Increased climate variability in the spring shoulder months, drier hotter summers, and lower summer baseflow are the most impactful climate change factors affecting conservation season water supply operations (Section 3.13, Water Supply).

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

4.14.3.3 Cumulative Effects under All Alternatives

Reservoir-related Water-based and Land-based Recreation Opportunities

Direct and indirect effects on recreation opportunities in the analysis area would be beneficial among most alternatives with some variations. However, substantial, direct, adverse effects on water-based recreation opportunities would occur under Alternative 3A and Alternative 3B at some reservoirs during the peak recreation season and in the latter part of the season in late summer because water-based uses would be prohibited. Substantial, adverse effects on water-based opportunities would occur at Cougar Reservoir under Alternative 2B. Consequently, there would be substantial, indirect, adverse effects on other analysis area reservoir-related recreation facilities due to displaced visitor use under these alternatives.

Additionally, substantial, direct, adverse effects on stored water would also occur under these alternatives. Combined with RFFA increases in population and ongoing climate change impacts affecting demands for recreation and demands on water supply, Alternative 3A and Alternative 3B would have the most substantial, adverse, cumulative effects on recreation opportunities in the analysis area over the 30-year implementation timeframe from prohibited water-based recreation uses.

Land-based recreation would not be directly adversely affected under any alternative because they would likely remain available at all reservoirs regardless of water-based closures (depending on safety management). However, there would likely be reduced incentive to use land-based facilities at reservoirs without water-based recreation opportunities under Alternative 3A and Alternative 3B and at Cougar Reservoir under Alternative 2B during the peak recreation season.

Cumulative effects would also occur on recreation resource management agencies from population growth and water supply RFFAs in addition to indirect, reduced incentives to use land-based recreation opportunities under Alternatives 2B, 3A, and 3B. Reduced visitor incentives may result in displaced visitor use to other analysis area reservoirs or dispersed use in undeveloped areas. Dispersed use and increased use demand from population growth may cause damage to natural resources in the vicinity of reservoirs without water-based recreation opportunities.

These impacts would also be cumulatively added to wildfire-related impacts on recreation opportunities and subsequent visitor displacement. Cumulative impacts on managing agencies would include staffing and financial resource requirements and site-specific recreation and land use planning modifications.

Implementation of all other action alternatives and the No-action Alternative would not result in substantial, direct or indirect, adverse effects on recreation opportunities over the 30-year implementation timeframe. Beneficial effects on recreation opportunities at the WVS reservoirs would occur under all other action alternatives during the peak recreation season. Substantial benefits would occur under the No-action Alternative.

It is anticipated that reservoirs with the most overall visitation at the time the alternatives were analyzed would continue to support the most use (Fern Ridge, Foster, Dexter Reservoirs). Additionally, population growth in metropolitan areas near these reservoirs is expected over the 30-year implementation timeframe.

Cumulative effects from population growth combined with climate change may adversely affect water-based recreation opportunities at any reservoir under any alternative regardless of direct and indirect benefits. Competing needs for water use under Congressionally authorized purposes may result in recreation closures (Chapter 1, Introduction, Section 1.10, Congressionally Authorized Purposes). Adverse effects would be amplified depending on the number of reservoirs without water-based recreation opportunities. However, not all reservoirs would lack water-based recreation opportunities during a peak recreation season even with combined RFFA effects. WVS operations under any alternative would continue to provide water-based and land-based recreation opportunities within the analysis area.

However, land-based recreation opportunities would not be impacted from these combined effects to the same degree, but may be overused or closed from wildfire risk or damage. Impacts on managing agencies would be similar to those described under Alternatives 2B, 3A and 3B.

<u>Land-based Recreation Opportunities Unrelated to Reservoir Use</u>

Several land-based recreation opportunities unrelated to reservoir use would continue to be provided in the analysis area throughout the 30-year implementation timeframe. Federal, state, tribal, and private organization habitat improvements and conservation efforts in the analysis area would enhance existing land-based recreation opportunities including hiking, hunting, and wildlife viewing.

Population growth and climate change-related effects could adversely impact conservation and habitat improvements from increased use and damage combined with wildfire damages. Over time, ecosystems damaged by wildfires can be restored, but wildfire risk is expected to be recurring over the 30-year implementation timeframe. Land management agencies and private organizations are expected to manage in response in RFFAs that would adversely impact conservation and habitat efforts. WVS operations and maintenance would not impact these efforts in combination with, or without the influences of, any RFFAs over the 30-year implementation timeframe.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.15 LAND USE

4.15 Land Use

THE DEIS LAND USE SECTION HAS BEEN DELETED IN THE FEIS

Summary of changes from the DEIS:

- **After considering analyses in the DEIS, there is no potential for a significant impact to occur to land use under any of the alternatives, including the No-action Alternative, over the 30-year implementation timeframe. NEPA regulations do not define "land use," and this is not a required category of analysis under 40 CFR 1500. However, an agency's proposed action could alter land uses by converting one type of use to another (e.g., open spaces to urban development) or may be incompatible with zoning ordinances that specify allowed types of use. Under these circumstances, it would be consistent with the purpose of NEPA to analyze potential impacts on uses of land. However, there would be no changes in land use under any alternative.**
- **USACE analyzed potential effects to land cover in the DEIS. Land use and land cover are not always identical. For example, land used for timber harvest and land used for wilderness share the same forested land cover category but different land uses. No land cover would be altered under any alternative.**
- **Land cover was analyzed by addressing potential effects to vegetation, wetlands, visual conditions, and to reservoirs through sediment from drawdowns under the alternatives, which were disclosed in DEIS Section 3.15 and Section 4.15, Land Use. However, detailed effects analyses to these resources are analyzed in DEIS and FEIS Section 3.6 and Section 4.6, Vegetation; Section 3.7 and Section 4.7, Wetlands; Section 3.22 and Section 4.22, Visual Resources; and Section 3.5 and Section 4.5, Water Quality.**
- **Land activities are generally supported by designated land uses. For example, urban neighborhoods are found in urban land use areas. All land use activities associated with the Willamette Valley System are described in Chapter 3, Affected Environment and Environmental Consequences (e.g., wildlife management, recreation opportunities, cultural resources).**
- **Deletion of Section 3.15 and Section 4.15, Land Use, is supported by 40 CFR 1501.1(d) and 1500.4(g) (identification of significant environmental issues and de-emphasizing insignificant issues), 1501.7 (identification of significant issues related to the Proposed Action), and 1500.1(b) (NEPA documents must concentrate on issues that are 'truly significant' to the Proposed Action).**

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.16 HAZARDOUS MATERIALS

TABLE OF CONTENTS

4.16 Hazardous Materials

THE HAZARDOUS MATERIALS SECTION HAS BEEN REVISED IN FORMAT FROM THE DEIS REPEATED INFORMATION HAS BEEN REMOVED

Summary of changes from the DEIS:

- **Additional information has been added on reasonably foreseeable future actions and anticipated effects from these actions.**
- **Additional information has been added on invasive plant growth under climate change conditions and the relationship to use of hazardous materials.**
- **Additional information has been added on the Implementation and Adaptive Management Plan as it pertains to climate change effects.**

4.16.1 Cumulative Actions Applicable to Hazardous Materials

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on wildlife and habitat when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on wildlife and habitat in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 8: Invasive Species Management
- RFFA 9: Climate Change

4.16.2 Hazardous Materials Use Cumulative Effects Analysis Area

The analysis area to assess cumulative effects on natural resources and to the public is the WVS. Hazardous materials are primarily used in the WVS at dams, fish collection and hatchery facilities, and construction sites for operations and maintenance activities and are, therefore, localized to system dams (Section 3.16.1, Affected Environment). Cumulative effects from hazardous wastes are analyzed in Section 4.18, Public Health and Safety – Hazardous, Toxic, and Radioactive Waste, where a broader analysis area was considered in comparison to the hazardous materials analysis. Section 4.18 also addresses pesticide use from reduced agricultural production in the analysis area (RFFA 2).

4.16.3 Cumulative Effects from Hazardous Material Use

For context, Section 3.16, Hazardous Materials, Table 3.16-3, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.16.3.1 Overview

Hazardous Materials are loosely defined as chemicals or chemical mixtures that can pose a risk to humans, animals, plants, or the environment. Federal and State agencies have varying definitions of these materials depending on their regulatory authority, the chemical use, how the chemical may be transported, and how the chemical should be disposed. USACE has well-established efforts that ensure the proper handling, use, and disposal of hazardous materials and are primarily informed by the U.S. Environmental Protection Agency, U.S. Department of Transportation, the Occupational Safety and Health Administration and others.

The initial construction of the WVS occurred over 80 years ago, which created a system that required the initial and ongoing use of hazardous materials for the operation and maintenance of the WVS. Typical hazardous materials use involves the storage of compressed gasses, various forms of petroleum products and pesticides. Asbestos containing materials (ACM), lead based paints and polychlorinated biphenyl (PCB) containing material were often used during initial construction but are no longer procured for use. However, these materials can exist in the facilities to some degree and are managed in place and removed and disposed of when necessary.

4.16.3.2 Reasonably Foreseeable Future Action Effects

RFFA 8—Invasive Species Management

Invasive species management will likely increase in the Willamette River Basin generally and WVS specifically over the 30-year implementation timeframe. Changes in climate conditions will likely favor invasive species (both native and non-native) that are early colonizers after disturbance, more resistant to climate perturbations, or favored by emerging climate regimes (such as those flora and fauna migrating northward). Although invasive species may increase under climate change conditions, the dynamics of invasive plants in the Pacific Northwest itself are likely to be highly variable both within and between species” (Gervais et al. 2020). Due to this variability, various management actions may be employed to control invasive plants in the analysis area, which are unknown at this time.

