US Army Corps of Engineers
Portland District

Willamette Basin Review Feasibility Study

FINAL

Integrated Feasibility Report and Environmental Assessment

December 2019

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Executive Summary

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 the Willamette River flows into the Columbia River. The basin is more than 11,200 square miles, averages 75 miles in width, and encompasses approximately 12 percent of the total area of the state (Figure ES-1). Within the watershed are most of the state's population (nearly 70 percent), larger cities, and major industries. The basin also contains some of Oregon's most productive agricultural lands and supports nationally and regionally important fish and wildlife species. Thirteen[1] of Oregon's thirty-six counties intersect or lie within the boundary of the Willamette River basin.

Through a series of Flood Control Acts the U.S. Congress authorized the U.S. Army Corps of Engineers (Corps) to construct, operate, and maintain thirteen major dams[2] in the Willamette River basin. Collectively, these dams, reservoirs and associated infrastructure are known as the Willamette Valley Project (WVP). With a combined conservation storage capacity of approximately 1,590,000 acre-feet, the WVP is capable of providing important benefits for flood risk management, hydropower, irrigation, municipal and industrial water supply, flow augmentation for pollution abatement and improved conditions for fish and wildlife, and recreation.

Feasibility Study History

The Willamette Basin Review Feasibility Study began in 1996 to investigate future Willamette River basin water demand. In 1999, the U.S. Fish and Wildlife Service (USFWS) listed the bull trout as threatened under the Endangered Species Act (ESA). In 1999, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) listed both the Upper Willamette River (UWR) spring Chinook salmon and the UWR winter-run steelhead as threatened species. The ongoing effects on these ESA-listed fish from the continued operation of the WVP were the subject of formal Section 7 consultation under the ESA. The feasibility study was put on hold in 2000 pending resolution of ESA consultation (detailed below).

The feasibility study was re-initiated in 2015 with the goal of reallocating WVP conservation storage for the benefit of ESA-listed fish (F&W), agricultural irrigation (AI), and municipal and industrial (M&I) water supply, while continuing to fulfill other project purposes. The study documented in this integrated Feasibility Report and Environmental Assessment analyzes current water uses in the basin for F&W, M&I, and AI, provides projections of water needs for these three project purposes, and develops a combined conservation storage reallocation and water management plan that would provide the most public benefit within the policies and regulations of the Corps and the state of Oregon. The non-federal sponsor for the feasibility study is the Oregon Water Resources Department (OWRD).

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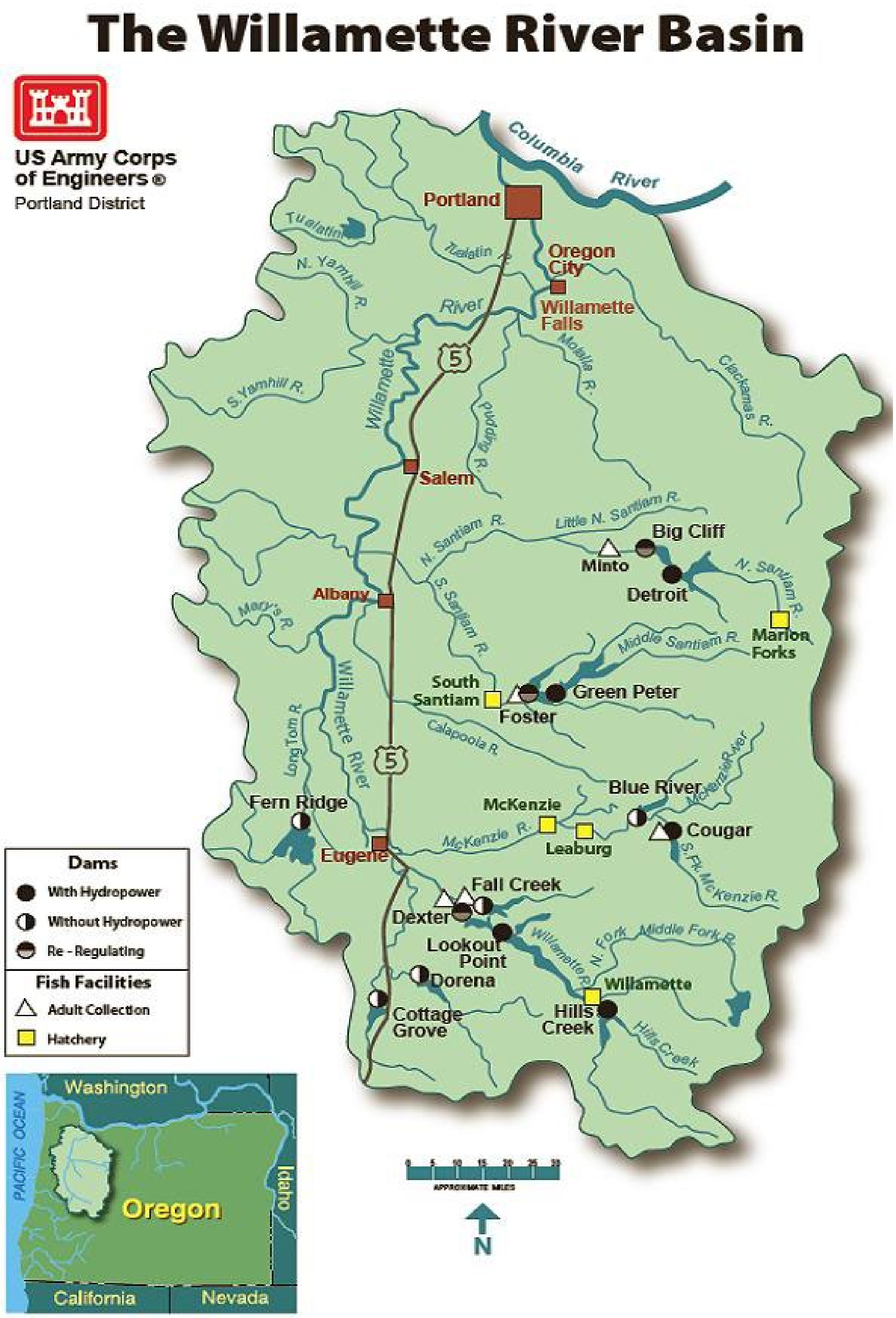
[1] Benton, Clackamas, Columbia, Douglas, Klamath, Lane, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill.

[2] Construction completion dates: Fern Ridge (1941), Cottage Grove (1942), Dorena (1949), Big Cliff (1953), Detroit (1953), Lookout Point (1954), Dexter (1954), Hills Creek (1961), Cougar (1963), Fall Creek (1966), Foster (1968), Green Peter (1968); Blue River (1969).

Figure ES-1
Willamette River Basin and Reservoir Projects



Willamette Valley Project Stored Water

In the state of Oregon, water law distinguishes between diverting water for storage, and releasing water from storage for use; each requires a different water right. In Oregon, the right to store water conveys ownership of the stored water. Because national policy prohibits the Corps from holding state water rights, the U.S. Bureau of Reclamation (Reclamation) has held two Oregon water storage rights on behalf of the federal government for all WVP conservation storage since construction of the WVP was completed.

Importantly, Reclamation's state water rights that allow the federal government to store water in WVP reservoirs were designated exclusively for irrigation. Given this limitation, OWRD would not grant a secondary water right to use WVP stored water to other potential water use categories (e.g., M&I, F&W). In order for non-irrigation use categories (e.g., M&I, F&W) to realize benefits from the reallocation of WVP conservation storage, Reclamation's storage rights need to undergo a transfer review process to change the character of use to reflect uses other than irrigation. Of the 1,590,000 acre-feet of WVP conservation storage, approximately 75,000 acre-feet of stored water (roughly five percent of total WVP conservation storage) is currently contracted through Reclamation for irrigation. If Reclamation does not file a transfer application for a change in character of use, OWRD cannot grant secondary water rights for the use of WVP stored water for either F&W benefits or M&I peak season water supply.

Endangered Species Act Consultation for Continued Operation of the WVP

In 2000, the Portland District submitted a Biological Assessment (BA) to the NMFS and USFWS (i.e., "the Services") to assess the effects of ongoing operation and maintenance of the WVP on ESA-listed species. Because of their coordinated decision-making relative to WVP operation, the BA also identified Reclamation and Bonneville Power Administration (BPA) as Action Agencies. The BA evaluated the likely effects of the continued operation of the WVP on ESA-listed fish and their critical habitat. The proposed action contained in the 2000 BA was based on operation of the WVP prior to the ESA-listing of UWR spring Chinook salmon and winter-run steelhead in 1999.

The Action Agencies prepared a revision to the proposed action and a supplement to the 2000 BA, and submitted a Supplemental BA in May 2007. The Supplemental BA included a revised proposed action that would more accurately reflect then-current WVP operations, particularly mainstem and tributary flow modifications implemented after preparation of the 2000 BA. Importantly, the Supplemental BA identified new measures that the Action Agencies have the authority to implement, which include:

- Changes to WVP reservoir management implemented subsequent to the 2000 BA, including mainstem and tributary minimum flow objectives;
- Completion of the selective withdrawal tower at Cougar Dam and actions underway to address fish passage and related issues at Cougar and Blue River dams under the Willamette Temperature Control Project;
- Strategies for reform of fish hatchery operations and associated mitigation;
- Habitat restoration actions undertaken on project lands through natural resources stewardship responsibilities, as well as offsite under the Corps General Investigation Program and Continuing Authorities Program;

- Evaluation of the potential feasibility and effectiveness of proposed major structural modifications at WVP dams to address ESA issues, including improved fish passage and handling, temperature control, and hatchery facilities at WVP dams other than Blue River and Cougar;
- Strategies for integration of operational, structural, habitat, and hatchery measures across the basin that enhance their effectiveness and take advantage of synergies that may exist; and
- Update and accurately describe implementation of the ongoing research, monitoring, and evaluation program, including a comprehensive program plan that better meets ESA requirements.

The Services provided the Action Agencies with their final Biological Opinions (BiOps) in 2008, addressing the effects of WVP operation and maintenance on ESA-listed fish. The NMFS BiOp[3] concluded that the proposed action described in the Supplemental BA caused jeopardy to the ESA-listed UWR Chinook and winter-run steelhead, and included a "*reasonable and prudent alternative*" (RPA). The USFWS BiOp concluded that the proposed action did not cause jeopardy to the ESA-listed bull trout as long as the RPA from the NMFS BiOp was implemented. Implementing the RPA would minimize possible adverse effects on ESA-listed fish and their critical habitat, and require monitoring and reporting to ensure compliance.

It was anticipated that the recommendations in the BiOp would include the use of WVP stored water to meet flow objectives for the Willamette River mainstem and its major tributaries. Since water year 2000, the Corps has adopted and implemented mainstem Willamette River flow objectives at Salem based on recommendations from NMFS and the Oregon Department of Fish and Wildlife.

From 2000 through 2003, the Corps worked with other federal and state agencies to develop a WVP flow management strategy. This strategy established a continuing framework for meeting both mainstem and tributary flow objectives that relies on monthly meetings and regular coordination teleconferences to provide updates on reservoir and flow conditions in the Willamette River and its tributaries. Implementation of the flow management strategy has resulted in the WVP being operated to meet tributary and mainstem flow objectives to the maximum extent possible for more than 15 years.

On April 9, 2018, the Corps reinitiated consultation on the 2008 NMFS BiOp.

Problems and Opportunities

The first step in the planning process was the identification of problems (i.e., undesirable conditions to be solved) and opportunities (positive conditions to be improved) that the planning team seeks to address. Problems and opportunities encompass current as well as future conditions and are defined in terms of their nature, cause, location, dimensions, origin, timeframe, and importance.

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[3] Available at http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

Problems

1. There is an inadequate supply of water to meet increasing Municipal & Industrial (M&I), Agricultural Irrigation (AI), and Fish and Wildlife peak season water demand in the study area over the next 50 years due to the combined effects of population growth, inadequate groundwater sources, and over-allocated surface waters.
2. Releases of WVP stored water for the benefit of ESA-listed fish are not protected instream due to restrictions with Oregon water law.
3. Although the WVP is federally authorized for multiple (joint-use) purposes, including fish and wildlife, agricultural irrigation, and municipal and industrial water supply, no specific allocation of storage has been made for those purposes. That and other existing administrative constraints, including state water law and policy, have limited access to stored water from the WVP and reduced the potential return on federal investment.
4. The Willamette River and its tributaries are over-allocated, and have multiple, often conflicting, uses, including endangered species critical habitat, M&I water supply, agricultural irrigation, recreation, and aesthetics.

Opportunities

1. There is an opportunity to use existing storage to provide future supply for instream and out-of-stream water uses.
    a. Flow requirements for ESA-listed fish Upper Willamette River Chinook salmon (*Oncorhynchus tshawytscha*), winter-run steelhead (*Oncorhynchus mykiss*), and bull trout *(Salvelinus confluentus)* can be met far more effectively in late summer months through the use of supplemental flows provided by storing a portion of spring inflows in WVP reservoirs and releasing water as needed to meet downstream requirements later in the season.
2. Mechanisms can be established by which water supply users can reimburse the Federal Treasury for WVP investment.
3. The Corps can fulfill its obligation under the 2008 BiOp RPA 2.9 (facilitate conversion of stored water to an instream water right) by making a specific F&W allocation of WVP conservation storage, which will lead to the instream protection of WVP stored water released for the benefit of ESA-listed fish.

Planning Objectives and Constraints

Planning objectives are the intended purposes of the planning process. Constraints are restrictions that limit the extent of the planning process. Constraints can be legal, policy related or study specific.

Planning Objectives

1. Provide sources of water to support forecasted future demands between now and 2070 for municipal and industrial water supply throughout the Willamette River Basin.
2. Provide sources of water to support forecasted future demands between now and 2070 for irrigated agriculture throughout the Willamette River Basin.

3. Provide water in the reaches of the Willamette River and tributaries controlled by the Corps Willamette Valley Project to support the needs of fisheries resources through the year 2070.

Planning Constraints

1. Maintain existing flood risk management benefits in the Willamette Basin, including tributaries where Corps dams exist.
2. Water reallocation proposals will fit within the existing Willamette Valley Project rule-curves.
3. Reservoir storage reallocation will be limited to the existing almost 1.59 million acre-feet of conservation storage. The study will not evaluate reallocation from the flood, power, or inactive/dead storage pools.
4. Construction or modification of structural facilities at Willamette projects to provide additional storage space for water supply is not being considered.

Planning Considerations

1. 100 percent reliable stored water for all water year types and all water uses is not viable because Willamette Valley Project reservoirs are annually emptied for flood control purposes and refill is not guaranteed. Agreements for stored water would be issued for less than 100 percent reliability.
2. Maintain operational ability to meet BiOp required flow targets to support ESA listed fish species.
3. Minimize negative impacts to existing reservoir and downstream recreation users.
4. Minimize impacts to hydropower generation at Willamette Valley Project hydropower projects.

Purpose and Need for Corps Action

The purpose for Corps action is to reallocate the 1,590,000 acre-feet of WVP conservation storage from Joint Use to specific uses in order to fulfill the multi-purpose goals of the WVP. This FR/EA identifies three different needs that could utilize WVP stored water (water held in WVP conservation storage in any given year), and requires specific allocations of conservation storage to meet those needs.

1. Among the issues addressed in the RPA, the Action Agencies must coordinate with OWRD to facilitate conversion of a portion of WVP stored water to instream water rights (RPA Measure 2.9[4]). Although the Corps releases WVP stored water to support ESA-listed fish in tributary reaches, the Corps cannot guarantee that these flows would be maintained throughout the reach. While the Corps has been operating the WVP to meet flow objectives since the year 2000, releases of WVP stored water are not protected instream. This is because OWRD, not the Corps, has enforcement authority over water rights. Reallocating a portion of WVP conservation storage specifically for F&W benefits would facilitate the

[4] The full text of RPA Measure 2.9 is provided in the Glossary of this document. The full RPA is available at http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

legal protection of WVP stored water released for instream purposes, as described in RPA Measure 2.9.

2. Of the 1,590,000 acre-feet of WVP conservation storage, approximately 75,000 acre-feet of stored water is currently under contract through Reclamation for AI. Reclamation may enter into irrigation contracts up to 95,000 acre-feet of stored water per year without the need to consult with the NMFS as established under the 2008 BiOp. WVP conservation storage in excess of 95,000 acre-feet per year would be needed to meet future demand for AI water supply. Although a specific allocation to AI is not necessary for Reclamation to continue to issue water supply contracts in excess of 95,000 acre-feet of stored water, a specific allocation would efficiently balance the reallocation of WVP conservation storage.
3. The state of Oregon has long identified the WVP as a potential source for future M&I peak season water supply needs in the basin. Despite the fact that Congress authorized the WVP for multiple purposes, including "*relatively low cost for domestic use when current facilities can no longer meet the demand,*" no portion of WVP conservation storage is specifically allocated to M&I. Without a specific quantity of WVP conservation storage allocated to M&I, Corps water supply policy does not allow water supply storage agreements to be executed.

No Action Alternative

Under the No Action Alternative (or future without-project conditions), there would be no Corps action to reallocate WVP conservation storage and no changes to the current operations to utilize WVP stored water to better meet the Congressionally-authorized multiple purposes. With respect to the No Action Alternative, the following assumptions can be made:

- The Corps would continue to operate the WVP to meet mainstem and tributary flow objectives as often as possible as described in the 2008 BiOp (NMFS, 2008);
- The Corps would continue to operate the WVP to assist Reclamation in meeting their irrigation water contract demands;
- Reclamation would continue to issue irrigation water contracts up to, and eventually exceeding, the 95,000 acre-feet of stored water per year as described in RPA Measure 3[5] (NMFS, 2008). As of 2017, Reclamation had issued irrigation water supply contracts for approximately 75,000 acre-feet of stored water per year, leaving approximately 20,000 acre-feet per year of WVP stored water available for new contracts before triggering the analyses and consultation described in RPA Measure 3. Based on the estimated rate of increase in demand for irrigation water, the need would be projected to exceed the 95,000 acre-feet of stored water per year limit after 2025;
- As described under RPA Measure 3, Reclamation and the Corps would need to "*reevaluate the availability of water from conservation storage for the water marketing program*" when future irrigation demand exceeds 95,000 acre-feet of stored water per year. If Reclamation proposed to issue additional contracts above 95,000 acre-feet of stored water per year, re-

[5] The full text of RPA Measure 3 is provided in the Glossary of this document. The full RPA is available at http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

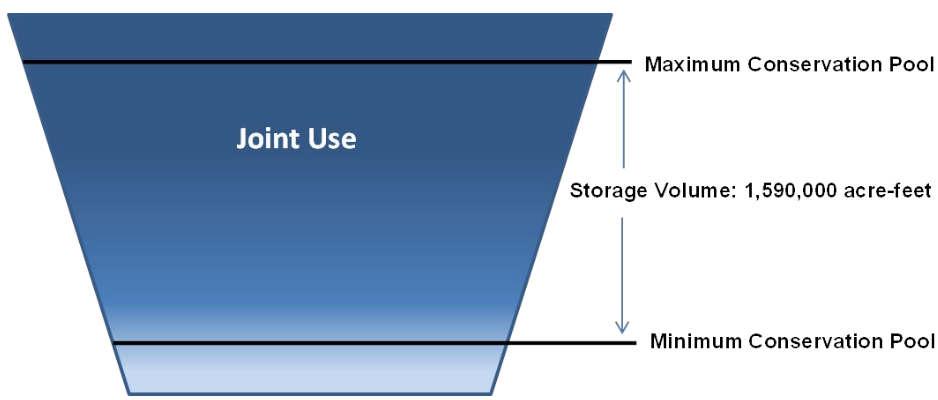
initiation of ESA consultation would be necessary. Assuming demand for irrigation materializes as projected in this analysis, the consultation would be expected to occur in the early 2020s. It is noteworthy that beyond the required consultation described in RPA Measure 3, there are no other institutional barriers to restrict Reclamation from issuing irrigation water contracts in excess of 95,000 acre-feet of stored water per year in the future;

- Without a reallocation of WVP conservation storage, Reclamation would not apply to OWRD for a change in character of use for their storage rights in order to match a proposed reallocation of WVP conservation storage for uses other than irrigation;
- Without a change in character of use for Reclamation's storage rights, a portion of WVP conservation storage would not be specifically allocated for F&W benefits. OWRD would not issue instream water rights for the use of WVP stored water as described in the 2008 BiOp (RPA Measure 2.9). Thus, the Corps would not be able to facilitate OWRD's conversion of WVP stored water releases for the benefit of ESA-listed fish to instream water rights as described in RPA Measure 2.9;
- Without instream water rights for WVP stored water releases intended to benefit ESA-listed fish, releases would continue to be unprotected and continue to be available for use by existing water right holders per Oregon water law; and
- Without a change in character of use for Reclamation's storage rights, future M&I peak season demands would be met through measures that do not include access to WVP stored water.

Under the No Action Alternative, 1,590,000 acre-feet of storage remains allocated to Joint Use, as depicted in the graphic below.

No Action Alternative
(Existing WVP Allocation)
(acre-feet)

F&W:	**0**
M&I:	**0**
AI:	**0**
Joint Use:	**1,590,000**
Total Allocation	**1,590,000**



M&I Peak Season Water Supply Deficits and Alternatives

The first step in the formulation process was to determine whether access to WVP stored water would provide a more efficient means for study area M&I systems to meet future peak season water supply deficiencies over a 50-year period of analysis. Three alternatives were developed to address future M&I water supply deficits:

1. M&I Peak Season Supply Alternative 1: address peak season deficits through the application of non-federal measures (e.g., expansion of groundwater withdrawals, aquifer storage and recovery, and interconnections with neighboring systems);
2. M&I Peak Season Supply Alternative 2: address peak season deficits through the allocation of WVP conservation storage for deficits remaining after evaluation of Alternative 1; and
3. M&I Peak Season Supply Alternative 3: address peak season deficits exclusively through the allocation of WVP conservation storage.

Following the evaluation of M&I Peak Season Supply Alternative 1, no deficits remained that would need to be addressed through an allocation of WVP conservation storage for M&I. While the costs of the non-federal measures are considerably greater than the cost of the federal measure (allocation of and access to WVP storage) in the aggregate, M&I peak season water supply needs could be met through non-federal measures. Given that there would be no difference in cost between Alternative 1 and Alternative 2, Alternative 2 was eliminated from further consideration.

Total annual costs of M&I Peak Season Supply Alternatives 1 and 3 were estimated at $59,833,000 and $24,353,000, respectively. Given the least cost advantages of Alternative 3 over Alternative 1, and because Alternative 3 would help to fulfill the intent of language included House Doc. 531, Volume 5. Paragraph 198 ("*Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand.*"), Alternative 3 was selected as the first element of the Proposed Action. The further development of the Proposed Action into the Agency Recommended Plan incorporated the selection of a conservation storage reallocation alternative for M&I, F&W, and AI, and the selection of a water management plan alternative.

WVP Conservation Storage Reallocation Alternatives

Table ES-1 shows peak WVP stored water demands for each of the three use categories. As shown in the table, the sum of the peak season demands (2,077,400 acre-feet) is greater than the amount of **total** WVP conservation storage (1,590,000 acre-feet). Therefore, a reallocation of WVP conservation storage for all uses at the volumes shown in Table ES-1 is infeasible. Nevertheless, peak season demands were used to develop four reallocation alternatives (in addition to the No Action Alternative) that would not exceed WVP conservation storage.

Table ES-1
Peak Season Demands for WVP Stored Water
M&I and AI Stated at Year 2070 Levels

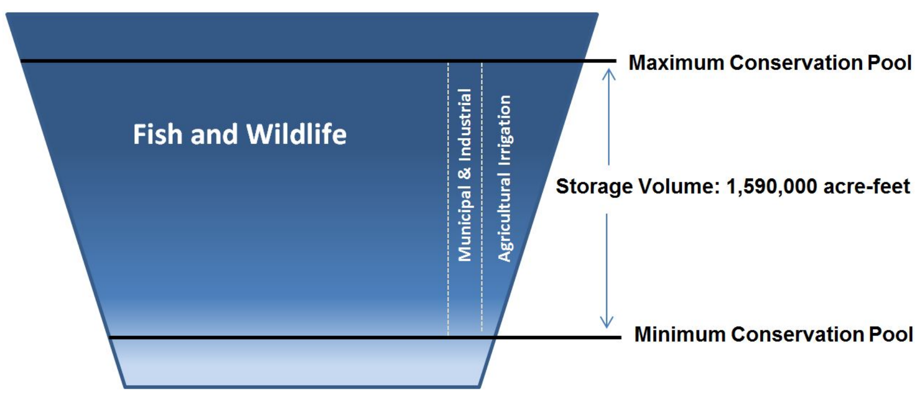
Allocation Use Category	Peak Demands (acre-feet)	Portion of Total (percent)
Fish & Wildlife	1,590,000	76.5
Municipal & Industrial	159,750	7.7
Agricultural Irrigation	327,650	15.8
Total	**2,077,400**	**100.0**

Reallocation Alternative A: <u>Proportionate Reduction in Storage for all Use Categories</u>

Under Reallocation Alternative A, each of the three allocation categories is reduced proportionately from those shown in Table ES-1. Since 1,590,000 acre-feet equals 76.5 percent of 2,077,400 acre-feet (total peak season demand for all three use categories), the reallocation of conservation storage for each use category would be proportionally reduced to 76.5 percent of peak season demand (2070 peak season demand levels for M&I and AI). The resulting allocations are shown below with no storage remaining in Joint Use.

Reallocation Alternative A
(acre-feet)

F&W:	**1,216,950**
M&I:	**122,250**
AI:	**250,800**
Joint Use:	**0**
Total Allocation	**1,590,000**

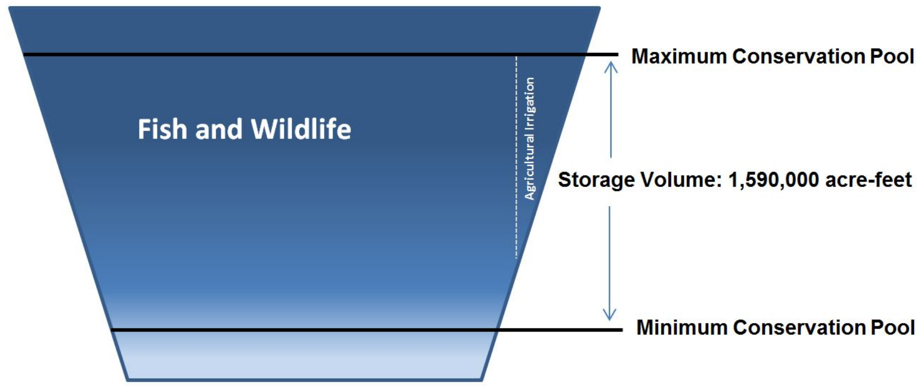


Reallocation Alternative B: <u>Prioritize Fish and Wildlife Storage at Peak Level</u>

Under Reallocation Alternative B, 1,508,600 acre-feet of conservation storage would be allocated to F&W, with 81,400 acre-feet remaining for allocation to AI. While the F&W peak demand is the full 1,590,000 acre-feet of WVP conservation storage, an allocation of 81,400 acre-feet for AI must be made to accommodate the volume of Reclamation contracts expected to be in place by Year 2020 (the beginning of the period of analysis) in order for the reallocation alternative to be institutionally feasible as Reclamation cannot be precluded from fulfilling its expected contract obligations. Under this reallocation alternative there would be no allocation to M&I. The resulting allocations are shown below with no storage remaining in Joint Use.

Reallocation Alternative B
(acre-feet)

F&W:	**1,508,600**
M&I:	**0**
AI:	**81,400**
Joint Use:	**0**
Total Allocation	**1,590,000**

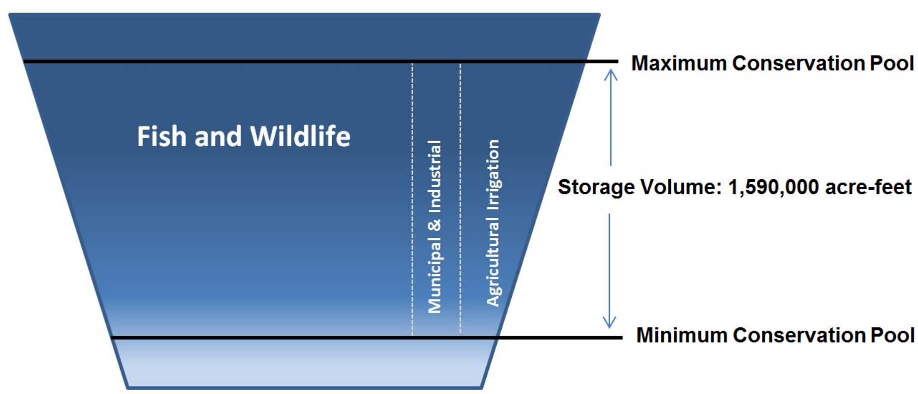


Reallocation Alternative C:
<u>Prioritize M&I and AI Storage at 2070 Peak Season Demand Levels</u>

Under Reallocation Alternative C, M&I would be allocated 159,750 acre-feet of conservation storage, and 327,650 acre-feet of conservation storage would be allocated to AI. The remaining 1,102,600 acre-feet of conservation storage would be allocated to F&W. The resulting allocations are shown below with no storage remaining in Joint Use.

Reallocation Alternative C
(acre-feet)

F&W:	**1,102,600**
M&I:	**159,750**
AI:	**327,650**
Joint Use:	**0**
Total Allocation	**1,590,000**

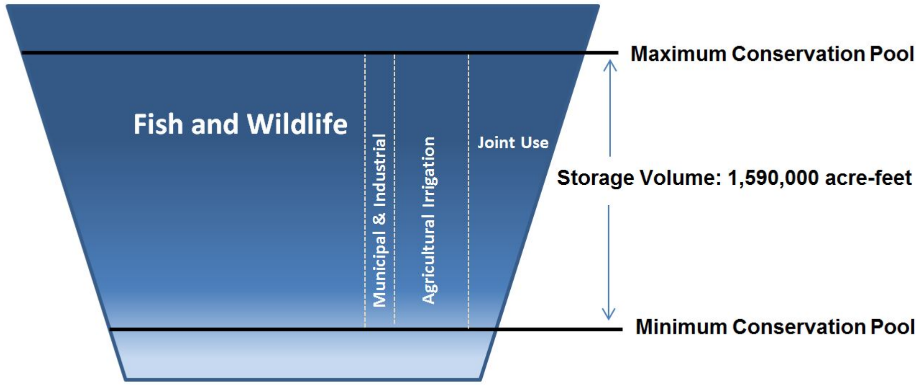


Reallocation Alternative D:
<u>Reallocation at Reduced Peak Season Demand Levels with Joint Use Flexibility</u>

Reallocation Alternative D reflects an approach where a reduced volume of conservation storage is allocated to each use category and a substantial share of conservation storage remains allocated to Joint Use. Allocations by use category for this alternative are shown below.

Reallocation Alternative D (acre-feet)

F&W:	**962,800**
M&I:	**73,300**
AI:	**253,950**
Joint Use:	**299,950**
Total Allocation	**1,590,000**



As shown above, 299,950 acre-feet of conservation storage would remain allocated to Joint Use to provide future flexibility, as all use categories could claim Joint Use storage to accommodate future needs as their peak season demands for stored water materialize. Reserving a portion of storage in Joint Use could accommodate unforeseeable changes to demand trends for WVP stored water. For example, with 299,950 acre-feet of conservation storage remaining allocated to Joint Use, the Corps would have additional flexibility to meet the demands under changing climate conditions. However, as stated in Section 3.4, water availability in the Willamette River basin throughout the summer month is already limited. As described in Section 2 of Appendix K, summer inflows consistently show a decrease from historical values, across the full spectrum of the global climate models and scenarios.

Tentatively Selected and Agency Recommended Reallocation Alternatives

Reallocation Alternative D provides the most flexibility to adapt to changing future conditions and was initially carried forward as the tentatively selected reallocation alternative.

After the Agency Decision Milestone, the Corps and OWRD determined Reallocation Alternative C best meets the planning objectives by providing a source of water to support the forecasted demands for M&I and AI water supply over the full period of analysis (2070) and provides increased percentage of stored water for fisheries This alternative also avoids potential future conflicts over the allocation of the remaining conservation storage over the period of 2050-2070.

Reallocation Alternative C provides a greater volume of WVP conservation storage for consumptive and instream purposes and addresses some of the concerns raised through public comments. OWRD fully understands that water will not be available to satisfy all authorized project purposes during time of drought, and that the Corps is required to meet the flow objectives specified in the 2008 BiOp. There is both sponsor and basin stakeholder support for this plan selection.

Alternative Water Management Plans

Development of the Agency Recommended Plan (ARP) also requires the development of water management plans for years when the WVP does not refill to 1,590,000 acre-feet of stored water. Management of stored water during years when the reservoirs do not refill has a substantial effect on the reliability of the WVP to release stored water for authorized purposes.

Three alternative water management plans were developed to describe how water shortages would be handled, and are briefly outlined below.

- Alternative Management Plan 1: All uses are reduced during years when WVP conservation storage does not fill to the volume of the reallocation for F&W, M&I and AI (1,590,000 acre-feet of stored water – total uses from Reallocation Alternative C). Under this alternative management plan, releases of WVP stored water for the three dedicated uses would be reduced when conservation storage does not refill.
- Alternative Management Plan 2: Stored water for F&W would be prioritized – up to the allocated amount. Any remaining stored water would be split between M&I and AI on a basis proportional to contracted volumes, not allocated volumes.
- Alternative Management Plan 3: Stored water for M&I and AI would be prioritized, up to the contracted amounts. Any remaining stored water would be used for F&W.

Only one of the alternative management plans, Management Plan 1, would provide water for all three use categories during most dry years. The other two alternative management plans result in years where one or more use categories would not have access to stored water.

Agency Recommended Plan

The Agency Recommended Plan (ARP)[6] is Alternative 3C1, which includes addressing M&I peak season deficits through the allocation of WVP conservation storage (M&I Peak Season Water Supply Alternative 3), allocations for specific use categories (Reallocation Alternative C), as well as guidelines for managing stored water releases when the conservation pools do not fill to 1,590,000 acre-feet, (Alternative Management Plan 1). The remainder of this Executive Summary focuses on impacts of the ARP relative to the No Action Alternative.

Resources Considered but Not Carried Forward for Analysis

Agencies are encouraged to concentrate on relevant environmental analysis in their NEPA documents, not to produce an encyclopedia of all applicable information (40 C.F.R. § 1500.4(b), 1502.2(a)); 40 C.F.R. § 1502.2(a) instructs that federal agency NEPA documents "*shall be analytic rather than encyclopedic*." As such, the impacts should be discussed in proportion to their significance, meaning that there should only be a brief discussions of insignificant issues (40 C.F.R. § 1502.2(b); see also 40 C.F.R. § 1502.2(c)). Impacts should be discussed in proportion to their significance, and if the impacts are not deemed significant, there should be only enough discussion to show why more study is not warranted (40 C.F.R. § 1502.2(b)). As such, a number of resources/impacts that can typically be discussed at length within NEPA documents have been considered and dismissed from further analysis.

Reservoir Resources Not Carried Forward for Analysis

While there would be lower summer reservoir pool elevations during some years, the variability of pool levels under the ARP is within the range of pool elevation changes already experienced

6 For the purposes of NEPA, the ARP is the preferred alternative.

during the conservation season. In addition, every year, at the end of the conservation season (early fall), release rates from reservoirs are increased and the reservoir pools are lowered to empty the conservation pool in preparation for the winter flood season. The existing conditions of the environmental resources at the reservoirs that could be affected by changes in reservoir pool elevations are controlled by the annual cycle of filling and draining the conservation pool to provide storage for flood risk management operations. There would be marginal in-summer changes to reservoir pool elevations in some years, but because these slight and infrequent changes are within the range of existing operations, there would be no predictable changes to reservoir resources. Because of the overt inability of the ARP to effect change to the physical environment at the reservoirs that would be different from the range of conditions currently observed, effects to vegetation, aquatic habitats, wetlands, non ESA-listed fish and wildlife, aesthetics, cultural resources, and erosion have been eliminated from detailed consideration.

Riparian Resources Not Carried Forward for Analysis

Predicted changes to water levels downstream of WVP reservoirs is the primary influencing factor in considering the potential for changes that could affect the environmental resources of the riparian corridor. The riparian corridor's environmental resources that could be affected by changes in water elevations are at risk during periods of draw-down as part of flood risk management operations. Bank-full flows occur as part of flood risk reduction operations and generally do not occur during the conservation season.

The proposed changes to releases from reservoirs would accumulate slowly over the period of analysis and even when fully realized (as of 2070), would result in changes to riverine flows that would be within the range of observed flows and associated water surface elevations under current conditions. Because of the overt inability of implementing the ARP to effect change to the physical environment that would be different from the range of conditions currently observed, effects to downstream riparian habitats/vegetation, aesthetics, wildlife (with the exception of listed species), and erosion have been eliminated from detailed consideration.

ARP Impacts to ESA-Listed Fish

The NMFS 2008 BiOp establishes mainstem minimum flow objectives on the Willamette River at Salem and Albany, and tributary minimum flow objectives on Willamette River tributaries located downstream of Big Cliff, Blue River, Cougar, Dexter, Fall Creek, Foster, and Hills Creek dams, as depicted in Tables ES-2 and ES-3 below. Mainstem flow objectives at Albany and Salem vary depending on the volume of water stored in the WVP, which defines the classification of a water year. The four classifications are Abundant, Adequate, Insufficient, and Deficit. The water year classification is then used to determine mainstem flow objectives for April through October of that year.