Actions could include prescribed fire, manual, chemical, or other newly developed control measures over the 30-year implementation timeframe. Management activities related to hazardous materials risk to natural resources and to the public would result from increased pesticide uses throughout the WVS.

Throughout the Willamette River Basin, USACE, Bonneville Power Administration, U.S. Bureau of Reclamation and other Federal land managers would continue to cooperate on weed management, invasive species prevention and eradication, and vegetation treatments under any alternative. To the extent that these efforts are successful, they would improve habitats for and the survival of native plants and animals under continual climate change-induced scenarios. Several other planning efforts and regulations would continue to provide a comprehensive framework for addressing invasive species in Oregon (Oregon Conservation Strategy No Date).

RFFA 9—Climate Change

Impacts related to hazardous chemical use resulting from climate change would be narrowed to vegetation management under all alternatives. No other operations or maintenance activity described in Section 3.16, Hazardous Materials, Subsection 3.16.1, Affected Environment, would be expected to change as a result of climate change in regard to how these activities present hazardous materials risks to natural resources and to the public.

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the Willamette River Basin as compared to existing conditions and independent of the WVS operations and maintenance activities over the 30-year implementation timeframe (Appendix F1, Qualitative Assessment of Climate Change Impacts, Chapter 3, Observed Trends in Current Climate Change Literature Review; Appendix F2, Supplemental Climate Change Information, Section 3.1, Overview of RMJOC II Climate Change Projections) (USACE 2018e; USGCRP 2018; NOAA 2022a). The Implementation and Adaptive Management Plan incorporates climate change monitoring and potential operations and maintenance adaptations to address effects as they develop (Appendix N, Implementation and Adaptive Management Plan).

Wetter winters and drier summers would be expected to lead to changes in vegetation community composition and distribution over time, as drought-tolerant species become more predominant and invasive plants potentially encroach further into communities of native species. Pest species, including those that are invasive, are managed using a variety of pesticides basin wide. As invasive species proliferate throughout the WVS over time because of climate change, the quantity of pesticides used to control them would be expected to increase proportionally.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

4.16.3.3 Cumulative Effects under All Alternatives

Under all alternatives, operations and maintenance of the WVS would continue with varying construction, demolition, and repair activities depending on the alternative and its incorporated measures. However, construction-related effects are not anticipated to result in cumulative effects when combined with the identified RFFAs that could lead to increases in risk on natural resources and to the public from hazardous materials. The cumulative effects of RFFAs on natural resources and to the public from hazardous materials risks when combined with past and present actions would result from the relationship between climate change and increased pesticide use to control noxious weed establishment and spread.

Overall, the effects to natural resources and to the public from increased pesticide use under any alternative because of climate change over the 30-year implementation timeframe would continue to be minor, adverse because most pesticide types would not likely change and would remain primarily non-hazardous[1]. Pesticide applications would be localized, and their use would be mitigated by Federal safety protocols.

Further RFFA 8 incorporates continued cooperative agency measures to manage increases in invasive species. Measures include pesticide use but also other methods for control and abatement. Although pesticide use would be localized in the WVS, any risks associated with use to address increases in noxious weed establishment resulting from RFFAs would be long term over the 30-year implementation timeframe.

[1] It is possible that new pesticide formulas would become available during the 30-year implementation timeframe. However, an analysis of such availability is not practicable because these are unknown chemicals and, therefore, considered speculative.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.17 PUBLIC HEALTH AND SAFETY—HARMFUL ALGAL BLOOMS

4.17 Public Health and Safety—Harmful Algal Blooms

THE DEIS PUBLIC HEALTH AND SAFETY HARMFUL ALGAL BLOOMS SECTION HAS BEEN DELETED IN THE FEIS

Summary of changes from the DEIS:

- **After considering analyses in the DEIS, this information was primarily redundant with the analyses of harmful algal blooms in Section 4.5, Water Quality. Section 4.5, Water Quality, has been updated in the FEIS to incorporate information from DEIS Section 4.17, Public Health and Safety – Harmful Algal Blooms, as necessary to provide full disclosure of these potential risks.**
- **See 40 CFR 1500.1(b) (NEPA documents should not "ammas needless detail"), id. at (d) ("NEPA's purpose is not to generate paperwork – even excellent paperwork – but to foster excellent action"), 1502.1 (Agencies…shall reduce paperwork and the accumulation of extraneous background data), 1503.4(c) (changes to a DEIS are to be circulated in the FEIS).**

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.18 PUBLIC HEALTH AND SAFETY—HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

TABLE OF CONTENTS

4.18 Public Health and Safety—Hazardous, Toxic, and Radioactive Waste

4.18.1 Cumulative Actions Applicable to Hazardous, Toxic, and Radioactive Waste and Analysis Area

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on wildlife and habitat when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on wildlife and habitat in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 2: Agricultural Production
- RFFA 8: Invasive Species Management
- RFFA 9: Climate Change
- RFFA 10: Mining Operations

4.18.2 Hazardous, Toxic, and Radioactive Waste Cumulative Effects Analysis Area

The analysis area to assess cumulative effects on public health and safety from hazardous, toxic, and radioactive waste (HTRW) is the WVS, but also includes some nearby facilities on private property within the Willamette River Basin such as mines, from which contamination has migrated onto USACE-managed property (Section 3.18.2, Affected Environment).

4.18.3 Cumulative Effects from Hazardous, Toxic, and Radioactive Waste by Alternative

For context, Section 3.18, Hazardous, Toxic, and Radioactive Waste, Table 3.18-6, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.18.3.1 Overview

The initial construction of the WVS dams, non-USACE dams, and supporting structures occurred over 50 years ago, but the lack of proper hazardous waste management left a legacy of contamination at many of the WVS dams. These contamination sites pose varying risks to public health and safety and are summarized in Section 3.18, Hazardous, Toxic, and Radioactive Waste. Additionally, the construction of the dams and supporting structures, specifically those that produce hydropower, created small ongoing sources of hazardous waste from the chemicals necessary for their operation, such as waste from oil used in turbines and transformers.

4.18.3.2 Reasonably Foreseeable Future Action Effects

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Industrial development is a notable contributor to hazardous waste in the U.S. As populations grow, increased industrial development would result in more hazardous waste, and increase the risk to public health and safety. Ongoing and present structural improvements could potentially generate small amounts of hazardous waste from activities such as using compressed gasses for cutting, welding, and brazing, or could otherwise require hazardous material and generate small amounts of hazardous waste from construction activities in general.

RFFA 2—Agricultural Production

The management of cropland in the Willamette River Basin includes the use of pesticides. The area of cropland within the Basin will likely continue to diminish as population and related development expands, including agricultural land adjacent to some WVS reservoirs. However, agricultural practices would continue in the Basin during the 30-year implementation timeframe.

RFFA 8—Invasive Species Management

Invasive species management will likely increase in the Willamette River Basin generally and WVS specifically over the 30-year implementation timeframe. Changes in climate conditions will likely favor invasive species (both native and non-native) that are early colonizers after disturbance, more resistant to climate perturbations, or favored by emerging climate regimes (such as those flora and fauna migrating northward). Although invasive species may increase under climate change conditions, the dynamics of invasive plants in the Pacific Northwest itself are likely to be highly variable both within and between species" (Gervais et al. 2020). Due to this variability, various management actions may be employed to control invasive plants in the analysis area, which are unknown at this time.

Actions could include prescribed fire, manual, chemical, or other newly developed control measures over the 30-year implementation timeframe. Management activities related to hazardous materials risk to natural resources and to the public would result from increased pesticide uses throughout the WVS.

Throughout the Willamette River Basin, USACE, Bonneville Power Administration, U.S. Bureau of Reclamation and other Federal land managers would continue to cooperate on weed management, invasive species prevention and eradication, and vegetation treatments under any alternative. To the extent that these efforts are successful, they would improve habitats for and the survival of native plants and animals under continual climate change-induced scenarios. Several other planning efforts and regulations would continue to provide a comprehensive framework for addressing invasive species in Oregon (Oregon Conservation Strategy No Date).

RFFA 9—Climate Change

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the WRB as compared to existing conditions and independent of the WVS operations and maintenance activities over the 30-year planning timeframe (Appendix F1, Qualitative Assessment of Climate Change Impacts; Appendix F2, Supplemental Climate Change Information) (USACE 2018e; USGCRP 2018; NOAA 2022a). The Implementation and Adaptive Management Plan incorporates climate change monitoring and potential operations and maintenance adaptations to address effects as they develop (Appendix N, Implementation and Adaptive Management Plan).

Climate change presents indirect risks to public health and safety from HTRW. Climate change is expected to exacerbate the frequency and severity of natural disasters such as wildfires and floods, which could increase the risk to public health by spreading or exposing contamination that had previously been inaccessible to the public. Seven superfund sites in the Basin have been found to be vulnerable to climate change, including one adjacent to the mainstem Willamette River (Hasemeyer and Olsen 2020). Other waste sites that are not classified as superfund sites but could potentially be vulnerable to climate change are those at Big Cliff, Blue River, Cougar, Detroit, Dexter, Dorena, Fall Creek, and Green Peter.

The vegetation community would also be expected to change in composition and distribution over time as the climate changes. Native plant communities could be outcompeted by drought-tolerate species and invasive plants that more easily adapt to the changing climate conditions. The amount of pesticides used throughout the Basin would likely increase over time to control these invasive species.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 10—Mining Operations

Mining operations produce hazardous waste and continue to be of growing interest within the Willamette River Basin. There are nearly 200 production mines and hundreds of active mining claims throughout the Basin. While there is no certainty that active claims would transition into production mines, ongoing maintenance requirements to maintain an active status indicates that these sites could transition into production mines in the future.