Table ES-2
Mainstem BiOp Flow Objectives at Salem and Albany (cfs)

Period	Salem Flow Objectives (cfs)			Albany Flow Objectives (cfs)		
	Abundant & Adequate	Insufficient	Deficit	Abundant & Adequate	Insufficient	Deficit
Apr 1-30	* 17,800	Salem flow objectives are linearly interpolated between Adequate and Deficit flow objectives based on mid-May system storage	* 15,000	--	--	--
May 1-31	* 15,000		* 15,000	--	--	--
Jun 1-15	* 13,000		* 11,000	† 4,500	† 4,500	† 4,000
Jun 16-30	* 8,700		* 5,500	† 4,500	† 4,500	† 4,000
Jul 1-31	† 6,000		† 5,000	† 4,500	† 4,500	† 4,000
Aug 1-15	† 6,000		† 5,000	† 5,000	† 4,500	† 4,000
Aug 16-31	† 6,500		† 5,000	† 5,000	† 4,500	† 4,000
Sep 1-30	† 7,000		† 5,000	† 5,000	† 4,500	† 4,000
Oct 1-31	† 7,000		† 5,000	† 5,000	† 4,500	† 4,000

* Seven-day moving average minimum flow
† Instantaneous minimum flow

Table ES-3
Tributary BiOp Flow Objectives Downstream of WVP Reservoirs (cfs)

Period	Big Cliff	Blue River	Cougar	Dexter	Fall Creek	Foster	Hills Creek
Apr 1-30	1500	50	300	1200	80	1500	400
May 1-15	1500	50	300	1200	80	1500	400
May 16-31	1500	50	300	1200	80	1100	400
Jun 1-30	1200	50	400	1200	80	1100	400
Jul 1-15	1200	50	300	1200	80	800	400
Jul 16-31	1000	50	300	1200	80	800	400
Aug 1-31	1000	50	300	1200	80	800	400
Sep 1-30	1500	50	300	1200	200	1500	400
Oct 1-15	1500	50	300	1200	200	1500	400
Oct 16-31	1200	50	300	1200	50	1100	400

The Willamette River basin was modeled using the Hydrologic Engineering Center (HEC) Reservoir System Simulation Program (ResSim) to assess the performance of the No Action Alternative and the ARP in meeting BiOp flow objectives. Performance of the BiOp flow objectives was evaluated for the period April 1 through October 31 in each of 80 simulated years, which provides 214 simulated days over 80 simulated years – a total of 17,120 simulated days. Metrics were developed as a means of evaluating flow objective achievement under the No Action Alternative and the ARP:

1. Flow Objective Achievement on Each Simulated Day; and

2. Percent of Flow Objective Volume of Water Met

Table ES-4 below provides a summary performance comparison of the No Action Alternative and the ARP in meeting mainstem and tributary flow objectives under expected demand conditions for WVP stored water releases and permitted M&I live flow diversions. Performance comparisons are shown for the period of record and Abundant, Adequate, Insufficient, and Deficit water year types. The table shows percentages for each, with values for the No Action Alternative provided first. For example, in a comparison of the percent of days over which the flow objective is met, performance may be indicated as 97/96, which denotes that No Action Alternative meets flow objectives 97 percent of the days, and the ARP meets flow objectives on 96 percent of the days.

Also included on the table is a graphic indicator of ✓, ⇧, ⇩, 🡅, or 🡇 where:

- ✓ indicates that there is no notable difference between the No Action Alternative and the ARP;
- ⇧ indicates a difference of less than two percent between the No Action Alternative and ARP performance with ARP performance superior to the No Action Alternative performance;
- ⇩ indicates a difference of less than two percent between the No Action Alternative and ARP performance with No Action Alternative performance superior to ARP performance;
- 🡅 indicates a difference of more than two percent between the No Action Alternative and ARP performance with ARP performance superior to the No Action Alternative performance; and
- 🡇 indicates a difference of more than two percent between the No Action Alternative and ARP performance with No Action Alternative performance superior to ARP performance.

Table ES-4:
Summary of Modeled BiOp Flow Objective Performance Comparison:
No Action/ARP Expected WVP Releases and M&I Permitted Live Flow Diversions

	Performance Metric	All Years	Abundant 44 Yrs	Adequate 14 Yrs	Insufficient 11 Yrs	Deficit 11 Yrs
Salem Mainstem Flow Objective	Pct Days Flow Objective Met	⇧ 89/90	✓ 98/98	⇧ 87/88	⇧ 77/78	✓ 71/71
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ 99/99	✓ 97/97	✓ 95/95
Albany Mainstem Flow Objective	Pct Days Flow Objective Met	⇧ 90/91	✓ 98/98	⇧ 88/90	⇧ 79/81	✓ 70/70
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ 99/99	✓ 96/96	✓ 94/94
Willamette Falls Mainstem Flow Objective	Pct Days Flow Objective Met	✓ 95/95	⇩ +99/99	✓ 96/96	✓ 87/87	⇩ 83/82
	Pct of Flow Objective Volume Met	⇩ +99/99	✓ +99/+99	✓ +99/+99	✓ 99/99	✓ 98/98
Big Cliff Tributary Flow Objective	Pct Days Flow Objective Met	✓ 97/97	✓ +99/+99	✓ +99/+99	✓ 97/97	⇩ 86/85
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ +99/+99	✓ 99/99	⇩ 95/94
Blue River Tributary Flow Objective	Pct Days Flow Objective Met	✓ +99/+99	✓ 100/100	✓ 100/100	✓ 100/100	⇩ 99/98
	Pct of Flow Objective Volume Met	✓ +99/+99	✓ 100/100	✓ 100/100	✓ 100/100	⇩ +99/99
Cougar Tributary Flow Objective	Pct Days Flow Objective Met	✓ 98/98	✓ 100/100	⇧ 99/+99	✓ 97/97	⇩ 89/88
	Pct of Flow Objective Volume Met	✓ 99/99	✓ 100/100	✓ +99/+99	✓ 99/99	✓ 94/94
Dexter Tributary Flow Objective	Pct Days Flow Objective Met	✓ 99/99	✓ 100/100	✓ 100/100	⇩ 99/98	⇩ 95/93
	Pct of Flow Objective Volume Met	⇩ +99/99	✓ 100/100	✓ 100/100	⇩ +99/99	⇩ 98/97
Fall Creek Tributary Flow Objective	Pct Days Flow Objective Met	⇩ 98/97	✓ 99/99	⬇ 98/95	⬇ 97/94	⇩ 95/93
	Pct of Flow Objective Volume Met	⇩ 98/97	✓ 99/99	⬇ 98/95	⬇ 98/95	⬇ 94/91
Foster Tributary Flow Objective	Pct Days Flow Objective Met	✓ 92/92	⇩ 97/96	⇩ 94/93	✓ 83/83	⇧ 77/79
	Pct of Flow Objective Volume Met	⇩ 97/96	✓ 99/99	⇩ 99/98	⇩ 94/92	⇩ 91/90
Hills Creek Tributary Flow Objective	Pct Days Flow Objective Met	⇩ +99/99	✓ 100/100	✓ 100/100	⇩ 99/98	⬇ 98/95
	Pct of Flow Objective Volume Met	✓ +99/+99	✓ 100/100	✓ 100/100	⇩ +99/99	⇩ 99/98

✓ - No notable difference between No Action and ARP performance

⇧ - < 2 % difference – ARP performance superior ⬆ > 2% difference – ARP performance superior

⇩ - < 2 % difference – No Action performance superior ⬇ > 2% difference – No Action performance superior

The following observations of the ARP's performance in meeting mainstem and tributary flow objectives can be made from Table ES-4:

Salem Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years. When compared across all years, the ARP out-performs the No Action Alternative in terms of the percentage of days for which BiOp flow objectives are met. The expected use and minimum flows at Salem still result in acceptable river conditions between Salem and Oregon City.

Albany Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years. When compared across all years, the ARP out-performs the No Action Alternative in terms of the percentage of days for which BiOp flow objectives are met.

Willamette Falls Mainstem: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in abundant and deficit water type years. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Big Cliff Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in deficit water type years. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Blue River Tributary: Flow objectives are met at a 100 percent level in abundant, adequate, and insufficient water type years. No Action Alternative out-performs the ARP in deficit water type years. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Cougar Tributary: Flow objectives are met at a 100 percent level in abundant water type years. The ARP out-performs the No Action Alternative in adequate water year types, and the No Action Alternative out-performs the ARP in deficit water year types. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Dexter Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water type years. The No Action Alternative out-performs the ARP in insufficient and deficit water year types. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Fall Creek Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in adequate, insufficient, and deficit water year types. When compared across all years, the No Action Alternative out-performs the ARP in terms of the percentage BiOp flow objective volume met.

Foster Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in inadequate and insufficient water year types. The ARP out-performs the No Action Alternative in deficit years. When compared across all years, there is no notable difference between the No Action Alternative performance and the ARP performance.

Hills Creek Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water year types, and the No Action Alternative out-performs the ARP in insufficient and deficit water year types. When compared across all years, the No Action Alternative out-performs the ARP in terms of the percentage of days for which BiOp flow objectives are met.

ARP Effects on Other Authorized Project Purposes

Flood Risk Management would remain a primary purpose for the WVP in the future. The projects would continue to be operated as they are now without changes to the conservation or flood storage seasons, or the flood control, power, conservation, and full pool elevations specified by each project's water control diagram.

Hydropower Production under the ARP would yield decrease in revenues over the No Action Alternative of $28,000 annually. The modeling of alternatives for the period April-October resulted in the shifting of water from winter months into the study period (i.e., deeper drafts from baseline). This shift could have a negative power impact in the winter months of November-March. The impacts on winter power are outside of the study period and not quantified.

Agricultural Irrigation under the ARP would be essentially unchanged from that described under the No Action Alternative.

Municipal and Industrial Water Supply would have access to WVP stored water to cover anticipated peak season supply deficits and a source for providing system redundancy. Providing an allocation for M&I use would help to fulfill intent of the language included House Doc. 531, Volume 5. Paragraph 198 ("*Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand.").*

Reservoir and Riverine Recreation would incur minor adverse effects under the ARP. There are expected to be no adverse impacts to riverine recreation, because there would be no reduction in WVP stored water releases that would impair downstream recreation. Reservoir recreation under the ARP would incur an average annual decrease of $12,150 in boating-related recreation benefits (reduction measured from the No Action Alternative).

ARP Construction-Related Impacts

There are expected to be no indirect construction-related effects (i.e., occurring later in time or removed in distance) in the near-term (less than 10 years). Near term growth in M&I peak season demand is expected to be met by entities withdrawing more water from existing infrastructure (intakes that currently draw from the Willamette River or its tributaries) and not requiring construction of new intakes for the use of WVP stored water. There are currently no proposed actions by public or private entities (e.g., M&I suppliers or agricultural irrigators) to construct water intake infrastructure that would not occur, "but for" the Corps' decision to reallocate storage in the WVP.

Longer-term (more than 10 years) projected growth in demand could eventually require infrastructure construction. However, in the absence of proposals for development from applicants, the construction effects of new intakes and distribution infrastructure would be too speculative to allow for meaningful analysis. The temporary and permanent environmental effects from ground disturbance, installation of conveyance pipe, and construction of associated support facilities for accessing water supply for irrigation or M&I are not assessed in detail within this document because the actions are not reasonably foreseeable and in the case of irrigation, are not caused by the ARP.

Because implementation of the ARP does not require construction or ground disturbing actions by the Corps and does not have reasonably foreseeable construction actions by future users of WVP stored water, the following additional resources characteristically assessed because of construction actions have been eliminated from detailed consideration: air quality; geology; hazardous, toxic, and radioactive waste; noise; occupational safety; soils; topography; traffic; race, poverty, and environmental justice.

Implementation of the ARP

Congressional approval of the ARP is the first step in realizing the benefits of federal storage in the Corps reservoirs. Remaining actions by the Bureau of Reclamation (BOR) and the State of Oregon (through OWRD) are required for M&I users and F&W to access federally stored water. The BOR indicated during the study phase the agency is willing to take action on requesting OWRD change the use on the existing storage certificates to acknowledge M&I and F&W as uses of the federally stored water. OWRD is implementing actions needed on the state level to facilitate the permitted use of stored water. Continued coordination with the BOR and OWRD is working to ensure users are able to fully realize the benefits of the reallocation of conservation storage to specific authorized purposes. While reallocation of storage is not dependent upon these measures occurring, they are necessary to contract for the storage and fully realize the intended benefits of the federal action. However, there is an existing and growing demand for the water and processes are in place to modify the existing storage certificates so the action is assumed to be reasonably certain to occur following reallocation.

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1 Introduction

The original plan for the system of dams in the Willamette River basin is described in House Document 544, 75th Congress, 3rd Session from March 16, 1938, as authorized by the Flood Control Act of 1938 (Pub. L. No. 75-761). Through a series of Flood Control Acts (including the 1938, 1950, and 1960 acts, among others) the U.S. Congress authorized the U.S. Army Corps of Engineers (Corps) to construct, operate, and maintain thirteen major dams[7] in the Willamette River basin. Collectively, these dams and associated infrastructure are known as the Willamette Valley Project (WVP). The operation of each dam contributes to an overall water resource plan designed to meet the Congressionally-authorized project purposes for the WVP.

Although there are multiple authorities pertaining to development of the WVP, House Document (House Doc.) 531 (81st Congress, 2nd Session), authorized by the Flood Control Act of May 17, 1950, remains the primary guiding document pertaining to operation and maintenance of the project (USACE, 2007). It provides the basic authorization for operations of the WVP to meet authorized project purposes.

The annual weather patterns and runoff characteristics of the Willamette River basin make the multiple purpose operation of the reservoir system possible. The well-defined limits of the flood season allow the reservoirs to be drawn down in the fall and winter to catch flood flows. The reservoirs are then filled in the spring and held full as long as possible in the summer so that water stored in, or released from, the reservoirs can serve a variety of beneficial uses. Each WVP reservoir is operated based on a water control plan which describes flow objectives, rates of flow changes, and establishes the elevation at which the pool is to be maintained during various seasons and seasonal transitions.

With a combined conservation storage capacity of approximately 1,590,000 acre-feet, the WVP is capable of providing important benefits for flood risk management, hydropower, irrigation, municipal and industrial water supply, flow augmentation for pollution abatement and improved conditions for fish and wildlife, and recreation. Of the 1,590,000 acre-feet of WVP conservation storage, approximately 75,000 acre-feet of stored water is currently contracted through the U.S. Bureau of Reclamation (Reclamation) for irrigation.

Annual visitation to the reservoirs includes an estimated 3.6 million recreation visits to Corps-managed areas, in addition to an estimated 700,000 visits to areas managed by the U.S. Forest Service (USFS), the U.S. Bureau of Land Management (BLM), the state of Oregon (including Detroit Lake State Recreation Area), and local counties (USACE, 2000).

The Portland District of the Corps operates the system of 13 reservoirs as the WVP. Importantly, the entire WVP conservation storage remains as originally allocated to Joint Use with no distinct allocations for specific project purposes. The WVP represents a combination of large economic investments and commitments of valuable natural resources, and can make important contributions

[7] Fall Creek Dam on Fall Creek; Fern Ridge Dam on the Long Tom River; Cottage Grove Dam on the Coast Fork Willamette River; Dorena Dam on the Row River; Big Cliff and Detroit Dams on the North Fork Santiam River; Green Peter on the Middle Santiam River, Foster Dam on the South Fork Santiam River; Blue River Dam on the Blue River, Cougar Dam on the McKenzie River; and Dexter, Hills Creek, and Lookout Point Dams on the Middle Fork Willamette River.

to the nation's economy (USACE, 1998). Over time, as population shifts and growth and need changes, the purposes of some WVP reservoirs may no longer satisfy the original project priorities to meet these changing needs. The Corps is evaluating a reallocation of WVP conservation storage to address these changes (USACE, 1998).

The Willamette Basin Review Feasibility Study began in 1996 to investigate future water demand in the basin with respect to the operation of the WVP during the conservation storage and flow release season, and to identify WVP reallocation options to assure the most public benefit within the policies and regulations of the Corps. Because of the state of Oregon's jurisdiction over water storage and use, the non-federal sponsor for the feasibility study was the Oregon Water Resources Department (OWRD). The feasibility study was put on hold in 2000 pending resolution of Endangered Species Act (ESA) consultation (detailed below). The feasibility study is now moving forward with the goal of reallocating WVP conservation storage over a 50-year period of analysis, while continuing to fulfill the other project purposes. If feasible solutions are identified, the study could result in a Chief of Engineer's report providing recommendations to Congress for reallocation. In addition, this report is an Integrated Feasibility Report/Environmental Assessment (FR/EA) to document the results of the feasibility study and comply with the requirements of the National Environmental Policy Act (NEPA).

1.1 Authority

The House Committee on Public Works resolution for the Willamette Basin Review Study, adopted September 8, 1988, Exhibit 1, authorized the Chief of Engineers to determine:

> *"...whether modifications to the existing projects are warranted and determine the need for further improvements with the Willamette River Basin (the Basin) in the interest of water resources improvements"*

1.2 SMART Planning Framework

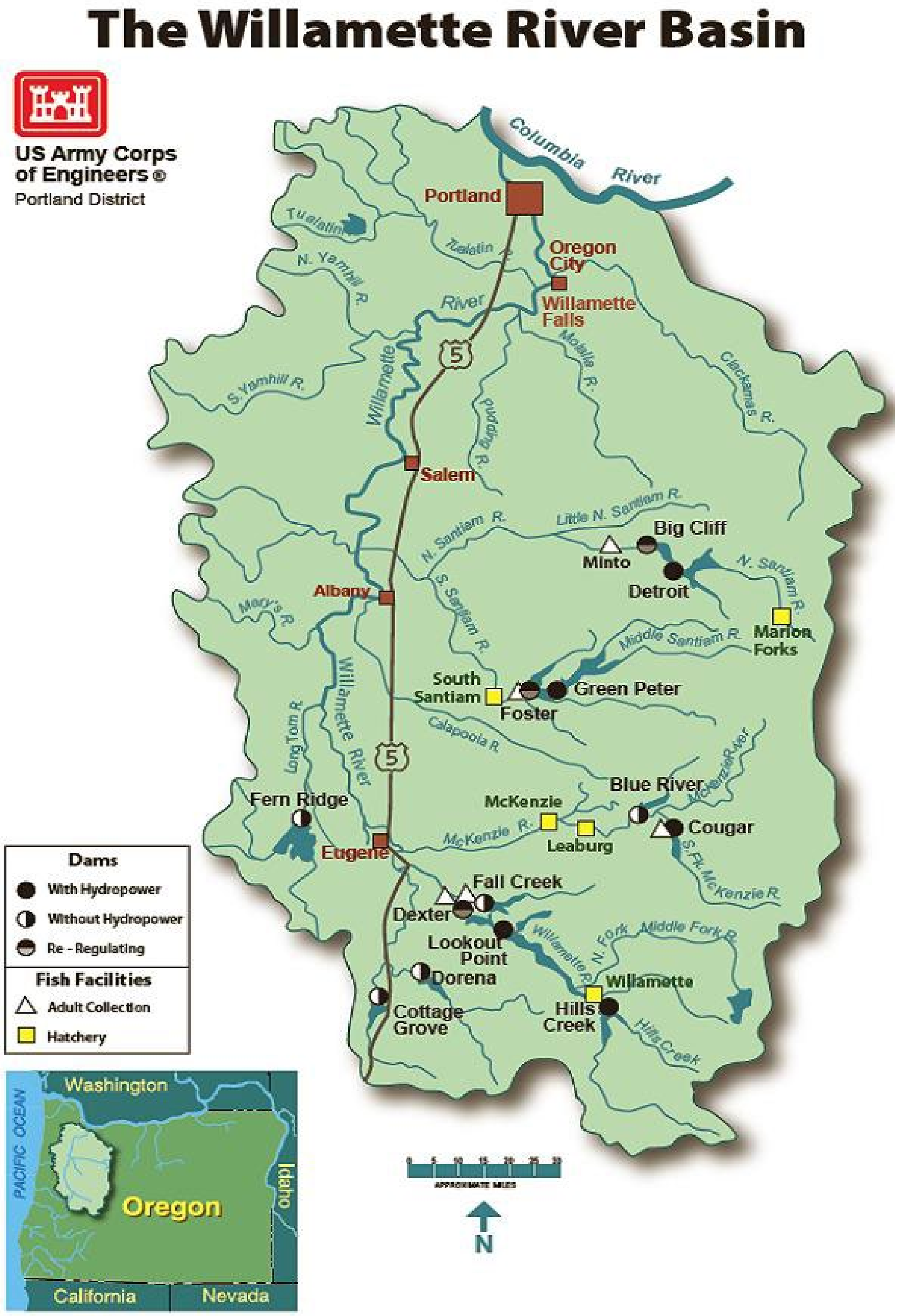
The current Willamette River Basin Review Feasibility Study is being conducted under planning modernization initiatives, per Corps memorandum dated 8 February 2012, titled "U.S. Army Corps of Engineers Civil Works Feasibility Study Program Execution and Delivery." Under these initiatives, the study is supposed to be completed within three years of initiation, cost less than $3 million (federal and non-federal costs combined), and be coordinated early and often through the Corps vertical team. The project received two schedule waivers and is completing the study in 3.5 years.

1.3 Project Area

With a watershed of more than 11,200 square miles, 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 (see Figure 1-1). The Willamette River is the 13^{th} 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.

Figure 1-1
Willamette River Basin and Reservoir Projects



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).

Within the watershed are most of the state's population, larger cities, and major industries. The basin also contains some of Oregon's most productive agricultural lands and supports nationally and regionally important fish and wildlife species. Thirteen of Oregon's thirty-six counties[8] intersect or lie within the boundary of the Willamette River basin and nearly seventy percent of Oregon's population lives within the basin.

1.4 Summary of Endangered Species Act Consultation for Continued Operation of the WVP

The WVP was authorized by the U.S. Congress with the full recognition[9] that constructing and operating the system of reservoirs would cut off extensive areas of upstream habitat for migratory salmon and steelhead (USACE, 2007). To compensate for this loss of fish habitat, a series of fish hatcheries were authorized; some new and some in replacement of state hatcheries that would be destroyed by the dams and reservoirs. In addition, House Doc. 531 contained continuing authority for the Corps to construct fish passage facilities at several of the WVP dams, and language from Congress encouraging the Corps to try to solve the problem of fish passage over the high-head dams to be constructed in the Willamette River basin.[10]

In 1993, the U.S. Fish and Wildlife Service (USFWS) listed the Oregon chub[11] as endangered under the ESA. In 1999, the bull trout was also listed as threatened; both species are found in the

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[8] Benton, Clackamas, Columbia, Douglas, Klamath, Lane, Linn, Marion, Multnomah, Polk, Tillamook, Washington, Yamhill,

[9] House Doc. 531, Appendix J, Willamette River Basin, p. 1732-1734, paragraphs 181-185, especially 181.

[10] House Doc. 531, Appendix J, Willamette River Basin; p. 1746-1747, para. 236; p. 1765, para. 305 (Cougar Dam); para. 384 (White Bridge Dam later moved to Foster under the 1960 Rivers and Harbors Act; para. 411 (hatchery summary); and para. 532 (continue efforts at fish passage).

[11] The Oregon chub has since been de-listed.

Willamette River basin. In 1999, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) listed both the Upper Willamette River (UWR) spring Chinook salmon and the UWR winter-run steelhead as threatened species. The ongoing effects on these ESA-listed fish from the continued operation of the WVP were the subject of formal Section 7 consultation under the ESA.

In accordance with the Section 7 consultation process, the Portland District submitted a Biological Assessment (BA) to the NMFS and USFWS (i.e., "the Services") to assess the ongoing operation and maintenance of the WVP (USACE, 2000). Because of their coordinated decision-making relative to WVP operation, the BA also identified Reclamation and Bonneville Power Administration (BPA) as Action Agencies. The BA evaluated the likely effects of the continued operation of the WVP on species and their critical habitat as listed under the ESA.[12]

In January 2006, the Corps notified the Services of the Action Agencies' decision to prepare a revision to the proposed action and a supplement to the 2000 BA (USACE, 2000), and submitted the Supplemental BA in May 2007 (USACE, 2007). In addition to hatchery operations,[13] the Supplemental BA included a revised proposed action that would more accurately reflect then-current WVP operations, particularly mainstem and tributary flow modifications implemented after preparation of the 2000 BA. Importantly, the Supplemental BA identified new measures that the Action Agencies have the authority to implement, which include:

- Changes to WVP reservoir management implemented subsequent to the 2000 BA, including mainstem and tributary minimum flow objectives;
- Completion of the selective withdrawal tower at Cougar Dam and actions underway to address fish passage and related issues at Cougar and Blue River dams under the Willamette Temperature Control Project;
- Strategies for reform of fish hatchery operations and associated mitigation;
- Habitat restoration actions undertaken on project lands through natural resources stewardship responsibilities, as well as offsite under the Corps General Investigation Program and Continuing Authorities Program;
- Evaluation of the potential feasibility and effectiveness of proposed major structural modifications at WVP dams to address ESA issues, including improved fish passage and handling, temperature control and hatchery facilities at WVP dams other than Blue River and Cougar;

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[12] The proposed action contained in the 2000 BA was based on operation of the WVP prior to the ESA-listing of UWR spring Chinook salmon and winter-run steelhead in 1999.

[13] A key element of the revised proposed action was integrating hatchery operations and recommendations for hatchery reform associated with development of Hatchery Genetic Management Plans (HGMPs) in coordination with Oregon Department of Fish and Wildlife (ODFW). The ESA coverage for Willamette Basin hatcheries operated by ODFW as mitigation for impacts of the WVP was previously covered under a 2001 NMFS BiOp, which lapsed in 2004. The action agencies agreed that since hatchery operations and management of hatchery fish was closely related to project operations, rather than addressing them as separate consultations they should be integrated into the same proposed action.

- Strategies for integrating operational, structural, habitat, and hatchery measures across the basin that enhance their effectiveness and take advantage of synergies that may exist; and
- Update and accurately describe the ongoing research, monitoring, and evaluation (RM&E) program in the Willamette River basin and develop a comprehensive RM&E plan that better meets ESA requirements.

The Services provided the Action Agencies with their final Biological Opinions (BiOps) in July 2008 (NMFS, 2008; USFWS, 2008), addressing the effects of WVP operation and maintenance on the respective ESA-listed fish for which they were responsible. These BiOps specify actions to ensure that the continued operation of the WVP dams, reservoirs, hatcheries, and 42 miles of riverbank protection projects would not reduce the likelihood of survival and recovery of the ESA-listed fish. NMFS BiOp concluded the proposed action described in the BA jeopardized the ESA-listed Upper Willamette Chinook and winter-run steelhead, and included a "*reasonable and prudent alternative*" (RPA). The USFWS BiOp (USFWS, 2008) concluded the proposed action did not jeopardize the ESA-listed bull trout. Implementing the reasonable and prudent measures would minimize possible adverse effects on listed species and their critical habitat and require monitoring and reporting to ensure compliance.

On April 9, 2018, the Corps reinitiated consultation on the 2008 NMFS BiOp. However, the Corps does not anticipate that the substantive requirements of RPA measure 2.9 will change as a result of the reinitiation of consultation. The Corps intends to continue to implement RPA measure 2.9, which requires the Action Agencies to facilitate conversion of stored water to an instream flow water right, by way of this project. Therefore, to immediately implement this RPA measure, the Corps has requested to enter into consultation with NMFS for this project separately from the reinitiated consultation on the 2008 NMFS BiOp.

1.4.1 Early Implementation of Flow-Related RPA Measure

It was anticipated that the recommendations in the BiOp would include the use of stored water to meet flow objectives for the Willamette River mainstem and its major tributaries. Since water year 2000, the Corps has adopted and implemented mainstem Willamette River flow objectives[14] at Salem based on recommendations from NMFS and the Oregon Department of Fish and Wildlife (ODFW) (USACE, 2007). In addition, tributary-specific flows, important to local populations of ESA-listed fish, have been closely monitored and adjusted when necessary (USACE, 2007). During informal consultation, NMFS recommended continuation of the spring and early summer mainstem minimum flows needed to support salmon and steelhead migration (USACE, 2007). The Corps has continued to operate the WVP in an attempt to meet tributary flow objectives since 2000.

From 2000 through 2003, the Corps worked with other federal and state agencies to develop a WVP flow management strategy. This strategy established a continuing framework for meeting flow objectives, that relies on monthly meetings and regular coordination teleconferences to provide updates on reservoir and flow conditions in the Willamette River and its tributaries.

[14] Flow objectives were based on the relationship between flow and temperature during the juvenile winter-run steelhead out-migration and subsequent adult returns.

Implementation of the flow management strategy has resulted in the WVP being operated to meet flow objectives[15] for more than 15 years.

1.5 Problems and Opportunities

The first step in the planning process, per USACE regulations, is the identification of problems (i.e., undesirable conditions to be solved) and opportunities (positive conditions to be improved) that the planning team seeks to address (ER 1105-2-100, Appendix E, p. E-2). Problems and opportunities encompass current as well as future conditions and are defined in terms of their nature, cause, location, dimensions, origin, timeframe, and importance.

1.5.1 Problems

1. There is an inadequate supply of water to meet increasing Municipal & Industrial (M&I), Agricultural Irrigation, and Fish and Wildlife peak season water demand in the study area over the next 50 years due to the combined effects of population growth, inadequate groundwater sources, and over-allocated surface waters.

2. Releases of WVP stored water for the benefit of ESA-listed fish are not protected instream due to restrictions with Oregon water law.
3. Although the WVP is federally authorized for multiple (joint-use) purposes, including fish and wildlife, agricultural irrigation, and municipal and industrial water supply, no specific allocation of storage has been made for those purposes. That and other existing administrative constraints, including state water law and policy, have limited access to storage from the WVP and reduced the potential return on federal investment.
4. The Willamette River and its tributaries are over-allocated, and have multiple, often conflicting, uses, including endangered species critical habitat, M&I water supply, and agricultural irrigation, recreation, and aesthetics.

1.5.2 Opportunities

1. There is an opportunity to use existing storage to provide future supply for instream and out-of-stream use.
    a. Flow requirements for ESA-listed fish (Upper Willamette River Chinook salmon (*Oncorhynchus tshawytscha*), winter-run steelhead (*Oncorhynchus mykiss*), and bull trout *(Salvelinus confluentus)* can be met far more effectively in late summer months through the use of supplemental flows provided by storing a portion of spring inflows in WVP reservoirs and releasing water as needed to meet downstream requirements later in the season.
2. Mechanisms can be established by which water supply users can reimburse the Federal Treasury for WVP investment.
3. The Corps can to fulfill its obligation under the 2008 BiOp RPA Measure 2.9 (facilitate conversion of stored water to an instream water right) by making a specific allocation of

[15] Minimum mainstem flows and minimum tributary flows.

WVP conservation storage, which will lead to the instream protection of WVP stored water released for the benefit of ESA-listed fish.

1.6 Planning Objectives, Constraints, and Considerations

Planning objectives are the intended purposes of the planning process. Constraints are restrictions that limit the extent of the planning process. Constraints can be legal, policy related or study specific.

1.6.1 Planning Objectives

1. Provide sources of water to support forecasted future demands between now and 2070 for municipal and industrial water supply throughout the Willamette River Basin.

2. Provide sources of water to support forecasted future demands between now and 2070 for irrigated agriculture throughout the Willamette River Basin.

3. Provide water in the reaches of the Willamette River and tributaries controlled by the Corps Willamette Valley Project to support the needs of fisheries resources through the year 2070.

1.6.2 Planning Constraints

1. Maintain existing flood risk management benefits in the Willamette Basin, including tributaries where Corps dams exist.
2. Water reallocation proposals will fit within the existing Willamette Valley Project rule-curves.
3. Reservoir storage reallocation will be limited to the existing almost 1.59 million acre-feet of conservation storage. The study will not evaluate reallocation from the flood, power, or inactive/dead storage pools.
4. Construction or modification of structural facilities at Willamette projects to provide additional storage space for water supply is not being considered.

1.6.3 Planning Considerations

1. 100 percent reliable stored water for all water year types and all water uses is not viable because Willamette Valley Project reservoirs are annually emptied for flood control purposes and refill is not guaranteed. Agreements for stored water would be issued for less than 100 percent reliability.
2. Maintain operational ability to meet BiOp required flow targets to support ESA listed fish species.
3. Minimize negative impacts to existing reservoir and downstream recreation users.
4. Minimize impacts to hydropower generation at Willamette Valley Project hydropower projects.

1.7 Purpose and Need for Corps Action

The purpose for Corps action is to reallocate the 1,590,000 acre-feet of WVP conservation storage from Joint Use to specific uses to fulfill the multi-purpose goals of the WVP.

The demand for stored water among the three use categories (see Section 3 of this document) exceeds the volume of WVP conservation storage. This FR/EA informs decision makers and the public in order to facilitate resolution of unresolved conflicts concerning alternative uses of the available resource. Three different use categories for WVP stored water, which require specific allocations of WVP conservation storage to meet peak season demands are described below.

1. Among the issues addressed in the RPA, the Action Agencies must coordinate with OWRD to facilitate conversion of a portion of WVP conservation storage to instream water rights (RPA Measure 2.9[16]). Although the Corps releases WVP stored water to support ESA-listed fish tributary reaches, the Corps cannot guarantee that these flows would be maintained throughout the reach because OWRD, not the Corps, has enforcement authority over water rights. While the Corps has been operating the WVP to meet flow objectives since the year 2000, releases of WVP stored water are not protected instream due to restrictions with state water law. Reallocating a portion of WVP conservation storage specifically for F&W benefits would facilitate the legal protection of WVP-released water for instream purposes, as described in RPA Measure 2.9.
2. Of the 1,590,000 acre-feet of WVP conservation storage, approximately 75,000 acre-feet of stored water is currently under contract through Reclamation for irrigation. Reclamation may enter into irrigation contracts up to 95,000 acre-feet of stored water per year without the need to consult with the NMFS as established under the 2008 BiOp (NMFS, 2008). WVP conservation storage in excess of 95,000 acre-feet per year would be needed to meet future demand for AI water supply. Although a specific allocation to AI is not necessary for Reclamation to continue to issue water supply contracts in excess of 95,000 acre-feet of stored water, a specific allocation must be included in order to efficiently balance the reallocation of WVP conservation storage.
3. The state of Oregon has long identified the WVP as a potential source for future municipal and industrial (M&I) water supply needs in the basin. Although an authorized project purpose, no portion of WVP conservation storage was ever specifically allocated to M&I water supply. In order comply with Corps water supply policy, the Corps must identify a portion of WVP conservation storage that could be allocated to M&I water supply. Without a specific quantity of WVP conservation storage allocated to M&I, water supply storage agreements for M&I uses of WVP stored water cannot be executed. Corps Policy, as described in the Planning Guidance Notebook, ER 1105-2-100, allows existing Corps projects to be modified to add storage for municipal and industrial water supply. Storage may also be reallocated from other purposes to municipal and industrial uses.

[16] The full text of RPA Measure 2.9 is provided in the Glossary of this document. The full RPA is available at http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

1.8 Federal Interest

There is a federal interest in determining an efficient reallocation of WVP conservation storage, as it would help to fulfill the intent of language included House Doc. 531, Volume 5. Paragraph 198 ("*Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand.").* Determining appropriate allocations of WVP conservation storage among the three water use categories would result in a balanced use of the resource and provide revenue to the Federal Treasury. Additionally, once a portion of WVP conservation storage is allocated for F&W benefits, the Corps would have facilitated "*conversion of stored water to an instream flow water right*", as directed by the NMFS 2008 BiOp (RPA Measure 2.9).

1.9 Non-Federal Sponsor

The state of Oregon, Oregon Water Resources Department (OWRD) is the non-federal sponsor for this study. OWRD is the regulatory agency responsible for directly addressing Oregon's water supply needs, including the restoration and protection of streamflows across the state. OWRD administers water rights, water management, water policy, and water supply planning for the state of Oregon. The Feasibility Cost Share Agreement (FCSA) was signed by the Corps and OWRD in August 2015.

1.10 Lead Agency and Cooperating Agency Designations

For every federal action subject to the requirements of NEPA, at least one federal agency must serve as the lead agency, which has the primary responsibility for decision-making and compliance with NEPA on a given proposed action. The Corps is the lead agency for this proposed action. If more than one federal agency is involved in a proposed action, the lead agency is determined by considering the:

- Magnitude of the federal agency's involvement,
- Approval authority over the proposed action,
- Expertise with regard to environmental effects,
- Duration of the federal agency's involvement, and
- Sequence of the federal agency's involvement (40 C.F.R. § 1501.5(c)).

When a federal agency other than the lead agency has discretionary authority over a proposed action (e.g., Reclamation with respect to irrigation contracts) or special expertise with respect to the environmental impact involved in the proposal (e.g., NMFS's expertise with respect to the ESA), they may be requested to participate as a Cooperating Agency (40 C.F.R. § 1508.5; Forty Questions No. 14(a, b, c)).

Agencies invited to participate in the feasibility study as cooperating agencies were the USFWS, Reclamation, and BLM; the Bonneville Power Administration (BPA); the USFS; and NMFS.

1.10.1 Bonneville Power Administration

BPA is responsible for managing, transmitting, and selling electrical power generated by WVP hydroelectric facilities, and is one of the three Action Agencies in the 2008 BiOps (along with the Corps and Reclamation). The Corps requested that BPA participate in the feasibility study as a cooperating agency (USACE, 2016), but the BPA declined participation because "*we [BPA]* *determined that allocation scenarios likely to be reviewed between all the required uses are unlikely to disrupt the output curve needed for continued power generation; therefore BPA has no decisionmaking responsibilities related to this proposal"* (USDOE, 2016).

1.10.2 U.S. Bureau of Reclamation

Reclamation administers the water marketing program whereby landowners and/or institutions contract for a portion of WVP conservation storage for the purpose of irrigation. In administering the water marketing program, Reclamation considers entering into water service contracts discretionary agency decisions subject to review under the requirements of NEPA (USBOR, 2012); Reclamation also receives payments for the contracted water on behalf of the U.S. Government.

The Corps requested that Reclamation participate in the feasibility study as a cooperating agency (USACE, 2016a) and Reclamation declined because they separately fulfill their NEPA obligations on each water service contract they issue, and do not require decisions from this feasibility study to continue their water service contracting actions. Nevertheless, Reclamation has provided ongoing coordination throughout the feasibility study.

1.10.3 National Marine Fisheries Service and U.S. Fish and Wildlife Service

NMFS and USFWS were invited to be cooperating agencies in the feasibility study because of their agencies' expertise with respect to species listed under the ESA (USACE, 2016b; USACE, 2016c). The USFWS accepted the invitation (USFWS, 2016); NMFS did not formally respond to the request. Although not responding to the request to be a cooperating agency, NMFS has been included in an interdisciplinary team engaged in reviewing and analyzing existing data regarding instream flow needs to support ESA-listed fish.

1.10.4 Bureau of Land Management and the U.S. Forest Service

BLM and USFS (Willamette National Forest and Umpqua National Forest) were invited to be cooperating agencies because of their management of federal lands adjacent or in proximity to WVP reservoirs (USACE, 2016d; USACE, 2016e; USACE, 2016f). On behalf of the USFS, the Forest Supervisor of the Willamette National Forest accepted participation in the feasibility study as a cooperating agency (USDA, 2016), but then later determined that their participation as a cooperating agency was not warranted. No formal response to the request was received by the Corps from representatives of the BLM or the Umpqua National Forest.

1.11 Other Agency Decisions Required

The Corps does not have unilateral authority to implement all actions that would be necessary to achieve all of the study goals – discretionary actions must be taken by Reclamation, OWRD, and ODFW. Should these agencies fail to implement the actions described below, the Corps decision to reallocate WVP conservation storage would be rendered ineffective in meeting the needs identified in Section 1.7.

1.11.1 Reclamation to Request Change to WVP Water Storage Rights Certificates

In the state of Oregon, water law distinguishes between diverting water for storage, and releasing water from storage for use; each requires a different water right. In Oregon, the right to store water conveys ownership of the stored water. Because policy prohibits the Corps from holding state water rights,[17] Reclamation filed two water storage right applications on behalf of the federal government for the entire WVP conservation pool (1,640,100 acre-feet[18]). OWRD approved these two applications and issued water right certificates.

However, the rights that allow Reclamation to store water in WVP reservoirs are designated exclusively for irrigation. Given this limitation, a secondary water right to use WVP stored water cannot be granted to other potential water use categories (e.g., M&I, F&W). In order for non-irrigation use categories (e.g., M&I, F&W) to realize benefits from the reallocation of WVP conservation storage, Reclamation's two storage rights need to undergo a transfer review process to change the character of use to match the proposed reallocation of WVP conservation storage.[19] Reclamation's Columbia-Cascades Area Office Deputy Area Manager indicated the agency would be willing to change the purpose of use on the two storage certificates (USBOR, 2017).

If Reclamation does not file a transfer application for a change in character of use, OWRD cannot approve secondary water rights for the use of WVP stored water for either F&W or M&I.

1.11.2 OWRD to Issue Change in Stored Water Character of Use

After Reclamation requests that OWRD issue a change in character of use for its two water storage rights, OWRD must review the transfer application. The review includes a determination of whether or not the proposed change in character of use would injure other water rights. In addition, the transfer must undergo a public review process where protests could be filed, potentially challenging an approval determination. OWRD may condition the approval order to eliminate potential injury to other water rights. If conditions would not eliminate injury, the application would be denied. Ideally, each of the considerations OWRD needs to make in order to issue the change in character of use for the two water storage rights would be accomplished through the review process of this FR/EA.

1.11.3 ODFW to Request Conversion of Instream Water Rights for Fish and Wildlife

Once OWRD has approved the change in character of use for Reclamation's storage rights, OWRD would pursue the conversion of Minimum Perennial Streamflows (MPSFs) into instream water rights for the purpose of protecting the flows from unauthorized diversion below the WVP reservoirs. Any volume of storage remaining after conversion of the MPSFs, ODFW would request that OWRD issue secondary water rights from storage as instream water rights for the protection of flows downstream. The NMFS 2008 BiOp RPA Measure 2.9 (Protecting Stored Water Released for Fish) states that "*In coordination with the OWRD and ODFW, the Action Agencies will facilitate conversion of stored water to an instream flow water right.*" Although the actions

[17] ER 1105-2-100, USACE Planning Guidance Notebook, Section 3-8 b(1), Water Supply, Specific Policies, states that "*The Corps will not acquire water rights necessary for use of stored water.*"

[18] Project conservation storage values stated in the certificates were rounded upward, which results in a sum of 1,640,100 acre-feet on the certificates. The actual volume of WVP conservation storage is just over 1,590,000 acre-feet, which is the system-wide conservation storage volume figure used throughout this report.

[19] The Willamette Valley Project, as listed in House Doc. 531, page 246, paragraph 527, was authorized for the primary purpose of controlling floods and as a solution to major drainage problems. Secondarily, after the flood season, stored water in the conservation pool was intended to be released for navigation, generation of hydroelectric power, irrigation, water supply, and reduction of stream pollution for health, fish conservation, and public recreation.

necessary to protect releases of WVP stored water for instream purposes are not within the purview of the Corps, this FR/EA will serve to *facilitate* the actions by the other agencies that are necessary to establish water rights for instream purposes.

1.11.4 OWRD to Issue Secondary Water Rights for Use of Stored Water

In order to utilize WVP stored water for consumptive purposes, entities must request, and be issued secondary water rights by OWRD. Each of the preceding actions by Reclamation and OWRD must occur before secondary water rights could be issued.

1.12 Government to Government / Tribal Coordination

Early in the study, the Corps sent formal requests to initiate government-to-government consultation with the following Tribal entities:

- The Cow Creek Band of Umpqua Indians (USACE, 2015);
- The Cowlitz Indian Tribe (USACE, 2015a);
- The Confederated Tribes of the Grand Ronde Community of Oregon (USACE, 2015b);
- The Confederated Tribes of the Siletz Indians (USACE, 2015c); and
- The Confederated Tribes of the Warm Springs Reservation of Oregon (USACE, 2015d).

No formal responses to the coordination letters were provided by any of the Tribal entities.

Tribes were notified of and invited to attend public scoping meetings in March 2016 as well as stakeholder meetings in March 2017.

1.13 Relevant Documents and Reports

Willamette Basin Comprehensive Study (Willamette Basin Task Force, 1969)

The purpose of the Willamette Basin Comprehensive Study was to develop information on future water and related resource needs and to prepare a plan for meeting those needs. The study was directed and coordinated by the Willamette Basin Task Force, which included the state of Oregon and several federal agencies (Corps; Bureau of Reclamation; Department of Agriculture; Department of Commerce; Federal Power Commission; Department of Labor; and the Department of Health, Education, and Welfare).

Final Environmental Impact Statement, Operations and Maintenance of the Willamette Reservoir System (USACE, 1980)

This FEIS was prepared to examine the environmental effects of continued operation and maintenance of the WVP. The FEIS analyzed the environmental effects of operating the WVP's system of reservoirs to fulfill all of the different project purposes.

Willamette Basin Reservation Request for Future Agricultural Economic Development (Oregon Department of Agriculture, 1994)

The Oregon Department of Agriculture submitted an application requesting for a reservation of water for future economic development by irrigation and related agricultural uses in February 1990. The request was submitted to OWRD, amended in December 1994, and requested 550,000 acre-feet of stored water from the federal reservoirs, 225,000 acre-feet of new stored water deemed feasible, and 1,127 cubic feet per second of early season natural flow, mostly from the Santiam River basin.

Willamette Basin Reservation Request – Surface Water for Future Municipal Use (League of Oregon Cities and Special Districts Assoc of Oregon, 1994)

This document is an application for a Willamette River basin municipal water reservation, which was a state process for any state agency to reserve unappropriated water for future economic development. The application was prepared by the League of Oregon Cities and Special Districts association of Oregon on behalf of municipal water suppliers in the Willamette River basin. The application requested a reservation of 287,217 acre-feet of stored water for municipal and industrial needs through the year 2050.

Willamette River Temperature Control, McKenzie Subbasin, Oregon. Final Feasibility Report and Environmental Impact Statement (USACE, 1995)

The study evaluated the potential for modifying the Cougar and Blue River projects for water temperature control because the two dams altered downstream water temperatures which were cooler in the late spring/summer and warmer in the late fall/winter than pre-dam conditions. The study investigated alternatives to modify the temperature of downstream releases to replicate pre-dam water temperatures to benefit anadromous and native fish species. Selective withdrawal was preferred because of its proven reliability, durability, and operational flexibility for both cooling and warming release temperatures. The Water Resources Development Act of 1996 authorized the installation of the water temperature control tower at Cougar Dam, and was reauthorized in the Water Resources Act of 1999.

Willamette Basin Reservoir Study Interim Report (USACE, 2000)

The Interim Report documented the progress made under the Willamette Basin Reservoir Feasibility since its initiation in 1996. The purpose of the feasibility study was to analyze current water uses in the basin, to project water needs for the variety of uses, and to identify reservoir water reallocation options to assure the most public benefit within the policies and regulations of the Corps. The report provides estimates for AI and M&I demand for WVP stored water. In March 1999, winter-run steelhead and UWR spring Chinook salmon in the upper Willamette basin were listed as threatened species under the ESA. In April 1999, the study was suspended pending the formal consultation between the Corps, NMFS, and USFWS as required under Section 7 of the ESA.

Biological Assessment of the Effects of the Willamette River Basin Flood Control Project on Species Listed Under the Endangered Species Act (USACE, 2000)

In April 2000, the Corps submitted a BA to NMFS and USFWS to assess the ongoing operation and maintenance of the WVP in accordance with Section 7 of the ESA (USACE, 2000). The BA evaluated the likely effects of the continued operation of the WVP on species and their critical habitat as listed under the ESA.[20] In addition to the Corps, the BA included Reclamation and BPA as action agencies.

Supplemental Biological Assessment of the Effects of the Willamette River Basin Flood Control Project on Species Listed Under the Endangered Species Act (USACE, 2007)

This document supplements the April 2000 BA of the Effects of the Willamette River Basin Flood Control Project on Species Listed under the ESA (USACE 2000). A key element of the Supplemental BA included the integration of hatchery operations and recommendations for hatchery reform associated with development of Hatchery Genetic Management Plans. In addition, the Supplemental BA identified new measures to address changes to reservoir management; completion of selective withdrawal towers; fish passage facilities; habitat restoration; and the integration of operational, structural, habitat, and hatchery measures across the basin to enhance their effectiveness. The Supplemental BA also updated ongoing research, monitoring, and evaluation programs in the basin geared to developing a comprehensive plan for meeting ESA requirements.

Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Willamette River Basin Flood Control Project (NMFS, 2008) and Biological Opinion On the Continued Operation and Maintenance of the Willamette River Basin Project and Effects to Oregon Chub, Bull Trout, and Bull Trout Critical Habitat Designated Under the Endangered Species Act (USFWS, 2008)

NMFS and USFWS completed final separate, but coordinated, BiOps in 2008 addressing the effects of the operation and maintenance of the WVP on the respective ESA-listed fish for which each agency is responsible. These BiOps specify actions to ensure that the continued operation of the Willamette Valley dams, reservoirs, hatcheries and 42 miles of the riverbank protection projects would not reduce the likelihood of survival and recovery of the ESA-listed fish. The BiOps include a RPA and reasonable and prudent measures to minimize possible adverse effects on ESA-listed fish and their critical habitat. They also require monitoring and reporting to ensure compliance with requirements.

The BiOps require actions that provide upstream and downstream fish passage, temperature improvements downstream of dams, improvements in downstream flows, screening of irrigation diversions, and restoring habitat and improving hatchery practices and facilities. The BiOps also specify timeframes for each action and include measures for coordination and research.

Willamette Valley Projects Configuration/Operation Plan (USACE, 2009)

The RPA in the 2008 NMFS BiOp required the Corps to evaluate a variety of potential actions intended to benefit ESA-listed fish to avoid jeopardy and to define biological criteria as a part of the Configuration/Operation Process (COP). The 2009 COP was a multi-year, multi-level, study that evaluated a range of potentially beneficial actions and provided the detailed analyses needed

[20] The proposed action contained in the 2000 BA was based on operation of the WVP prior to the ESA-listing of UWR spring Chinook salmon and winter-run steelhead in 1999.

to implement the actions. The Corps adopted the COP process to examine measures related to the operation and maintenance of the projects that had the potential to reduce Willamette Project operations effects on ESA-listed fish.

Oregon's Integrated Water Resources Strategy (OWRD, 2012)

The fundamental purpose of this document was to understand Oregon's water needs and to articulate a strategy to meet those needs into the future. OWRD took the lead to develop this document, and worked closely with ODEQ, ODFW, and the Oregon Department of Agriculture. Recommended Action 10.B in the 2012 Integrated Water Resources Strategy, Improve Access to Built Storage, included implementation actions to "Reallocate water in federal reservoir systems that have not undertaken formal allocation processes in Oregon" and "Authorize and fund the State to invest in and purchase water from stored water facilities."

Coast Fork Willamette River, Oregon, Surplus Water Letter Report (USACE, 2014)

The purpose of the study documented in this report was to identify whether 437 acre-feet of water stored in the WVP Cottage Grove and Dorena reservoirs could be available as surplus for the City of Creswell's M&I use. OWRD acted as the non-federal cost-share sponsor for the study. Based on the findings of the report, it was recommended that Creswell be issued a surplus water agreement for 437 acre-feet of surplus water from Dorena and Cottage Grove Reservoirs, combined. The report includes steps required for implementation.

Willamette Valley Projects Configuration/Operation Plan, Phase II Report (USACE, 2015)

The Configuration/Operation Plan (COP) Phase II Report presented specific implementation plans to NOAA Fisheries based on the COP; based on their review, NOAA would determine whether the actions proposed were likely to have the biological results that NOAA relied on in their 2008 BiOp to avoid jeopardy. The RPA outlined actions to be implemented to avoid jeopardy to ESA-listed fish to from continued operations and maintenance of the Willamette Project. The actions identified for implementation included construction of a selective withdrawal structure and three downstream fish passage improvement structures to provide effective fish passage to above-dam habitat for three populations of UWR Chinook and two populations of UWR winter-run steelhead.

2015 Statewide Long-Term Water Demand Forecast (OWRD, 2015)

This report, prepared by OWRD, provides key findings and estimates of total diversion demands, and advice on how to apply data from the report to place-based integrated water resources planning efforts. Individual chapters of the report and appendices are dedicated to agricultural water demand forecasts, and municipal, domestic, and industrial water demand forecasts. Findings are presented at the state, county, and major watershed level.

2 Existing Conditions / Affected Environment

NEPA reviews should coordinate and take appropriate advantage of existing documents and studies, including through adoption and incorporation by reference[21] (CEQ, 2012). Agencies are encouraged to concentrate on relevant environmental analysis in their documents and not to produce an encyclopedia of applicable information. Impacts should be discussed in proportion to their significance, and if the impacts are not deemed significant there should be only enough discussion to show why more study is not warranted; clearly insignificant issues should be discussed briefly. Scoping, incorporation-by-reference, and integration of other environmental analyses are additional methods that may be used to avoid redundant or repetitive discussion of issues (CEQ, 2012).

Many documents have assessed the affected environment of the study area, including a large number of Corps planning documents that address actions in the Willamette River basin. Within these documents, the existing environmental, socioeconomic, and historical characteristics (i.e., the affected environment) have been described in detail. As a result, there exists an extensive multidisciplinary body of literature that is available and routinely supplemented, the most relevant of which are listed below.

- Two EISs (USACE, 1980; USACE, 1995) and 14 resource use planning documents have been prepared by the Corps (USACE, 1955; 1963; 1974; 1974a; 1976; 1987; 1987a; 1988; 1989; 1989a, 1992; 1994; 2000a; and 2010) on various project elements of the WVP.
- The Corps published a BA (USACE, 2000) and Supplemental BA (USACE, 2007) that examined the effects of the WVP on species listed under the ESA.
- The USFWS and NMFS published BiOps on the continued operation and maintenance of the WVP (USFWS, 2008; NMFS, 2008) in response to the Corps Supplemental BA.
- The Portland District published an environmental assessment and finding of no significant impact (FONSI) examining the availability of surplus water on the Coast Fork of the Willamette (USACE, 2014)
- The Portland District published a two-phased Configuration/Operating Plan (COP) for all of the WVP (USACE, 2009; USACE, 2015f). The COP, Phase II Report from 2015 provides recommendations to address the major substantive measures in the RPA from the NMFS 2008 BiOp and is being used to document the long-term plan for implementing the RPA.

Collectively, these documents comprehensively characterize the affected environment of the WVP reservoirs and surrounding areas, and are incorporated by reference.

[21] "Agencies shall incorporate material into an EIS by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. As such, the incorporated material shall be cited in the statement and its content briefly described" (40 C.F.R. § 1502.21). The documents incorporated by reference within this draft FR/EA have a hypertext link included in the reference and are accessible on line.

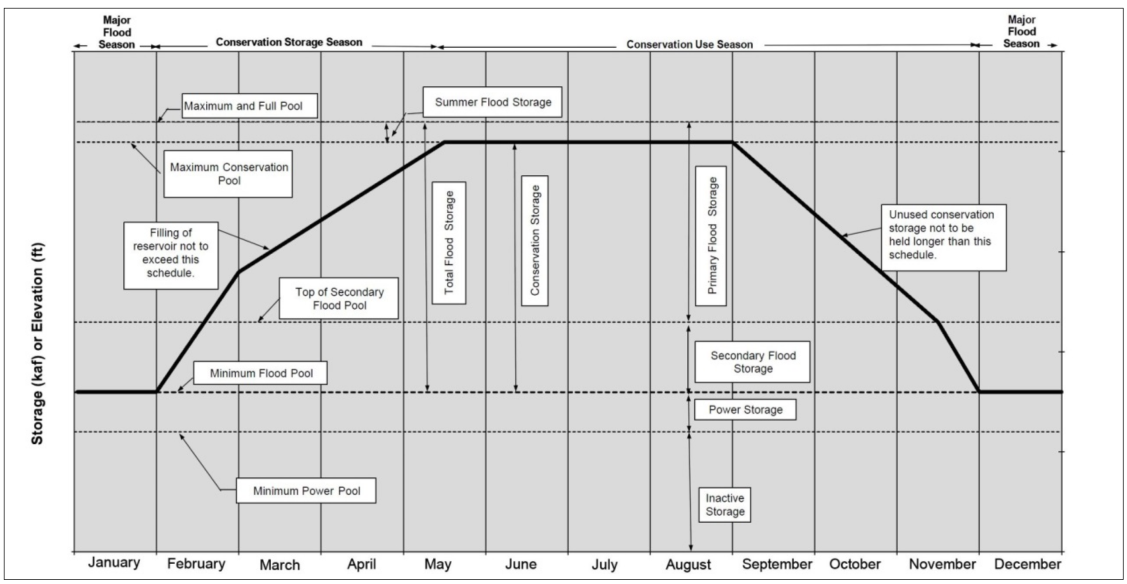
2.1 Willamette Valley Project and System Operational Overview

WVP dams and reservoirs are located on five major tributaries to the Willamette River, regulating about 27 percent of the drainage area of the Willamette River basin upstream of Portland. Each year has three reservoir control periods: flood risk management (fall/winter), conservation storage (spring), and conservation holding and release (summer), with the dates of these seasons varying slightly for each reservoir (USACE, 2014).

Operation of each project is guided by a water control diagram, including the rule curve, which establishes the elevation at which the pool is to be maintained at or below during various seasons and during seasonal transitions unless regulating a flood event. Figure 2-1 depicts a typical WVP water control diagram, including the rule curve.

As shown in Figure 2-1, from September to November (or December, depending on the project), the reservoirs are drawn down to minimum flood pool elevations in order to reserve space to detain and release winter flood flows as necessary. In February (depending on the project), reservoirs begin to accumulate water in conservation storage (i.e., fill, by releasing less water than flows in), and by about the end of May or June, WVP reservoirs are as full as possible for the summer season (USACE, 2015f).

Figure 2-1
Typical Willamette Basin Project Water Control Diagram and Rule Curve



Because the water in each reservoir's conservation pool is emptied each fall in preparation for the flood season, the volume of water available to refill the conservation pool each spring is strictly a function of water flow into the reservoirs during that given spring. For the entire basin, the annual precipitation total is about 63 inches based on rain gage and snow depth data with 60-percent falling during November through March (USACE, 2015f).

Average annual runoff is approximately 16 million acre-feet per year as measured at Salem; however, the extremes of annual inflows range from a minimum of approximately nine million acre-feet (recorded in 1944) to a maximum of approximately 28 million acre-feet (recorded in 1996) as measured at Salem. WVP stored water available for meeting project purposes in any given year is dependent upon the forecasted, usable, system-wide stored water accumulated by mid-May (USACE, 2015f). Over the period of record, the average WVP stored water available in any given year is approximately 1,340,000 acre-feet, the maximum is 1,590,000 acre-feet, the median is 1,510,000 acre-feet, and the minimum is 340,000 acre-feet.

2.1.1 Flow Management Coordination

As required by Congress, the Corps manages the WVP to meet multiple responsibilities, including flood risk management, power production, pollution abatement, recreation, irrigation, navigation, and fish and wildlife benefits. In making operational decisions to meet the requirements of the ESA, the Corps takes appropriate actions within their authority to avoid jeopardy to ESA-listed fish. In some years, inflow into WVP reservoirs would not be sufficient to completely meet all of the traditional Corps responsibilities as well as the ESA responsibilities for the WVP.

The Corps annually prepares an operating plan for the conservation storage and release seasons (February-October) in the Willamette River basin. Called the Willamette Conservation Plan (WCP or Conservation Plan), the WCP describes how meeting the authorized project purposes will be accomplished during the conservation storage and release seasons given the volume of stored water forecasted to be available during the present water year. The preparation of the annual WCP is initiated in January following the release of the initial water supply forecast for the basin from the Natural Resources Conservation Service (NRCS). The WCP is finalized by late May in coordination with state and federal agencies, including the USFWS and NMFS.

The annual WCP forecasts mainstem flows and stored water volumes likely to occur over the conservation season (based on system operational alternatives and constraints) with consideration given to system operational constraints and to the resulting operation of the WVP for the impending spring, summer, and fall periods. Part of the WCP preparation includes close coordination with the Willamette Action Team for Ecosystem Restoration (WATER) that includes representatives from the USFWS, NMFS, Corps, Reclamation, BPA, OWRD, and ODFW. The WATER team works to coordinate annual development of the WCP and real-time operations for the projects during the conservation season (April through October).

2.1.2 Flow Management Planning

The objective of flow management planning is to develop a strategy for the release of stored water after anticipated precipitation and runoff patterns are analyzed (USACE, 2015f). Each year, NMFS, USFWS, Action Agencies, and other WATER members (through the Flow Management Water Quality Team) work cooperatively before and during the conservation storage and release season to plan WVP releases for meeting flow objectives for ESA-listed fish and management for other project purposes. This method is preferable to establishing fixed operating criteria because it is not possible for the Corps to forecast, describe, model, and implement a comprehensive release program that addresses potential management scenarios and contingencies without frequent coordination.

Beginning in January of each year, the Corps evaluates whether or not there is likely to be a sufficient volume of WVP stored water to meet flow objectives and WVP conservation storage goals. Each conservation season's flow management plan is guided by a forecast of water availability, recognizing that hydrologic modeling developed early in the season may result in forecasts that differ markedly from actual conditions later in the same conservation season.

The Conservation Plan describes individual reservoir and system flow objectives, reservoir drawdown priorities, minimum and maximum flows, and balances the multipurpose needs given the availability of water. The general operational goal – assuming sufficient inflow of water – is to maintain each reservoir above minimum conservation pool through October 31 while attempting to meet the other project purposes (USACE, 2015f).

Since the WCP calls for setting operational flow objectives at Salem beginning on April 1, before the reservoir refill period ends, WVP releases may need to be adjusted through the conservation season. The availability of water is re-assessed as necessary (at a minimum, monthly) through October, and changes in WVP management strategy are made in coordination with the representatives from WATER throughout the conservation season.

2.2 Climate and Climate Change

Topography, proximity to the Pacific Ocean, and exposure to middle latitude westerly winds are the principal climate controls for the Willamette River basin. The basin climate ranges from warm dry summers and cool wet winters in the center of the basin to extreme alpine conditions in the highest Cascade Mountain reaches. Rainfall ranges from 40 inches per year in most of the basin to over 200 inches per year in the highest Cascade Mountain reaches; for the entire basin, annual precipitation totals approximately 63 inches – based on rain gage and snow depth data with 60 percent falling during November through March (USACE, 2015f).

During the winter months, high-pressure centers are characteristically to the south so that winds consistently come from the relatively warm and humid ocean surface and bring precipitation into the basin. In contrast, summer conditions typically have high-pressure centers near the west coast, which often forces the flow of air over the basin from a northerly direction. This pattern decreases relative humidity and reduces the amount of cloud cover and precipitation over the entire area during summer months. Thunderstorms can occur during the summer, but are not a major source of precipitation in the basin. During spring and autumn, intermediate conditions occur causing alternating wet and dry periods (USACE, 2015f).

2.2.1 Climate Change

Decisions involving the future supply of, and demand for, water in the Willamette River basin have the potential to be influenced by climate change over the period of analysis. Engineering and Construction Bulletin (ECB) No. 2016-25 requires an analysis of potential climate change effects upon Corps hydrology-related projects and operations. FR/EA Appendix K (Discussion of Climate Change Impact on Future Regulation) to this report meets the requirements outlined in ECB 2016-25. Appendix K includes an evaluation of observed present and possible future climate threats and vulnerabilities, and also discusses the potential impacts of climate change relevant to the study goals. Additionally, Appendix K provides an overview of applicable literature and a summary of climate change impacts on stored water needs for meeting BiOp flow objectives. FR/EA Appendix A (Municipal and Industrial Demand and Supply Analyses) Section 11 provides peak season stored water forecasts for M&I demand that incorporate climate change-induced live flow supply reductions and climate change-induced demand increases. FR/EA Appendix B (Agricultural Irrigation Demand Analyses) Section 8 describes the expected increase in AI demand for stored water in response to anticipated summer temperature increases.

Climate change induced impacts on demands for WVP stored water are quantified later in this document (Section 3.4). Three major, previous study efforts have been undertaken to assess potential trends in climate in the study area: the Pacific Northwest is the Pacific Northwest (PNW) Hydroclimate Scenarios Project (2860), the Willamette Water 2100 analysis, and the Third Oregon Climate Assessment Report. These three regionally specific climate studies are described below.

The most comprehensive study of climate change in the Pacific Northwest is the Pacific Northwest (PNW) Hydroclimate Scenarios Project (2860) (Climate Impacts Group, 2010). Datasets from the Climate Impacts Group study were used by the Oregon Climate Change Research Institute (OCCRI) to write a report for the Corps, titled Historical Trends and Future Projections of Climate and Streamflow in the Willamette River and Rogue River basins (OCCRI, 2015). The OCCRI report describes general climate projections for 2030-2059 as having higher regional minimum and maximum temperatures, meaning that both winters and summers will be warmer, with a greater increase in summer temperatures than winter temperatures. The predicted amount of precipitation varied among the models by both season and whether the model predicted a decrease or increase in precipitation (OCCRI, 2015).

Willamette Water 2100 (Jaeger et al., 2017) examined the interactions of humans, hydrology, and ecology on water supply in the Willamette River basin. In the case of precipitation, the three climate scenarios evaluated by Willamette Water 2100 indicate that winters will become slightly wetter and summers slightly drier, but based on the examination of more than 40 climate models, there is no consensus about whether the Willamette River basin's climate will become wetter or drier overall (Jaeger et al., 2017). Snowpack may be dramatically reduced, and in areas where streamflow depends on snowmelt, would result in reduced flows that arrive earlier in spring and summer than has been the case historically. However, because spring precipitation plays a much larger role than snowpack in determining spring and summer flows, the reduction in snowpack would likely have little effect on the supply of water for human uses in the lower basin (Jaeger et al., 2017).

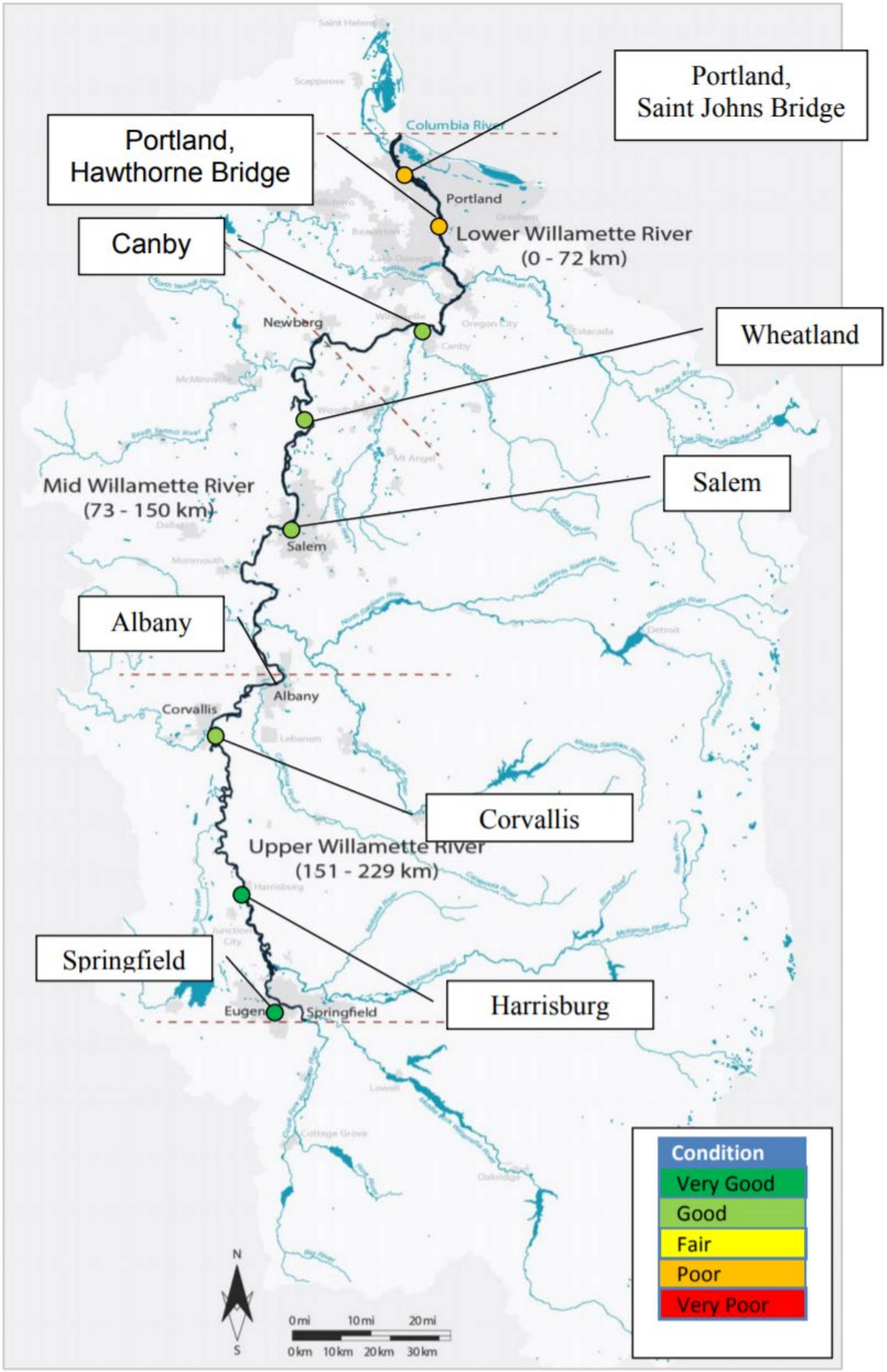
Trends in precipitation have been examined by others and Dalton et al. (2017) as part of the Third Oregon Climate Assessment. These trends show that annual precipitation totals (1895-2015) averaged over Oregon ranged from 22 inches in 1930 to about 49 inches in 1996 with an anemic trend – 0.73 inch increase per century – in annual totals. Likewise, averaged over the Pacific Northwest, there was no significant trend in annual precipitation from 1901-2012, although a positive trend was noted for spring. Interannual-to-decadal variability dominated the data so there were no long-term trends in precipitation identified (Dalton et al., 2017).

2.3 Water Quality

Information on Willamette River water quality is summarized from the Oregon Department of Environmental Quality (ODEQ) report titled "More Information About the Willamette River Report Card Water Quality Indicator" (ODEQ, 2015). ODEQ monitors a network of 160 river sites six times each year to assess water quality status and trends. As shown in Figure 2-2, these sites include nine sample sites on the Willamette River from Springfield/Eugene to the Saint John's Bridge in Portland (ODEQ, 2015). The Willamette River is segmented into three assessment regions for water quality comparisons:

1. Upper Willamette River (approximately from Springfield/Eugene to Albany);
2. Mid Willamette River (from Albany to Newberg); and
3. Lower Willamette River (from Newberg to the confluence with the Columbia River).

Figure 2-2
ODEQ Water Quality Monitoring Sites in the Willamette River



Source: ODEQ, 2015.

Since the 1970s, ODEQ has consolidated these data into the Oregon Water Quality Index (OWQI) where trends are shown using the three-year average of seasonal minimum measurements for eight water quality parameters: pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total solids (TS), ammonia + nitrate nitrogen (N), total phosphorus (P), fecal bacteria, and water temperature (ODEQ, 2015).

The overall water quality of the Willamette River declines from very good conditions in the upper region to fair conditions in the lower region (ODEQ, 2015). Biochemical oxygen demand (BOD), total solids (TS), and nutrients (N and P) show the greatest declines from upstream to downstream. However, all three regions and individual sites show an overall improving trend in water quality. Of the individual sites assessed, six show improving water quality trends and three show no change in water quality (no sites show declining water quality trends). Most individual parameters also show improving trends with only BOD and total solids being the two parameters with the most declining condition trends.

Examination of the 30-year trend of OWQI scores for each of the three assessment regions showed that all reaches and sites show a consistent overall improvement in water quality. This is noteworthy because, since 1980, the population of the Willamette River basin increased by approximately one million persons (ODEQ, 2015). The status and trend for each water quality parameter reported are summarized below.

pH. pH is an indicator of the acid/base balance of water. It is an important water quality parameter that has many effects on aquatic life, including direct impacts on the health and survival of aquatic organisms, as well as indirect effects on overall water chemistry. Most aquatic species in the Willamette River are comfortable in a pH range around neutral (7), and become increasingly stressed at pH below 6.5 and above 8.5. The pH levels of the Willamette River are generally in a desired range for protecting aquatic life in all assessment sections with no change in trend (ODEQ, 2015).

Dissolved Oxygen (DO). DO is the amount of oxygen gas dissolved in the water, and is critically important for the breakdown of organic material and release of energy for growth and activity. Minimum DO requirements can vary with different species and different life stages, but sensitive species like salmon and trout need fairly high DO levels at or near saturation at all life stages to survive and thrive. The DO levels in all assessment reaches are at or near the levels needed to protect sensitive aquatic life most of the time with improving DO trends in the mid and upper reaches (ODEQ, 2015).

Biological Oxygen Demand (BOD). BOD is the amount of dissolved oxygen needed by aerobic organisms in a water body to break down organic material present in the water in a certain amount of time and at a certain temperature. BOD is widely used in water quality assessments as an indication of the overall amount organic material in water. Inputs of organic material into the water that would increase BOD include soil erosion, dead plant material, sewage treatment plant and industrial discharges, animal waste, or anything that can be decomposed by microorganisms. Overall, BOD is the worst performing OWQI parameter in the Willamette River with BOD in fair condition in the mid and upper reaches, and mostly poor condition in the lower reach. This represents an overall decline in BOD condition from upstream to downstream in the Willamette River. In addition, these BOD trends are unchanging in the upper reach and mostly in declining condition in the mid and lower reaches (ODEQ, 2015).

Total Solids (TS). TS is the weight of material remaining when a known volume of water is evaporated to dryness. It includes all dissolved and suspended material and is an indication of the amount of sediment suspended the water column. High TS can impair the ability of fish to find prey and avoid predators, can smother fish eggs and benthic organisms, decrease inter-gravel dissolved oxygen, and eliminate or impair benthic fish and macroinvertebrate habitat. In general, the TS condition declines from upstream to downstream with an overall unchanging 10-year trend in the mid and lower reaches, and declining condition trend in the upper reach (ODEQ, 2015). TS in the upper reach (specifically at the Springfield site) is one of the few indicators that has a declining 10-year condition trend (ODEQ, 2015).

Nitrogen and Phosphorus Nutrients (N and P). The nitrogen and phosphorus nutrient parameters in the OWQI is dissolved inorganic nitrogen in the form of ammonia, nitrate and nitrite combined, and total phosphorus, mostly in the form of phosphate. As nitrogen and phosphorus are necessary nutrients for algae and aquatic plants to grow, they are also necessary for terrestrial plant growth. Fertilizer containing nitrogen and phosphorus is applied to crops, forest lands, gardens, and lawns to stimulate growth. Fertilizer nutrients applied in excess of what the plants take up for growth can enter groundwater and streams and increase algae growth. In addition, soil erosion, sewage plant discharges, and decomposition of organic material are also sources of these nutrients. The overall pattern in the Willamette River is that nutrient conditions decline (i.e., concentrations of these parameters increase) from upstream to downstream. Nitrogen conditions range from very good to good in the upper reach and from poor to very poor in the lower reach. Phosphorus conditions similarly range from good to fair in the upper reach, fair in the middle reach, and mostly poor in the lower reach. The 10-year trends for both nutrients (N and P) are improving at all sites and assessment reaches (ODEQ, 2015).

Bacteria (*E. coli*). Escherichia coli (*E.coli*) is a bacterium that lives in the intestines of warm blooded animals (mammals and birds); ODEQ tests rivers for *E. coli* as an indicator organism for fecal pollution as its presence is an indication of fecal contamination. *E. coli* in surface water can originate from a variety of sources including failing septic systems, discharges of untreated or poorly treated sewage, and storm water runoff carrying feces into surface water from domesticated animals and wildlife. *E. coli* concentrations are below the level safe for swimming and other contact water recreation most of the time in all three reaches of the Willamette River; since the 1980s, high *E. coli* levels usually associated with rainy weather have declined to a nearly non-existent level in the Willamette River (ODEQ, 2015).

Water Temperature. Water temperatures in the Willamette River have been rising over the past decade due to drought, decreased snow pack, and changing flows (Costanzo et al., 2015). The trend of increased water temperature threatens ESA-listed fish in the basin such as Chinook salmon and winter-run steelhead trout because they are cold-water fish and require water temperatures in the range of 8-15ºC (45-60ºF) for optimal survival and reproduction (Costanzo et al., 2015). As temperatures rise, salmon and steelhead become stressed and are more susceptible to disease, increasing the risk of pre-spawning mortality.

Analysis of river temperature and its environmental implications is based on state temperature standards for the protection of ESA-listed fish in the Willamette River. U.S. Geological Survey flow gage data loggers continuously record temperature in 15 minute intervals. Using these data, the 7-day average maximum temperature (7DAM) was calculated from June 21, 2014 to September 22, 2014 – when water temperatures are the warmest for the year – and compared to the applicable water quality temperature standard assigned to each of the three assessment regions of the Willamette River. The standards for each assessment region depend on the life histories of designated fish species at that location and time of year. The two most downstream stations are designated as "salmon and steelhead migration corridors" with a 20ºC 7DAM criterion and the other stations are located in "salmon and trout rearing and migration designated fish use areas" with an 18ºC 7DAM criterion. This distinction results in the temperature standard being slightly warmer in the lower river (i.e., less restrictive) than the standard applied to the middle and upper river (Costanzo et al., 2015).