Legacy environmental contamination exists within the Willamette River Basin and is managed under the WVS CERCLA process. Contamination is a result of historic mining activities and initial construction and operations and maintenance of the WVS. Several production mines and active and/or closed mining claims exist near the Blue River, Cottage Grove, Detroit, Dorena, Fall Creek, Foster, Green Peter, and Lookout Point Reservoirs.

Contamination from historical mining operations primarily involve heavy metals and include but are not limited to arsenic, mercury, and chromium (Section 3.5, Water Quality). Contamination from the construction of the WVS includes hazardous or toxic substances such as diesel, polychlorinated biphenyls (PCBs), and heavy metals (Section 3.16, Hazardous Materials).

4.18.3.3 Cumulative Effects under All Alternatives

Under all alternatives, operations and maintenance of the WVS would continue with varying construction, demolition, and repair activities depending on the alternative and its incorporated measures. However, construction-related effects are not anticipated to result in cumulative effects when combined with the identified RFFAs that could lead to increases in risk on natural resources and to the public from HTRW. The cumulative effects of RFFAs on natural resources and to the public from hazardous materials risks when combined with past and present actions would result from the relationship between climate change and increased pesticide use to control noxious weed establishment and spread.

Overall, the effects to natural resources and to the public from increased pesticide use under any alternative because of climate change over the 30-year implementation timeframe would continue to be minor, adverse because most pesticide types would not likely change and would remain primarily non-hazardous[1]. Pesticide applications would be localized, and their use would be mitigated by Federal safety protocols.

Further RFFA 8 incorporates continued cooperative agency measures to manage increases in invasive species. Measures include pesticide use but also other methods for control and abatement. Although pesticide use would be localized in the WVS, any risks associated with use to address increases in noxious weed establishment resulting from RFFAs would be long term over the 30-year implementation timeframe.

[1] It is possible that new pesticide formulas would become available during the 30-year implementation timeframe. However, an analysis of such availability is not practicable because these are unknown chemicals and, therefore, considered speculative.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.19 PUBLIC HEALTH AND SAFETY—DRINKING WATER

TABLE OF CONTENTS

4.19 Drinking Water

THE DRINKING WATER CUMULATIVE EFFECTS ANALYSIS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

4.19.1 Cumulative Actions Applicable to Drinking Water

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on drinking water when considered together with actions under all alternatives and past actions are listed below and would be the same as those identified under Section 4.5, Water Quality and Section 4.13, Water Supply. Cumulative effects on drinking water in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 2: Agricultural Production
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvements
- RFFA 8: Invasive Species Management
- RFFA 9: Climate Change
- RFFA 10: Mining Operations
- RFFA 11: Timber and Logging Operations

4.19.2 Drinking Water Cumulative Effects Analysis Area

The drinking water analysis area is the same as the area analyzed for direct and indirect effects in Section 3.19, Drinking Water. The analysis area encompasses the Willamette River Basin, which includes the Willamette Valley System (WVS). It is not anticipated that drinking water effects would occur beyond this analysis area when combining operations and maintenance actions with future actions.

4.19.3 Cumulative Effects on Drinking Water

A summary of RFFA impacts that would affect drinking water is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.19, Table 3.19-2, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.19.3.1 Overview

Although USACE is not responsible for drinking water supply or treatment, effects to drinking water from WVS operations would be the result of direct effects from water supply necessary for drinking water use. Adverse or beneficial effects on drinking water could occur from operational effects to available water.

Indirect effects to drinking water quality could occur if water quality is adverse below a dam, affecting a drinking water source under any alternative. Subsequent direct effects on drinking water quality would be the result of post-treatment conditions and not the result of WVS operations.

The expected direct, indirect, and cumulative effects from water quality and water supply under each alternative are integral to the assessment of cumulative drinking water conditions in the analysis area. Consequently, information from these analyses is synthesized into the drinking water analyses (Section 4.5, Water Quality; Section 4.13, Water Supply).

USACE has not identified any groundwater wells that are hydrologically connected to WVS reservoirs. There was no documented impact on groundwater wells in areas adjacent to WVS reservoirs during the 2024 deep drawdown operations.

Groundwater wells that are hydrologically connected to rivers downstream of USACE reservoirs benefit from augmented streamflows, especially during dry years, which helps to maintain the water table at levels accessible by groundwater wells. There was no documented impact on groundwater wells in areas downstream of WVS reservoirs during the 2024 deep drawdown operations. Consequently, there are no anticipated cumulative effects on groundwater wells as a source of community drinking water in the analysis area from implementation of any alternative.

4.19.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on drinking water are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Water Quality

Population in the analysis area is expected to increase over the 30-year implementation timeframe. Increases in population result in increased urban development and associated water quality impacts from urban runoff, pollution, and in-water uses.

Stormwater would continue to be discharged from residential, commercial, industrial, and agricultural land uses. In-water recreation at WVS reservoirs and in the Willamette River and its tributaries is also likely to increase with population growth. An increase in runoff and in-water use from population growth may introduce non-point and point source pollution into the analysis area, which would continue to adversely affect water quality.

Increased nutrient inputs may facilitate continued adverse water quality effects from harmful algal blooms, which would be localized but possibly recurring seasonally.

Water Supply

As the population increases throughout the Willamette River Basin, municipal and industrial needs will increase, putting pressure on existing water supplies. Increased water supply demands will also result in decreased in-stream water in the Basin.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water over the 30-year implementation timeframe are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

RFFA 2—Agricultural Production

Water Quality

Although agricultural production in the analysis area had been decreasing at the time the alternatives were analyzed, water demand for agricultural use will continue over the 30-year implementation timeframe. Agricultural practices will, therefore, continue to adversely affect water quality in the analysis area from pollutant, nutrient, and bacteria runoff and soil erosion in localized areas.

Water Supply

Although agricultural production in the analysis area had been decreasing at the time the alternatives were analyzed, water demand for agricultural use will continue over the 30-year implementation timeframe (Section 3.13, Water Supply, Table 3.13-2).

WVS conservation storage totals approximately 1,590,000 acre-feet. As of September 2024, of this total, only 84,349 acre-feet of stored water (less than 5 percent of the WVS conservation storage volume) was contracted through U.S. Bureau of Reclamation for agricultural irrigation use on 45,715 acres in the analysis area (Section 3.13, Water Supply).

The expansion of agricultural irrigation in the Willamette River Basin was slow until the 1940s, when irrigated acres increased during the post-World War II decades, from 27,000 irrigated acres in 1940 to approximately 194,000 irrigated acres in 1964 (OWRB 1967). Irrigated acreage increased to about 300,000 acres by 2007 and was 276,000 acres in 2017 (USDA 2019). Unlike in other basins in Oregon, there are limited irrigation districts in the Willamette River Basin, with most irrigation diversions installed by individual users (USACE 2019a).

Future demands for agricultural water use would need to be met with stored water from the WVS because most waterways in the Willamette River Basin have limited availability for river flow water rights (Section 3.13, Water Supply). A total of 327,650 acre-feet was reallocated to the specific use of agricultural irrigation in the Water Resources Development Act of 2020 (USACE 2019a) based on the forecasted demand[1] for stored water for agricultural irrigation use to the year 2070.

RFFA 3—Water Withdrawals for Municipal, Industrial, and Agricultural Uses (Water Supply Effects)

In addition to future demands for agricultural water use, at the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). This need was one of the factors that led to the Willamette Basin Review Feasibility Study (USACE 2019a), which resulted in a total of 159,750 acre-feet of conservation storage reallocated to the purpose of municipal and industrial water supply.

Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

RFFA 5—Federal and State Wildlife and Lands Management (Water Quality Effects)

Federal lands management objectives in the analysis area can align with preservation of water quality conditions through land conservation practices. Conserving forested and other natural landscapes can aid in preservation of water quality conditions by preventing soil erosion or chemical uses that pollute water systems.

State lands management in analysis area headwaters would continue to be managed to protect water quality and for watershed protection as required under the Oregon Statewide Planning Goals and Guidelines (ODLCD 2019).

[1] The Willamette Basin Review Feasibility Study period was 50 years (USACE 2019a).

However, some water quality impairment is likely to occur over the 30-year implementation timeframe from Federal and state management practices that include logging, road development and use, recreation near water sources, livestock grazing, resource extraction, and other uses.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvements

Water Quality

Watershed protection and conservation projects aimed at improvements in fish and aquatic habitat would necessarily preserve or improve water quality parameters needed to support habitat over the 30-year implementation timeframe. Water quality parameters, such as water temperature, may also benefit depending on upland-focused wildlife and land management strategies. For example, modifications to riparian management could result in stable streambank conditions minimizing turbidity and runoff. Additionally, retention of riparian timber would maintain or improve localized instream temperatures in the analysis area.

These management actions could result in long-term, permanent water quality benefits; however, some actions may result in short-term, adverse effects such as instream riprap or beaver analog work, culvert placement, bank stabilization projects, etc. that would temporarily increase turbidity. Such impacts would be localized in stream areas and would not adversely affect the entire analysis area.

Water Supply

Tribes, state, and local agencies, environmental organizations, and private communities are expected to continue non-Federal habitat activities and projects focused on improving general habitat and ecosystem function or species-specific conservation objectives in Oregon. Improvements could result in conversion of minimum perennial streamflows to instream water rights, giving protections to instream flows and seniority against out-of-stream uses. This could result in alternative sources of municipal, industrial, and agricultural water supply for users during the 30-year implementation timeframe.