The reported results are the percent of 7-day average maximum temperatures meeting the temperature standards for each reach during the 94-days from June 21 through September 22, 2014. The data showed that the lower Willamette River stayed cooler than the temperature standard on 21 of 94 days (22-percent of the days), the mid Willamette River stayed cooler than the temperature standard on 16 of 94 days (17-percent of the days), and the upper Willamette River stayed cooler than the temperature standard on 22 of the 94 days (23-percent of the days) (Costanzo et al., 2015).

2.4 ESA-Listed Fish

In 2015, NMFS, through the Northwest Fisheries Science Center (NFSC), published its *Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest* (NFSC, 2015). The 2015 NFSC document contains the most recently updated information on the Pacific salmon ESU and steelhead distinct population segment (DPS) populations and it is incorporated-by-reference. The USFWS' *Recovery Plan for the Coterminous United States Population of Bull Trout (2015)* summarizes the current status of the bull trout and is also incorporated-by-reference. The following sections summarize biological information for the UWR Chinook salmon ESU, UWR winter-run steelhead DPS, and the bull trout.

2.4.1 Upper Willamette River Chinook Salmon ESU

In 1999, NMFS listed the Upper Willamette River Chinook ESU (*Oncorhynchus tshawytscha*) (UWR Chinook salmon) as a threatened species under the ESA. This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon. Six artificial propagation programs are considered to be part of the ESU:

- McKenzie River Hatchery Program (Oregon Department of Fish and Wildlife (ODFW) Stock #24);
- Marion Forks /North Fork Santiam River Program (ODFW Stock #21);
- South Santiam Hatchery (ODFW Stock #23) in the South Fork Santiam River;
- South Santiam Hatchery (ODFW stock #23) in the Mollala River;
- Willamette Hatchery (ODFW Stock #22); and
- Clackamas Hatchery (ODFW Stock #19) spring-run Chinook hatchery programs (70 FR 37160, 37175).

The Willamette/Lower Columbia Technical Recovery Team (WLCTRT) identifies seven independent, historical populations within this ESU:

- Clackamas River

- Molalla River
- North Fork Santiam River
- South Fork Santiam River
- Calapooia River
- McKenzie River
- Middle Fork Willamette River

UWR Chinook salmon are one of the most genetically distinct groups of Chinook salmon in the Columbia River basin. Historically (before the laddering of Willamette Falls), passage by returning adult salmonids over Willamette Falls was possible only during the winter and spring high-flow periods. The early run timing of UWR Chinook salmon relative to other lower Columbia River spring-run populations is viewed as an adaptation to flow conditions at Willamette Falls. Since the Willamette Valley was not glaciated during the last epoch, the reproductive isolation provided by Willamette Falls was probably uninterrupted for a considerable time and provided the potential for significant local adaptation relative to other Columbia River populations.

Historically the Upper Willamette supported large numbers (perhaps exceeding 275,000 fish) of UWR Chinook salmon (Myers et al. 2006). Currently, abundance levels are well below their recovery goals (NFSC, 2015). The 2015 NFSC status review concluded that the UWR Chinook salmon ESU population risk trend is "declining" compared to its previous 2010 review. The Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but both have experienced declines in abundance. Overall, populations appear to be at either moderate or high risk (NFSC, 2015). In its 2016 five-year status review, NMFS concluded that the UWR Chinook salmon ESU should remain listed as a threatened species under the ESA (NMFS, 2016).

The major limiting factors for UWR Chinook salmon, as described in the 2008 NMFS BiOp, include:

- Degradation of the Willamette River mainstem and lower reaches of all the tributaries to the Willamette River (e.g., reduced habitat complexity, reduced access to off-channel habitat, reduced floodplain function and connectivity, loss of holding pools, elevated water temperatures, insufficient stream flows, toxic water pollutants, and altered substrate compositions);
- Changes in estuary habitat;
- The existence and operation of the WVP;
- Hatcheries management (risk for genetic introgression due to the high proportions of hatchery-origin fish on the spawning grounds);
- Predation (yearling smolts from birds and mature fish predation by pinnipeds - e.g., sea lions and seals) at the base of the Willamette Falls); and
- Unfavorable ocean and climate conditions.

2.4.2 UWR Winter-Run Steelhead DPS

NMFS listed the Upper Willamette River Winter-Run Steelhead DPS (*Oncorhynchus mykiss*) (UWR steelhead) as a threatened species under the ESA in 1999. This DPS includes all naturally spawned populations of winter-run steelhead in the Willamette River and its tributaries upstream of Willamette Falls to the Calapooia River. This DPS does not include any artificially propagated steelhead stocks that reside within the historical geographic range of the DPS. Hatchery summer-run steelhead occur in the Willamette River basin but are an out-of-basin stock that are not included as part of the DPS (71 FR 834, 849).

There are four independent populations recognized within the UWR winter-run steelhead DPS:

- Molalla River,
- North Fork Santiam River,
- South Fork Santiam River, and
- Calapooia River.

UWR winter-run steelhead are genetically distinct from steelhead in the lower river. Reproductive isolation from lower river populations may have been facilitated by Willamette Falls, which is known to be a migration barrier to some anadromous salmonids (USACE, 2000). UWR winter-run steelhead enter the Willamette River beginning in February until about May, but they do not ascend to their spawning areas until late March or April. Spawning takes place from March to June (Myers et al., 2006; ODFW & NMFS, 2011). The major limiting factors for UWR winter-run steelhead trout, as described in the 2008 NMFS BiOp, are identical to those listed above for the UWR Chinook salmon.

2.4.3 Bull Trout

The USFWS listed all populations of bull trout *(Salvelinus confluentus)* within the coterminous United States as a threatened species in 1999 (64 FR 58910). USFWS combines bull trout core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) with core populations (i.e., a group of one or more local bull trout populations that exist within core habitat) to create a "core area," which is the basic unit on which to gauge recovery within a recovery unit. There are six bull trout recovery units, which are used in the USFWS' *Recovery Plan for the Coterminous United States Population of Bull Trout (2015)* and the Coastal Recovery Unit (including the Upper Willamette River, Clackamas River, North Santiam River, and South Santiam River are located within this recovery unit) is within the Willamette River basin.

Of all the native salmonids in the Pacific Northwest of the United States, bull trout have the most specific habitat requirements, which are often referred to as "the four Cs": cold, clean, complex, and connected habitat. These requirements include cold water temperatures compared to other salmonids (often less than 54 degrees Fahrenheit); the cleanest stream substrates; complex stream habitat including deep pools, overhanging banks and large woody debris; and connectivity between spawning and rearing areas and downstream foraging, migration, and overwintering habitats. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (USFWS, 2015).

Bull trout express both resident and migratory life history strategies. Resident forms of bull trout complete their entire life cycle in the tributary or nearby streams in which they spawn and rear. Migratory bull trout spawn in tributary streams, where juvenile fish rear for one to four years before migrating to either a lake (adfluvial form), river (fluvial form), or in certain coastal areas, to saltwater (anadromous). Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior. Bull trout normally reach sexual maturity in four to seven years; they frequently live for 10 years and occasionally for 20 years or more (USFWS, 2015).

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Migratory bull trout frequently begin upstream spawning migrations as early as April. Depending on water temperature, egg incubation is normally 100 to 145 days, and after hatching, young fry remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (USFWS, 2015).

USFWS originally designated bull trout critical habitat in 2005 (70 FR 56212), and then revised it in 2010 (75 FR 63897). There are nearly 200 stream miles designated as critical habitat within the Willamette River basin (194.3 stream-miles) representing less than one percent of the range-wide stream miles designated as critical habitat for bull trout (21,918.7 stream miles range-wide).

The primary constituent elements of bull trout critical habitat, as described by USFWS in the 2010 final revised critical habitat rule, include:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia;

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers;

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

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure;

5. Water temperatures ranging from 2 to 15 ºC (36 to 59 ºF), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range would depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence;

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions.

The size and amounts of fine sediment suitable to bull trout would likely vary from system to system;

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph;

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited; and

9. Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

At the time of the listing in 1999, bull trout – although still widely distributed – were estimated to have been extirpated from approximately 60 percent of their historical range (USFWS, 2015). USFWS completed a five-year status review of bull trout in 2008, and found that listing the species as "threatened" remained warranted range-wide in the coterminous United States. In its review, USFWS evaluated the status of the 121 core areas recognized at that time; of those, 23 exhibited population trends that were declining from slightly to severely, 18 were stable, 14 were increasing, and 66 were unknown. The USFWS also found that 75 core areas had substantial or moderate, imminent threats, with the remainder being less threatened (USFWS, 2008a).

Based on the 2008 five-year status review, USFWS reported in its most recent recovery report to Congress that bull trout were "stable" overall range-wide (i.e., the species status neither improved nor declined during the reporting year), with some core area populations decreasing, some stable, and some increasing (USFWS, 2010).

The major limiting factors for the bull trout, which are described in the USFWS 2008 BiOp and the 2015 bull trout recovery plan are (USFWS, 2015):

- Habitat degradation (e.g., passage barriers impair connectivity, increase population isolation, and increase habitat fragmentation, and nonpoint source water pollution from livestock grazing, mining, residential development, and urbanization);

- Fisheries management activities (e.g., incidental bycatch mortality may impact bull trout in some core areas);

- Natural events (e.g., wildfire, drought, and flooding);

- Nonnative species (e.g., lake trout and brook trout) can outcompete and prey upon bull trout in lake environments where they co-occur or other large predators that may prey upon and/or compete or hybridize with bull trout. Brook trout is a congeneric species that competes with, and can hybridize with, bull trout;

- Predation (e.g., brown trout and northern pike have been documented as predators on juvenile and sub-adult bull trout);

- Climate change (e.g., vulnerable to the effects of warming climate, changing, precipitation and hydrologic regimes, changing stream temperatures, amount of groundwater base flow contribution to the stream, lower summer flows inhibiting movement between populations, and increased frequency and extent of wildfires).

In their 2008 BiOp, the USFWS (USFWS, 2008) reviewed the effect of the continued operation and maintenance of the WVP and concluded, "*after reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS' biological opinion that the proposed action, as modified by the NMFS' RPA, is not likely to jeopardize the continued existence of the coterminous United States population of bull trout.*"

2.5 Flood Risk Management

Documented floods in the Willamette River basin occurred in 1814, 1843, 1844, 1849, 1852, and 1861, when the largest peak flood flow of 500,000 cfs was recorded at Salem. About 510,000 acres of land were flooded in 1861. Another major flood occurred in the basin in 1964, inundating over 320,000 acres of land – regulation of the WVP held the peak flood stage at Salem to 37.8 feet with a discharge of 309,000 cfs. Flooding still occurred (Willamette River flood stage is 28 feet at Salem), though without the WVP in place, peak flood stage would have been 45.3 feet with a discharge of 472,000 cfs. The elevation of the 1861 floodwater reached some 17 feet higher than the flood of 1964, though the 1964 flood was regulated by the WVP to reduce flood risk. Probable Maximum Floods for the WVP reservoirs currently are being updated.

The major flood season generally runs from the middle of November through early February. Floods result principally from rainfall, augmented by snowmelt. House Document 531 established the guidelines for flood season operation for the WVP. Two types of flood storage were created. Primary flood storage provides risk management for floods of record except for the 1861 flood – the largest flood of record. Secondary flood storage provides risk management for the primary flood level up to the 1861 level, and can be used jointly for flood risk management and power production purposes. The legislation mandates that secondary flood storage at the non-power projects, as well as primary flood storage, must be evacuated at the start of each flood season. Cougar and Hills Creek, as well as primary flood storage at Lookout Point, Green Peter and Detroit, must be evacuated at the start of each flood season. Current practice is to evacuate all projects (excluding Big Cliff and Dexter) to minimum conservation pool prior to the beginning of the flood season.

After a flood, evacuation of water for primary storage is accomplished as rapidly as dictated by release schedules specific to each project (typically within seven to 10 days). Water evacuated from secondary storage is generally used for power generation. If another flood is imminent, however, releases are made through regulating outlets to evacuate the reservoirs to minimum flood risk management pools.

2.6 Federal Hydroelectric Power Generation

Federal hydroelectric power facilities were constructed by the Corps at eight of the 13 WVP dams. The electrical energy generated at the projects is marketed by BPA throughout the Pacific Northwest and Pacific Southwest over transmission systems built and maintained by BPA. The BPA is responsible for repaying to the U.S. Treasury all costs allocated to the federal power facilities. These costs include the initial and replacement construction costs for specific power facilities, such as the powerhouse, and hydropower's share of the joint facilities, such as the dam. These investment costs are repaid over a 50-year period. In addition, BPA reimburses the U.S. Treasury for the annual operation and maintenance costs allocated to hydropower at each project, and the interest on all these costs.

All WVP hydropower facilities include exclusive storage for power generation. This storage is relatively small, and drawdowns into this storage are limited to special power requirement periods that may occur during a period of extended cold weather. In general, exclusive power storage is kept full to increase the hydraulic head for power generation.

Operation of the power facilities at the projects is a highly coordinated effort between the Corps and BPA. Electrical power is dispatched through BPA's Dittmer station located at Vancouver, Washington. Daily power generation schedules are made by the Reservoir Control Center (located in the Portland District of the Corps), after discussions with the BPA scheduling team. The close coordination between these offices enables additional flexibility in WVP operations when the need arises for power and non-power emergency operation.

There are no specific plans for major improvements or major rehabilitation activities at any of the power projects, and no commitments to operational changes for power production purposes. Due to aging of the WVP power production facilities, some minor reductions in capacity could be expected because of lost reliability and deterioration as units are taken off-line more frequently for maintenance, or experience emergency/unplanned outages. Also, it is unlikely that new power facilities would be added to the WVP by federal or non-federal entities, though a non-federal entity recently added power generation to Dorena Dam.

2.7 Agricultural Irrigation Water Use

The expansion of AI was slow until the 1940s. There were about 1,000 irrigated acres of farmland in the Willamette River basin in 1911 and 3,000 irrigated acres in 1920. By 1930, the basin contained 5,000 irrigated acres, which increased to 27,000 acres by 1940. A dramatic increase in the number of irrigated acres occurred in the Willamette River basin during the postwar decades. In 1964, approximately 194,000 acres were irrigated in the basin (OWRB, 1967). Irrigated acreage increased to about 300,000 acres by 2007, and irrigated acreage reported for 2012 decreased to a level of 250,000 (2007 and 2012 reported values from the U.S. Department of Agriculture, Census of Agriculture)[22].

AI was recognized as a project purpose in the WVP authorizing legislation, and irrigation was thought to be the largest future use of WVP stored water. However, agricultural irrigation water demand in the Willamette Valley has not grown at the rate foreseen in the authorizing documents. Water use and conservation practices employed by the agricultural community also have changed since the WVP was authorized. WVP conservation storage totals approximately 1,590,000 acre-feet. Of this total, only 74,950 acre-feet of stored water is currently contracted through Reclamation for irrigation use, though it should be noted that the vast majority of AI is not reliant

[22] 2012 Census of Agriculture, Table 10. Total of Irrigated Land for the counties of Benton, Clackamas, Columbia, Douglas, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Washington, and Yamhill. While irrigated acreage from Columbia County, Douglas County, and Lincoln County are included in the totals, it should be noted that each county contains large portions of land that are not within the Willamette River basin.

on Reclamation water service contracts. At the current low level of use for water service contracts it is typically not necessary for the Corps to make special operational adjustments (i.e., increasing WVP releases) to meet current contract requirements. However, Detroit Dam on the North Santiam River and Fern Ridge Dam on the Long Tom River include operational adjustments to satisfy Reclamation's water service contracts.

Oregon's 2015 Statewide Long Term Water Demand Forecast (OWRD)[23] provides a 2015 estimate of 605,700 acre-feet of water per year diverted for AI use within the Willamette River basin, and an estimate of 708,400 acre-feet of water per year by the year 2050 under hotter-drier conditions (a 35-year increase of 102,700 acre-feet of water per year).

Irrigation water rights in Oregon identify a season of use, a rate, and a duty of water, which vary by location within the state. The season is the period of the year in which the right can be exercised, which typically corresponds to the growing season and may be extended if asked to do so by the Oregon Department of Agriculture.[24] The rate is the maximum amount of water that may be diverted or pumped, which is normally expressed in cfs. Duty is the volume of water that can be applied over the course of the season associated with the water right, which is normally expressed in acre-feet of water applied per acre. The maximum rate cannot typically be sustained on a full-time basis without exceeding the duty; from a practical water-use accounting standpoint, few water rights holders measure their rates, or their duties.

2.8 Municipal and Industrial Water Use

Some of the largest cities[25] in the Willamette River basin rely on the Willamette River and its tributaries for domestic water, and to serve municipal and industrial needs. Oregon's 2015 Statewide Long Term Water Demand Forecast (OWRD) provides a 2015 estimate of 361,100 acre-feet of water per year demanded by M&I systems within the Willamette River basin. The report also provides an M&I system estimate of 436,800 acre-feet of water per year that would be required by the year 2050 (a 35-year increase of 75,700 acre-feet of water per year). As population increases throughout the basin, M&I system needs increase – putting pressure on existing water supplies.

Despite the fact that Congress authorized the WVP for multiple purposes, including "*relatively low cost for domestic use when current facilities can no longer meet the demand*", Reclamation's storage rights for WVP conservation storage are designated only for irrigation use. As such, no M&I supplier may obtain a secondary water right from OWRD for the use of WVP stored water for purposes other than for irrigation. To date, M&I systems have developed and rely on other water sources, though population growth eventually would lead to a demand for water that exceeds existing supplies for many M&I systems throughout the basin

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[23] Available on line at https://www.oregon.gov/OWRD/WRDPublications1/OWRD_2015_Statewide_LongTerm_Water_Demand_Forecast.pdf

[24] Oregon Revised Statutes (ORS) 537.385.

[25] Portland, whose population is supplied water by the Portland Water Bureau is located within the Willamette River basin, but does not rely on the Willamette River or its tributaries as a source of domestic water supply.

Throughout the basin, some industrial facilities obtain water directly (through their own water rights) instead of purchasing supply from an M&I system – referred to as self-supplied industrial (SSI) water users. Oregon's 2015 Statewide Long Term Water Demand forecast provides a 2015 SSI water use estimate of 283,800 acre-feet of water per year, though OWRD forecasts no change in this estimate to the year 2050.

M&I systems must fully incorporate future population growth and peak season water supply demand in their long-term planning. As a result, M&I systems apply for water rights that are in excess of water than presently needed so that an adequate supply would be ensured when sufficient numbers of ratepayers live in a community to justify and pay for the construction work. M&I systems are almost never in a position to complete full build-out of their water systems when they apply for a permit, as they lack the immediate need and ratepayer support. Still, the core mission for every M&I supplier is to secure a safe, adequate, and reliable water supply to meet current and future demand. By its nature, then, municipal water supply planning dictates identification of water supplies to meet projected needs decades into the future.

Municipalities are often given preferential treatment under the Oregon water rights system because of the public safety component of municipal water use, which is called the "Growing Communities Doctrine." The following are the components of municipal water use preferences in Oregon, which make up the Growing Communities Doctrine:

- M&I systems are not required to initiate construction of surface water diversion works within one year of being issued a water right permit (systems have up to 20 years to initiate construction plus an opportunity for extension);[26]
- If the water right permit is to store water for municipal use, M&I systems have ten years to begin and complete construction of diversion or storage works; however, systems may apply for extensions in ten-year increments;[27]
- An M&I system can certificate a portion of its water right permit, without cancellation of the remaining portion of water authorized to be diverted under the right. To do so, the municipality must "perfect" at least 25-percent of the amount authorized on the permit;[28]
- An M&I system water right generally is not subject to forfeiture. Although a water right that is unused for five consecutive years is presumed forfeited, the presumption is overcome by showing that the use was for a municipal purpose;[29]
- Water rights issued to M&I systems may be used on lands to which the right is not appurtenant, under certain circumstances; and
- Municipal uses for human consumption may take preference over other types of senior instream water rights established through the permitting process (as opposed to conversion or acquisition) if OWRD determines that this would be in the public interest.

[26] ORS 537.230.

[27] ORS 537.248.

[28] ORS 537.260(4).

[29] ORS 540.610(2)(a).

Taken together, this means that there are undeveloped M&I system water rights throughout the basin because use and population for some M&I systems have not yet grown to the extent reflected in their existing water right permits. It is important to note that undeveloped M&I system uses are considered by OWRD when water availability calculations are conducted.

2.9 Reservoir and Riverine Recreation

Recreation opportunities within the Willamette River basin include reservoir-based and riverine-based activities. Both include boating, kayaking, fishing, swimming, camping, day-use, picnicking, and related outdoor activities. The Corps cooperates with the USFS, Oregon State Parks, ODFW, and Linn and Lane counties to build and manage a system of water-related recreation facilities (USACE, 2015f). Corps documentation of reservoir and riverine recreation provides a thorough description of the recreation activities of the WVP, and is incorporated by reference (USACE, 2000). The Portland District also maintains a webpage of WVP recreational activities and access point updates.[30]

2.9.1 Reservoir Recreation

There are more than 50 developed recreation sites along WVP reservoirs (USACE, 2015f). Annual visitation typically builds slowly beginning in April and into May when the reservoirs are beginning to refill and much of the visitation at Corps reservoirs during springtime can be directly attributed to the opening of fishing seasons (USACE, 2015f). Typically, the reservoirs receive a large surge in use during Memorial Day weekend and visitor use builds rapidly through June and July remaining high through Labor Day. In September, visitation begins to decline regardless of reservoir operations with about 60-percent of average annual visitation occurring during the three peak summer months of June, July, and August (USACE, 2015f).

Recreational demand in the basin has put more pressure on maintaining WVP reservoirs near maximum conservation pool for the entire recreational season (USACE, 2015f). Over time, a drawdown priority for the WVP has evolved where the projects with highest recreation demand are last to be used for meeting downstream flow requirements, so their pool elevations usually are higher until early September (USACE, 2015f). Conversely, the projects with lower recreation demand are used first for meeting summer flows and are drawn down earlier. The three most important reservoirs for recreational use are Detroit, Fern Ridge, and Foster; these three are last to be evacuated to meet summer instream flow objectives (USACE, 2015f).

Recreational power boating in the reservoirs depends on the ability of boats to gain access and egress to the water via boat ramps. There are a total of 33 boat ramps at the different reservoirs in the WVP; the ramps are only usable by boaters when the water level in the reservoirs is at or above a minimum pool elevation necessary to launch (generally three feet above the elevation of the end of the ramp). FR/EA Appendix I (Reservoir-Related Boating Recreation Benefits Impact Analyses) provides the elevations of boat ramps at each WVP reservoir.

The following is a description of recreational use at each reservoir listed in decreasing order of recreational popularity, although visitation at each reservoir varies from year to year.

[30] http://www.nwp.usace.army.mil/Missions/Recreation/Willamette.aspx.

Fern Ridge Lake. Fern Ridge Lake is a highly developed reservoir on the Long Tom River and one of the most popular WVP reservoirs for recreation. Its large surface area and consistent winds make it one of the best sailing lakes in Oregon.

Detroit Lake. Detroit Lake is located on the North Santiam River and is one of the most frequently visited WVP reservoirs. Detroit Lake has extensive public recreation facilities, although none of them are operated by the Corps; four are operated by the USFS and two are operated by Oregon State Parks. Based on a 2007 State survey of registered boats, Detroit Lake was ranked fourth out of 215 Oregon water bodies by boat-use days.

Foster Lake. Foster Lake is a re-regulating reservoir for the Green Peter project located on the South Santiam River. Because it is a re-regulating reservoir, visitors can expect to enjoy a full or nearly full reservoir for the whole summer. Linn County operates six recreational areas on Foster Lake; there are three boat ramps, one day-use area, and one campground with a day-use area. The Corps operates Andrew S. Wiley Park.

Cottage Grove Lake. Cottage Grove Lake is located on the Coast Fork Willamette River. The Corps operates all five recreation sites on Cottage Grove Lake (four day-use parks and one campground), which all include extensive facilities to support recreational activities.

Dorena Lake. Dorena Lake is located on the Row River and is a popular lake for sailing, sailboarding, and camping. Lane County operates Baker Bay Park, the Corps manages the Schwarz Campground and manages two day-use parks, while the BLM manages the Row River Trail, a 5-mile hiking, biking, and horseback riding trail that borders Dorena Lake.

Green Peter Lake. Green Peter Lake is located on the Middle Santiam River and has a primitive, high-mountain lake character, surrounded by private and public forests. Linn County operates a campground, day-use area, and two boat ramps on Green Peter Lake.

Dexter Lake. Dexter Lake is a re-regulating reservoir for Lookout Point dam and is popular for day-use recreation activities. The Corps operates Orchard Park, a day-use park on the northeast end and Oregon State Parks operates two recreation areas that provide boat ramps.

Fall Creek Lake. Fall Creek Lake experiences moderate visitation relative to other WVP reservoirs. The Corps operates the Tufti day-use area, while Oregon State Parks manages seven parks, including one campground.

Cougar Lake. Cougar Lake is relatively large and located on the South Fork of the McKenzie River. The USFS operates one day-use area and several campgrounds on Cougar Lake, but Cougar is not one of the most visited projects because of the distance from population centers (50 miles east of Eugene) and the availability of competing recreation opportunities.

Lookout Point Lake. Lookout Point Lake is located on the Middle Fork Willamette River and has the second largest surface area of all the WVP reservoirs, but visitation is relatively low compared to other WVP reservoirs. The Corps operates the Ivan Oakes Campground, Signal Park boat ramp, and Meridian Park. Black Canyon Campground and Hampton Landing are located on the south shore of Lookout Point Lake and are operated by the USFS. The desirability for boating use is limited by a lack of facilities, difficult access, and a high degree of reservoir level fluctuation.

Hills Creek Lake. Hills Creek Lake is located on the Middle Fork Willamette River and has limited recreational use due to reservoir operations and limited facilities. The USFS operates all parks on Hills Creek Lake, which include two campgrounds, two picnic areas, and a boat ramp.

Blue River Lake. Blue River Lake is a small reservoir located on a tributary to the McKenzie River where the USFS operates two campgrounds and two boat ramps.

2.9.2 Riverine Recreation

The timing and quantity of flows released from the WVP[31] could either benefit or negatively affect downstream recreation opportunities, although WVP operations during the conservation season do not typically have a marked impact on recreational use below the reservoirs (USACE, 2000). Limited data are available for recreational use of riverine segments downstream of WVP reservoirs, but the extent to which boat ramps have been developed on river segments is a reasonable proxy for the relative importance of the river segment for boat-related recreational activities. Figure 2-3 shows the location of boat ramps/boat access points on the tributaries within the Willamette River basin, and illustrates the relative importance of the McKenzie River and North and South Santiam Rivers for riverine recreation.

Figure 2-4 depicts river segments within the Willamette River basin that have been federally-designated as Wild & Scenic Rivers (blue) and state-designated as Oregon Scenic Waterways (green). There are no federally-designated Wild and Scenic Rivers downstream of WVP dams and a single reach of Oregon-designated Oregon Scenic Waterway is below Cougar Dam on the South Fork of the McKenzie River.

[31] It should be noted that the WVP does not release or regulate water specifically for downstream recreation, but for other project purposes.

Figure 2-3
Boating Access in the Willamette River Valley

Figure 2-4
Scenic Waterways in the Willamette River Valley

2.10 Navigation

Navigation was an authorized purpose of the WVP, but due to a lack of commercial navigation traffic in the upper Willamette River, the WVP was de-authorized for navigation by the Water Resources Development Act of 1986. Reservoir discharges are no longer regulated for navigation above Willamette Falls Lock (USACE, 2015f).

WVP authorizing documents (HD 544, 75th Congress, third session, March 16, 1938) stipulated a minimum flow of 5,000 cfs between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively, above Willamette Falls (USACE, 2015f). Over the years, ODEQ allowed municipalities to construct wastewater treatment plants with the expectation that these navigation flows would remain in effect. In addition, water quality and fishery management strategies have been based on the expectation navigation flow requirements originally established at Albany and Salem would continue. Therefore, the Corps continues to provide these flows to help fulfill the project purpose of improving water quality, even though releases for navigation purposes are no longer required (USACE, 2015f).

2.11 Cultural Resources and Historic Properties

For the purposes of this feasibility study, cultural resources include pre-contact and historic archaeological resources, architectural or built-environment resources, places and locations important to Native Americans (which may include burial sites) and other ethnic groups. Historic properties, a type of cultural resources, are any pre-contact or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (National Register). The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria. It also includes properties that possess historic, architectural, engineering, archaeological, or cultural significance at the national, state, and local levels.

The area of potential effect (APE) is approximately 20,452 acres. An APE is defined as the area that encompasses the maximum possible area that could be affected within a geographic boundary to assist with the implementation of an undertaking. Though the APE has not been fully delineated for this feasibility study; the study's intent is the reallocation of conservation storage within the WVP's 11 storage reservoirs; therefore, for the purposes of this current study each of the fluctuation zones within these reservoirs are considered the APE. These zones may include recreational areas, reservoir margins, and environmental stewardship areas. During the consultation phase of this feasibility study, the Corps will seek concurrence with the Oregon State Historic Preservation Office (SHPO), affected Tribes and other consulting parties, on the preferred action's APE. The APE will be delineated on a map, along with a written description of the types of activities that are anticipated to occur that could both directly and indirectly affect historic properties.

2.11.1 Historic Properties

The feasibility study's intent is to reallocate conservation storage from Joint Use to specific authorized purposes, which has the potential to cause a change in the general operations of the dams. This change may include an earlier drawdown period, but still within the normal operating elevations of the reservoirs. There are 13 reservoirs in the WVP. Eleven reservoirs (Cougar, Dorena, Detroit, Foster, Green Peter, Blue River, Hills Creek, Fall Creek, Lookout Point, Cottage Grove and Fern Ridge) are authorized for storage and are part of this feasibility study (see Table

2-1). There are 367 recorded archaeological and historic cultural resources within these APE; only five of these sites have been evaluated for inclusion in the National Register of Historic Places, and only two of those are Eligible (see Table 2-1). Eighty-six additional archaeological or historic cultural resources are known, but not formally recorded within the reservoirs for a total of 453 known cultural resources. All of the 453 known cultural resources within the APE are either inundated, seasonally inundated, or partially inundated.

Table 2-1
Listing of Archaeological and Historic Resources and National Register Evaluations by WVP Project

Reservoir	Archaeological and Historic Resources	National Register Evaluation
Fern Ridge	172	171 Unevaluated / 1 Not Eligible
Foster	20	20 Unevaluated
Green Peter	16	15 Unevaluated / 1 Not Eligible
Hills Creek	3	2 Unevaluated / 1 Eligible
Lookout Point	64	63 Unevaluated / 1 Eligible
Fall Creek	69	69 Unevaluated
Blue River	32	32 Unevaluated
Dorena	9	9 Unevaluated
Cougar	20	18 Unevaluated/2 insufficient data
Cottage Grove	15	15 Unevaluated
Detroit	24	23 Unevaluated / 1 Not Eligible
Dexter	7	7 Unevaluated
Big Cliff	2	2 Unevaluated

The majority of the lands within the study area have not been inventoried for cultural resources. The probability is high for additional resources, specifically in reservoirs such as Cottage Grove, Fern Ridge, Green Peter, Detroit, Lookout Point and Fall Creek. There are no documented traditional cultural properties (TCPs) within the WVPs. However, during the consultation phase of this feasibility study, the Corps will work with affected Tribes on the potential TCPs.

2.12 Dam Safety Considerations

Dam Safety Issue Evaluation Studies, part of the routine Dam Safety Program, are underway at several Corps projects in the Willamette Basin to better understand the risk at the projects. These studies may lead to Dam Safety Modification Studies. Dam Safety Modification Studies are conducted to investigate dam safety deficiencies that could result in loss of life, formulate one or more alternatives that reduce the risks to tolerable levels, and recommend an appropriate solution in a Dam Safety Modification Report. Alternatives to reduce risks may impact operations and available stored water.

3 Demands for Willamette Valley Project Stored Water

3.1 Demand for WVP Stored Water: Fish and Wildlife

The NMFS 2008 BiOp establishes mainstem minimum flow objectives on the Willamette River at Salem and Albany, and tributary minimum flow objectives on Willamette River tributaries located downstream of Big Cliff, Blue River, Cougar, Dexter, Fall Creek, Foster, and Hills Creek dams[32].

Mainstem flow objectives at Albany and Salem vary depending on the volume of water stored in the WVP, which defines the classification of a water year. Appendix B of the Supplemental BA (USACE, 2007) designates four water year classifications that are based on the combined volume of water in reservoir storage as measured each day from May 10 through May 20 of a given year. The water year classification is then used to determine mainstem flow objectives for April through October of that year. The maximum amount of WVP stored water is 1,590,000 acre-feet and the range of WVP stored water associated with each water year classification is specified in Table 3-1.

Table 3-1
Willamette Valley Project Water Year Types

Water Year Type	Stored Water Between 10-20 May
Abundant	Greater than 1,480,000 acre-feet
Adequate	From 1,200,000 to 1,480,000 acre-feet
Insufficient	From 900,000 to 1,200,000 acre-feet
Deficit	Less than 900,000 acre-feet

32 Referred to throughout this document as mainstem BiOp flow objectives and tributary BiOp flow objectives.

Table 3-2 provides the mainstem BiOp flow objectives at Salem and Albany. Tributary BiOp flow objectives are provided in Table 3-3.

Table 3-2
Mainstem BiOp Flow Objectives at Salem and Albany (cfs)

Period	Salem Flow Objectives (cfs)			Albany Flow Objectives (cfs)		
	Abundant & Adequate	Insufficient	Deficit	Abundant & Adequate	Insufficient	Deficit
Apr 1-30	* 17,800	Salem flow objectives are linearly interpolated between Adequate and Deficit flow objectives based on mid-May system storage	* 15,000	--	--	--
May 1-31	* 15,000		* 15,000	--	--	--
Jun 1-15	* 13,000		* 11,000	† 4,500	† 4,500	† 4,000
Jun 16-30	* 8,700		* 5,500	† 4,500	† 4,500	† 4,000
Jul 1-31	† 6,000		† 5,000	† 4,500	† 4,500	† 4,000
Aug 1-15	† 6,000		† 5,000	† 5,000	† 4,500	† 4,000
Aug 16-31	† 6,500		† 5,000	† 5,000	† 4,500	† 4,000
Sep 1-30	† 7,000		† 5,000	† 5,000	† 4,500	† 4,000
Oct 1-31	† 7,000		† 5,000	† 5,000	† 4,500	† 4,000

* Seven-day moving average minimum flow
† Instantaneous minimum flow

Table 3-3
Tributary BiOp Flow Objectives Downstream of WVP Reservoirs (cfs)

Period[33]	Big Cliff	Blue River	Cougar	Dexter	Fall Creek	Foster	Hills Creek
Apr 1-30	1500	50	300	1200	80	1500	400
May 1-15	1500	50	300	1200	80	1500	400
May 16-31	1500	50	300	1200	80	1100	400
Jun 1-30	1200	50	400	1200	80	1100	400
Jul 1-15	1200	50	300	1200	80	800	400
Jul 16-31	1000	50	300	1200	80	800	400
Aug 1-31	1000	50	300	1200	80	800	400
Sep 1-30	1500	50	300	1200	200	1500	400
Oct 1-15	1500	50	300	1200	200	1500	400
Oct 16-31	1200	50	300	1200	50	1100	400

[33] The ten periods correspond to a combined set of analysis periods, which includes all partial months as described in the BiOp. The combined set of periods was used to provide a common time period framework for all tributaries.

FR/EA Appendix C (Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows) details the calculation steps used to obtain the total water volume from the WVP that is used to meet the minimum flow objectives at Salem and Albany on the Willamette River mainstem and the minimum tributary flows downstream of the WVP dams.

The total volume calculations described in FR/EA Appendix C have been parsed into different flow components: water derived from WVP storage; water passed through the WVP without being stored to meet BiOp flow objectives, volume shortages in meeting the BiOp flow needs, and other incidental water volumes. These water volumes are calculated for 79 years of flow data for the Willamette River basin by using the program ResSim to model current reservoir operations and then processing the simulation output data. The water volume computations are presented in FR/EA Appendix C for all years in the dataset analyzed, and the water volume computations are summarized in percentile form.

The analyses described in FR/EA Appendix C show that all years have at least some calculated shortage in meeting BiOp flow objectives. However, in real-time water management, the minimum flow objectives would be met more frequently than is indicated by the shortage calculations shown in FR/EA Appendix C. High quantities of remaining stored water shown in FR/EA Appendix C Figure 17.2 indicate that with real-time water management there would have been stored water available to release to cover some shortages. Since the ResSim model does not operate to look ahead to predicted stored water levels or forecasted streamflows, there are times that supplemental flows are not released in the simulation *when they would have been* in real-time water management. This means that some shortages shown in FR/EA Appendix C Figure 17.2 are artifacts of ResSim and not of water management. It can be assumed that in some years, real-time water management would have provided more supplemental flows than calculated by the ResSim model.

FR/EA Appendix C Table 17.1e summarizes the maximum amount of stored water needed to fully meet the 2008 BiOp flow objectives at Salem and Albany. In four of the simulated years, this value exceeds the maximum volume of WVP conservation storage of 1,590,000 acre-feet. As such, the peak demand for F&W must be limited to 1,590,000 acre-feet of stored water, as it would be infeasible for the WVP to meet a demand for a volume of water that exceeds its conservation storage.

3.2 Demand for WVP Stored Water: M&I Systems and SSI

This section provides a description of the analyses conducted to develop M&I system and SSI water demand forecasts and water supply deficit forecasts for the peak season of June 1 through September 30 over the 50-year period of analysis (2020-2070). Analyses and estimates presented in this section are provided in more detail in FR/EA Appendix A (Municipal & Industrial Demand and Supply Analyses), which includes M&I system peak season demand and supply deficit projections in addition to those discussed below[34].

3.2.1 M&I System Study Area

The M&I system study area was initially defined broadly as the geographic boundaries of the Willamette River basin. The vast majority of people in the basin are supported by M&I public water systems that meet basic human needs, provide fire protection, and support business and industrial development.