This scenario was considered as part of the Willamette Basin Review Feasibility Study (USACE 2019a) resulting in reallocation of the conservation storage to the authorized purposes of municipal and industrial water supply, irrigation, and fish and wildlife.

RFFA 8—Invasive Species Management (Water Quality Effects)

Management of analysis area aquatic and upland invasive plants will continue over the 30-year implementation timeframe. Management will include use of herbicides to control growth.

Wetter winters and drier summers related to climate change would be expected to lead to changes in vegetation community composition and distribution over time, as drought-tolerant species become more predominant and invasive plants potentially encroach further into communities of native species. The quantity of pesticides used to control invasive species would be expected to increase proportionally as invasive species proliferate throughout the WVS over time because of climate change-related conditions (Section 3.16, Hazardous Materials).

Herbicides and insecticides are types of pesticides (Section 3.16, Hazardous Materials). These chemicals are applied as spot treatments on a small scale as part of routine maintenance to prevent the establishment of new invasive species, manage/control existing populations, and to enhance habitat for native species.

The continue use and increased use of herbicides can adversely affect reservoir water quality through pollutant overspray, soil erosion, or if suspended in water runoff.

RFFA 9—Climate Change

Water Quality

Studies on the effects of climate change on water quality demonstrate and project increases in average annual temperatures in the analysis area from 1950 to 2100 (Appendix F2, Supplemental Climate Change Information). Precipitation is also anticipated to increase in winter months and decrease during the spring and summer months. Such impacts could be expected in the analysis area over the 30-year implementation timeframe under any alternative. Moreover, these effects would likely be long-term, affecting stream reaches above and below all WVS dams.

Climate change would affect water quality due to an increase in air temperature, which would increase water temperatures in the analysis area, including reservoir and instream temperatures. Increased water temperatures in reservoirs will likely increase ongoing adverse, localized, and seasonal effects from harmful algal blooms in the WVS.

Increased air temperatures will also continue to foster wildfires in the Willamette River Basin. Wildfire alters the land surface and can have strong influences on runoff, erosion, and sediment transport into water systems. This will contribute adverse effects to ongoing turbidity effects downstream of WVS dams.

Climate change-related temperature increases coupled with increased analysis area population will also likely result in increased in-water recreation uses. Increased uses in WVS reservoirs and the Mainstem Willamette River will cause increases in water pollution and bacteria, adding to existing direct, adverse water quality conditions.

Water Supply

Climate change would have an adverse effect on water supply and to municipal and industrial water and agricultural irrigation users under any alternative. Increased climate variability in the spring shoulder months, drier hotter summers, and lower summer baseflow are the most impactful climate change factors affecting conservation season water supply operations. Consequently, water supply from water stored in analysis area reservoirs and groundwater wells and from river flow may be adversely affected in the long term under any alternative. Additionally, decreased summer baseflows would adversely affect water users under any alternative as there may not be adequate water in the rivers to satisfy existing water rights.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 10—Mining Operations (Water Quality Effects)

Mining operations have the potential to adversely affect water quality by introducing minerals and contaminants into streams and reservoirs from runoff upstream and downstream of WVS dams. Localized water quality impairment could occur from runoff associated with drilling, excavation, and survey work in the analysis area over the 30-year implementation timeframe.

RFFA 11—Timber and Logging Operations (Water Quality Effects)

Similar to mining operations, timber and logging operations in the analysis area have the potential for localized water quality impacts from soil erosion into water sources near operations. Although logging operations had decreased in the analysis area at the time the alternatives were analyzed, some operations will continue upstream of streams in the Willamette River Basin over the 30-year implementation timeframe.

4.19.3.3 Cumulative Effects under All Alternatives

Water Quality and Treatment Facility Operations under All Alternatives

Drinking water quality would be indirectly, adversely affected by the liberation of previously stored sediments caused by construction activities or by deep reservoir drawdowns over the 30-year implementation timeframe. These effects would be basin-wide. Both USACE operations could cause an increase in the amounts of turbidity and harmful algal blooms discharged downstream into drinking water sources, which would be combined with RFFAs. These cumulative conditions would result in indirect, adverse, temporary treatment costs of additional chemicals, testing, and facility maintenance as well as administrative costs and delays in drinking water supplied to affected communities (Section 3.11, Socioeconomics).

Reasonably Foreseeable Future Action Effects and Turbidity

Conservation land management would continue to moderate water quality effects in the analysis area. However, it is not likely that these RFFAs would measurably contribute to stabilizing or to improving water quality conditions immediately below dams resulting from operations under any alternative. This is because of the localized effects of land management and of dam operations. Regardless, overall water quality conditions in the Willamette River Basin would continue to benefit from conservation land management.

Conversely, erosion from some land management practices in the analysis area would continue to adversely affect water quality downstream of WVS dams. This impact may be combined with ongoing direct, adverse effects of turbidity in downstream reaches under all alternatives except Alternative 1 and Alternative 4. Additionally, these cumulative effects would worsen with erosion and sediment entering Willamette River Basin streams from wildfire landscape alterations, which are expected to be an increasing risk from climate change effects.

Reasonably Foreseeable Future Action Effects and Harmful Algal Blooms and Mercury

A predominant, combined effect of RFFAs on water quality would be effects from runoff containing pollutants, nutrients, and bacteria. These adverse conditions would be combined with slight, adverse, direct effects from harmful algal blooms and mercury under the NAA and increases in these adverse conditions under all action alternatives. Direct and cumulative effects would be greatest under Alternative 3A and Alternative 3B (Section 3.5, Water Quality, Figure 3.5-62 and Figure 3.5-63).

Consequently, water quality conditions from anticipated ongoing effects combined with RFFA effects would result in increased impaired water quality over the 30-year implementation timeframe. It is anticipated that these effects would be localized and possibly seasonal when combined with harmful algal blooms under any alternative.

Cumulative Effects on Drinking Water and Facility Operations from Reasonably Foreseeable Future Actions, Turbidity, and Harmful Algal Blooms

All indirect and cumulative adverse water quality resulting from USACE operations and RFFAs under any alternative would be addressed by water treatment and would remain compliant with Federal and state regulations for safe drinking water.

Specifically, water sourced from downstream of the WVS reservoirs would continue to be treated by a combination of filtration, aeration, and disinfection at a public water treatment facility before it is distributed within the analysis area under any alternative over the 30-year implementation timeframe.

Elevated turbidity and harmful algal blooms from WVS operations and RFFAs combined, and subsequent treatment requirements, could temporarily include increased costs of additional chemicals; testing; and facility maintenance, repairs, and/or equipment replacement. Adverse cost impacts from WVS operations could be worsened with additional water quality effects combined with RFFAs.

Indirect, adverse effects to communities could also include temporary loss of drinking water access and the requirement to supplement potable water, but there may be no measurable additional effect on these impacts when combined with RFFA effects.

Water Withdrawals

All forecasted demands for municipal, industrial, and agricultural water withdrawals as water supply, including from the RFFAs considered in these forecasts, would be met under all alternatives except Alternative 3A and Alternative 3B.

Stored Water under Alternative 3A

Compared to the NAA, Alternative 3A would result in direct and cumulative, substantial, adverse effects to water supply because the combined operations would adversely affect system-wide conservation storage during the 30-year implementation timeframe (Section 3.13, Water Supply, Table 3.13-13). The reduced storage as compared to the NAA would result in no water available for municipal and industrial water supply forecasted demands that considered the combined RFFAs during the 30-year implementation timeframe. This would be an indirect and cumulative, substantial, adverse effect to drinking water users in the analysis area.

River Flow under Alternative 3A

Direct and cumulative effects to river flow water supply and indirect and cumulative effects to drinking water users under Alternative 3A would be beneficial except in the North Santiam River Subbasin (Section 3.13, Water Supply, Table 3.13-14). In this subbasin, the spring drawdown at Detroit Reservoir would eliminate the ability to store water to augment naturally low flows in the summer as compared to the NAA during the 30-year implementation timeframe. This would be an indirect and cumulative adverse effect to drinking water users dependent on flows below Detroit Dam.

Stored Water under Alternative 3B

Unlike the NAA, there would be a direct and cumulative, substantial, adverse effect on water supply under Alternative 3B because the combined operations for fish passage would adversely affect system-wide conservation storage during the 30-year implementation timeframe (Section 3.13, Water Supply, Table 3.13-15).

Due to conditions in the Willamette Basin Review Feasibility Study Biological Opinion (USACE 2019a), water that would be stored in the WVS reservoirs would be used primarily to support minimum flows for fish and wildlife under Alternative 3B. The reduced storage as compared to the NAA would result in no water available for municipal and industrial drinking water users during the 30-year implementation timeframe and would be an indirect and cumulative, substantial, adverse effect on these users in the analysis area.

River Flow under Alternative 3B

Direct and cumulative effects on river flow water supply and indirect and cumulative effects to drinking water users under Alternative 3B would be beneficial except in the South Santiam River Subbasin (Section 3.13, Water Supply, Table 3.13-16). In this subbasin, the spring drawdown at Green Peter Reservoir would eliminate the ability to store water to augment naturally low flows in the summer as compared to the NAA during the 30-year implementation timeframe. This would be an indirect and cumulative, adverse effect to drinking water users dependent on flows below Green Peter Dam.

Water Availability in Dry Years under All Alternatives

Per the Willamette Basin Review Feasibility Study (USACE 2019a), delivery of water stored in the WVS reservoirs for agricultural irrigation and municipal and industrial uses, forecasted with consideration of the RFFAs, may be ceased or curtailed in dry years, limiting availability for drinking water. This would be an adverse effect to drinking water supply under all alternatives and would impact several communities in the analysis area but to varying degrees depending on alternative operations.