Because this feasibility study is focused on the reallocation of WVP conservation storage, the study area for M&I system demand was limited to M&I systems that draw water (either by surface draw or through wells) from the Willamette River or its tributaries. This refinement of the study area ensures that M&I demand for WVP stored water would not be overstated. Given this distinction, several M&I systems located within the Willamette River basin (though not using the Willamette River or its tributaries as a water source) were excluded from the analysis – systems were excluded ONLY if their source of water supply is located outside of the Willamette River basin. Several systems of varying sizes were excluded on the basis of this rationale, including the Portland Water Bureau (PWB) and those systems whose sole source of supply is the wholesale purchase of water from PWB.

The 90 M&I water suppliers in the study area are distributed throughout the Willamette River basin as shown on Figure 3-1, and together serve a total population of approximately 1.62 million persons (62-percent of the entire basin-wide population of 2.6 million persons). It is important to note that the PWB serves a population of approximately 970,000 persons, and is *not* included in the service area population of 1.62 million. However, the basin-wide population of 2.6 million is generally reconciled by the sum of the study area and the PWB service area (1.62 million + 0.97 million = 2.59 million).

The 90 study area M&I systems are of varying service area population sizes. Seven representative population size categories are shown on Table 3-4[35], along with the number of systems within each size category and the total service area population for each size category. As shown on the table, 62 of the 90 systems (69 percent of all systems) serve a population of 10,000 persons or fewer, though the total population served by these 62 systems amounts to only about 163,000 persons (about 10 percent of the total study area population). The remaining 28 M&I systems serve 90 percent of the study area population, and three of the largest systems serve 35 percent of the study

[34] M&I system demand projections included in FR/EA Appendix A for the period of analysis are: annual (365-day) average demand; peak season demand estimated by using peak season gallons per capita day over the 122-day peak season; peak season demand estimated by average peak season use; estimated demand assuming that a 10 percent unaccounted-for water loss goal is achieved; and estimated demand for residential and non-residential sectors.

[35] Table 2-1 of FR/EA Appendix A (M&I Demand and Supply Analyses).

area population. Figure 3-2 depicts the geographic extent of the service areas for the study area M&I systems.

Table 3-4
Population Size Characteristics of Study Area M&I Water Suppliers

Population Category	Number of Systems	2015 Total Population
Under 1,000	24	11,800
1,000 to 5,000	28	72,300
5,000 to 10,000	10	79,000
10,000 to 25,000	11	197,600
25,000 to 50,000	7	235,000
50,000 to 100,000	7	449,700
Over 100,000	3	573,700
TOTAL	**90**	**1,619,100**

3.2.2 Population Projections

After the study area was fully defined, population forecasts were developed for each of the 90 study area M&I systems. Population projection estimates used in the analysis were derived from the Oregon Office of Economic Analysis (OEA) Population Forecasts to 2050 and the Regional Water Providers Consortium Population Forecasts to 2045. The period of analysis extends through the year 2070, though population projections for neither of the forecast sources extend through 2070. The methodology used to extend the population projections through the end of the period of analysis was to project the growth rate forward to the year 2070 using the last five-year increment provided in the population projection.

Table 3-5[36] shows total study area M&I systems' population for 2015 and population projections in 10-year increments through the end of the period of analysis in 2070. The table provides the projections by population category size as of 2015. As shown in the table, total population is projected to grow from a current population of 1,619,100 in 2015 to a population of 2,901,600 in 2070, which corresponds to an average annual rate of growth equal to 1.1 percent.

Table 3-5
Study Area Population Projections for the Period of Analysis

Population Size Category	2015	2020	2030	2040	2050	2060	2070
Under 1,000	11,800	12,600	14,300	15,700	17,100	18,600	20,200
1,000 to 5,000	72,300	77,400	88,400	98,100	107,000	116,500	126,800
5,000 to 10,000	79,000	84,600	96,600	107,200	117,200	127,900	139,600
10,000 to 25,000	197,600	217,600	250,400	278,800	303,700	331,300	362,200
25,000 to 50,000	235,000	261,900	301,300	332,000	368,400	408,500	453,500
50,000 to 100,000	449,700	488,200	554,500	614,200	671,500	732,300	799,200
Over 100,000	573,700	618,300	698,500	774,500	844,800	919,100	1,000,100
TOTAL	1,619,100	1,760,700	2,004,000	2,220,500	2,429,600	2,654,200	2,901,600

[36] Table 3-2 of FR/EA Appendix A (M&I Demand and Supply Analyses)

Figure 3-1
Geographic Distribution of Study Area M&I Systems

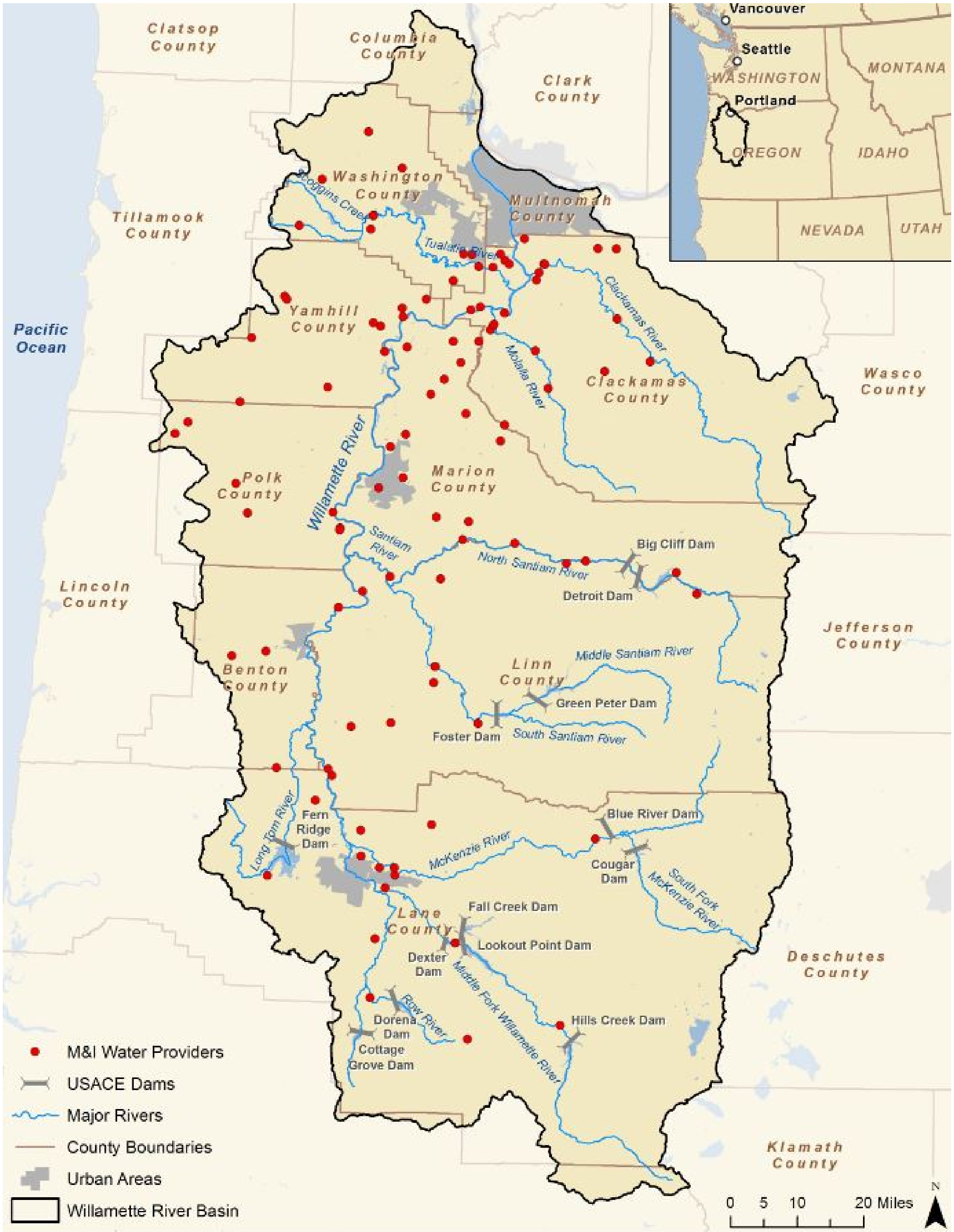
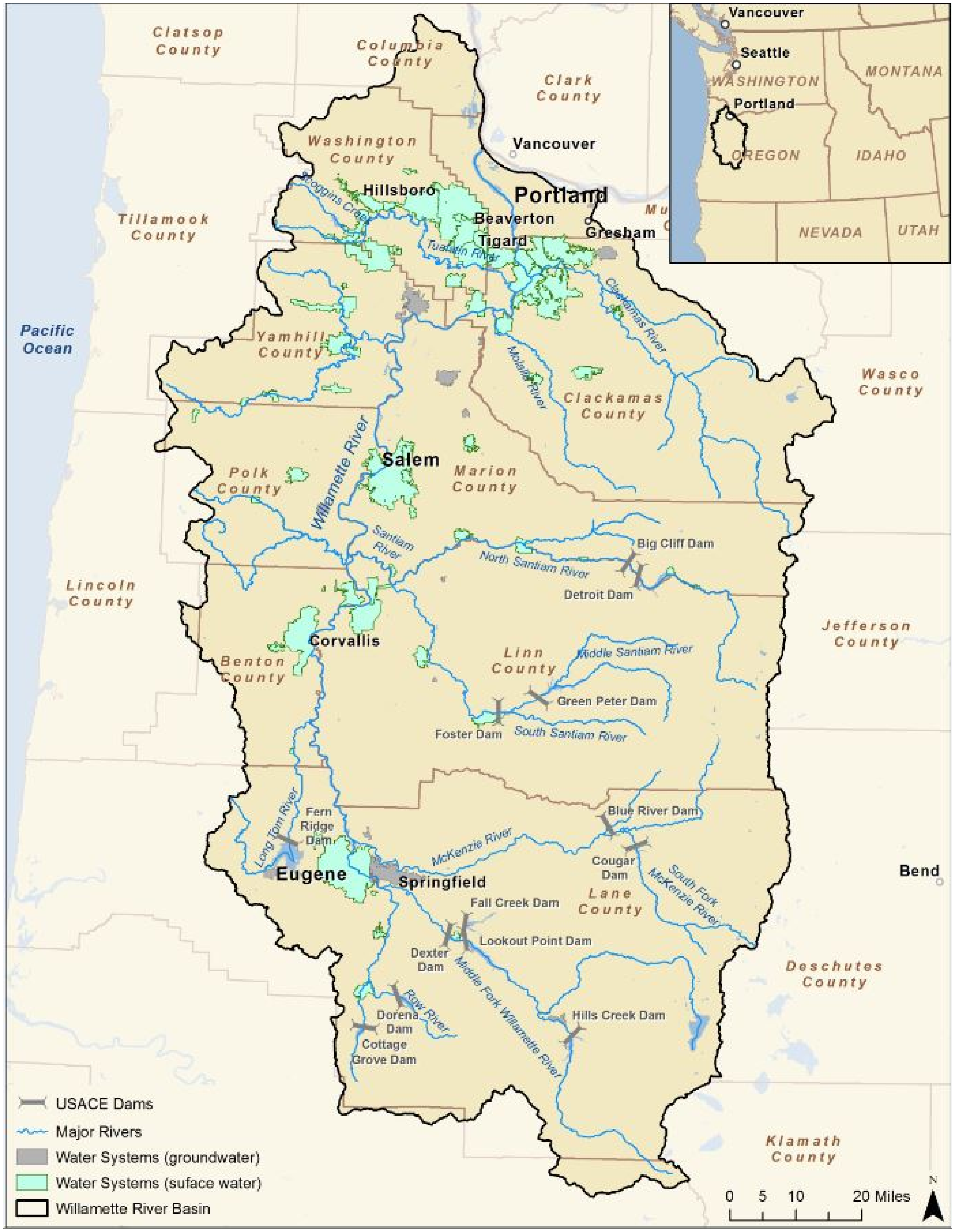


Figure 3-2
Geographic Extent of Existing Water District Distribution



3.2.3 M&I System Water Use Metrics

Many M&I systems are required to submit planning documents to OWRD and to the Oregon Health Authority (OHA). Generally, suppliers are required to submit a Water Management and Conservation Plan (WMCP) to OWRD[37], and a Water System Master Plan (WSMP) to the OHA. Both documents describe the water system and its needs, identify its sources of water, and explain how the water supplier will manage those supplies to meet present and future needs over a 20-year planning horizon.

Planning documents for all 90 M&I systems were requested, but 35 planning documents were unavailable for use in the analysis[38]. In addition, internet sites of all systems for which planning documents were not obtained were investigated to find online information relevant to the analysis.

Because extensive, system-specific data are available for many Oregon M&I systems through planning documents, the analysis reflects the use of system-specific data in all calculations, whenever possible. This methodology differs from broad-based M&I demand forecasts in which standardized, or average water use metrics (e.g., gallons per day, gallons per capita day, peak gallons per day, etc.) are applied to a jurisdictional population in order to estimate demand. The water use metrics described below were compiled for all 90 M&I systems – details on their derivation and additional water use metrics are described in FR/EA Appendix A (Municipal & Industrial Demand and Supply Analyses).

- **Average Daily Demand and Average Gallons per Capita Day**. Average day demand (ADD) equals the total annual production divided by 365 days. Production refers to the total amount of water that enters the system from a surface water treatment plant, wholesale supplier, or groundwater well. ADD values were then divided by the system's service area population to arrive at an Average Gallons Per Capita Day (Average GPCD) figure for each M&I system.
- **Maximum Daily Demand and Peak Gallons Per Capita Day**. Maximum Daily Demand (MDD) represents the maximum daily amount of water used by an M&I system, and is an important value for water system planning. The supply facility's infrastructure (e.g., treatment plants, pipelines, reservoirs) and water rights must be capable of meeting the MDD. If the MDD exceeds the combined supply capacity on any given day, finished water storage levels would be reduced. MDD for study area M&I providers was obtained through a direct examination of 55 WMCPs and WSMPs for study area systems. MDD values were then divided by the system's service area population to arrive at Peak Gallons Per Capita Day (Peak GPCD) for each M&I system.
- **Average Peak Season Use.** Average peak season use calculations are based on ADD and the portion of ADD that occurs from June through September. OWRD maintains a

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[37] WMCP submission is typically required: 1) as a condition of a new water use permit; 2) as a condition of a permit extension of time; or 3) as specified in a final order approving a previous WMCP.

[38] It should be noted that both types of planning documents typically are submitted as part of certain permit requirements - when systems are seeking a long term permit extension and must demonstrate a need for increased diversions of water, or when an M&I system is undertaking a major system expansion. It can be presumed that recent permit extensions or major expansions of those 35 systems that would have triggered submission of a planning document have not taken place.

database that contains reported water use data on a monthly basis, and these data were downloaded and analyzed for study area M&I systems. For each M&I system, monthly water use data were aggregated by month and divided by annual water use (as reported within the database) in order to arrive at a percent estimate of monthly M&I water use. June through September water use data were aggregated to establish an estimate of a system's average peak season use.

3.2.4 M&I System Peak Season Water Demand Projections

As noted above, several projections of M&I system peak season demand are provided in FR/EA Appendix A (Municipal & Industrial Demand and Supply Analyses). The appendix provides projections developed for alternative peak season demand metrics, residential and nonresidential sectors, and assumptions regarding an M&I system's ability to reduce unaccounted-for water to a level of 10 percent. The M&I system peak season demand estimate selected as the peak season demand component of M&I system peak season supply deficits (described in Section 3.2.6 below) is based on:

- Peak GPCD use metric (in total – residential and nonresidential demand combined); and
- No incorporation of unaccounted-for water goals.

For each M&I system, demand projections were assembled using population projections and the Peak GPCD use metric. Projected population for each year in the period of analysis was multiplied by the system's Peak GPCD use metric, which, in turn was converted to acre-feet of water in order to arrive at the M&I demand projections shown in Table 3-6[39] – which also shows breakdowns by the residential and non-residential sectors.

Table 3-6
M&I Systems Peak Season Water Demand – Peak GPCD Use Metric

Projection Year	Residential (acre-feet)	Non Residential (acre-feet)	Total (acre-feet)
2020	128,100	65,300	193,400
2030	145,800	73,800	219,600
2040	161,300	81,500	242,800
2050	176,700	88,700	265,400
2060	193,400	96,400	289,800
2070	211,700	104,900	316,600

[39] Data derived from Table 5-1 of FR/EA Appendix A, rows labeled Peak Season Demand (Peak GPCD Metric). Additional estimates also are available in Table 5-1 of FR/EA Appendix A.

3.2.5 Peak Season Supply Evaluation for M&I Systems

Data maintained by OWRD provides detailed information on each entity's water rights. Additional analyses were undertaken to determine the extent to which each entity could rely on its water rights during the peak season. Water rights listed in each entity's WMCP were evaluated in order to establish a reliable volume of water which could be stated as existing supply during peak season.

M&I systems that draw surface water from the Willamette River mainstem face several permit limitations. The various surface water permit categories that are subject to summer limitations are:

- extended permits (i.e., permits that are not fully developed);
- permits issued after the NMFS 2008 BiOp was issued; and
- permits junior in priority date to instream water rights.

For groundwater permits, the planning rate was limited to current well capacities. Costs to repair wells or drill new wells may be avoided if reliable stored water is available, especially when limitations on the groundwater supply or quality would also affect new wells.

Study area M&I systems show total water rights of 2,570 cfs from groundwater and surface water sources for the providers to draw upon to satisfy daily customer demand. However, very real supply constraints (e.g., curtailment conditions based on instream flow objectives) exist for the vast majority of providers that limit the reliable peak season supply to 1,020 cfs. Over the June through September peak season the reliable supply of 1,020 cfs equates to roughly 246,700 acre-feet. An additional 15,000 acre-feet of water could be used as reliable peak season supply from water storage projects not owned by the Corps (i.e., storage projects other than WVP reservoirs).

3.2.6 M&I Systems Peak Season Supply Deficits

M&I system peak season supply deficit projections were assembled using M&I peak season demand forecast and reliable peak season supply estimates described above. For each M&I system, peak season demand for each analysis year was subtracted from its reliable peak season supply (converted to acre-feet of water) in order determine its peak season supply deficit (if any) for that analysis year. This calculation was conducted for each M&I system individually[40], and the results aggregated to provide cumulative M&I peak system supply deficits by decade of the period of analysis shown in Table 3-7.[41]

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[40] It is important to emphasize that the M&I analysis is based on a system-by-system accounting of peak season demand, reliable peak season supply, and the resulting peak season water supply deficits (if any). For this reason, a comparison of total peak season demand to total peak season reliable supply is irrelevant, and will provide misleading results. FR/EA Appendix A (M&I Demand and Supply Analyses) Section 7 introduction provides further discussion of this issue.

[41] Table derived from Table 7-1 of FR/EA Appendix A (M&I Demand and Supply Analyses). Additional projections also are provided in FR/EA Appendix A.

Table 3-7
M&I System Peak Season Water Supply Deficits

Projection Year	Supply Deficit (acre-feet)
2020	24,500
2030	36,100
2040	47,800
2050	62,400
2060	81,500
2070	103,200

3.2.7 M&I System Single Source Redundancy Needs

M&I systems may enter into contracts for WVP stored water as a means to provide water source redundancy in the event that their primary water source becomes impaired or limited (e.g., as a result of acute or chronic contamination, or low flow conditions). M&I systems that rely on a single source of water were identified using the following criteria:

1. An M&I system is considered to rely on a single source if all of its water rights authorize the use of groundwater, or if all of its water rights authorize the use of a single surface water source. M&I systems with groundwater rights from multiple aquifers were not considered to rely on a single source.
2. If an M&I system relies on the Willamette River or WVP tributary as a single source, WVP stored water could not serve as a redundant supply source for that system. This is because the single source evaluation is intended to determine whether access to WVP stored water could be used in the event of contamination or low flow from a water source other than those controlled by the WVP[42].
3. If documentation shows that an M&I system relies on water rights from a single source, but is known to rely on water supply obtained from another M&I system, it is not considered to rely on a single source.

Using these criteria, a total of 42 out of the 90 study area M&I systems (47-percent) were determined to be served by a single source. The estimate of water volume required to provide system redundancy is based on total peak season demand for each of the 42 M&I systems determined to rely on a single supply source. In contrast to M&I peak season demand used in calculations of peak season supply deficits (based on the Peak GPCD Use metric), M&I peak season demand used to establish redundant supply needs are based on peak season demand based

[42] Low flow conditions for M&I systems that rely on the Willamette River or WVP tributaries is fully evaluated within the analysis of peak season supply deficits (through the examination of reliable peak season supply). Including any demand estimates from those systems in the calculations of single source redundancy needs would overstate the estimate.

on the Average Peak Season Use[43] metric. Table 3-8[44] shows the cumulative M&I systems' redundant supply needs for the peak season by decade of the period of analysis.

Table 3-8
M&I System Peak Season Single Source Water Supply Redundancy Needs

Projection Year	Water Supply Redundancy Needs (acre-feet)
2020	23,700
2030	26,900
2040	29,600
2050	32,400
2060	35,300
2070	38,600

3.2.8 Self-Supplied Industrial Demand

Self-Supplied Industrial (SSI) peak season demand represents the demand for WVP stored water for commercial and industrial water users that hold their own water rights – independent of M&I systems. These include a variety of uses, from small facilities to major industrial plants. It is important to recognize that much of the Willamette River basin's commercial and industrial water use is provided by M&I systems and is captured in the M&I systems category of demand. Those demands are not considered SSI demands, as the SSI category includes only commercial and industrial entities with their own separate water supplies. It was necessary to treat these facilities separately because the data and methodology needed to forecast this category is different from those used for M&I systems.

3.2.8.1 Estimating Future SSI Demand

A single data source was used to establish SSI demand for WVP stored water: OWRD's Water Rights Information System (WRIS) for the Willamette River basin. WRIS was queried for industrial water use categories, and the associated water rights were exported into Microsoft Excel for further processing and vetting to remove duplicate records and outliers. The methodology used to forecast SSI demand for WVP stored water is summarized in the following steps:

1. Identify SSI permits issued annually based on WRIS water rights records. This includes seven categories under the water use classification system: Manufacturing (IM), Commercial Uses (CM), Shop (SH), Sawmill (SM), Log Deck Sprinkling (LD), Laboratory (LA), and Geothermal (GT);

[43] See FR/EA Appendix A (M&I Demand and Supply Analyses) for additional information.

[44] Table derived from Table 7-5 of FR/EA Appendix A (M&I Demand and Supply Analyses).

2. Determine nominal water rights based on WRIS records. The instantaneous water right flow value associated with each permit was used to determine nominal water rights. This flow value represents the maximum quantity a water rights holder is permitted to divert or pump on an instantaneous basis. It is measured in gallons per minute or cfs; and
3. Apply standard assumptions to all SSI users identified to convert nominal water rights into estimated acre-feet of water use during the peak season of June through September. The conservative assumptions were:
   - facility operations use 50 percent of the instantaneous water right; and
   - facilities operate at this level for two shifts (16 hours) per day, seven days a week, 52 weeks of the year.

Thirty years of permit data were examined to develop an estimate of annual incremental increase in SSI demand expected to materialize over the period of analysis. The 75th percentile of the distribution was selected as a conservative estimate[45] of annual incremental permit demand, equal to approximately 840 acre-feet of water per year. Data maintained in WRIS includes the beginning and ending days in the year for which all water rights are authorized to be exercised. These data were relied upon in the allocation of SSI water demanded across months in the year. For rights showing no restrictions over the entire calendar year, June-September demand was allocated equally across all peak season months. For rights showing a date restricted use (e.g., begin day authorized: January 1 / end day authorized: March 1) use of the right was allocated entirely to the authorized use window. Using these data, it was determined that the peak season accounts for 42-percent of SSI water use.

New SSI demand (through the issuance of new permits) was calculated for all years in the period of analysis by application of the annual growth in new SSI permits (840 acre-feet of water per year) multiplied by the seasonal factor of 42 percent, or roughly 350 acre-feet of water per year. Future SSI stored water demand and deficit projections differ from future M&I demand and deficit projections in that future SSI demand over the period of analysis was estimated as a function of new permit demand expected to materialize each year. Therefore, all future SSI water demand would not be an increased use of existing SSI water rights.[46]

While future SSI demand is expressed in terms of demand for additional water rights, it is unlikely OWRD would issue new SSI water rights during the peak season because:

1. OWRD has determined that surface water is not available for “new” appropriations in many tributaries during the late summer months;
2. Conditions may be placed on “new” permits to incorporate recommendations of reviewing resource agencies (i.e., ODFW, ODEQ) that would limit use under certain low flow scenarios (i.e., during the peak season);
3. A “new” permit would be subject to regulation (cut back or shut off) to protect existing senior water rights; and

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[45] To ensure that SSI would not be understated – selection of the median (530 acre-feet) of the distribution would be considered a less conservative estimate.

[46] Increased use of existing SSI water rights <u>can</u> occur over the period of analysis without impacting the demand for new SSI water rights, which are independent of existing SSI water rights.

4. Groundwater may be insufficient or of poor quality for SSI use, and the use of groundwater is limited by the Willamette Basin Program.

For these reasons, all future incremental SSI water demand is classified as a water supply deficit, or a demand for WVP stored water, and is shown in Table 3-9[47] in acre-feet of stored water demand, cumulatively, by decade over the period of analysis.

Table 3-9
Self-Supplied Industrial Peak Season Water Supply Deficits

Year	Peak Season Deficit for New SSI Rights (acre-feet)
2020	350
2030	3,850
2040	7,400
2050	10,900
2060	14,450
2070	17,950

3.2.9 Total M&I Peak Season Demand for WVP Stored Water

Below is an overall summary of M&I system and SSI demand (which together are considered total M&I demand) for WVP stored water. M&I systems' peak season supply deficits, M&I systems' peak season redundancy needs, and SSI peak season deficits are summarized in Table 3-10 (table data taken from Tables 3-7, 3-8, and 3-9 above) as peak season demands for WVP stored water. Data are provided by decade over the period of analysis.

Table 3-10
Total M&I Peak Season Demand for WVP Stored Water

WVP Stored Water Demand Category	2020 AF	2030 AF	2040 AF	2050 AF	2060 AF	2070 AF
M&I Systems Demand (Peak Gallons Per Capita Day Basis)	24,500	36,100	47,800	62,400	81,500	103,200
M&I Systems Single Source Redundancy Demand	23,700	26,900	29,600	32,400	35,300	38,600
SSI Demand	350	3,850	7,400	10,900	14,450	17,950
Total Demand for WVP Stored Water	**48,550**	**66,850**	**84,800**	**105,700**	**131,250**	**159,750**

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47 Data taken from Table 8-1 of FR/EA Appendix A (M&I Demand and Supply Analyses).

3.3 Demand for WVP Stored Water: Agricultural Irrigation

Agricultural water use varies widely across Oregon, but as a use category, AI accounts for the largest volume of water demand in the state. The analysis described in this section focuses on the estimation of expected future AI demand for WVP stored water. The period of analysis used in this evaluation is 2020 through 2070.

Seven separate methods of estimating diverted AI demand were developed to establish AI demand for WVP stored water during the period of May through September. FR/EA Appendix B (Agricultural Irrigation Demand Analyses) provides extensive documentation on all seven methods. The appendix documents four separate estimates that are based on the calculation of crop-specific evapotranspiration using two methods (Blaney-Criddle and Penman-Monteith). Both the Blaney-Criddle and Penman-Monteith methods calculate evapotranspiration for a "reference crop", though calculations differ between the two methods. Both methods require spatially-referenced (i.e., at the location of the crop under investigation) climatic data in the calculation of reference evapotranspiration. One estimate method develops an AI estimate based on reported water use (i.e., actual AI water demand). Two additional estimate methods are based on the legal maximum allowable volume of water to be withdrawn, also referred to as "duty" (typically 2.5 acre-feet of water per acre irrigated).

One of the estimates based on duty was selected as being the most representative and acceptable, based on feedback from the irrigation stakeholder group in December 2016, and is the estimate discussed within this section.

3.3.1 Agricultural Irrigation Study Area

Definition of the study area relied on geospatial data obtained from two sources:

1. U.S. Department of Agriculture's Cropland Data Layer
2. Oregon WRIS

3.3.1.1 U.S. Department of Agriculture's Cropland Data Layer

The identification of cropland and crops in agricultural production relied exclusively on data obtained from the U.S. Department of Agriculture's 2014 Cropland Data Layer (CDL) – a GIS-based crop-specific land cover data layer with a ground resolution of 30 meters that covers the contiguous United States. The CDL is produced using satellite imagery and remote sensing techniques. Crop classification accuracy of the CDL ranges from 85 percent to 95 percent across the United States, and its data offers crop acreage throughout the growing season. Based on the CDL, there are approximately 1.8 million acres of cropland in the Willamette River basin, growing seventy-one different crops (excluding covered nurseries and greenhouse plants/crops[48]). Figure

[48] The CDL does not identify these plants/crops or their associated acreage because these crops are grown under cover. The USDA's Oregon Nursery and Greenhouse Survey – 2010 provides a nursery and greenhouse estimate of 49,750 acres for study area counties, though it is likely that much of this acreage is uncovered and would have been identified by the CDL. The 2010 study also provides acreage estimates of greenhouses and plants grown in containers

3-3 shows the coverage of all agricultural crops as a single layer within the Willamette River basin, as identified in the CDL. Not surprisingly, agricultural crops are clustered around the Willamette River and its major tributaries.

3.3.1.2 Oregon Water Rights Information System Data

OWRD's WRIS includes a data set that tracks Place of Use (POU) data. The POUs represent lands on which the permitted withdrawal of water (surface or groundwater) can be applied for irrigation. Available POU GIS data were used to determine which lands within the Willamette River basin hold a legal right to AI. Figure 3-4 depicts the geographic coverage of POU data for AI permits within the Willamette River basin.

3.3.1.3 Study Area Limits

The study area for AI demand was defined by those lands capable and suitable for agricultural production and likely to be irrigated. Not all agricultural land located within the Willamette River basin, as shown in Figure 3-3, could cost-effectively access released WVP stored water. Moving water long distances, whether through open channels or pipes, represent substantial costs to potential irrigators that affect the feasibility of using WVP stored water to irrigate lands far from the rivers. For this reason, the project study area was not defined as the entire Willamette River basin. Rather, the project area was defined as a four-mile (linear) boundary from the Willamette River mainstem and tributaries on which WVP reservoirs are located, as shown in Figure 3-5.

The four-mile boundary was selected as a result of analyses conducted using existing POU data that showed that the closest edge of over 90-percent of all Willamette River basin AI POUs are located within 1.25 miles of the Willamette River or a major tributary on which a WVP reservoir is located. As the distance increased to four miles, the corresponding percent of POU edges within the four-mile distance increased to 95 percent. In other words, 95-percent of existing use of water is within four miles of the Willamette River or a major tributary on which a WVP reservoir is located. Additional one-mile increments in distance yielded no appreciable increase in the number of POUs captured, so the geographic extent of the study area was established as depicted on Figure 3-5.

The study area within the four-mile buffer was further refined to include only those lands capable and suitable for agricultural production. Only those lands in the 4-mile buffer study area classified by the NRCS as "Lands Suited to Cultivation" are considered potentially irrigable. In addition, only areas classified as "Exclusive Farm Use" or "Mixed Farm Forest" were considered suitable for agriculture, and Urban Growth Boundaries were removed from consideration. These resulting modifications to the study area represent lands zoned as exclusive farm use or mixed farm forest, but not within an urban growth boundary (UGB). Total acreage defined in the four-mile buffer (as shown in Figure 3-5) is 1.9 million acres, though the total study area as defined by the NRCS criteria listed above and acreage under agricultural production in 2014 amounts to roughly 573,000 acres.

(1,200 and 9,000, respectively), though these estimates are statewide totals. Available at: https://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/Horticulture/2010_nursery.pdf

Figure 3-3
CDL Coverage of Agricultural Crops in the Willamette River Basin

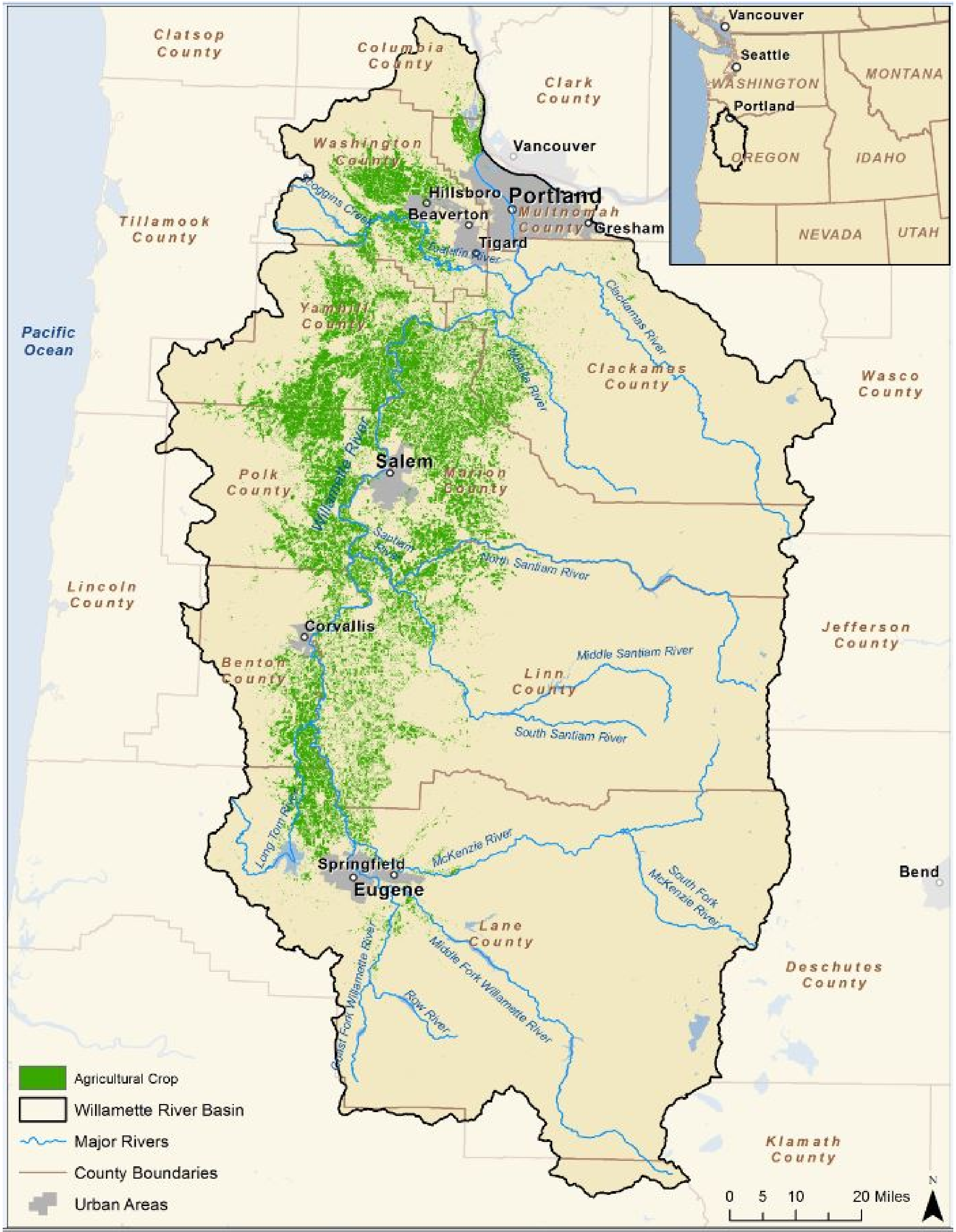


Figure 3-4
WRIS POU Data Coverage in the Willamette River Basin

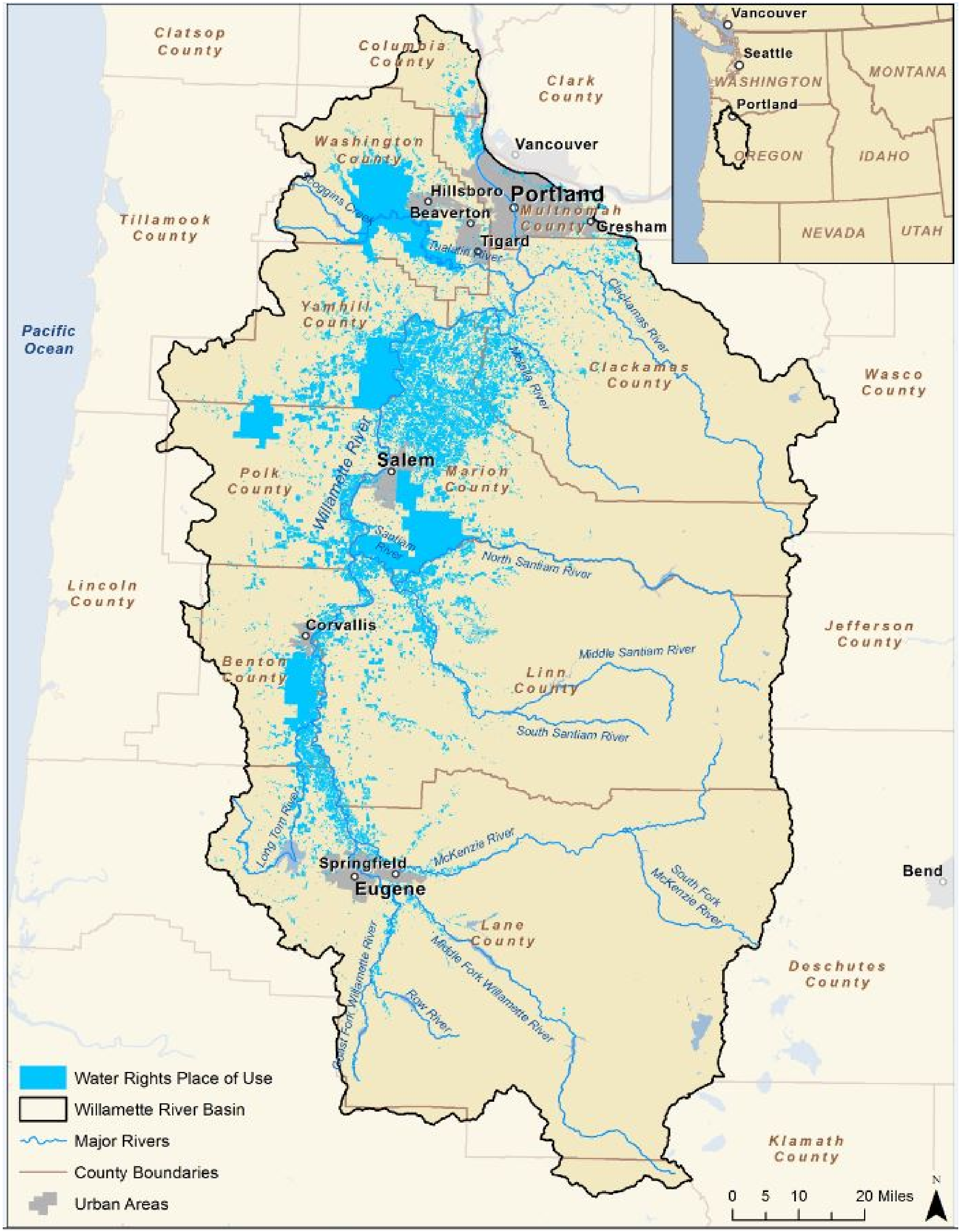
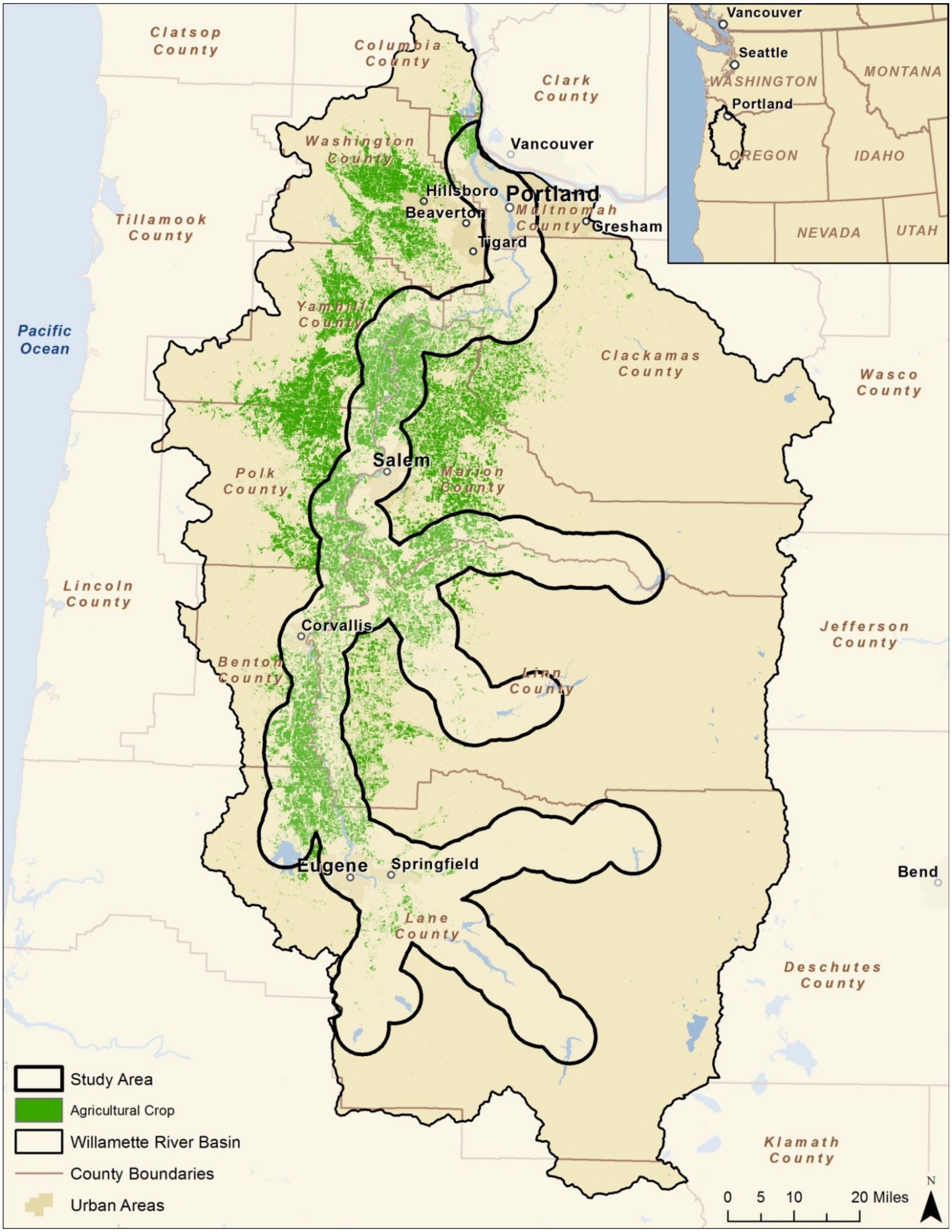


Figure 3-5
Geographic Extent of the AI Study Area with CDL Overlay



3.3.2 2014 Agricultural Irrigation Estimate

Year 2014 and projected irrigation estimates were constructed using geo-spatially organized data available at the basin, county, and state level –year 2014 refers to the data year of the CDL used in the analyses.