The indirect impact to drinking water users from dry-year water supply management cannot be accurately assessed. However, it is anticipated that dry water-year effects would not be continuous over the full 30-year implementation timeframe, but dry water years could be re-occurring depending on annual climate conditions.

No additional, cumulative effects on water supply would occur when combining the anticipated RFFA impacts with direct and indirect effects. This includes the combined effect of all RFFAs over the 30-year implementation timeframe because the impact of population increases and other RFFA demands on water supply were incorporated into forecasted water demands used for the direct and indirect effect alternatives analyses (Section 3.13, Water Supply).

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.20 ENVIRONMENTAL JUSTICE

4.20 Environmental Justice

THE DEIS ENVIRONMENTAL JUSTICE SECTION HAS BEEN DELETED IN THE FEIS

Summary of changes from the DEIS:

- **Executive Order 14148 was rescinded on January 20, 2025 by Executive Order. Executive Order 14173 was rescinded on January 21, 2025 by Executive Order. The two 2025 Executive Orders rescinded the previous Executive Orders requiring agencies to analyze environmental justice-related effects from proposed actions. In compliance with these 2025 directives, environmental justice analyses have been removed from the FEIS.**

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.21 CULTURAL RESOURCES

TABLE OF CONTENTS

4.21 Cultural Resources

THE CULTURAL RESOURCES SECTION HAS BEEN REVISED IN FORMAT FROM THE DEIS
REPEATED INFORMATION HAS BEEN DELETED
INSERTION OF LARGE AMOUNTS OF TEXT IS IDENTIFIED; MINOR EDITS ARE NOT DENOTED

Summary of changes from the DEIS:

- **The cultural resources analysis area for cumulative effects has been clarified in FEIS Section 4.21.2.**
- **Additional information has been added on reasonably foreseeable future actions and anticipated effects from these actions.**
- **DEIS Table 4.21-1, Summary of Past and Present Actions Relevant to Cultural Resources, has been deleted because this was repetitive information provided in Section 3.21, Cultural Resources.**
- **DEIS Table 4.21-2, Summary of Reasonably Foreseeable Future Actions (RFFAs) Relevant to Cultural Resources, was deleted because this information is present in more detail in narrative form in FEIS Section 4.21.2.2, Reasonably Foreseeable Future Actions.**
- **The analysis of effects has been modified to expand descriptions of anticipated effects when combing the RFFA effects on cultural resources with operations and maintenance effects under the alternatives (Section 4.21.3.3, All Alternatives including the No-action Alternative).**

4.21.1 Cumulative Actions Applicable to Cultural Resources

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on wildlife and habitat when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on wildlife and habitat in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate Change

- RFFA 10: Mining Operations
- RFFA 11: Timber and Logging Industry Operations

4.21.2 Cultural Resources Cumulative Effects Analysis Area

The analysis area for direct, indirect, and cumulative effects is the Willamette River Basin. Cumulative impacts to cultural resources would occur if RFFAs, combined with effects from ongoing actions, erode or expose archaeological resources or damage or modify built resources of the WVS historic districts (Section 3.21, Cultural Resources).

Cultural resources are stationary and situated along the WVS waterways and downstream of the WVS. Therefore, cumulative effects would be those from water-based effects in the analysis area. Due to the hydrological morphology and processes known to exist in the Willamette River Basin (Section 3.2, Hydrological Processes), any water-based effects could not come from outside the Willamette River Basin.

4.21.3 Cumulative Effects to Cultural Resources by Alternative

For context, Section 3.21, Cultural Resources, Table 3.21-7, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.21.3.1 Overview

The annual cycles of draft and fill of the WVS reservoirs, occurring over 50 to 80 years depending on the operating location, has had major direct adverse effects to cultural resources that are located within or overlap with a reservoir as discussed in Section 3.21, Cultural Resources. Annual draft cycles have created a routine and frequent cycle of erosion that incrementally destroys the physical integrity of sites and creates exposure that increases vulnerability at each site to unauthorized collection and other forms of human-caused destruction. These impacts have been additive over the past 50 to 80 years and are also ongoing. Further, cultural resource impacts from draft cycles are irreversible.

The built environment would also be directly adversely affected by structural modifications and additions that have occurred and would continue to occur from operations and maintenance activities that change the historic character of the 13 historic districts of the WVS (Section 3.21, Cultural Resources). However, cultural resources downstream of the WVS have also benefitted from long-term WVS operations, which has substantially reduced flooding along the 465 river miles that are downstream of the WVS (Appendix T, Cultural Resources Analysis).

4.21.3.2 Reasonably Foreseeable Future Actions

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population growth would result in intensive use of the Willamette River Basin through physical expansion of communities (or urban sprawl), more recreation at existing and new locations, and additional development, which would additively contribute to adverse impacts to archaeological sites and built resources. Population increases in the analysis area would increase the potential for unauthorized collection of artifacts. Increased construction activities related to development would result in ground disturbance that would affect archaeological sites.

Expansion of recreation resources would likely drive increased use by more people from a growing population to reservoir areas and relatedly an increase in artifact collection. Built resources would be impacted by development that would result in modification or removal of historic structures. Built resources at recreation sites would experience heavier use and related degradation that would directly and adversely impact the aspects (character defining features) that qualify them for listing in the National Register of Historic Places.

RFFA 5—Federal and State Wildlife and Lands Management

Federal and state wildlife and land management may have adverse or beneficial effects to cultural resources, which is dependent on how resources and lands are managed. Massive wildfires occur annually in the Willamette Valley and destroy large swaths of forested lands and wildlife habitat, which may lead land managers to set aside public lands to conserve wildlife habitat and protect remaining forests from development and resource extraction.

If landscapes are stabilized by promoting native vegetation establishment, this would be directly beneficial to archaeological sites that would have reduced exposure and visibility to people and subsequent lowered risk of unauthorized collection of artifacts. Conversely, if a waterway is returned to pre-dam conditions requiring removal of the historic built environment or ground disturbance that impacts archeological sites, this would have additive adverse effects to archaeological sites and built resources. Habitat restoration that increases periodic flooding would adversely affect cultural resources through erosion and exposure of archaeological resources and erosion that undercuts the stability of built resources existing in floodplains.

Conservation set asides could result in more intensive development and resource extraction on other public lands that would result in additive adverse effects to cultural resources in those areas due to increased ground disturbing activities (logging, mining, and development) and collection of artifacts (due to increased and more intensive public use).

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvement

Tribal, state, and local fish and wildlife improvement may be adverse or beneficial to some cultural resources for the same reasons discussed for RFFA 5. Adverse impacts would be additive to ongoing impacts from WVS operations and maintenance activities, while beneficial impacts would reduce or stop erosion and exposure, but not improve the conditions of any cultural resources because archaeological sites cannot be rehabilitated once their physical integrity has been destroyed and the contextual information of an artifact cannot be recovered once it is removed from its original location through unauthorized artifact collection.

The Confederated Tribes of the Grand Ronde Community of Oregon and the Confederated Tribes of the Warms Springs Reservation of Oregon manage tribally owned lands along the North Santiam River for fish and wildlife habitat through the Oregon Department of Fish and Wildlife Willamette Wildlife Mitigation Program (ODFW No Date-b). The Nature Conservancy is also active in the Willamette Valley and has worked with several partners to buy riverfront lands and wildlife-rich places to promote fish and wildlife habitat conservation (TNC 2024).

These efforts include restoration and conservation efforts, which have beneficial and adverse effects to cultural resources. As lands and wildlife are conserved and protected, it is possible that resource extraction and development will intensify in unprotected areas, as discussed with RFFA 5.

RFFA 9—Climate Change

Climate change would have negative effects to cultural resources when combined with ongoing adverse effects from WVS operations and maintenance activities. Notable impacts would include increased winter rains from existing conditions that would increase bank and soil erosion and cause instability to archaeological components (RMJOC 2018). This would also expose more artifacts to unauthorized collection throughout the Willamette River Basin as compared to existing conditions.

Less water in the summer would cause similar site risks by increasing reservoir bed exposure concurrent with likely increases in shoreline recreation (RMJOC 2018). Consequently, these conditions would increase the risk of unauthorized collections in exposed, non-vegetated reservoir beds.

Increased wildfires are a major negative direct impact to cultural resources. Fires destabilize soils and denude forests, which cause erosion at archaeological sites. Reduced vegetative cover from wildfire also increases visibility of archaeological sites and leaves them vulnerable to unauthorized collection.

Changes to the landscape from wildfire impacts could also lead to greater high-water events that weaken soils and increase erosion and channel incision, both causing direct, adverse effects to built resources. Historic built resources would also be replaced by modern and efficient infrastructure.

The USACE Implementation and Adaptive Management Plan would incorporate climate change monitoring and potential operations and maintenance adaptations to address effects as they develop over the 30-year implementation timeframe (Appendix N, Implementation and Adaptive Management Plan).

RFFA 10—Mining Operations

Mining operations have the potential to adversely affect cultural resources through disturbance of soils that would cut into existing archaeological sites as well as to create unstable river banks that are more likely to erode and would indirectly affect archaeological sites downstream from mining operations. Built resources could also be damaged with slope instability and erosion, or modification or replacement of historic resource types to take advantage of advances in the mining industry.

RFFA 11—Timber and Logging Industry Operations

Timber and logging industry operations are declining in western Oregon (Rooney 2021). However, there is still much timber activity and related fire suppression of private timber company inholdings and in the Willamette National Forest. Timber operations have the potential to adversely affect archaeological sites through ground disturbance, soil instability, and water runoff in newly unvegetated areas.