3.3.2.1 Diverted Water Demand Calculation: Duty Method

As described above, duty is defined as the quantity of water that is allowed to be diverted to irrigate a given area. Oregon does not have a statutorily set duty of water, though permits typically contain specific duties. The vast majority of permits issued for irrigation on the west side of the state specify a duty rate of 2.5 acre-feet of water per acre irrigated and most permits issued for nursery use specify a duty rate of 5.0 acre-feet of water per acre irrigated. Out of 551,650 acres with AI permits in the entire Willamette River basin, 527,600 acres (95.6-percent) are specified to be irrigated at a rate of 2.5 acre-feet of water per acre irrigated.[49]

The calculation of diverted water demand using duty represents the legal maximum of AI that could be applied to crops specified in the CDL. Calculating diverted water demand (DWD) by the application of the average duty requires the determination of the number of acres under cultivation and multiplying by 2.5 acre-feet of water per acre, as given below.

DWD = acres under cultivation * 2.5 acre-feet/acre

It is important to note that the diverted water demand values as derived by the duty method represent a theoretical legal maximum volume of water that could be diverted to irrigate crops under production. At this step of the analysis, these values have not been adjusted to reflect whether irrigation occurs on the agricultural lands under production. As such, these volumes of water are not representative of water withdrawn from groundwater, the Willamette River, or its tributaries, but the volumes should be viewed as a theoretical construct only. Additional steps were taken to distinguish between irrigated and non-irrigated cropland in the study area, as described below.

<u>Place of Use Spatial Intersection</u>

Calculation of diverted water demand merely expresses the crop's need for diverted water, but does not indicate whether the need for diverted water is legally authorized from existing supply sources for use. Therefore, it was necessary to segment the diverted water demand results of the analyses in order to distinguish between irrigated and non-irrigated cropland since the CDL does not provide this distinction.

To identify legally authorized irrigated croplands, the analysis relied on water rights data from the WRIS database and its associated GIS layers. As discussed previously, POU data contained in WRIS represents lands on which the permitted withdrawal of water (surface or groundwater) could be applied. POUs were mapped within the GIS layers of WRIS, and were used in this analysis as an overlay atop the study area boundaries and CDL to identify which areas under agricultural development were associated with a primary water right. Only those crops spatially associated

[49] About 1,500 acres in the Willamette River Basin are specified to be irrigated at a rate lower than 2.5 acre-feet of water per acre irrigated, and 22,550 acres are specified to be irrigated at a rate higher than 2.5 acre-feet of water per acre irrigated.

with a water right were considered irrigated. By using this process, the 573,000 acres specified as the study area above are associated with roughly 263,300 POU irrigated acres.

The 2014 irrigation estimate was based on the typical legal maximum duty of 2.5 acre-feet of water per acre applied to all cropland with AI permits within the study area. The estimate of 2014 irrigation is refined based on whether cropland identified in the CDL falls within a valid POU as identified by WRIS. The AI estimate for the base year of 2014 totals 658,200 acre-feet of water[50] diverted.

3.3.3 Projected Increases in Agricultural Irrigation

Projections of future AI through the 2020-2070 period of analysis were developed by assigning increases based on an annual rate of increased agricultural acreage that would be irrigated.

3.3.3.1 Growth in Agricultural Irrigation Acreage

Within WRIS, water rights data representing the years 1905 through 2015 were examined to derive an annual rate the increase in irrigated acreage. Based on the review of data, 602 AI permits, representing 36,839 acres of new AI acreage were granted over the past 25 years (1991 through 2015). This growth in AI acreage over the time period was used to develop annual factors by which AI acreage would be projected to grow over the period of analysis (roughly 1,500 acres of new irrigation permits per year). This 25-year examination period was selected because expansion of AI within the basin began in the 1940s and leveled off in the 1990s (Jaeger, et al., 2017).[51] Additional detail regarding the development of the assumed annual growth of irrigated acres is provided in FR/EA Appendix B (Agricultural Irrigation Demand Analyses).

3.3.3.2 Projected Study Area Irrigation Estimate

For consistency, all forecasted increases to AI acreage were projected to be irrigated at a duty of 2.5 acre-feet of water per acre. Table 3-11[52] provides a projected, cumulative increase in irrigation estimate implementing the annual growth rate in acreage from 2014 through 2070. It is important to distinguish that this estimate does not reflect increased lands in agricultural production (i.e., newly developed farmland), but rather an increase in permitted agricultural acreage on lands already in agricultural production (i.e., existing farmland that is newly irrigated). As shown in the table, demand grows over the 50-year period of analysis from a 2020 estimate of 680,300 acre-feet of water to an estimate of 864,500 acre-feet of water in the year 2070.

[50] Again, this is a theoretical estimate of the amount of water that could be applied given a duty rate of 2.5 acre-feet of water per acre irrigated, but not an estimate of how much water is applied to irrigated fields.

[51] Jaeger, W., A.J. Plantinga, C. Langpap, D. Bigelow, and K. Moore. (2017) *Water, Economics, and Climate Change in the Willamette Basin, Oregon (EM 9157)*. Oregon State University Extension Service.

[52] Data derived from Tables 7-3 and 7-4 of FR/EA Appendix B (Agricultural Irrigation Demand Analyses).

Table 3-11
Projected Agricultural Irrigation Estimates

Year	Irrigated Agricultural Acreage (acres)	Diverted Water Demand (acre-feet)	DWD Increase from Year 2020 (acre-feet)
2014	263,300	658,200	n/a
2020	272,100	680,300	n/a
2030	286,900	717,200	36,900
2040	301,600	754,000	73,700
2050	316,300	790,800	110,500
2060	331,100	827,700	147,400
2070	345,800	864,500	184,200

3.3.4 Impact of Minimum Perennial Stream Flows on Agricultural Irrigation

Within the Willamette River basin, there are several minimum perennial streamflows (MPSFs) that have yet to be converted to instream water rights, as required by state law. These MPSFs specify that a certain quantity of live flow, along with an unspecified amount of water released from storage, must be maintained on major tributaries and at several points along the mainstem of the Willamette River to support aquatic life and to minimize pollution. MPSFs exist in tributaries below the WVP reservoirs. Once converted to instream water rights, the MPSFs will carry a priority date of June 22, 1964.

The conversion of the MPSFs to instream water rights may result in the curtailment of junior water rights in the future. To account for this potential increase in AI demand, an analysis was conducted to identify existing primary irrigation water rights that authorize the use of surface water in streams that are expected to have their MPSF converted to an instream water right, but whose water rights are junior in priority to June 22, 1964. Using these criteria, an estimated 62,050 acre-feet of water may become unavailable for irrigators because once established, the priority date of the instream water rights would be 1964. It should be noted that this represents a conservative estimate (i.e., worst-case scenario), where it has been assumed that the MPSFs flow objectives would not be met in the future, thereby triggering a curtailment of all junior water rights by OWRD.

3.3.5 Total Agricultural Irrigation Demand for WVP Stored Water

Table 3-12 provides an overall summary of AI demand for WVP stored water. The estimate includes AI demand derived from the analysis summarized in Table 3-11 above, and two additional estimates: AI rights at-risk of curtailment; and Reclamation contracts expected to be in place by year 2020. It is expected that, outside of increases in AI storage demand, 62,050 acre-feet of stored water would be requested when the MPSFs are converted to instream water rights to mitigate for the potential curtailment of those AI rights. A reallocation of WVP conservation storage must include the contracted volume of Reclamation stored water contracts in place when conservation storage is reallocated. In the base year of 2020, it is expected that the volume of WVP stored water under Reclamation contracts for AI would total 81,400 acre-feet. This value is derived in FR/EA

Appendix F (ResSim WVP and Live Flow Diversions for Base Year 2020, No Action Alternative, and ARP Model Runs), and shown in FR/EA Appendix F, Table 2.

Table 3-12
Total Agricultural Irrigation Demand for WVP Stored Water

WVP Stored Water Demand Category	2020 AF	2030 AF	2040 AF	2050 AF	2060 AF	2070 AF
Increase in AI Demand from Year 2020	0	36,900	73,700	110,500	147,400	184,200
Existing AI Rights at Risk of Curtailment	62,050	62,050	62,050	62,050	62,050	62,050
Reclamation Contracts in Place in Year 2020	81,400	81,400	81,400	81,400	81,400	81,400
Total Demand for WVP Stored Water	**143,450**	**180,350**	**217,150**	**253,950**	**290,850**	**327,650**

3.3.6 Agricultural Irrigation Conservation and Efficiency

It is recognized that western agriculture has made significant water-use efficiency improvements. Advances in AI conservation include drip irrigation, which delivers water directly on the surface or directly to the roots of plants. This method of irrigation can conserve up to 50 percent of the water used for irrigation. Additionally, advances in technology can provide real-time precipitation reports and forecasts, which can be used to inform weather-based irrigation scheduling in order to determine specific quantities of irrigated water a particular crop needs.

Advances in AI conservation are not incorporated into the AI demand estimates because the estimates are based on irrigated acreage using a duty rate of 2.5 acre-feet of water per irrigated acre. Implicit in the duty rate (though not explicitly calculated) are long-held assumptions regarding conveyance and application efficiencies. While it would be inappropriate to assume more efficient conveyance and application methods are in widespread use throughout the study area without further study, it is possible that AI demand for WVP stored water could decrease on a per acre basis in the future as advances in AI conservation are adopted as standard industry practice.

3.4 Climate Change-Induced Impacts to WVP Stored Water Demands

The impact of climate change on water supply is expected to be an issue over the period of analysis. The U.S. Environmental Protection Agency states that many areas of the United States, especially the West, currently face water supply issues. Water availability in these areas (including the Willamette River basin throughout the summer months) is already limited, and demand would continue to rise as population grows.

Separate analyses of climate change-induced impacts were conducted for each of the three categories of demand for WVP conservation. Discussion of the analyses will not be repeated here, though are available in:

- FR/EA Appendix K (Climate Change Impact on Future Regulation). Climate change induced impacts to the F&W increase in demand are based on analyses provided in this appendix. The climate change induced impacts are calculated by estimating the average decrease in the volume of unregulated flow at the Salem gage, and are based on 19 emissions scenarios. Values provided below are derived from Table 3.1 of Appendix K.
- FR/EA Appendix A (M&I Demand and Supply Analyses), Section 11. Analyses are based on climate change induced impacts to reliable peak season supply, and on increases in peak season demand attributable solely to climate change. Impacts to peak season supply are based on estimated streamflows from 19 emissions scenarios for three time points (2020, 2040, and 2080). Increases in demand attributable to climate change are based on an analysis conducted on behalf of the Portland Water Bureau[53], and are expected to be an additional 8 percent by the year 2040. Values provided below are derived from Table 11-9 of Appendix A, and represent the combined climate induced impact of decreasing peak season supply and increasing peak season demand.
- FR/EA Appendix B (Agricultural Irrigation Demand Analyses) Section 8. Impacts of future climate change on irrigation demand within the study area were estimated by calculating the diverted water demand using the Penman-Monteith method. Climate change was modeled by increasing mean minimum, mean, and mean maximum monthly 2014 temperatures by 0.057 °C per year and maintaining precipitation at 2014 levels[54] (Jaeger, 2017). Future agricultural irrigation projections through the period of analysis were developed by incorporating increases based on both an annual rate of increased acreage under agricultural irrigation and impacts of climate change. Data shown below is the difference between Appendix B Tables 8-6 (Estimate 1) and 7-4 (Estimate 1).

Summary results from these three appendices that correspond to the demand for WVP stored water provided above in Sections 3.1, 3.2, and 3.3 are provided in tables 3-13, 3-14, and 3-15 below.

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[53] Palmer, R.N. and Hahn, M. (2002) The Impacts of Climate Change on Portland's Water Supply. Portland Water Bureau, Portland, OR.

[54] Future climate is based on projections made by the MIROC5 global climate model, which predicts that summer temperatures in the Willamette River Valley will increase an average of 0.57 ºC per decade between 2010 and 2100, and that there will be little change in precipitation magnitude and timing.

Table 3-13
F&W Increase in Demand for WVP Stored Water
Incorporating Climate Change-Induced Impacts

Year	Climate Change Induced Impact (acre-feet)
2020	0
2030	46,500
2040	93,000
2050	139,500
2060	186,000
2070	232,500

Source: Appendix K (Climate Change Impact on Future Regulation), Table 3.1

Table 3-14
M&I Peak Season Increase in Demand for WVP Stored Water
Incorporating Climate Change-Induced Impacts

Year	Peak Season Demand for WVP Stored Water Without CC Impact (acre-feet)	Peak Season Demand for WVP Stored Water With CC Impact (acre-feet)	Climate Change Induced Impact (acre-feet)
2020	48,550	48,550	0
2030	66,850	71,450	4,600
2040	84,800	99,200	14,400
2050	105,700	134,350	28,650
2060	131,250	172,800	41,550
2070	159,750	216,650	56,900

Source: Appendix A (M&I Demand and Supply Analyses), Table 11-6

Table 3-15
AI Peak Season Increase in Demand for WVP Stored Water
Incorporating Climate Change-Induced Impacts (growth in irrigated acreage)

Year	Peak Season Demand for WVP Stored Water Without CC Impact (acre-feet)	Peak Season Demand for WVP Stored Water With CC Impact (acre-feet)	Climate Change Induced Impact (acre-feet)
2020	n/a	13,700	13,700
2030	36,900	75,100	38,200
2040	73,700	138,400	64,700
2050	110,500	203,900	93,400
2060	147,400	271,200	123,800
2070	184,200	340,600	156,400

Source: Appendix B (Agricultural Irrigation Demand Analyses), Tables 7-4 and 8-6.

Table 3-16 consolidates the climate change-induced increases into one table. As shown in the table, the total climate change induced impact on demands for WVP stored water is estimated to be 445,800 acre-feet by the year 2070. This amount is roughly one third the total capacity of WVP conservation storage. Given 2070 total demand for WVP stored water of 2,077,400 acre-feet listed in Sections 3.1, 3.2, and 3.3 without accounting for any climate-induced impacts (F&W: 1,590,000 acre-feet, M&I: 159,750 acre-feet, AI: 327,650 acre-feet). The additional 445,800 acre-feet attributable to climate induced impacts raises the total demand for WVP stored water to 2,523,200 acre-feet. With WVP stored water capacity of 1,590,000 acre-feet, demands including climate change induced impacts are equal to 159% of capacity. As such, accommodating climate change induced impacts to stored water demand will be infeasible.

Table 3-16
Total Climate Change-Induced Impacts Demands for WVP Stored Water

Year	F&W Climate Change Induced Impact (acre-feet)	M&I Climate Change Induced Impact (acre-feet)	AI Climate Change Induced Impact (acre-feet)	Total Climate Change Induced Impact (acre-feet)
2020	0	0	13,700	13,700
2030	46,500	4,600	38,200	89,300
2040	93,000	14,400	64,700	172,100
2050	139,500	28,650	93,400	261,550
2060	186,000	41,550	123,800	351,350
2070	232,500	56,900	156,400	445,800

While Table 3-16 shows estimated values for climate change induced impacts on WVP stored water demand, there is considerable uncertainty associated with the values. For F&W and M&I values, analysis is based on ensemble averages from 10 projected, climate changed streamflow records for an A1B emissions scenario and nine records for a B1 emissions scenario. The range of results produced as a result of analyzing these scenarios reveals some of the uncertainties associated with climate changed, projected future hydrology derived from using different General Circulation Models (GCMs). There are many sources of uncertainty inherent to projected, climate changed hydrology. Sources of uncertainty include, but are not limited to, timing of precipitation, changes to ground cover on the terrain, changes in the location of precipitation, changes to large scale circulation issues such as the jet stream, in addition to assumptions in any of the GCMs or emission scenarios, downscaling techniques, and hydrologic model techniques applied. Regarding the AI values, numbers provided in Table 3-16 are based on regional temperature changes that are in the middle of the range of changes predicted by a suite of three GCMs run for two emission scenarios determined to perform well for the Pacific Northwest, and assumes that there will be little change in precipitation magnitude and timing. The range of temperature changes being predicted by the ensemble of GCMs reveals some of the uncertainty associated with using GCM outputs.

Given the extensive uncertainties associated with the estimates provided in Table 3-16, it should be noted that the estimated climate induced impacts to WVP stored water demand are provided only for informational purposes. The estimates give a qualitative indication of a likely realization of the operational significance of changes in water supply demand that could be caused by climate change impacts on the Willamette Basin's hydrology. The analyses were undertaken to illustrate the potential impact on demand for WVP stored water, and will not be used in any alternative for the re-allocation of WVP conservation storage.

4 Formulation of Alternative Plans

The limited peak season capacity of water sources, coupled with Willamette River basin flows required to benefit ESA-listed fish, pose considerable constraints into the future for expanding M&I withdrawals or diversions during critical times of need. Plan formulation begins with an evaluation of whether or not a reallocation of WVP conservation storage would help to achieve the federal objective of water and related land resources project planning. This objective is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements.

Peak season demands for WVP stored water were estimated in Section 3 as:

- Fish & Wildlife 1,590,000 acre-feet per year (Section 3.1)
- Municipal & Industrial 159,750 acre-feet per year by year 2070 (Section 3.2.9)
- Agricultural Irrigation 327,650 acre-feet per year by year 2070 (Section 3.3.5)

Together, these peak season demands for WVP stored water equal 2,077,400 acre-feet.

4.1 Future Without-Project Conditions / No Action Alternative

The CEQ allows that in instances involving federal actions where ongoing programs initiated under existing legislation and regulations would continue, the No Action Alternative would be "no change" from current management direction or level of management intensity (CEQ, 1981). For this analysis, the No Action Alternative may be thought of in terms of continuing with the present course of actions with respect to how the Corps manages the WVP until that action is changed.

Under the No Action Alternative (future without-project conditions), there would be no Corps action to reallocate WVP conservation storage and no changes to the current operations to utilize WVP stored water to meet the Congressionally-authorized multiple purposes. With respect to the No Action Alternative, the following assumptions can be made:

- The Corps would continue to operate the WVP to meet mainstem and tributary flow objectives to the maximum extent possible as described in the 2008 BiOp (NMFS, 2008);
- The Corps would continue to operate the WVP to assist Reclamation in meeting irrigation water contract demands;
- Reclamation would continue to issue irrigation water contracts up to, and eventually exceeding, the 95,000 acre-feet of stored water per year as described in RPA Measure 3[55] (NMFS, 2008). As of 2017, Reclamation had issued irrigation water supply contracts for approximately 75,000 acre-feet of WVP stored water per year, leaving approximately 20,000 acre-feet per year of WVP stored water available for new contracts before triggering the analyses and consultation described in RPA Measure 3. Based on the estimated rate of increase in demand for irrigation water, the need would be projected to exceed the 95,000 acre-feet per year of WVP stored water threshold after 2025.

[55] The full text of RPA Measure 3 is provided in the Glossary of this document. The full RPA is available at http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

- As described under RPA Measure 3, Reclamation and the Corps would need to "*reevaluate the availability of water from conservation storage for the water marketing program*" when future irrigation demand exceeds 95,000 acre-feet of stored water per year. If Reclamation proposed to issue additional contracts above 95,000 acre-feet of stored water per year, re-initiation of ESA consultation would be necessary. Assuming demand for irrigation materializes as projected in this analysis, the consultation would be expected to occur in the early 2020s. It is noteworthy that beyond the required consultation described in RPA Measure 3, there are no other institutional barriers to restrict Reclamation from issuing irrigation water contracts in excess of 95,000 acre-feet of stored water per year in the future.
- Without a reallocation of WVP conservation storage, Reclamation would not apply for a change in character of use for their storage rights to match a reallocation of conservation storage for uses other than irrigation;
- Without a change in character of use for Reclamation's storage rights, a portion of WVP conservation storage would not be specifically allocated for F&W. OWRD would not issue instream water rights for the use of WVP stored water as described in RPA Measure 2.9. Thus, the Corps would not be able to facilitate OWRD's conversion of stored water to instream water rights as described in RPA Measure 2.9;
- Without a conversion of WVP stored water releases to instream water rights, stored water releases for F&W would continue to be unprotected and continue to be available for use by existing water right holders per Oregon water law; and
- Without a change in character of use for Reclamation's storage rights, future M&I peak season demands would be met through measures that do not include access to WVP stored water. These measures are discussed in Section 4.2 below.

Implications of the No Action Alternative impacts to fish and wildlife are clear. In the event that no action is taken, releases of WVP stored water intended to benefit ESA-listed fish would continue to not be protected by instream water rights, and would preclude the Corps from fulfilling its requirements under RPA Measure 2.9. Similarly, the implications of the No Action Alternative to AI is straightforward – Reclamation would continue to issue irrigation contracts up to and exceeding 95,000 acre-feet of stored water per year (subject to additional ESA consultation with NMFS) to meet future AI needs for WVP stored water.

The effects of the No Action Alternative on the ability of M&I users to meet peak season demands, however, requires the analyses described throughout the remainder of this section. For this reason, measures were identified to determine whether an allocation of WVP conservation storage would provide benefits to M&I users of WVP stored water. Measures to address M&I peak season water supply are described and screened below – including a measure to utilize WVP stored water. Screening of the measures leads to the identification of three alternatives, from which a proposed action is selected.

4.2 Measures for M&I Peak Season Water Supply

A measure is a feature (i.e., a structural element that requires construction), or an activity (i.e., a nonstructural action) that could either work alone or be combined with other measures to form alternative plans. Measures were developed to address future M&I peak season water supply needs, and are derived from a variety of sources including prior studies and M&I system planning documents. The structural and nonstructural measures listed below were identified for evaluation and screening.

Non-Structural Measure

- Conservation / incentive programs / new regulations / public education / drought contingency planning.

Structural Measures

- Allocation of WVP conservation storage[56] for M&I use;
- Expansion of existing or new surface water diversions;
- Expansion of groundwater withdrawals;
- Storage of off-peak season water;
- Aquifer storage and recovery (ASR); and
- Use of inter-supplier linkages.

4.2.1 Screening of Measures

Measures identified above were evaluated to determine which measures should be carried forward in the planning process and included in the formulation of alternative plans. Four criteria are used in the formulation and evaluation of alternative plans: completeness, effectiveness, efficiency, and acceptability. Each measure was screened using these four criteria to determine whether its implementation could make a substantial contribution to achieving the goals and objectives of the study. While none of these criteria are absolute, it is clearly reasonable to screen out from further consideration any measure that:

1. Does not account for all necessary investments or other actions to ensure realization of the planning objectives, including actions by other federal and non-federal entities (completeness);
2. Does not meet the planning objectives and screening criterion, as listed in Section 1.6 above (effectiveness);
3. Is not the most cost-efficient means to provide a source of water for the entire planning period (efficiency); or
4. Is not workable or viable with respect to Federal and non-Federal entities and the public, and is not compatible with applicable laws, regulations, and public policies (acceptability).

This is not to imply that some measures that are screened from further consideration may not be beneficial public policies or effective solutions to legitimate problems of the study area. Rather, a

[56] Allocation of WVP conservation storage for M&I use is considered a structural measure since there is generally some construction of pipelines and intakes eventually that may be required in order for an entity to access stored water. Although there would be no new federal construction activities for access to WVP stored water, the Corps convention is to consider reallocation (adding an allocation for M&I use) a structural measure.

measure is screened from further consideration when it can be reasonably determined that the measure would not substantially contribute to meeting study goals and objectives or resolving the problems and needs that the study was initiated to address.

4.2.1.1 Non-Structural Measure – Conservation (Measure 1)

This measure entails the implementation of water conservation practices to reduce or defer the need for additional water supply capacity. Conservation measures include a combination of activities consistent with Oregon Administrative Rules (OAR) Division 690-086 that address customer uses, water system uses, and water losses. The requirement for M&I systems to address conservation were adopted in 1994, and components of the conservation plans include:

- periodic audits of production and usage;
- leak detection, leak repair, and line replacement;
- rate structures and billing practices;
- public education to promote efficient water use;
- technical assistance and financial incentives;
- retrofit or replacement of plumbing fixtures; and
- changes in operational procedures.

Conservation is a viable measure for dealing with short-term emergency peak season water supply shortages and temporary drought conditions. Water Management and Conservation Plans (WMCPs) are required of most Oregon M&I systems, per OAR 690-086. A water conservation element is among the major components of an M&I system's WMCP, and provides detailed information on:

- progress on implementation of previously proposed conservation measures;
- water use measurement and reporting;
- annual water audits;
- full metering of system;
- meter testing and maintenance;
- rate structures based on quantity of water metered;
- leak detection program;
- public education program; and
- currently implemented conservation measures.

Future conditions assume that M&I systems will to continue to make non-quantifiable gains in water conservation and use efficiency, and refine drought management practices to the maximum extent practicable. However, it is not feasible to articulate and incorporate into the analysis an overall conservation water savings goal for M&I systems because the success of further gains in efficiency cannot be adequately projected. While all M&I systems must report on their progress in promoting water conservation in their WMCPs, the progress reported typically is not in quantitative terms of water saved. Rather, the progress reports quantify numbers of meters replaced, technical assistance programs implemented, dollars spent on rebate programs as an incentive for customers to install more efficient plumbing fixtures and appliances, and other progress made toward encouraging conservation.

In addition the basin-wide application of additional conservation practices outlined above are highly dependent on individual non-quantifiable investments and actions by M&I systems (e.g., rate structure changes and financial incentives, public education, leak repair and line replacement investments, etc.). As such, the measure cannot satisfy the completeness criterion, as necessary investments and actions required for additional conservation to contribute to the objective of identifying long-term peak season water supply needs for future M&I uses cannot be accounted for or relied upon as a solution.

Because conservation measures are already being implemented by M&I systems throughout the basin, additional conservation measures would not represent a change from the future without project condition and are not carried forward as a stand-alone measure for further consideration. In other words, while conservation can help reduce future demands, alone they cannot support the forecasted demands for M&I or AI so they are not effective at meeting the objectives of the study. Nevertheless, it is assumed that additional local-level efforts aimed at water conservation, increased water use efficiencies and continual refinements of drought management plans will continue to be implemented under both the future without and future with conditions.

4.2.1.2 Allocation of WVP Conservation Storage for M&I Use (Measure 2)

The need for M&I use of WVP stored water was found to be relatively low when the capacity of the WVP was planned. However, the Flood Control Act of 1950 reauthorized the Corps to construct and operate the WVP, as described in House Doc. 531, which included water supply as an intended and authorized project purpose. Domestic water supply as an authorized purpose is discussed on pages 1735-1736 of House Doc. 531, Volume 5. Paragraph 198, page 1736 states:

> *"The total quantity of water required for domestic use would be small in comparison with the total storage capacity of reservoirs proposed for flood-control and other multiple-purposes uses. Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand."*

To date, there are no active agreements for using WVP stored water for M&I water supply, though a Surplus Water Supply Agreement between the Corps and the City of Creswell for provision of up to 437 acre-feet of WVP stored water has been finalized[57] (USACE, 2014).

Allocation of WVP conservation storage for M&I purposes is carried forward as an element in the formulation of alternatives, as this measure could be used to meet a large portion of the unmet future M&I demand increases throughout the basin. In addition, this measure fully meets the criteria of completeness, effectiveness, efficiency, and acceptability. It is complete in that the Corps, once granted authority by Congress, has the ability to reallocate the storage; and while the contracting of that storage is dependent on the State of Oregon taking actions to revise its storage certificates, these actions are reasonably certain to occur following reallocation as there is incentive to do so to meet demands and there are legal procedures in place to facilitate the action. It is effective in that it meets the objectives by supporting forecasted demands while providing sufficient water for fish and wildlife. As demonstrated in section 7.3 (Test of Financial Feasibility) this is the most cost effective method of supplying water to meet future demands which fully meets the efficiency criteria. It is acceptable in that it is compliant with state and local laws and does not violate local plans.

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[57] The report was finalized but there is no signed agreement resulting from the report as of August 2017.

4.2.1.3 Expansion of Existing or New Surface Water Diversions (Measure 3)

Expansion of existing surface water diversions and the development of new surface water diversions were analyzed as a measure to provide additional M&I peak season water supply through the year 2070. Expansion or development of new surface water withdrawal rights for peak season use are typically not suitable supply measures due to low peak season water availability. Given the practical limitations associated with expansion of existing withdrawal rights or the establishment of new surface water diversions for peak season use, this measure would not be a complete or effective solution to apply throughout the basin, and is not carried forward for further consideration. It is not complete in that acquisition or additional water rights are dependent upon the action of the state and are unlikely to occur as some existing water rights are already curtailed. It has limited effectiveness as expansion of existing diversions would be insufficient to provide a meaningful contribution to supporting the forecasted demand in terms of both volume and distribution.

4.2.1.4 Expansion of Groundwater Withdrawals (Measure 4)

Groundwater resources in the study area are limited – the geology is such that the aquifers are not highly productive and surficial units are vulnerable to contamination from agriculture or urbanization. The physical setting of the region is such that precipitation follows surface or sub-surface pathways to streams resulting in rapid runoff and limited natural water storage. The relatively small amounts of natural storage and low permeability of the region's aquifers contribute, in general, to a quick decline in streamflow once precipitation ceases. Moreover, recharge to the ground water system, especially the deeper confined units, is limited and withdrawals are often subject to rapid water level decline.

The area's groundwater reserves are marked by low aquifer permeability, resulting in wells and springs with relatively low yields. Additionally, some of the M&I system communities rely on groundwater that has high levels of naturally occurring iron, manganese, and arsenic. The only reliable ground water supplies in the region are located in the local alluvial deposits along the Willamette River. While most of the surface water sources in the Willamette River basin are deemed to be limited during summer months, this lack of water availability also could affect the use of groundwater if OWRD determines that additional groundwater withdrawals would affect, to an impermissible degree, the surface water source.

While permitting hurdles and construction costs may preclude the widespread use of this measure throughout the Willamette River basin, increased groundwater withdrawals from newly constructed or existing wells may be able to meet at least a portion of the unmet future demand in some areas of the basin. This measure is partially complete as it would rely on the actions of others which have some uncertainty as to their permissibility due to concerns of effects on surface water. It is partially effective in that it could make a perceptible contribution to support forecasted demands, but would not fully meet the demands due to the low availability of groundwater. Through further analysis, it was revealed to not be the most cost-effective method to support future demands so it is less efficient than other measures but was retained for analysis as part of the test of financial feasibility. It is partially acceptable as local laws and ordinances limit the amount of groundwater withdrawals that are permissible throughout the study area. As such, this measure partially meets the criteria of completeness, effectiveness, efficiency, and acceptability, and was retained for further analysis primarily as part of the test of financial feasibility.

4.2.1.5 Above-ground Storage of Off-Peak Season Water (Measure 5)

This measure includes the creation of new dams and impoundments as well as new intakes, treatment plants, transmission mains, and pumping facilities. This measure could pose substantial environmental issues, as dams used for the impoundment of off-peak season water can block juvenile or adult fish from moving to cold-water refuges that help them survive high summer temperatures. Dams can also increase water temperatures, harbor predator species, eliminate water flows and associated aquatic habitat downstream and induce erosion of the bed and banks of streams and introduce major fluctuations in water levels upstream of the dam impacting biota, aquatic vegetation and riparian zone inhabitants. Permitting hurdles and environmental impacts most likely preclude the widespread use of off-peak season storage throughout the Willamette River basin. This measure is not complete in that it is not reasonably certain to occur due to environmental concerns. It would be partially effective depending on the size and location of reservoirs, could meaningfully support forecasted demands but may not be able to fully meet them alone. It is not likely to be efficient due to the high cost of constructing new dams and reservoirs. Additionally, while it may be permissible under state laws, it likely would have significant environmental effects which would be unmitigatable and would cause serious concerns related to the endangered species act. As such, this measure violates the completeness, efficiency and acceptability criteria, and is not carried forward for further consideration.

4.2.1.6 Aquifer Storage and Recovery (Measure 6)

This measure involves the development of ASR systems for off-season storage of water. Water would be diverted from an intake or existing well, and pumped to the ASR system during the non-peak season. During peak season months when diversions would be limited, water stored in the ASR system could be used to help meet increased peak season demand. The use of ASR requires the ability of the aquifer to accept water, the ability to retain water, sufficient storage to reach economy of scale, and favorable aquifer boundary conditions. This shallow recharged water is then recovered as potable water. As an example, The City of Salem began ASR in 1997, and its facilities store up to 600 million gallons per year from its North Santiam River water source. Treated drinking water is transferred to Salem's ASR wells, where water is stored to meet peak demands or for emergency use. The ASR storage volume is estimated at 600 million gallons and current theoretical supply capacity of Salem's system is 13.3 cfs, or 8.6 million gallons per day (MGD).

This measure is effective as it is able to meet a significant portion of the unmet future M&I peak season demand throughout the basin. Although there may be engineering and physical challenges in some areas, it is complete and has been demonstrated to be possible within the basin. Through further analysis, it was revealed to not be the most cost-effective method to support future demands so it is less efficient than other measures but was retained for analysis as part of the test of financial feasibility. It is acceptable as there are no known state or local regulations barring implementation. It is retained for further analysis.

4.2.1.7 Interconnections with Other Systems (Measure 7)

This measure involves the use of system interties between and among neighboring M&I systems to consolidate supply, and to supply water among inter-linked systems. Implementation of this measure requires the utilization of existing M&I system interties, and the development of inter-governmental agreements. Numerous interties and regional suppliers exist within the Willamette

River basin. Regional water systems also are prevalent throughout the basin (e.g., Clackamas River Water, Joint Water Commission, South Fork Water Board, etc.). In addition, several M&I systems are pursuing additional interties and regionalization agreements in an effort to access water during peak demand periods. This measure has been used within the basin for decades and continues to be explored as an option for the assurance of future water supplies. This measure is partially effective as it is anticipated to meet a portion of the unmet future peak season demand throughout the basin. Although it is wholly dependent upon the actions of others, these actions have occurred in the past and are reasonably certain to occur in the future so it meets the test of completeness. It is likely to be efficient as it would be a relatively low-cost method of re-distributing water to meet demands. While there may be some legal and administrative hurdles, there are no known state or local laws barring this so it is likely to be acceptable. It is retained for further analysis.