Timber and logging operations can also create indirect effects through modification of the forested viewshed (as can mining operations). While the WVS is a human constructed entity, the 13 dams and reservoirs are nestled into pastoral or timbered landscapes, and they are places where people go to recreate and enjoy the natural setting (Section 3.14, Recreation Resources; Section 3.22, Visual Resources). This aesthetic is important to the appeal of the 13 historic districts. Impacts to the viewshed from timber and logging operations would be temporary but would last throughout the 30-year implementation timeframe.

4.21.3.3 Cumulative Effects under All Alternatives

The most recent 200 years of human settlement and development of the Willamette Valley has had major adverse effects to cultural resources in the direct, indirect, and cumulative effects analysis area. Development and population growth (RFFA 1) would greatly increase adverse effects to cultural resources in the analysis area throughout the 30-year implementation timeframe when combined with ongoing adverse effects from operations under all alternatives.

Alternatives 3A, 3B, and 5, would have major adverse impacts archaeological sites due to operations that would include deep drawdowns at two or more reservoirs and result in substantial archeological site erosion and exposures. Exposed sites and eroded artifacts would be at greater risk of unauthorized collection under the alternatives when combined with an increase in analysis area population and increased use of recreation areas during the 30-year implementation timeframe.

The No-action Alternative (NAA) and Alternatives 1, 2A, 2B, and 4 would result in the least (but still great) adverse effects to archaeological sites in WVS reservoirs when combined with development and population increases because operations would only include deep drawdowns at Fall Creek Reservoir and, therefore, the most extreme erosion and site exposure that occurs during deep drawdowns would be restricted to one reservoir.

Across all alternatives, built resources would be vulnerable due to increased demand on the recreation infrastructure of the WVS historic districts that would occur with development and population growth throughout the 30-year implementation timeframe. Increased visitation would result in increased infrastructure development to meet visitor demands, which would require modifications to the character defining features of the contributing recreation properties of the WVS historic districts.

The NAA would result in the least adverse effect to built resources because no operational measures would be implemented and dam, powerhouse, and fish facility contributing resources would not be modified (changes would only occur to recreation contributing resources). Alternatives 2A, 2B, 3A, 3B, 4, and 5 would result in greater adverse impacts to built resources because these alternatives recommend changes to dam, powerhouse, and fish facility contributing resources at four to seven of the operating projects.

Resource extraction related to mining and the timber industry (RFFA 10 and RFFA 11) would increase adverse effects to cultural resources in the analysis area throughout the 30-year implementation timeframe when combined with WVS operations across all alternatives. Mining and logging actions, which typically include site specific ground disturbance, combined with Alternatives 3A, 3B, and 5, which would have deep drawdowns at multiple reservoirs, would have the greatest adverse effect to archaeological sites because thousands of acres in the reservoir beds would have extreme site erosion and artifact exposure. This would be increased by mining and logging occurring along waterways that would affect archaeological site downstream and directly within the extraction areas.

Cumulative effects of mining and logging operations in combination with the NAA and Alternatives 1, 2A, 2B, and 4 would be less adverse to archaeological sites because erosion and ground disturbance would not occur as often or across as much acreage. Deep drawdowns would be restricted to only Fall Creek Reservoir.

Across all alternatives, when WVS operations are combined with logging and mining operations, the WVS historic districts would be minorly adversely affected by limited erosion due to their design, placement on bedrock, and primary purpose (flood risk management) but small and isolated built resources along the waterways would be at greater risk from erosion or direct removal within mining and logging areas.

Impacts from mining and logging to cultural resources would be minimized by compliance with state and federal laws that protect cultural resource and require that mitigation efforts occur to offset adverse effects. State and federal cultural resources laws incentivize operational and post-operational restoration plans that prioritize protection of archaeological sites and maintaining the historic aesthetic and historic districts, which would further reduce impacts to cultural resources.

State, Federal, tribal, and local land management plans that prioritize improving or conserving wildlife populations and habitat (RFFA 5 and RFFA 7) would have adverse and beneficial effects to cultural resources when combined with the WVS operations throughout the 30-year implementation timeframe. Under the NAA, and Alternatives 1, 2A, 2B, and 4, these effects are most likely to be beneficial because deep drawdowns are only occurring at Fall Creek Reservoir and efforts to protect and conserve lands and wildlife would likely result in acreage within the WVS to be protected through reduced development and public use compared to existing conditions (e.g., to compensate for wildfire impacts long-term). Such protection measures should ultimately reduce ground disturbance, erosion, and unauthorized collection.

There would still be site specific, adverse effects including restoration efforts that are intended to create pre-dam conditions but cause erosion and expose archaeological resources and undercuts the stability of landforms where built resources exist along waterways and in historic floodplains. Conversely, stabilizing habitat through vegetation and ground cover would result in site specific beneficial impacts to archaeological sites through reduced site visibility and indirectly reducing unauthorized artifact collection.

Management plans that comply with Federal and state laws and prioritize cultural resources protection would reduce negative impacts to cultural resources. However, under Alternatives 3A, 3B, and 5, wildlife and land management efforts would likely increase adverse effects to cultural resources throughout the 30-year implementation timeframe.

These alternatives would have deep drawdowns at multiple reservoirs, which would result in unstable environments that erode and destroy the physical integrity of cultural resources over thousands of acres, and land and wildlife management efforts, which use ground disturbing methods to restore habitat or return waterways to pre dam conditions, would expand the acreage within the WVS where these adverse impacts would occur. It is probable that site-specific efforts would be tailored to take advantage of the deep drawdowns thereby expanding the range of fish and wildlife habitat improvement along waterways, which could also increase the number of cultural resources that could be adversely affected over the 30-year implementation timeframe.

Climate change (RFFA 9) would have major adverse impacts throughout the 30-year implementation timeframe when combined with ongoing adverse effects from WVS operations under all alternatives. Impacts under the NAA and Alternatives 2A, 2B, and 4 when combined with climate change would have similar major adverse effects to archaeological sites due to increased winter rainfall that erodes exposed reservoir beds and exposes archaeological materials for unauthorized collection.

Warmer weather in the summer and limited water would also expose sites at higher elevations in the pools and would be accessible for unauthorized artifact collection. Operational efforts to retain water elevation and flows would cause further site erosion and artifact exposure.

When combined with climate change, under Alternative 1, more water would be retained in the reservoirs as compared to the NAA, which would potentially reduce shifts in reservoir elevations (which cause site erosion and artifact exposure) and result in a beneficial impact over the 30-year implementation timeframe. Under Alternatives

When combined with climate change, archaeological sites would continue to quickly degrade under reservoir operations proposed with Alternatives 3A, 3B, and 5. This would be due to the frequency and number of deep drawdowns (at multiple reservoirs) that would greatly accelerate site erosion and artifact exposure to the NAA. Responses to operations for climate change-related management including attempts to would exacerbate this negative outcome.

Similarly to RFFA 1, as humans respond to climate change there would be increased competition for resources and access (for example more intensive use of remaining recreation sites or reduced waterfront access) that would adversely affect historic built resources when combined with WVS operations, across all alternatives within the 30-year implementation timeframe. Modifications to or new development within the existing WVS historic districts in response to climate change would diminish or destroy the character defining features of contributing recreation properties (e.g. installing solar panels on a historic building or removing a historic building and replacing it with an energy efficient structure).

As with RFFA 1, the NAA would result in the least adverse effect to built resources because no operational measures would be implemented and dam, powerhouse, and fish facility contributing resources would not be modified (but there would be changes to recreation contributing resources). Alternatives 2A, 2B, 3A, 3B, 4 and 5 would result in greater adverse impacts to built resources because these alternatives recommend changes to dam, powerhouse, and fish facility contributing resources at four to seven of the operating projects.

It is anticipated that all public and private entities, including USACE, would comply with all Federal and state laws for the protection of cultural sites during the 30-year implementation timeframe, which may minimize or prevent the potential for long-term cumulative effects from RFFA activities when combined with USACE operations and maintenance activities (Section 3.21.3, Federal Laws and U.S. Army Corps of Engineers Regulations).

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.22 VISUAL RESOURCES

TABLE OF CONTENTS

4.22 Visual Resources

THE VISUAL RESOURCES SECTION HAS BEEN REVISED IN FORMAT FROM THE DEIS
REPEATED INFORMATION HAS BEEN REMOVED

Summary of changes from the DEIS:

- **The reasonably foreseeable future actions have been narrowed to those that could impact viewsheds surrounding dams in the Willamette Valley System when combined with dam operations and maintenance under the alternatives. Several reasonably foreseeable future actions will contribute to changes in the visual character of the broader Willamette River Basin. However, cumulative effects with dam operations and maintenance would occur only within dam viewsheds because operations and maintenance would be narrowed to dam and reservoir footprints and would not be visible beyond surrounding viewsheds.**

- **Analyses related to specific measures under each alternative have been incorporated into effects expected by implementation of the alternatives in their entirety.**

- **Information on Visual Resource Management objectives has been removed. The U.S. Army Corps of Engineers does not manage under these objectives, which are U.S. Bureau of Land Management planning objectives.**

- **Analyses have been added for routine and non-routine maintenance and construction activities and wildfire events.**

THIS SECTION HAS BEEN MODIFIED FROM THE DEIS TO REVISE TEXT, OR TO INCLUDE NEW TEXT, IN THE FEIS

4.22.1 Cumulative Actions Applicable to Visual Resources

Past, present, and reasonably foreseeable future actions (RFFAs) pertaining to the Willamette Valley System (WVS) and the Proposed Action to continue operations and maintenance of the system are identified in Section 4.1.3, Cumulative Actions. RFFAs that would have cumulative effects on visual resources when considered together with actions under all alternatives and past actions are listed below. Cumulative effects on visual resources in the analysis area would not result from other RFFAs identified in Section 4.1.3, Cumulative Actions because effects are expected to be narrowed to dam and reservoir footprints visible only from surrounding viewsheds.

- RFFA 1: Future Population Growth and Accompanying Urban, Industrial, and Commercial Development
- RFFA 3: Water Withdrawals for Municipal, Industrial, and Agricultural Uses
- RFFA 5: Federal and State Wildlife and Lands Management
- RFFA 7: Tribal, State, and Local Fish and Wildlife Improvement
- RFFA 9: Climate change
- RFFA 11: Timber and Logging Industry Operations

4.22.2 Visual Resources Cumulative Effects Analysis Area

The visual resources analysis area is the same as the area analyzed for direct and indirect effects in Section 3.22, Visual Resources. The RFFAs in combination with operations and maintenance would impact viewsheds surrounding each of the 13 WVS dams and reservoirs. Therefore, the analysis area for cumulative effects focuses on viewshed impacts in the immediate vicinity of WVS dams where vantage points would provide views of dams, reservoirs, and surrounding landscapes, and does not encompasses the broader Willamette River Basin.

4.22.3 Cumulative Effects on Visual Resources

A summary of RFFA impacts that would affect visual resources is provided below. This is followed by analyses of cumulative effects under the alternatives.

For context, Section 3.22, Vegetation, Table 3.22-8, provides a summary of direct and indirect effects under the alternatives. A summary of measures under each alternative is provided in Chapter 2, Alternatives, Section 2.8, Final Measures Developed for the Action Alternatives.

4.22.3.1 Overview

Routine and Non-routine Maintenance and Construction Activities

Routine, planned or unscheduled, non-routine maintenance activities would occur under all alternatives in the analysis area (Section 1.11.3, Operation, Maintenance, Repair, Replacement, and Rehabilitation). Construction activities would occur under the action alternatives.

Equipment associated with maintenance and construction activities would be visible within dam-associated viewsheds and would include trucks, work vehicles, excavators, bulldozers, machinery, and building materials. Final constructed elements would also be visible in viewsheds depending on dam and construction sites as described in Section 3.22, Visual Resources.

Reservoir Drawdowns

Reservoir drawdowns would continue under all alternatives within all WVS viewsheds over the 30-year implementation timeframe. USACE manages water levels in the reservoirs by typically maintaining low water in the winter and re-filling reservoirs in spring, holding water over the summer at full pool. In recent years, around the time the alternatives were analyzed, reservoirs had not been filled because of drought, early drawdowns (required by the 2008 National Marine Fisheries Service Biological Opinion), and summer low water.

Wildfires

Wildfires are a continuing threat in the analysis area viewsheds. During the 2020 wildfire season, four wildfires—Beachie Creek, Lionshead, P-515[1], and Holiday Farm—damaged many recreation sites, forest structures, and road corridors in parts of the Willamette National Forest (USFS 2020a) (Section 3.14, Recreation Resources).

These wildfires greatly reduced the Willamette National Forest by burning 176,000+ acres of the total forested area (USFS 2024). Impacts from wildfires included vegetation and structural losses that substantially altered viewshed visual character. As a result of the wildfires, buildings at both private marinas on Detroit Reservoir were lost.

Wildfire intensity and frequency at the time the alternatives were analyzed has altered the design elements associated with forested, natural landscapes in areas surrounding by substantially changing the color, form, and texture due to the burnt, darkened, and decimated landscapes that follow wildfires. Periodically, wildfire ash will also deposit in reservoirs, streams, and rivers, increasing turbidity and affecting the visual quality of those water bodies (Oregon Department of Energy 2023) (Appendix F1, Qualitative Assessment of Climate Change

[1] 2020 wildfires in the North Santiam River Subbasin included the Beachie Creek, Lionshead, and P-515 Fires. These fires combined and formed the Santiam Fire. The Holiday Farm Fire occurred in the McKenzie River Subbasin (Section 3.6, Vegetation, Section 3.6.2.3, 2020 Wildfires).

Impacts, Section 4.8, Summary of Projected Trends in Climate; Appendix F2, Supplemental Climate Change Information, Section 3.1.5, Wildfire Danger).

Wildfires increases are likely to harm or potentially destroy recreation sites, trails, and large areas of forested landscape within the analysis area viewsheds.

4.22.3.2 Reasonably Foreseeable Future Actions

RFFAs that could result in cumulative effects on visual resources are described below.

RFFA 1—Future Population Growth and Accompanying Urban, Industrial, and Commercial Development

Population in the analysis area is expected to increase over the 30-year implementation timeframe. As the population increases throughout the Willamette River Basin, adverse impacts to visual resources could include additional infrastructure such as commercial and residential buildings and transportation corridor modifications or increases in use. Landscape alterations would be associated with conversion from rural or undeveloped settings to developed characteristics.

Most dams and reservoirs are not visible from existing urban areas; however, Foster Dam and Reservoir are visible from Sweet Home, Oregon, and urban or residential urban growth may occur near other WVS dams and reservoirs during the 30-year implementation timeframe.

RFFA 3 - Water Withdrawals for Municipal, Industrial, and Agricultural Uses

At the time the alternatives were analyzed, population growth created a demand for water that exceeded existing supplies for many municipal and industrial systems throughout the Willamette River Basin (Section 3.13, Water Supply). Demands for water stored in the WVS to supply municipal and industrial and agricultural irrigation water are spread across all subbasins (USACE 2019a). However, the greatest demand is on the Mainstem Willamette River (Section 3.13, Water Supply, Table 3.13-2).

Frequent water fluctuations in reservoirs to address water withdrawals affect the scenic quality of the viewsheds surrounding each reservoir. While drawdowns are a known aspect of the existing visual characteristics, drought conditions could alter this characteristic by preventing refill and deep drawdowns would expose more shoreline.

RFFA 5—Federal and State Wildlife and Lands Management

Federal lands management objectives in the analysis area can align with preservation of analysis area visual character through land conservation practices. Conserving forested and other natural landscapes can aid in preservation of vegetation by preventing land disturbances that alter landscapes in WVS dam viewsheds.

RFFA 7—Tribal, State, and Local Fish and Wildlife Improvements

Watershed protection and conservation projects aimed at improvements in fish and wildlife habitat would necessarily preserve or improve riparian, wetland, and upland habitat over the 30-year implementation timeframe. Floodplain restoration projects may include native plant preservation, invasive plant removal, and native species plantings thereby preserving or enhancing the vegetated scenic characteristics near WVS dams and reservoirs.

RFFA 9—Climate Change

Climate change is expected to result in wetter winters, drier summers, lower summer flows, increased reservoir evaporation, and increased wildfire intensity and frequency in the Willamette River Basin as compared to existing conditions over the 30-year implementation timeframe (Climate Impacts Group 2010; RMJOC 2020) (Appendix F1, Qualitative Assessment of Climate Change Impacts, Chapter 4, Projected Trends in Future Climate and Climate Change; Appendix F2, Supplemental Climate Change Information, Chapter 3, Supplemental Data Sources, Section 3.1, Overview of RMJOC II Climate Change Projections). Increased wildfires throughout the Basin would change the composition of vegetative communities and, therefore, the scenic quality of viewsheds surrounding WVS dams and reservoirs.

Reservoir levels under all alternatives may fall more frequently and refill would be more difficult than under existing or proposed operations with climate-related conditions and subsequent operational adjustments. Reservoir fluctuations coupled with drought conditions will favor invasive plants suited to these environments throughout the analysis area and at the local, reservoir-adjacent level, which would alter the existing viewshed characteristics.

RFFA 11—Timber and Logging Operations

Timber and logging operations in the analysis area have the potential to alter the existing landscape if within a viewshed surrounding a dam. If visible from public viewpoints, alterations would include removal of standing timber, road development and use, and possible visibility of logging operations. However, these effects may be mitigated as Oregon State forest regulations provide protections for riparian areas and wetlands.

Although logging operations had decreased in the analysis area at the time the alternatives were analyzed, some operations will continue in the Willamette River Basin over the 30-year implementation timeframe. Locations of logging operations in relation to WVS dams and reservoirs were unknown at the time the alternatives were analyzed.

4.22.3.3 Cumulative Effects under All Alternatives

Introduction or Modification of Structural Elements

The introduction of structural elements is not included under the No-action Alternative (NAA). Consequently, there would be no combined effect with RFFAs on dam-associated viewsheds.

Structural elements would be incorporated or modified at various dams under the action alternatives that could include water control towers, adult fish facilities, fish passage structures, and floating screen structures. Structural elements would be introduced or modified in the following WVS viewsheds:

- Alternative 1 – Dexter, Lookout Point, Foster, Green Peter, Big Cliff, and Detroit Dams
- Alternative 2A – Lookout Point, Cougar, Foster, Green Peter, and Detroit Dams
- Alternative 2B and Alternative 5 – Lookout Point, Cougar, Foster, Green Peter, and Detroit Dams
- Alternative 3A and Alternative 3B – Hills Creek, Blue River, and Green Peter Dams
- Alternative 4 – Dexter, Lookout, Hills Creek, Cougar, Foster, Green Peter, and Detroit Dams

The introduction of permanent features into existing viewsheds would alter exiting visual characteristics, which may occur in combination with increased urban development, transportation corridor uses or development, rural uses, or landscape conversions from population growth. The combined impact on visual resources would likely be minor, however, because most dams are not visible from urban areas with the exception Foster Dam and Reservoir that is visible from Sweet Home, Oregon. However, it is unlikely that structural improvements at Foster under Alternative 1 and Alternative 4 would be visible from this community.