4.2.2 Summary of Measures Screening

Table 4-1 shows the measures considered for this study, the results of initial screening, and whether the measure is a federal measure to accomplish or a non-federal measure to undertake.

Table 4-1
Summary of M&I Water Supply Measures Screening Analysis

Measure		Considered in Alternatives	Federal/Non-Federal
1	Conservation	No	Non-Federal
2	Allocation of WVP conservation storage for M&I use	Yes	Federal
3	Expansion of existing or new surface water diversions	No	Non-Federal
4	Expansion of groundwater withdrawals	Yes	Non-Federal
5	Above-ground storage of off-peak season water	No	Non-Federal
6	Aquifer storage and recovery	Yes	Non-Federal
7	Interconnections with other systems	Yes	Non-Federal

4.3 Final Array of Alternatives

Based on the analysis described above, four measures were carried forward into formulation of alternative plans to meet peak season M&I needs. The measures were combined to create plans that were evaluated in order to identify a proposed action. Three alternatives (in addition to the No Action Alternative) emerge when non-federal measures are combined with the federal measure of reallocating WVP conservation storage, as summarized in Table 4-2 and discussed below.

Table 4-2
Final Array of Alternatives Studied in Detail

Measures	No Action	Alternative 1	Alternative 2	Alternative 3
2: Allocation of WVP conservation storage for M&I use			✓	✓
4: Expansion of groundwater withdrawals		✓	✓	
6: Aquifer storage and recovery		✓	✓	
7: Interconnections with other systems		✓	✓	✓

4.3.1.1 No Action Alternative

Under the No Action Alternative there would be no reallocation of WVP conservation storage, and M&I entities (M&I systems and SSI facilities) would not be able to access WVP stored water to address 159,750 acre-feet of peak season water supply needs by the year 2070. Reclamation would continue to issue irrigation water contracts up to, and eventually exceeding, 95,000 acre-feet of stored water per year. WVP stored water would continue to be released for ESA-listed fish, as described in the 2008 NMFS BiOp, though the WVP stored water releases for ESA-listed fish would not be protected by instream water rights.

4.3.1.2 Alternative 1
Meet M&I Water Supply Needs through Non-Federal Measures

Under Alternative 1, the feasibility of applying non-federal measures (Measures 4, 6, and 7 from Table 4-1) were evaluated for the study area's 159,750 acre-feet of M&I peak season water supply needs. All feasible tools (expansion of groundwater withdrawals, aquifer storage and recovery, and interconnections with other systems) would be implemented to meet future needs to the extent possible. Consistent with the existing condition, WVP conservation storage water would continue to be used to meet forecasted AI demands as well as support flows for ESA listed fish species (including an allocation of conservation storage for this purpose which would permit protection of in-stream flows). This alternative is likely to fall short of supporting the forecasted demands for M&I over the study period, leading to potential concerns over the effectiveness of this alternative.

4.3.1.3 Alternative 2
Meet M&I Water Supply Needs through a Combination of Non-Federal Measures and WVP Stored Water

While it is expected that anticipated M&I demand deficits and redundancy needs could be addressed through the measures included under Alternative 1 to some degree, Alternative 2 is in place to ensure that the study goals would be achieved in the event that demand deficits remain after the full analysis of Alternative 1. Under this alternative, any shortfall of future M&I peak season demand remaining after full consideration of Alternative 1 would be addressed through an allocation of WVP conservation storage for M&I (partial implementation of measure 2). This alternative combines all measures carried forward (2, 4, 6, and 7) to enhance the effectiveness of Alternative 1. WVP stored water would continue to be available for AI, and an allocation of WVP conservation storage would have been made for F&W. As such, WVP stored water released for the benefit of ESA-listed fish would be protected by instream water rights.

4.3.1.4 Alternative 3
Meet M&I Water Supply Needs through WVP Stored Water

Under this alternative, anticipated M&I peak season supply needs would be addressed through an allocation of WVP conservation storage. Future demands would be primarily met through measure 2; allocating WVP storage to AI, M&I, and Fish and Wildlife to support future demands.

4.4 Costs of Alternatives for M&I Peak Season Water Supply

Costs of the measures that comprise Alternatives 1 through 3[58] are evaluated below, and are based on the assumption that existing M&I infrastructure would minimize the cost of adapting existing infrastructure to an alternative water source. It is also assumed that existing infrastructure would be utilized to the extent possible.

Total peak season M&I water needs for the year 2070 is 159,750 acre-feet[59] per year. Fifty-one of the 90 M&I systems are projected to have a peak season water supply deficit, which has an aggregate total of 103,200 acre-feet per year in planning year 2070. In addition to these supply deficit needs, year 2070 peak season water supply redundancy needs of 38,600 acre-feet of water per year and year 2070 SSI peak season water supply deficits of 17,950 acre-feet of water per year are included in the 159,750 acre-feet total.

4.4.1 Application of Non-Federal Measures for M&I Peak Season Supply

The costs and feasibility of applying non-federal measures for M&I peak season supply needs were evaluated for the study area M&I systems (Measures 4, 6, and 7). A combination of these non - federal measures is anticipated to be used throughout the basin, and selection of measures anticipated to be implemented is based on the assumptions listed below.

- Use of ASR to store off-peak season water (Measure 6) would be preferred over the expansion of groundwater withdrawals (Measure 4). While the costs of constructing ASR

[58] While not analyzed separately in this section, the No Action Alternative is identical to Alternative 1 with respect to the measures available to M&I systems and SSI facilities in meeting peak season demands.

[59] See Tables 3-7, 3-8, 3-9, and 3-10 above for demand figures cited in this paragraph.

facilities exceed the costs of constructing additional groundwater wells, the overall lack of groundwater availability throughout the basin would favor ASR over the expansion of groundwater withdrawals. It is recognized that there is uncertainty over whether or not universal implementation of either Measure 4 or Measure 6 would provide a reliable source of peak season supply. However, storing water during the off-peak season in ASR wells is likely to yield more basin-wide success than relying on expanded groundwater withdrawals to meet future M&I peak season needs. For this reason, Measure 4, expansion of groundwater wells, was eliminated from further consideration.

- Access to water supplied through existing interconnections with other M&I suppliers with excess capacity (Measure 7) would be the preferred non-federal measure, if feasible.

4.4.1.1 M&I Aquifer Storage and Recovery (Measure 6)

Total 2070 M&I system peak season supply deficits that would be expected to be met through ASR is 70,300 acre-feet of water per year. ASR unit costs for ASR are based on an indexed[60] cost from a 2009 system ASR facility constructed by a study area M&I system. The unit cost includes costs for construction, property acquisition, and contingencies – costs updated to 2017 are approximately $3,570,000 per MGD of capacity. This unit capital cost was applied individually to the 48 systems expected to employ this measure for a total of 70,300 acre-feet (converted to GPD) of peak season deficits. For the unmet peak season demand of 70,300 acre-feet of water per year in year 2070 across the 48 systems, capital costs equal approximately $670,076,000.

SSI peak season supply deficits of 17,950 acre-feet of water per year in the year 2070 also were addressed through implementation of this measure at an aggregate capital cost of $171,156,000.

In total, M&I system and SSI peak season supply deficits carry an ASR capital cost of $841,232,000.

Peak season system redundancy needs for all M&I systems in the study are expected to total 38,600 acre-feet of water per year by the year 2070. The most viable option for the 42 systems with a need for system redundancy also was assumed to be achieved through ASR. ASR unit capital costs for system redundancy are based on the same unit costs as described above for M&I system peak season supply deficits ($3,570,000 per MGD of capacity). For the redundant supply demand of 38,600 acre-feet of water per year by the year 2070 across the 42 systems, total capital costs of this measure equals $368,095,000.

4.4.1.2 M&I Interconnected Supply (Measure 7)

Twenty-four of the M&I systems projected to show a peak season water supply deficit in the year 2070 currently maintain physical interconnections with other M&I systems in the basin. Within the basin, 11 systems with excess peak season supply in the year 2070 maintain interconnections to the 24 systems. Year 2070 excess peak season supply available in the aggregate from the 11 systems amounts to approximately 40,530 acre-feet of water, though only 32,900 acre-feet of water could be transmitted to M&I systems with 2070 deficits through existing interconnections (i.e., not all excess supply could be utilized because not all of the excess supply is accessible to each of the 24 M&I systems). Under the interconnection supply measure, a total of 32,900 acre-feet of

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[60] October 2017 price level

alternative peak season water supply would be achieved through peak season wholesale water supply to M&I systems with peak season supply deficits in the year 2070. The annual cost of the interconnected supply measure assumes that the wholesale water purchase cost would be at a uniform rate of $1.05 per 100 cubic feet of water[61], which equates to a peak season cost of $457.38 per acre-foot. At the 2070 level of M&I peak season demand deficits that could be met through this measure (32,900 acre-feet), the annual total peak season cost for 2070 is estimated at $15,038,000.

4.4.2 Application of the Federal Measure

The costs and feasibility of applying Measure 2 (Allocation of WVP Conservation Storage for M&I Use) is evaluated below.

Total M&I peak season demand for WVP stored water in year 2070 amounts to 159,750 acre-feet of water per year. Peak season M&I system deficits are expected to be 103,200 acre-feet of water per year, peak season M&I system redundant supply needs are estimated at 38,600 acre-feet of water per year, and SSI peak season deficits are expected to total 17,950 acre-feet of water per year. Under this measure, 159,750 acre-feet of peak season demand would be met through an allocation of WVP conservation storage, and subsequent releases of stored water for M&I. The costs involved in implementation of this measure include: payment to the U.S. Treasury for the cost of storage, and non-federal capital costs of intake pipelines to a point of access, new water intakes at the points of diversion, and pump stations.

4.4.2.1 2070 Peak Season Supply Deficits for M&I Systems and SSI

The FY19 updated cost of storage for the WVP is equal to a capital cost of $2,789 per acre-foot[62] of storage. The total M&I peak demand deficit in the year 2070 is equal to 103,200 acre-feet of water per year, which yields a storage cost of $287,824,800. SSI peak season demand deficits of 17,950 acre-feet of water per year yields a storage cost of $50,062,550 – bringing the total storage cost for M&I system and SSI peak season deficits to $337,887,350.

Unit costs of intake pipelines[63] range from $94.79 per linear foot for a 7 MGD pipeline to $259.51 per linear foot for a 40 MGD pipeline. Pipeline distances to the nearest access point[64] were estimated in GIS for each of the 51 M&I systems with a peak season water supply deficit in year 2070 (an average of these distances was used for SSI facilities). Unit costs of the intake pipelines were applied to the distances, which yielded a total capital cost of $139,592,000.

Unit costs of new intakes and pump stations were estimated at $12,500 per MGD, and costs for new pump stations were estimated at $132,500 per MGD. The unit costs were applied to the year 2070 peak season MGD requirements of the 51 M&I systems and SSI facilities for a total capital cost of $49,900,000.

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[61] The current (2017 price level) average price charged by major M&I systems for wholesale water in the basin.

[62] See Section 7, Table 7-3 below. December 2019 price level.

[63] Unit costs for intake pipelines, intakes, and pump stations were derived from the 2008 Yamhill County Water Supply Analysis, and updated to October 2017 price levels.

[64] For M&I systems with existing surface water rights to the Willamette River or tributaries on which a WVP reservoir is located, this distance is equal to zero.

4.4.2.2 2070 M&I System Redundancy

Unit costs involved in implementation of this measure are identical to those used in the analysis of M&I 2070 system deficits, above. The total M&I redundant demand in the year 2070 is equal to 38,600 acre-feet of water per year, which yields storage costs of $107,655,400. Unit costs of intakes and pump stations were applied to each of the 42 systems with redundancy needs, which yielded a total capital cost of $14,950,000.

4.4.2.3 Operation and Maintenance Cost Share

An annual Operation and Maintenance (O&M) cost is based on the O&M expense for the WVP from the federal fiscal year most recently ended. FY19 O&M costs for the WVP total roughly $35,467,000. The M&I demand for 159,750 acre-feet of WVP stored water represents 10.05 percent of the 1,590,000 acre-feet of conservation storage available. At the 10.05 percent share level, M&I would be responsible for $3,561,400 in annual O&M charges, though the actual O&M cost charged would be recalculated each year based on the previous year's O&M cost.

4.5 Comparison of Alternatives

Initial capital costs and annual costs of the measures are assembled in this section for Alternatives 1 through 3. Cost data are provided for each alternative, and the section concludes with a comparative summary of these data for the alternatives.

4.5.1 Alternative 1: Meet M&I Water Supply Needs through Non-Federal Measures

Alternative 1 is identical to the No Action Alternative with respect to the measures available for future M&I peak season water supply - M&I suppliers would not be able to access WVP stored water. However, Alternative 1 would differ from the No Action Alternative, as it would include an allocation of WVP conservation storage for F&W – WVP stored water released for F&W benefits would be protected by instream water rights. Under Alternative 1, total M&I peak season demands of 159,750 acre-feet of water per year would be met through non-federal Measures 6 and 7. Measure 6, ASR, would address 126,850 acre-feet of water supply deficits per year, redundancy needs, and SSI demands. Measure 7, interconnected supply, would address 32,900 acre-feet of water supply deficits per year.

Table 4-4 provides a summary of initial capital and annualized costs for Alternative 1. As shown on the table, Alternative 1 is associated with total initial capital costs of $1,209,327,000, and total annual costs[65] of $60,930,000.

[65] Initial capital costs annualized using the FY 2019 discount rate of 2.875 percent over a 50 year period of amortization

Table 4-4
Alternative 1 Cost Summary

INITIAL CAPITAL COSTS (Oct 2017 price level)	**Cost ($)**
Aquifer Storage and Recovery M&I systems and SSI deficits, Measure 6 88,250 acre-feet of demand met through measure	841,232,000
Aquifer Storage and Recovery (38,600 acre-feet) M&I systems redundancy, Measure 6 38,600 acre-feet of demand met through measure	368,095,000
TOTAL INITIAL CAPITAL COSTS	**1,209,327,000**
ANNUAL COSTS	
Annualized Capital Costs	45,892,000
Interconnection Wholesale Water Purchase M&I systems deficits, Measure 7 32,900 acre-feet of demand met through measure	15,038,000
TOTAL ANNUAL COSTS (159,750 acre-feet)	**60,930,000**

4.5.1 Alternative 2: Meet M&I Water Supply Needs through a Combination of Non-Federal Measures and Willamette Valley Project Reservoir Storage

Alternative 2 is in place to ensure that study goals would be achieved in the event that M&I demand needs remain after the full analysis of Alternative 1. Under this alternative, any shortfall of future M&I peak season needs remaining after full consideration of Alternative 1 would be addressed through an allocation of WVP conservation storage for M&I.

Following the full evaluation of Alternative 1 for M&I peak season needs, no deficits remained that would need to be addressed through an allocation of WVP conservation storage for M&I. While the costs of the non-federal measures (Measures 6 and 7) are considerably greater than the cost of the federal measure in the aggregate, M&I peak season water supply needs could be met through non-federal measures. Given that there would be no difference in cost between Alternative 1 and Alternative 2, Alternative 2 was eliminated from further consideration.

4.5.2 Alternative 3: Meet M&I Water Supply Needs through WVP Stored Water

Alterative 3 uses Measure 2, Allocation of WVP Conservation Storage for M&I Use, to address 159,750 acre-feet of anticipated M&I peak season water supply demands in year 2070. Table 4-5 provides a summary of initial capital and annualized costs for Alternative 3. The updated cost of WVP storage for 159,750 acre-feet is represented by the first two cost items in Table 4-5 ($309,417,100 and $98,584,400). As shown on the table, Alternative 3 has total initial capital costs of $594,493,500 and total annual costs[66] of $25,840,300.

[66] Initial capital costs annualized using the FY 2019 discount rate of 2.875 percent over a 50 year period of amortization

Table 4-5
Alternative 3 Cost Summary

INITIAL CAPITAL COSTS (Oct 2017 price level)	**Cost ($)**
WVP Storage Allocation Capital Costs M&I systems and SSI deficits, Measure 2 121,150 acre-feet of demand met through measure	309,417,100
WVP Storage Allocation Capital Costs M&I systems redundancy, Measure 2 38,600 acre-feet of demand met through measure	98,584,400
Conveyance to Access WVP (M&I systems and SSI deficits, Measure 2)	139,592,000
Intakes and pump stations to Access WVP (M&I systems and SSI deficits, Measure 2)	46,900,000
Intakes and Pump Stations to Access WVP (M&I systems redundancy, Measure 2)	14,950,000
TOTAL INITIAL CAPITAL COSTS	**594,493,500**
ANNUAL COSTS	
Annualized Capital Costs	22,559,900
WVP O&M Cost Share (based on 159,750 acre-feet, Measure 2)	3,280,400
TOTAL ANNUAL COSTS (159,750 acre-feet)	**25,840,300**

4.5.3 Comparison of Alternatives 1 and 3

Initial capital costs and annual costs for Alternatives 1 and 3 are shown on Table 4-6. The table shows that Alternative 3 is the least-cost alternative in terms of both initial capital costs, and annual costs. Table 4-7 shows the comparison of Alternatives 1 and 3 against the four P&G criteria.

Table 4-6
Costs Comparison of Alternatives

INITIAL CAPITAL COSTS (Oct 2017 price level)	**Alternative 1 ($)**	**Alternative 3 ($)**
Aquifer Storage and Recovery M&I systems and SSI deficits, Measure 6 88,250 acre-feet of demand met through measure	841,232,000	
Aquifer Storage and Recovery (38,600 acre-feet) M&I systems redundancy, Measure 6 38,600 acre-feet of demand met through measure	368,095,000	
WVP Storage Allocation Capital Costs M&I systems and SSI deficits, Measure 2 121,150 acre-feet of demand met through measure		309,417,100
WVP Storage Allocation Capital Costs M&I systems redundancy, Measure 2 38,600 acre-feet of demand met through measure		98,584,400
Conveyance & Intakes to Access WVP (M&I systems and SSI deficits, Measure 2)		139,592,000
Intakes and pump stations to Access WVP (M&I systems and SSI deficits, Measure 2)		46,900,000
Conveyance & Intakes to Access WVP (M&I systems redundancy, Measure 2)		14,950,000
TOTAL INITIAL CAPITAL COSTS	**1,209,327,000**	**594,493,500**
ANNUAL COSTS		
Annualized Capital Cost	45,892,000	22,559,900
Interconnection Wholesale Water Purchase M&I systems deficits, Measure 7 32,900 acre-feet of demand met through measure	15,038,000	
M&I WVP O&M Cost Share (based on 159,750 acre-feet, Measure 2)		3,280,400
TOTAL ANNUAL COSTS	**60,930,000**	**25,840,300**

Table 4-7 TSP Comparison Criteria

Comparison Criteria	Alternative 1	Alternative 3
Completeness – The extent a given alternative provides and accounts for all necessary investments or other actions to ensure realization of the planning effects.	Less Complete: would require extensive water rights transfers and construction of water transfer infrastructure that are likely to cause implementation challenges.	More Complete: Storage can be allocated to the identified purposes and the state is likely to undertake legislative actions necessary to permit awarding contracts.
Effectiveness – The extent the alternative meets the planning objectives.	Effective – Demonstrated that forecasted demands could be supported through this alternative	Effective – Demonstrated that forecasted demands could be supported through this alternative.
Efficiency – The extent to which an alternative is the most cost-effective water source to the public.	Less Efficient – Total annual costs = $60,930,000	More Efficient – Total annual costs = $25,840,300
Acceptability – The workability and viability of the alternative with respect to Federal and non-Federal entities and the public, and is compatible with applicable laws, regulations, and public policies	Less Acceptable – Potential legal hurdles with transfer of existing water rights.	More Acceptable – State of Oregon water rules identify federal storage as a source of future water supply. State legislative processes are in place to permit transfer of storage certificates.

Given the least cost advantages of Alternative 3 over Alternative 1, and because Alternative 3 would help to fulfill the intent of language included House Doc. 531, Volume 5. Paragraph 198 ("*Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand.")*, Alternative 3 was selected as the Proposed Action. Its further development into the Agency Recommended Plan is documented in the following section.

5 Proposed Action Development into the Agency Recommended Plan

This section documents the refinement of the Proposed Action (Alternative 3) into an Agency Recommended Plan (ARP). The ARP includes a conservation storage reallocation and water management guidelines for the use of the reallocated conservation storage over the full range of water year types[67]. Specifically, the development process involves the selection of an alternative WVP conservation storage reallocation volume for each of the water use categories described in Section 3: F&W; M&I; and AI. The ARP development process also involves the selection of alternative water management guidelines for years when WVP stored water would be insufficient to meet all of the reallocated uses.

5.1 Planning Considerations and Criteria

Planning Objectives and Constraints outlined in Section 1 of this document guided the overall planning process for the feasibility study, and continue to guide the formulation and evaluation of reallocation alternatives and water management alternatives. The formulation and evaluation of reallocation and management alternatives also was guided by more specific planning considerations and criteria, as listed below.

Consideration 1: One hundred percent reliability of WVP stored water is not feasible for all water year types and all water use categories. Conservation storage at WVP reservoirs is emptied annually for flood storage, and full refill of conservation storage is not guaranteed. Agreements for WVP stored water would be issued for less than 100 percent reliability.

Consideration 2: Operational flexibility will be maintained to achieve mainstem and tributary flow objectives to the maximum extent possible in support of ESA-listed fish.

Criterion 1: Maintain flood risk management capabilities

Criterion 2: Minimize costs for M&I water supply

Criterion 3: Meet BiOp flow objectives to the maximum extent possible

Criterion 4: Minimize impacts to reservoir and riverine recreation

Criterion 5: Minimize impacts to hydropower production capabilities

Criterion 6: Maintain technical feasibility and operational flexibility

Criterion 7: Adaptable to changing demands and climate conditions

Criterion 8: Meet demands at least 80 percent of the time

5.2 Conservation Storage Reallocation Alternatives

The development of reallocation alternatives for WVP conservation storage begins with the sum of peak demands for WVP stored water from each of the three use categories. The sum of peak

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67 See Section 3.1 above for a discussion of water-year types.

storage demands equals 2,077,400 acre-feet of stored water per year, as described below and shown in Table 5-1.

5.2.1 Fish & Wildlife Demand

The F&W peak demand for WVP stored water is the maximum amount of water that would be released from WVP stored water plus the shortage required to be released from WVP stored water needed to supplement instream flows to meet all tributary and mainstem minimum flow objectives defined in the BiOp. F&W peak demand for WVP stored water is **1,590,000**[68] acre-feet. This value is based on the estimated volume of WVP stored water needed to meet BiOp mainstem and tributary flow objectives 100 percent of the time, with a maximum value limited to the volume of WVP conservation storage (1,590,000 acre-feet). F&W peak demand is fully documented in FR/EA Appendix C (Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows).

5.2.2 Municipal & Industrial 2070 Peak Season Demand

M&I peak season demand for WVP stored water of **159,750** acre-feet is comprised of three elements: [69]

1. M&I system peak season demand of **<u>103,200</u>** acre-feet of stored water for the year 2070, which represents aggregate M&I system peak season supply deficits.
2. M&I system peak season redundant supply demand of **<u>38,600</u>** acre-feet of stored water for the year 2070, which represents storage demand for supply backup purposes.
3. New SSI peak season demand at **<u>17,950</u>** acre-feet of stored water in the year 2070.

5.2.3 Agricultural Irrigation Peak Demand

AI peak season demand for WVP stored water of **327,650** acre-feet is comprised of three elements: [70]

1. Increase in demand for AI storage at **<u>184,200</u>** acre-feet of stored water, which is based on irrigated acreage increases from the year 2020 through the year 2070 at a 2.5 acre-feet per acre irrigation rate.
2. At-risk live flow water rights of **<u>62,050</u>** acre-feet of stored water, which is based on water rights currently being drawn on streams with MPSFs. It is expected that, outside of increases in AI storage demand, 62,050 acre-feet of stored water would be requested when MPSFs are converted to instream water rights.
3. Reclamation water supply contracts projected to be in place at year 2020, which totals **<u>81,400</u>** acre-feet of stored water.

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[68] See Section 3.1.

[69] Sources of the values are described in Section 3.2 above, and are summarized on Table 3-10.

[70] Sources of the values are described in Section 3.3 above, and are summarized on Table 3-12.

Table 5-1
Peak Season Demands for WVP Stored Water
M&I and AI Stated at Year 2070 Levels

Allocation Use Category	Peak Demands (acre-feet)	Portion of Total (percent)
Fish & Wildlife	1,590,000	76.5
Municipal & Industrial	* 159,750	7.7
Agricultural Irrigation	* 327,650	15.8
Total	2,077,400	100.0

* Peak demands presented for M&I and AI are peak season demands at 2070 levels.

As shown in the table, the sum of the peak season demands (2,077,400 acre-feet of stored water) is greater than the amount of **total** WVP conservation storage available (1,590,000 acre-feet). Therefore, reallocation of all uses at the volumes shown in Table 5-1 is infeasible. Nevertheless, peak season demands were used to develop reallocation alternatives that would not exceed WVP conservation storage. Reallocation alternatives are as follows:

- Reallocation Alternative A: Proportionate Reduction in Storage for all Uses
- Reallocation Alternative B: Prioritize F&W Storage at Peak Level
- Reallocation Alternative C: Prioritize M&I and AI Storage at 2070 Peak Levels
- Reallocation Alternative D: Partial Allocation for all Uses with Joint Use Flexibility

5.2.4 Reallocation Alternative A: Proportional Reduction in Storage for all Uses

Under Reallocation Alternative A, the allocation for each of the three use categories is reduced proportionately from those shown in Table 5-1. Since 1,590,000 acre-feet equals 76.5 percent of 2,077,400 acre-feet (total peak season demand for all three use categories), the reallocation of WVP conservation storage for each use category would be set at 76.5 percent of its peak demand (2070 peak season demand levels for M&I and AI). The resulting allocations by use category are shown below with all of the existing Joint Use allocation depleted.

- F&W conservation storage allocation: 1,216,950 acre-feet
- M&I conservation storage allocation: 122,250 acre-feet
- AI conservation storage allocation: 250,800 acre-feet
- Joint Use conservation storage allocation: 0 acre-feet

5.2.5 Reallocation Alternative B: Prioritize Fish & Wildlife Storage at Peak Level

Under Reallocation Alternative B, 1,508,600 acre-feet of WVP conservation storage would be allocated to F&W, with 81,400 acre-feet remaining for allocation to AI. While F&W peak demand is the full 1,590,000 acre-feet of WVP stored water, an allocation of 81,400 acre-feet of conservation storage for AI must be made to accommodate the volume of Reclamation water supply contracts expected to be in place by Year 2020. Without the AI allocation of 81,400 acre-feet of storage, this reallocation alternative would be institutionally feasible – Reclamation would be prevented from fulfilling its expected water supply contract obligations. Under this reallocation alternative there would be no allocation to M&I, as WVP conservation storage would be fully allocated to F&W and AI. The resulting allocations by use category are shown below with all of the existing Joint Use allocation depleted.

- F&W conservation storage allocation: 1,508,600 acre-feet
- M&I conservation storage allocation: 0 acre-feet
- AI conservation storage allocation: 81,400 acre-feet
- Joint Use conservation storage allocation: 0 acre-feet

5.2.6 Reallocation Alternative C: Prioritize M&I and AI Storage at 2070 Peak Season Demand Levels

Under Reallocation Alternative C, M&I would be allocated 159,750 acre-feet of WVP conservation storage, and 327,650 acre-feet of conservation storage would be allocated to AI. The remaining 1,102,600 acre-feet of conservation storage would be allocated to F&W. The resulting allocations by use category are shown below with all of the existing Joint Use allocation depleted.

- F&W conservation storage allocation: 1,102,600 acre-feet
- M&I conservation storage allocation: 159,750 acre-feet
- AI conservation storage allocation: 327,650 acre-feet
- Joint Use conservation storage allocation: 0 acre-feet

5.2.7 Reallocation Alternative D: Reallocation at Reduced Peak Demand Levels with Joint Use Flexibility

Reallocation Alternative D reflects an approach where a reduced volume of WVP conservation storage is allocated to each use category and a substantial share of conservation storage remains allocated to Joint Use. The allocations by use category for this alternative are shown below.

- F&W conservation storage allocation: 962,800 acre-feet
- M&I conservation storage allocation: 73,300 acre-feet
- AI conservation storage allocation: 253,950 acre-feet
- Joint Use conservation storage allocation: 299,950 acre-feet

5.2.7.1 Reallocation Alternative D Fish & Wildlife Allocation Volume

Under this reallocation alternative, F&W would be allocated 962,800 acre-feet of WVP conservation storage – a reduction of 39.5 percent from the F&W peak volume of 1,590,000 acre-feet of stored water. The reduction to the F&W allocation under Reallocation Alternative D mirrors the reduction imposed on the combined M&I and AI peak demand volumes[71] for this alternative. As discussed in 5.2.2 and 5.2.3 above, the sum of M&I and AI peak demands in Year

[71] Excluding Reclamation contracts in the amount of 81,400 acre-feet expected to be in place at year 2020.

2070, excluding Year 2020 Reclamation water supply contracts, is 406,000 acre-feet, and is comprised of 159,750 acre-feet of stored water for M&I and 246,250[72] acre-feet of stored water for AI. The sum of reduced M&I and AI peak demand volumes for Reallocation Alternative D is 245,850 acre-feet of stored water, and is comprised of 73,300 acre-feet of stored water for M&I and 172,550[73] acre-feet of stored water for AI. The total reduction for the combined M&I and AI demands from the combined peak demands equals 160,150 acre-feet of stored water (406,000 acre-feet – 245,850 acre-feet), a 39.5 percent reduction.

5.2.7.2 Reallocation Alternative D Municipal & Industrial Allocation Volume

The WVP conservation storage allocation for M&I is reduced from 2070 peak season demands to reflect the uncertainty that demands projected for the year 2070 would fully materialize when expected. Conservation storage allocated to M&I is the peak season M&I system demand of 62,400 acre-feet of stored water in the year 2050, and SSI demand of 10,900 acre-feet of stored water in the year 2050 (see Table 3-10 above). Under this allocation alternative, M&I redundant supply demands are not included in the dedicated allocation, though would be supplied from the Joint Use allocation of 299,950 acre-feet of WVP conservation storage through surplus water agreements. Additionally, M&I redundant supply demands were not included in the Reallocation Alternative D because M&I systems would be responsible for repaying the cost of storage (see Section 7 below) for redundant supply whether or not WVP stored water is used. As such, a surplus water agreement tied to the Joint Use allocation would provide a more economically efficient option for meeting M&I redundant supply needs.

5.2.7.3 Reallocation Alternative D Agricultural Irrigation Allocation Volume

Similar to the M&I allocation, the WVP conservation storage allocation for AI is reduced from 2070 peak season demands (for increases in irrigated acreage only) in recognition of the inherent uncertainty of a forecast made 50 years into the future. The entire AI allocation of 253,950 acre-feet of WVP conservation storage is comprised of:

- 110,500 acre-feet of increased irrigation demand for stored water due to permitted acreage increases expected by the year 2050[74];
- At-risk live flow water rights of 62,050 acre-feet (unchanged from the volume provided in Section 5.2.3 above); and
- Reclamation water supply contracts in the amount of 81,400 acre-feet of stored water expected to be in place at year 2020 (unchanged from the volume provided in Section 5.2.3 above).

5.2.7.4 Reallocation Alternative D Joint Use Allocation Volume

As shown above, 299,950 acre-feet of WVP conservation storage would remain as Joint Use to provide future flexibility in meeting demands, as all use categories could claim a portion of Joint

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[72] Addition of 81,400 acre-feet of Year 2020 Reclamation contracts brings the AI total to 327,650 acre-feet.

[73] Excluding 81,400 acre-feet in Reclamation contracts expected to be in place by Year 2020.

[74] See Section 3.3, Table 3-12.

Use storage as their peak season demands for WVP stored water materializes. Further, Table 3-16 (see Section 3.4 above) shows climate change-induced impacts could result in an increase of over 445,000 acre-feet in peak season demand for stored water by the year 2070. With 299,950 acre-feet of WVP conservation storage remaining allocated to Joint Use, the Corps would be provided with additional flexibility in meeting demands in the event that demands become influenced by changing climate conditions.

5.2.8 Summary and Screening of Reallocation Alternatives

A summary of Reallocation Alternatives A through D is shown in tabular form on Table 5-2, and graphically on Figure 5-1. It should be reiterated that the No Action Alternative includes all 1,590,000 acre-feet of conservation allocated to Joint Use, with no specific allocation for dedicated uses.

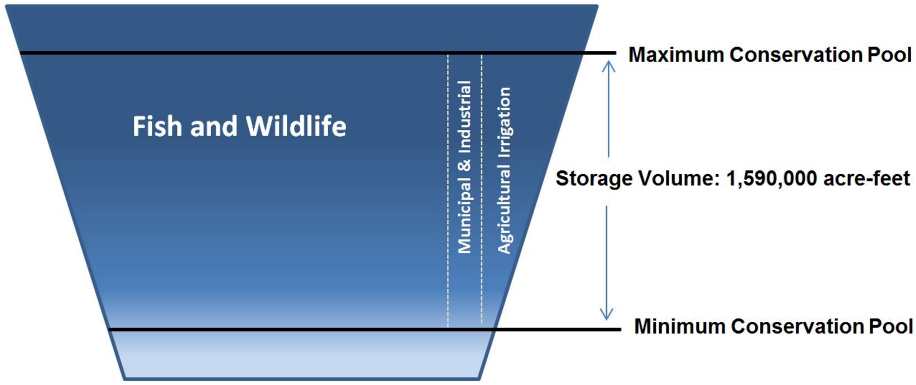
Table 5-2
Summary of Reallocation Alternatives

Allocation Use Category	Peak Storage Demand	Reallocation Alt A	Reallocation Alt B	Reallocation Alt C	Reallocation Alt D
		Conservation Storage Allocation (acre-feet)			
Fish & Wildlife	1,590,000	1,216,950	1,508,600	1,102,600	962,800
Municipal & Industrial	159,750	122,250	0	159,750	73,300
Agricultural Irrigation	327,650	250,800	81,400	327,650	253,950
Joint Use	0	0	0	0	299,950
Total	**2,077,400**	**1,590,000**	**1,590,000**	**1,590,000**	**1,590,000**
		Percent of Allocation			
Fish & Wildlife	76.5	76.5	94.9	69.3	60.6
Municipal & Industrial	7.7	7.7	0.0	10.1	4.6
Agricultural Irrigation	15.8	15.8	5.1	20.6	16.0
Joint Use	0.0	0.0	0.0	0.0	18.8
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 5-1
Graphic Comparison of Reallocation Alternatives A through D

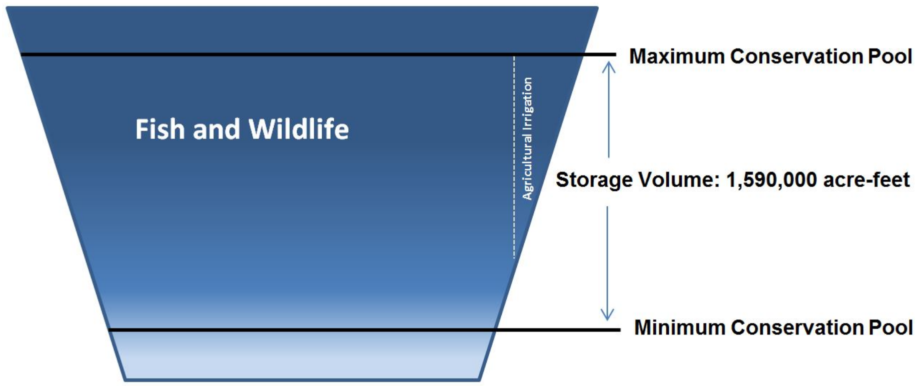
Reallocation Alternative A (acre-feet)

F&W:	1,216,950
M&I:	122,250
AI:	250,800
Joint Use:	0
Total Allocation	1,590,000



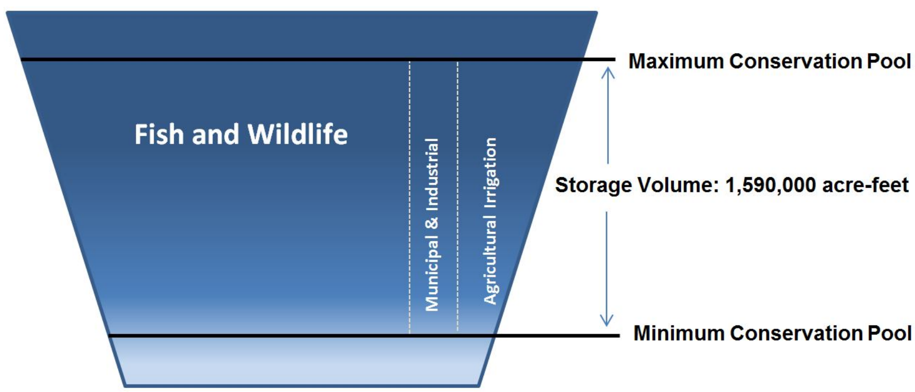
Reallocation Alternative B (acre-feet)

F&W:	1,508,600
M&I:	0
AI:	81,400
Joint Use:	0
Total Allocation	1,590,000



Reallocation Alternative C (acre-feet)

F&W:	1,102,600
M&I:	159,750
AI:	327,650
Joint Use:	0
Total Allocation	1,590,000



Reallocation Alternative D (acre-feet)

F&W:	962,800
M&I:	73,300
AI:	253,950
Joint Use:	299,950
Total Allocation	1,590,000

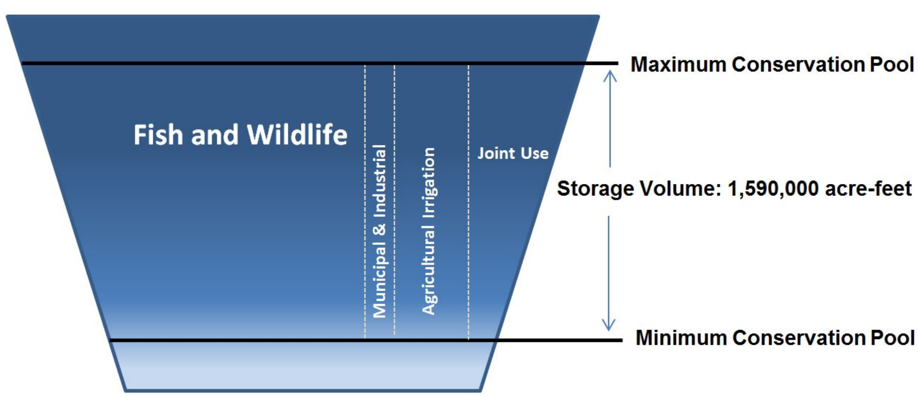


Table 5-3 Screening of Reallocation Alternatives

Reallocation Screening Criterion	Alternative A	Alternative B	Alternative C	Alternative D
Criterion 1: Maintain flood risk management capabilities	+++	+++	+++	+++
Criterion 2: Minimize costs for M&I water supply	+++		+++	++
Criterion 3: Meet BiOp flow objectives to the maximum extent possible	+++	+++	+++	++
Criterion 4: Minimize impacts to reservoir and riverine recreation	+++	+++	+++	+++
Criterion 5: Minimize impacts to hydropower production capabilities	+++	+++	+++	+++
Criterion 6: Maintain technical feasibility and operational flexibility	++	++	++	+++
Criterion 7: Adaptable to changing demands and climate conditions	+	+	+	+++
Criterion 8: Meet demands at least 80 percent of the time	++	+	+++	++

Table 5-3 shows the evaluation of the reallocation alternatives against the screening criteria. As a result of the screening process, it was determined that all of the reallocation alternatives would maintain flood risk management capabilities (Criterion 1). Reallocation Alternative B would contribute nothing to the minimization of costs for M&I water supply (Criterion 2), though all of the remaining reallocation alternatives would provide WVP stored water for M&I use at a reduced cost from the No Action Alternative. The ability to meet BiOp flow objectives to the maximum extent possible (Criterion 3) played a primary role in the development of the reallocation alternatives. Each alternative ensures that WVP stored water would be available to meet this goal. It also was determined that impacts to recreation (Criterion 4) and hydropower production (Criterion 5) would not be measurably different among the reallocation alternatives, and that each of the reallocation alternatives would be technically feasible, though Reallocation Alternative D would provide the most operational flexibility (Criterion 6).