Three selective withdrawal structures would be constructed at Lookout Point, Green Peter, and Detroit Dams under Alternative 1 and at Lookout Point, Hills Creek, and Detroit Dam under Alternative 4. One selective withdrawal structure would be built at Detroit Dam under Alternatives 2A, 2B, and 5. These structures may have the greatest visual impact on viewsheds surrounding these dams due to their size as a permanent feature. They may be seen from various vantage points including reservoir use during the peak recreation season; however, visual contrast would be low because structures would be consistent with the aesthetic character of associated dams and would be within the dam footprint. Further it is not anticipated that selective withdrawal structures introduced into any dam-associated viewshed would intensify any combined effect on visual resources from population-driven alterations in the viewshed.

Land conservation by Federal, state, tribal, and local entities would continue to preserve the aesthetic character of each dam viewshed as a whole. Consequently, the introduction of new structures or the modification of existing structures at any dam would not affect the overall visual character of an entire viewshed.

Logging operations may alter portions of a viewshed characteristic and could be combined with other effects such as wildfires, urban development, corridor use, and newly constructed dam structures to degrade visual quality. The degree of this potential, combined effect on the visual character surrounding a WVS dam would depend on the extent of the combined effect and the relationship to vantage points.

Further, landscapes will continue to change throughout the 30-year implementation timeframe, which may improve or degrade visual resource conditions. For example, structural elements and rural and urban development will eventually become part of the visual character over the 30-year implementation timeframe, while climate change-related wildfires will continue to periodically, adversely affect visual character in unpredicted viewshed locations and extents.

Construction and Routine and Non-routine Maintenance

Unlike the NAA, where construction activities would not occur, construction elements would likely be visible to observers in the vicinity of the dams and reservoirs during the duration of construction phases under the action alternatives. However, use of vehicles and equipment would not alter any of the basic design elements or the visual character of the viewshed or surrounding landscapes.

Consequently, direct effects from construction activities under the action alternatives would result in adverse, minor effects to visual resources as compared to the NAA, as the vehicles and equipment would be seen but would not attract attention and would not dominate the landscapes. Conversely, there may be negligible to major, direct, beneficial impacts to viewers attracted to dams specifically to view construction-related activities under the action alternatives.

The extent of direct, adverse or beneficial visual impacts would range from small to large depending on the number of visitors that would be adversely affected by construction activities at a given dam under a given action alternative. The duration of effect would likely be short- to medium-term from construction activities and would not be permanent.

Infrastructure at the WVS dams has been in place for several decades requiring continual routine and non-routine maintenance as part of ongoing viewshed characteristics. Activities in the viewsheds unrelated to WVS operations have contributed to viewshed characteristics and would continue to do so over the 30-year implementation timeframe such as highway and utility maintenance and conservation landscape management throughout the analysis area.

When considered in combination with other cumulative actions, routine and non-routine maintenance and construction activities would have temporary, adverse or beneficial (i.e., attraction to activities) cumulative effects in viewsheds of dam operations. These effects would range from no effect to major effects over the short or medium term.

<u>Reservoir Drawdowns</u>

The continual demand for water use will be combined with, and addressed by, alternative implementation to meet Congressionally authorized purposes (Chapter 1, Section 1.10, Congressionally Authorized Purposes). Drawdowns at all reservoirs are an existing element of the visual character surrounding WVS dams and reservoirs. However, deep drawdowns or climate change-related operations that prevent refill would alter this existing condition with adverse visual effects from vantage points in a surrounding viewshed.

The most substantial effects would likely occur under Alternatives 2B, 3A, and 3B where refill would not occur during the peak, summer recreation season and deep drawdowns would occur during the late summer/early fall months under Alternative 3A and Alternative 3B. Cougar Reservoir would not be filled during peak, high visitor-use, summer months under all three alternatives. Additionally, Lookout Point and Detroit Reservoirs would not be refilled during the peak recreation season under Alternative 3A. Green Peter and Hills Creek Reservoirs would not be refilled during this season under Alternative 3B.

Deep drawdowns would occur during the late summer/early fall recreation season at Hills Creek, Green Peter, and Blue River Reservoirs under Alternative 3A and at Lookout Point, Detroit, and Blue River under Alternative 3B.

These reservoir conditions would create a major, adverse visual effect from the lack of a lake-like appearance, which would be visible from numerous vantage points accessed by summer and early fall analysis area visitors. The adverse effect of this visual contrast would be combined with the introduction of structural elements at Cougar Dam under Alternative 2B.

Although the viewshed surrounding Cougar Dam would be degraded during summer months, and into typically scenic, fall months, land conservation by Federal, state, tribal, and local entities would continue to preserve the aesthetic character of each dam viewshed as a whole.

Logging operations may alter portions of a viewshed characteristic and could be combined with other effects such as wildfires, urban development, corridor use, newly constructed dam structures, and deep drawdowns to degrade visual quality. The degree of this potential, combined effect on the visual character surrounding Cougar Dam would depend on the extent of the combined effect and the relationship to vantage points.

Climate Change

Climate change-related effects from increased runoff and sedimentation could further alter the basic reservoir design elements of color, texture, and form. Effects on visual resources could be more severe under Alternatives 2B, 3A, and 3B when combined with climate change-related impacts to create increased visual contrast within the Cougar Dam and Reservoir viewshed.

Long-lasting droughts and warm conditions could compromise earth dams, such as Fall Creek Dam, as soils crack from drying, potentially eroding and altering landscape characteristics (Fourth Annual Climate Change Assessment 2018) (Appendix F1, Qualitative Assessment of Climate Change Impacts, Section 4.1.2, Fourth National Climate Assessment; Appendix F2, Supplemental Climate Change Information, Section 3.1.1, Temperature).

Warmer temperatures from climate change could also provide favorable conditions for the propagation of harmful algal blooms, which can discolor, cloud, or cover the water's surface adversely affecting visual quality (Section 3.5, Water Quality).

As a result of changes in annual precipitation and precipitation amounts, climate change could also exacerbate long-term, recurring effects from drawdowns and further change the design elements of color, texture, and form (Warner et al. 2015) (Appendix F1, Qualitative Assessment of Climate Change Impacts, Section 4.5, Changes in Winter Atmospheric Rivers; Appendix F2, Supplemental Climate Change Information, Section 3.1.2, Precipitation). Direct effects on shoreline erosion could occur and cause sedimentation and increased turbidity, affecting water color and clarity if reservoir levels are lowered due to low summer flows and long-lasting droughts.

Indirect effects to color would then occur as water changes slightly to a darker color with the introduction of darker clays, silts, and sediments; texture would change slightly with the introduction of grainy sediment particles and other larger suspended particulate materials; and form would change slightly with the introduction of a variety of irregular shapes, sizes, and masses from the suspended solids.

Climate change-related effects at the reservoir level would be combined with other visual resource effects in the surrounding landscape from wildfires, storm event damage, urban and rural uses, transportation corridor uses, logging, etc. Effects may be lessened by ongoing land conservation management that would preserve the visual character of some areas visible within a dam viewshed.

END REVISED OR NEW TEXT

US Army Corps
of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.23 NOISE

4.23 Noise

THE NOISE SECTION HAS BEEN DELETED FROM THE FEIS

Summary of changes from the DEIS:

- **After considering analyses in the DEIS, there is no potential for a significant impact to occur to noise levels under any of the alternatives, including the No-action Alternative, over the 30-year implementation timeframe. Per the DEIS analysis, noise impacts under the alternatives would be generated from construction activities and facilities operations. However, these actions are ongoing and activities under the alternatives would not measurably increase the ambient noise levels above existing conditions. Existing condition noise levels do not carry beyond the vicinity of a dam or reservoir.**
- **Per the DEIS analysis, noise "receptors" (i.e., those who would hear activity noise) would be primarily recreationists in campgrounds and on trails and reservoirs. There may be little recreation use in the area depending on the time of year that noise activities would occur. Lastly, increases in noise levels would be temporary and would remain localized/would not travel beyond a dam or reservoir site.**
- **Deletion of Section 3.23 and Section 4.23, Noise, is supported by 40 CFR 1501.1(d) and 1500.4(g) (identification of significant environmental issues and de-emphasizing insignificant issues), 1501.7 (identification of significant issues related to the Proposed Action), and 1500.1(b) (NEPA documents must concentrate on issues that are 'truly significant' to the Proposed Action).**

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 4 CUMULATIVE EFFECTS

SECTION 4.24 TRIBAL RESOURCES

4.24 Tribal Resources

TRIBAL RESOURCES CUMULATIVE EFFECTS HAS BEEN REVISED IN ITS ENTIRETY FROM THE DEIS

Potential cumulative effects of the alternatives on tribal resources encompass all Reasonably Foreseeable Future Actions (RFFAs) and resource effects analyzed in Chapter 3, Affected Environment and Environmental Consequences. Direct and indirect effects under every resource analyzed as part of the human environment, either adverse or beneficial, would be combined with ongoing actions and all RFFAs to continue to impact tribal resources in the Willamette River Basin.

For example, adverse effects on fish habitat from population growth would continue to negatively impact fish when combined with adverse habitat effects under a given alternative. This would result in a long-term, cumulative adverse effect on fish habitat as a tribal resource.

Some beneficial effects on tribal resources would be realized under some alternatives. For example, improvements to water quality parameters would occur in some subbasins. However, when combined with adverse impacts from climate change, population growth, and other influences on water resources, measurable benefits may not occur on tribal resources involving water quality. Exceptions may occur depending on location, hydrologic conditions, and RFFAs that would protect land uses from development such as Federal and State Wildlands and Lands Management and tribal management.

Effects on other resources when combined with the 11 RFFAs in the Willamette River Basin would have similar outcomes on tribal resources over the 30-year implementation timeframe.