The major difference among the reallocation alternatives lies in their ability to adapt to changes in long-term demand and changes in climate conditions that may further affect demand (Criterion 7). Reallocation Alternatives A, B and C were eliminated from further consideration during the first iteration of the formulation process, since these alternatives would not provide flexibility to respond to changes in demand, to implement changes in WVP operations related to BiOp implementation, and to implement changes in WVP operations related to Dam Safety Interim Risk Reduction Measures.

5.2.9 Tentatively Selected and Agency Recommended Reallocation Alternatives

During the first iteration of the formulation process, it was determined that Reallocation Alternative D would provide the most flexibility to adapt to changing future conditions and was initially carried forward as the tentatively selected reallocation alternative.

After the Agency Decision Milestone, the Corps and OWRD determined Reallocation Alternative C best meets the planning objectives by providing a source of water to support the forecasted demands for M&I and AI water supply over the full period of analysis (2070) and provides increased percentage of stored water for fisheries.. This alternative also avoids potential future conflicts over the allocation of the remaining conservation storage over the period of 2050-2070.

Reallocation Alternative C provides a greater volume of WVP conservation storage for consumptive and instream purposes and addresses some of the concerns raised through public comments. OWRD fully understands that water will not be available to satisfy all authorized project purposes during time of drought, and that the Corps is required to meet the flow objectives specified in the 2008 BiOp. There is both sponsor and basin stakeholder support for this plan selection.

5.3 Alternative Water Management Plans

Implementation of the ARP also requires the development of water management plans for years when WVP conservation storage does not refill to 1,590,000 acre-feet. Management of WVP stored water during years when the reservoirs do not refill has a substantial effect on the reliability of the WVP meet authorized purposes. Reliability is measured by whether stored water would be available in the reallocated volumes or not. Since the reservoirs do not fill every year, 100% reliable water supply from storage is not possible. M&I and AI users would need to seek other sources of water or employ additional conservation measures to achieve 100% reliability.

Three alternative water management plans were developed to describe how water shortages would be managed, and are outlined below.

- Alternative Management Plan 1: All uses are reduced during years when WVP conservation storage does not fill to the volume of the reallocation for F&W, M&I and AI (1,590,000 acre-feet of stored water – total uses from Reallocation Alternative C in Table 5-2). Under this alternative management plan, releases of WVP stored water for the three dedicated uses would be reduced when conservation storage does not refill.
- Alternative Management Plan 2: Use of WVP stored water for F&W would be prioritized up to its allocated amount. Any remaining WVP stored water would be divided between M&I and AI on a basis proportionate to contracted volumes, not allocated volumes.

- Alternative Management Plan 3: Use of WVP stored water for M&I and AI would be prioritized, up to the contracted amounts. Any remaining WVP stored water would be provided to F&W.

The alternative water management plans were combined with Reallocation Alternative C and further screened to evaluate how well demands could be met, especially during dry years. Table 5-4 provides the screening results of whether the modeled implementation alternatives met demands of F&W, AI, and M&I in more than or less than 80 percent of the years simulated.

Table 5-4
Expected Frequencies for Meeting Use Category Demands

Implementation Alternative	F&W BiOp Flow Objectives	M&I Peak Season Demands	AI Peak Season Demands
Reallocation Alternative C Mgmt Plan 1	Fully met in less than 80% of years, once the storage is fully contracted for. Conservation storage up to 1.23 MAF is 80% reliable. Storage above 1.23 MAF is less reliable.		
Reallocation Alternative C Mgmt Plan 2	Fully met in more than 80% of years simulated.	Fully met in less than 80% of years simulated and results in years where no stored water is available for use.	Fully met in less than 80% of years simulated and results in years where no stored water is available for use.
Reallocation Alternative C Mgmt Plan 3	Fully met in less than 80% of years simulated and results in years where no stored water is available for use.	Fully met in more than 80% of years simulated.	Fully met in more than 80% of years simulated.

Only one of the alternative management plans, Management Plan 1, enables the Corps to manage the WVP in order to provide stored water for all use categories across the full range of water year types. The other two alternative management plans result in years where one or more use categories would not have access to WVP stored water.

5.4 Agency Recommended Plan

The ARP[75] is Alternative 3C1, which includes allocations for specific uses, Reallocation Alternative C, as well as guidelines for managing WVP stored water releases when conservation storage does not fill to 1,590,000 acre-feet, which is Alternative Management Plan 1. Impacts to the authorized purposes associated with the ARP are evaluated in detail throughout the remaining sections of this report. The evaluations show that differences between the No Action Alternative and the ARP are minimal in most years, with the greatest differences occurring in extremely dry years.

[75] For the purposes of NEPA, the ARP is the preferred alternative.

5.4.1 ARP Conservation Storage Allocations

Under the reallocation alternative selected to accompany the ARP (Reallocation Alternative C), WVP conservation storage allocations by use category are as follows[76]:

- F&W conservation storage allocation: 1,102,600 acre-feet
- M&I conservation storage allocation: 159,750 acre-feet
- AI conservation storage allocation: 327,650 acre-feet
- Joint Use conservation storage allocation: 0 acre-feet

5.4.2 ARP Adaptive Management Plan

The ARP includes an adaptive water management plan. Adaptive management of flows involves making adjustments to reservoir operations and flow releases based on current and forecasted hydrologic conditions and will distribute the risk of insufficient water quantities among all authorized project purposes. In years of short water supply, stored water will be made available to each use category relative to contracted volumes, not allocated volumes. The Corps recommends this approach when the full supply of WVP conservation storage is not available, so the maximum possible benefits for authorized uses could be achieved. Allocated storage that is not under contract would be treated as Joint Use on an annual basis. Release of this water would be managed to provide the most beneficial overall regulation.

F&W, M&I and AI uses have the highest priority on the 1,590,000 acre-feet of WVP stored water between minimum and maximum conservation pool elevations. WVP stored water released for other uses are water quality and hydropower operations. Reservoir and riverine recreation have no priority on WVP stored water; however, as much consideration as possible will be extended without adversely affecting the other authorized purposes. In most instances, WVP stored water released for a specific purpose would also benefit other interests. Insofar as possible, regulation of the WVP considers the requirements of the non-consumptive interests as well as F&W, AI, and M&I so that preferential treatment would not be accorded any particular interest to the exclusion of the needs of the others. The basic policy will be to provide the most beneficial overall regulation of the WVP that is consistent with the water control plan and federal and state water laws.

During the conservation release season, demand for WVP stored water will vary from year to year depending upon the natural streamflow and the amount of stored water in the reservoirs. Water available for each use in any given year is dependent upon the system-wide WVP conservation storage accumulated during the refill period. Therefore, a fixed schedule for releasing WVP stored water is not practical. To implement the ARP on an annual basis, a draft plan for reservoir operations for the upcoming year will continue to be developed annually with state and federal agencies, and shared with local groups and the public. The draft plan used currently is called the "Willamette Basin Project Conservation Release Season Operating Plan, Water Year 20XX, where "XX" is the water year. This plan is referred to as the "annual Conservation Plan", or Conservation Plan." The plan identifies flow and storage needs for each WVP tributary and reservoir based on the anticipated total system storage in mid-May and from the April forecast and will be finalized in June of each year. The objective is to develop a collaborative plan for the release of WVP stored

[76] Derivation of these volumes is provided in Section 5.2.6 above.

water which accommodates a broad range of beneficial uses, once anticipated precipitation and runoff patterns are analyzed and the release of stored water from the conservation pool can be scheduled. The plan provides detailed individual project and system flow objectives, project operating drawdown priorities, minimum and maximum flows, and recommends flow shaping operations to balance the multipurpose needs given the availability of water and is referred to during actual operations. The general operational goal is to ensure that each reservoir holds water stored above its minimum conservation pool elevation through October 31 while meeting all project purposes.

The Conservation Plan is reviewed periodically throughout the conservation release season and is revised, if necessary, to meet changing conditions and water demands. During years with inadequate conservation storage when minimum flow requirements and contracted WVP stored water cannot be met in full, all authorized project purposes would be reduced.

The existing interagency group, called the Flow Management Water Quality Team (FMWQT), will continue meeting regularly during the conservation planning and release seasons to adaptively manage WVP stored water as basin conditions change or differ from those anticipated when the annual Conservation Plan was developed. The FMWQT is made up of representatives from federal, state and local agencies including the Corps, OWRD, ODFW, ODA, ODEQ, Oregon State Marine Board, NOAA Fisheries, USFWS, USFS, USBLM, and Reclamation. OWRD acts as the representative of the state of Oregon.

During droughts, the Corps goal is to respond proactively so that drought-related impacts to authorized purposes can be minimized. Using the information discussed in the Drought Contingency Plan, the Corps may declare a WVP stored water shortage; coordination with other federal and state agencies will be initiated, and a modified release schedule will be developed. In this manner, WVP stored water shortages would be effectively moderated so that F&W, M&I, and AI receive a reduction from their contracted portion of WVP conservation storage.

Once secondary water rights are issued for use of WVP stored water, OWRD will manage the water rights for use of the water following state water laws.

5.5 System of Accounts Comparison

Table 5-5 summarizes the system of accounts analysis for the No Action Alternative and the Agency Recommended Plan.

The National Economic Development (NED) account includes the annualized costs to implement, maintain, and operate each alternative. In addition, the NED account summarizes the annual value of NED recreation benefits under each alternative. The Regional Economic Development (RED) account addresses economic characteristics important to the state, counties, and communities in the study area. No federal funds would be allocated to this effort. In the event the local sponsors choose to take advantage of federal financing, they pay for reallocated storage over time along with appropriate level of interest (repayment period not to exceed 30 years). In any event, no significant RED impact is considered likely and the cost of an input output study to better identify the impacts is not believed to be warranted for this analysis.

The Environmental Quality Account summarizes potential environmental issues, impacts, and related information associated with each alternative. Each of the impact areas are discussed in more detail in Section 6 of this FR/EA. The Other Social Effects Account compares alternatives in areas of life, health, safety, and community cohesion. Downstream life, safety, and health would not be affected because neither alternative would increase existing flood risks.

Table 5-5
System of Accounts: No Action Alternative & Agency Recommended Plan

	No Action Alternative	Agency Recommended Plan
National Economic Development Account		
Annual NED Cost	Approximately $60 million average annual costs to residents and businesses due to need to offset water demand by other, more costly means.	Approximately $25 million average annual costs to in Storage Allocation and O&M Costs to access WVP stored water
Annual NED Recreation Benefits	No effect	Minor decrease in annualized motorized boating recreation benefits of $12,150
Regional Economic Development Account	No significant regional costs	No significant regional costs
Environmental Quality Account		
Climate and Climate Change	No effect	No negative effect expected
Cultural Resources	No effect	No negative effect expected
Water Quality	No effect	No negative effect expected
Noise Levels	No effect	No negative effect expected
Aesthetics	No effect	No negative effect expected
Sediment and Erosion	No effect	No negative effect expected
Flooding	No effect	No negative effect expected
Aquatic Habitat	No effect	No negative effect expected
Riparian Habitat	No effect	No negative effect expected
Wetlands	No effect	No negative effect expected
T&E Species	Without a reallocation of WVP conservation storage, stored water releases intended to benefit ESA-listed fish, releases would continue to be unprotected and continue to be available for use by existing water right holders per Oregon water law.	Stored water releases intended to benefit ESA-listed fish, releases would be protected. No negative effect expected.

Prime and Unique Farmland	No effect	No negative effect expected
Other Social Effects Account	No effect	No negative effect expected

6 Environmental Consequences

6.1 Determining Significance – Consideration of Context and Intensity

NEPA and the CEQ's Implementing Regulations require that NEPA documents identify the likely environmental effects of a proposed project and that the agency determine whether those impacts may be significant. The determination of whether an impact significantly affects the quality of the human environment must consider the *context* of an action and the *intensity* of the impacts (40 C.F.R. § 1508.27).

The term *context* refers to the affected environment in which the proposed action would take place and is based on the specific location of the proposed action, taking into account the entire affected region, the affected interests, and the locality. The term *intensity* refers to the magnitude of change that would result if the proposed action were implemented.

Determining whether an effect significantly affects the quality of the human environment also requires an examination of the relationship between *context* and *intensity*. In general, the more sensitive the context (i.e., the specific resource in the proposed action's affected area), the less intense an impact needs to be in order for the action to be considered significant. Conversely, the less intense of an impact, the less scrutiny even sensitive resources need because of the overt inability of an action to effect change to the physical environment.

The Corps is evaluating the reallocation of WVP conservation storage.[77] Operation of WVP reservoirs has released stored water to meet flow objectives to benefit ESA-listed fish for more than 15 years and would continue under the ARP.

From a practical standpoint, the growth in demand for AI and M&I water supply would materialize over the period of analysis, but these demands are not imminent. Over the period of analysis, the increase in demand, associated actions by others (irrigators and M&I systems), and changes to system operations to meet that demand would increase over time.

Because the demand for stored water would accumulate over the 50-year period of analysis, Corps operational changes to meet those demands would similarly release an increasing amount of stored water over the period of analysis. The environmental effects from implementing the ARP would accumulate over time as entities took actions to gain access to stored water. In the near term (less than 10 years), implementing the ARP would be expected to result in few actions by those seeking to utilize stored water, with little change in system operations.

6.2 Scope of Environmental Effects Analysis

The scope of the environmental effects analysis evaluates the reasonably foreseeable direct, indirect, and cumulative effects of the ARP.[78]

For the ARP, the area of potential influence for the analysis of effects consists of:

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[77] Storage allocation volumes (acre-feet) under the ARP: F&W 1,102,600; M&I 159,750; and AI 327,650.

[78] Direct effects are caused by the action and would occur at the same time and place (40 C.F.R. § 1508.8) (e.g., actions involving construction to increase the volume of water a dam stores). Indirect effects are caused by the action, but typically occur later in time or are farther removed in distance, but are still reasonably foreseeable (40 C.F.R. §

- The WVP's reservoirs and the riverine reaches downstream of the reservoirs; and
- The geographic area within which water supply could be utilized for AI and M&I use.

From a practical standpoint, environmental effects could occur:

- Within a footprint of disturbance where M&I water intakes and associated water distribution infrastructure (e.g., pumps, pipelines, etc.) would need to be constructed, operated, and maintained;
- Where changes in daily releases from WVP reservoirs would result in changes to the water surface elevations of the reservoirs;
- Where changes in releases from WVP reservoirs would result in changes to the flow and water surface elevations downstream of dams;
- Where water supply intakes and depletions from riverine reaches could result in changes to flow and water surface elevations in downstream reaches; and
- Where the availability of WVP stored water could change the patterns of water supply infrastructure and water distribution development in the basin.

These represent the largest area of *potential* influence where effects might be observed. However, effects must be traceable through a chain-of-causation. Only effects that are caused by the action and reasonably foreseeable need be addressed in a NEPA analysis; impacts that are speculative and that depend on actions that are remote or hypothetical need not be considered.

6.3 Assumptions Regarding the Effects Analyses

To assess the environmental consequences of implementing the ARP, this analysis evaluates the environmental consequences assuming WVP conservation storage allocated to AI, M&I, and F&W under the ARP would be fully utilized. As such, the allocations for AI and M&I would be assumed to be fully contracted and the demand being met as of the year 2070. The analyses assume that WVP conservation storage is fully contracted and assess the effects of meeting the future demand for WVP stored water. Importantly, the demand for WVP stored water is not imminent – the demand is assumed to materialize gradually over the 50-year period of analysis.

Implementing the Corps decision to reallocate WVP conservation storage would not trigger any direct or immediate effects on the environment (i.e., effects caused by the reallocation decision, and occurring at the same time and place).

6.3.1 No change in Flood Risk Management Operations

There are no changes to WVP Flood Risk Management operations associated with implementation of the ARP. The WVP reduces flood levels in the basin by temporarily detaining water during flood events, and then controlling the release of that detained water once flows downstream have subsided below flood or bankfull levels. This type of operation is governed by flow levels at various control points in the tributaries and on the mainstem, and additional releases for the ARP

1508.8). A cumulative impact is defined as "*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 C.F.R. § 1508.7).

demands are well below any bankfull flow levels at all control points. In addition, the water control diagrams are not changed for any WVP reservoirs, which govern the time of year the reservoirs are evacuated to reserve space for the detention of inflows during flood events. The increased M&I demands for WVP stored water modeled in the ARP occur only for June through September. Any flood events that occur during this time period would still be accommodated by the same flood storage space available in the WVP as under current conditions.

Because there are no changes in Flood Risk Management operations associated with implementing the ARP, the analysis does not evaluate changes in downstream flood risk potential or examine the effects to riparian resources that could be affected during flood events.

6.3.2 No Modifications to Dams to Increase Storage in WVP Reservoirs

Implementing the ARP would not include any structural changes at any WVP reservoirs that would increase the volume of stored water (e.g., increasing the dam height). Implementation of the ARP would not require construction or result in any ground-disturbing actions by the Portland District to modify dams to increase the storage capacity.

Because there are no structural changes at any of the reservoirs, there is no potential for implementation of the ARP to cause construction-related effects at WVP dams and there is no change to the dam safety status of the dams.

6.3.3 No New Water Supply Intakes on Corps Property

Implementing the ARP would not require or involve new water supply intakes on Corps property for the use of WVP stored water. WVP reservoirs are upstream in the watershed relative to the centers of population, industry, and agriculture; the patterns of land use and municipal development are typically downstream of the reservoirs. As a result, the pattern of water supply users accessing surface water has been by constructing water supply intakes in the free-flowing reaches of the Willamette River's mainstem and tributaries. The use of water from WVP reservoirs has not required construction of water supply intakes on Corps property. There are only three existing water supply users in the entire basin that have ever had water intake infrastructure on Corps property and each of them is in excess of 50 years old.[79]

The existing pattern of water supply users gaining access to water supply from the free-flowing segments of the mainstem and tributaries (i.e., downstream of WVP reservoirs) would be expected to continue. Because of these established patterns of water supply infrastructure development, implementation of the ARP would not be expected to require the construction of new water supply intakes on Corps lands over the entire 50-year period of analysis.

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[79] During the original construction of the Hills Creek Dam and reservoir (completed in 1961), a municipal water supply pipe for the city of Oakridge, OR was installed but the water supply source is no longer used; during the original construction of the Foster Dam and reservoir (completed in 1968), a municipal water supply pipe for the town of Sweet Home, OR was installed and is still in use; and at the Dexter Dam and reservoir, water supply is diverted from the reservoir to the Dexter Ponds/Willamette Hatchery. Originally constructed as two separate facilities, the Willamette Trout Hatchery (in 1922) and Oakridge Salmon Hatchery (in 1911), both facilities were combined in 1983 and operate today as Willamette Hatchery.

6.3.4 No Reasonably Foreseeable Infrastructure Construction by Water Users

There are expected to be no indirect construction-related effects (i.e., occurring later in time or removed in distance) in the near-term (less than 10 years). Near term growth in M&I peak season demand is expected to be met by entities withdrawing more water from existing infrastructure (intakes that currently draw from the Willamette River or its tributaries) and not requiring construction of new intakes for the use of WVP stored water. There are currently no proposed actions by public or private entities (e.g., M&I suppliers or agricultural irrigators) to construct water intake infrastructure that would not occur, "but for" the Corps' decision to reallocate storage in the WVP.

Longer-term (more than 10 years) projected growth in demand could eventually require infrastructure construction. However, in the absence of proposals for development from applicants, the construction effects of new intakes and distribution infrastructure would be too speculative to allow for meaningful analysis. The temporary and permanent environmental effects from ground disturbance, installation of conveyance pipe, and construction of associated support facilities for accessing water supply for irrigation or M&I are not assessed in detail within this document because the actions are not reasonably foreseeable and in the case of irrigation, are not caused by the ARP.

Future construction of M&I or irrigation water supply infrastructure would likely be subject to Corps Regulatory Branch review for permitting under Section 404 of the Clean Water Act (33 U.S.C. 1344) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403), which would also necessitate ODEQ Water Quality Certification under Section 401 of the Clean Water Act. The Corps would complete these evaluations when the specific plans for infrastructure are proposed. Future construction of infrastructure may also be subject to a number of other federal, state, and local environmental and land use permits.

When future irrigation water service contracts are requested, Reclamation considers entering into each water service contract a discretionary decision that is individually subject to review under the requirements of the National Environmental Policy Act (USBOR, 2012). Reclamation evaluates the applicant's proposals and determines whether extraordinary circumstances are present that could be environmentally significant (USBOR, 2017a).

6.3.4.1 Induced Growth

Consideration of indirect effects also includes a consideration of growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or the growth rate of an industry. However, effects must be traceable through a chain-of-causation and the indirect effects should be addressed in relation to their proximity to the action. Only effects that are caused by the ARP and are reasonably foreseeable need be addressed in a NEPA analysis; impacts that are speculative, bear only an attenuated relationship to the ARP, could occur with or without the ARP, or that depend on actions that are remote or hypothetical need not be considered.

While the reallocation of WVP conservation storage would allow the Corps to grant storage agreements and could lead to indirect effects from inducing growth or changing patterns of population growth or land use, there is currently no immediate unmet demand awaiting this action to be completed. In the absence of applications for Corps easements or new industrial growth trends[80] in the Willamette River basin, construction and operation of new intake infrastructure is not reasonably foreseeable at this time. Evaluating the environmental consequences of theoretical new intakes or water distribution systems, without any applicants, would be too speculative to be meaningful. Therefore, the scope of analysis in this EA does not assess the effects of hypothetical new water supply intakes or water distribution systems; the estimates of theoretical, new infrastructure have been included in this analysis for the purpose of cost comparison, but the construction actions would be speculative and do not allow meaningful analysis.

6.3.4.2 Revisions to Water Control Manuals

Implementation of the ARP and entering water supply agreements would require slight changes to individual WVP reservoir releases that are within the operational flexibility as described in the current Water Control Manuals. However, the reallocation of storage and slight operational changes in project operations would require amendments to the Water Control Manuals and the WVP's Drought Contingency Plan (USACE, 2017).

6.3.5 Resources Considered but Not Carried Forward for Analysis

In 2012, the CEQ published guidance on improving the process for preparing efficient and timely environmental reviews under NEPA (CEQ, 2012). NEPA and the CEQ Regulations implementing NEPA provide numerous techniques for preparing efficient and timely environmental reviews.

Agencies are encouraged to concentrate on relevant environmental analysis in their NEPA documents, not to produce an encyclopedia of all applicable information (40 C.F.R. § 1500.4(b), 1502.2(a)); 40 C.F.R. § 1502.2(a) instructs that federal agency NEPA documents "*shall be analytic rather than encyclopedic*." As such, the impacts should be discussed in proportion to their significance, meaning that there should only be a brief discussions of insignificant issues (40 C.F.R. § 1502.2(b); see also 40 C.F.R. § 1502.2(c)). Impacts should be discussed in proportion to their significance, and if the impacts are not deemed significant, there should be only enough discussion to show why more study is not warranted (40 C.F.R. § 1502.2(b)). As such, a number of resources/impacts that can typically be discussed at length within NEPA documents have been considered and dismissed from further analysis.

6.3.5.1 Reservoir Resources Not Carried Forward for Analysis

While there would be lower summer reservoir pool elevations during some years, the variability of pool levels under the ARP is within the range of pool elevation changes already experienced during the conservation season. In addition, every year, at the end of the conservation season (early fall), release rates from reservoirs are increased and the reservoir pools are lowered to empty the conservation pool in preparation for the winter flood season. The existing conditions of the environmental resources at the reservoirs that could be affected by changes in reservoir pool elevations are controlled by the annual cycle of filling and draining the conservation pool to provide storage for flood risk management operations. There would be marginal in-summer changes to reservoir pool elevations, but because these slight changes are within the range of existing operations, there would be no predictable changes to reservoir resources.

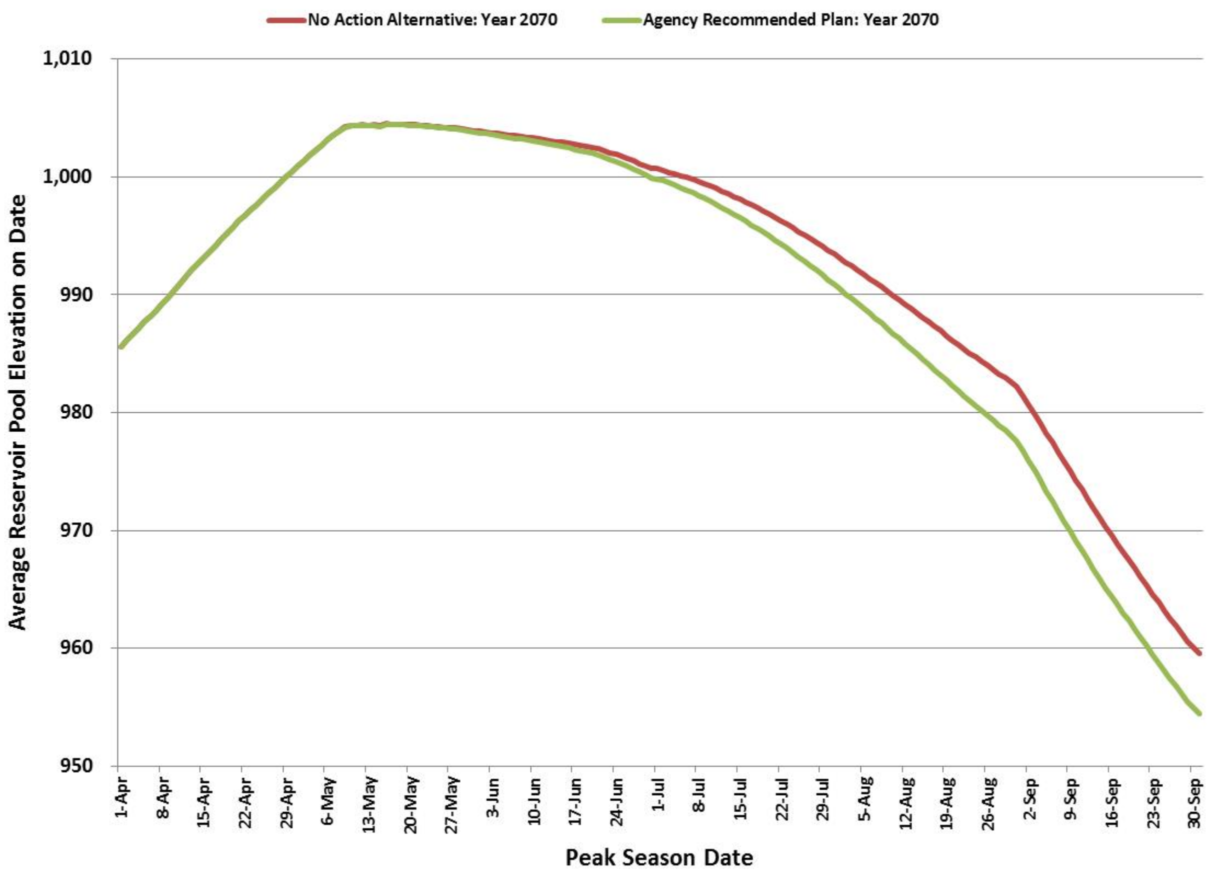
[80] Over and above industrial trends already accounted for the demand analysis.

Reservoir pool elevations were examined to determine the extent of timing differences between the No Action Alternative and the ARP. Of particular interest was the difference in the rate of drawdown of the pool during the conservation season. In general, it was found that average reservoir pool elevations under the ARP would occur from hours to days prior to the same pool elevation occurring under the No Action Alternative. The timing differences listed below represent the maximum number of days that reservoir pool elevations under the No Action Alternative lagged reservoir pool elevations under the ARP during the conservation season. Figure 6-1 depicts the reservoir for which the lag was greatest (Green Peter), which would represent the largest difference in pool elevation timing between the No Action Alternative and the ARP.

- Blue River 2 days
- Cottage Grove 3 days
- Cougar 1 day
- Detroit 4 days
- Dexter 0 days
- Dorena 1 day
- Fall Creek 4 days
- Fern Ridge 0 days
- Foster 4 days
- Green Peter 5 days
- Hills Creek 3 days
- Lookout Point 2 days

Because of the overt inability of the ARP to effect change to the physical environment at the reservoirs that would be different from the range of conditions currently observed, effects to vegetation, aquatic habitats, wetlands, non ESA-listed fish and wildlife, aesthetics, cultural resources, and erosion have been eliminated from detailed consideration.

Figure 6-1
Green Peter Average Reservoir Pool Elevation by 2070 Peak SeasonDate Under No Action Alternative and ARP



6.3.5.2 Riparian Resources Not Carried Forward for Analysis

Predicted changes to water levels downstream of WVP reservoirs is the primary influencing factor in considering the potential for changes that could affect the environmental resources of the riparian corridor. The riparian corridor's environmental resources that could be affected by changes in water elevations are at risk during periods of draw-down as part of flood risk management operations. Bank-full flows occur as part of flood risk reduction operations and generally do not occur during the conservation season.

The proposed changes to releases from reservoirs would accumulate slowly over the period of analysis and even when fully realized (as of 2070), would result in changes to riverine flows that would be within the range of observed flows and associated water surface elevations under current conditions (and expected under the No Action Alternative). Because of the overt inability of implementing the ARP to effect change to the physical environment that would be different from the range of conditions currently observed (and expected under the No Action Alternative), effects to downstream riparian habitats/vegetation, aesthetics, wildlife (with the exception of listed species), and erosion have been eliminated from detailed consideration.

6.3.5.3 Additional Resources Not Carried Forward for Analysis

Because implementation of the ARP does not require construction or ground disturbing actions by the Corps and does not have reasonably foreseeable construction actions by future users of WVP stored water, the following additional resources characteristically assessed because of construction actions have been eliminated from detailed consideration: air quality; geology; hazardous, toxic, and radioactive waste; noise; occupational safety; soils; topography; traffic; race, poverty, and environmental justice.

6.4 Climate and Climate Change

As required by Engineering and Construction Bulletin No. 2016-25[81], the goal of a qualitative analysis of potential climate change effects upon Corps hydrology-related projects and operations is to describe the observed present and possible future climate threats, vulnerabilities, and impacts relevant to the study goals or engineering designs (USACE, 2016h). Decisions involving the future supply of, and demand for, water in the Willamette River basin have the potential to be influenced by climate change over the period of analysis. Depending on the extent to which climate changes occur, there could be important shifts in the timing and form of precipitation and increases in ambient temperatures. Water demand for agriculture (due to future ambient temperature increases), supply constraints for municipal water use (due to future reduced peak season flow levels), and climate change-induced increases to M&I demand give rise to the vulnerability of the demand estimates used in the reallocation of WVP conservation storage. Uncertainties regarding the magnitude and timing of these climactic shifts require recognition of the potential threat to ESA-listed fish and their critical habitat. These threats to ESA-listed fish and their critical habitat may occur under the No Action Alternative and the Agency Recommended Plan. In order to assess the potential climate change effects upon this study, the climate threats to the vulnerability of the peak season demands for WVP stored water are summarized in Table 3-16 (above) and in the following appendices:

- FR/EA Appendix K (Discussion of Climate Change Impact on Future Regulation) Section 4;
- FR/EA Appendix A (Municipal & Industrial Demand and Supply Analyses) Section 11; and
- FR/EA Appendix B (Agricultural Irrigation Demand Analyses) Section 8.

Climate change-induced increases in needs for WVP stored water to achieve BiOp flow objectives in Year 2070 are calculated to be 232,500 acre-feet by the year 2070 (see FR/EA Appendix K and Table 3-13 above). Climate change-induced increases in M&I demand for WVP stored water are calculated to be 56,900 acre-feet by the year 2070 (See FR/EA Appendix A and Table 3-14 above). Climate change-induced increases in AI demand for WVP stored water are calculated to be 156,400 acre-feet by the year 2070 (See FR/EA Appendix B and Table 3-15 above).

[81] Guidance for Incorporating Climate Change Impacts into Inland Hydrology in Civil Works Studies, Designs, and Projects

At this time, there have been no recommendations reflecting changes to the BiOp flow objectives in response to anticipated climate change. Should such recommendations be formally made, the changes would be factored into planning for future water supply.

6.4.1 No Action Alternative

Failing to implement the ARP would prevent the Corps from facilitating the conversion of a portion of WVP conservation storage to instream water rights as described in RPA Measure 2.9. Without instream water rights in place, releases of an additional 232,500 acre-feet of stored water to meet BiOp flow objectives in the face of changing climate conditions would be available for use by existing water right holders (e.g., M&I and AI) as live flow per Oregon water law.

6.4.2 Agency Recommended Plan

The total additional stored water needed to accommodate climate change would be the climate change-induced increases in WVP stored water demand for AI, M&I, and F&W. Table 3-16 (above) provides a combined estimate of 445,800 additional acre-feet of water that may be needed as a result of climate change-induced impacts on demand for WVP stored water by the year 2070. Under the ARP, any increase in WVP stored water releases made for the benefit of fish and wildlife would be protected by instream water rights.

6.5 Water Quality

As described in Section 2.3, water quality in the upper, mid, and lower Willamette River showed a consistent overall improvement in water quality over a 30-year period despite a population increase of more than 1,000,000 people over the same time period.

6.5.1 Evaluation of Tributary Water Temperature Differences: No Action Alternative and ARP

Potential water temperature differences between the No Action Alternative and the ARP were evaluated for the North Santiam River and the South Santiam River as part of an effort to support implementation of NMFS 2008 BiOp RPA (Buccola, in preparation). The analysis used CE-QUAL-W2 v3.1 models (Cole and Wells, 2015) of Detroit Lake (Sullivan et al., 2004; Buccola et al., 2015), the North Santiam River (Sullivan and Rounds, 2004) and South Santiam River (Bloom, 2016). The models were developed for the Willamette temperature Total Maximum Daily Load study and updated to a customized version of v4.0 obtained from the U.S. Geological Survey (USGS). This customized version of W2 includes a module that will track heat from a source, such as a dam. Temperature targets developed by a multi-agency team and currently used 2017 at Detroit Dam (USACE, 2017b) were applied. Two outlet configuration scenarios were modeled:

- Existing specifies the current outlet configuration at Detroit Dam, which consists of a spillway (469.7 m), power penstocks (427.6 m), and upper regulating outlet (408.4 m). A minimum of 40 percent of the outflow is placed on the power penstock outlet, as is currently agreed upon by BPA and the Corps.
- TempTower specifies the proposed outlet configuration with a future temperature tower and floating screen structure. This includes a series of six simulated outlets floating near the surface of the lake down to 3.87 m [12.7 ft] depth with a total combined flow ranging between 1000 and 4500 cfs.

The analysis found that the ARP provided cooler temperatures than the No Action Alternative in the North and South Santiam rivers in July and August, and warmer temperatures in September and October, however these differences were small. Temperature differences between the ARP and No Action Alternative were estimated to be less the 1.5°C, and usually less than 0.5°C. Little difference would be expected since flow differences in the four major tributaries affected by WVP operations are estimated to be minimal between the No Action Alternative and the ARP. There would also be minimal expected differences in water temperature changes in the McKenzie and Middle Fork Willamette rivers downstream of WVP dams given the minimal changes in flows estimated for the No Action Alternative and the ARP downstream of WVP dams in those tributaries. Cooler temperatures in July and August would be beneficial to ESA-listed fish and other native aquatic resources because stressfully high water temperatures are common during those warm summer months. For example, many adult spring Chinook salmon in the Willamette River basin die after reaching spawning tributaries but prior to spawning (prespawning mortality, PSM). Environmental stressors, especially water temperatures, contribute to PSM rates, and therefore rates would be expected to decrease when temperatures are cooler. In September and October, a temperature increase of 1.5°C in September and October would affect incubation of spring Chinook salmon eggs resulting in an earlier emergence timing of the fry stage.

6.5.2 Evaluation of Mainstem Willamette River Water Temperature Differences: No Action Alternative and ARP

The USGS developed modeling tools to assess the effects of dams on streamflow and water temperature in the Willamette River and its major tributaries (USGS, 2010). The modeling tools utilize regression models to predict 7-day water temperatures at Salem/Keiser, Albany, and Willamette Falls based on streamflow and air temperature. For the current analyses, USGS utilized these models to evaluate the potential changes to water temperature comparing the No Action Alternative to the ARP as of 2050 (Rounds, S.A and Stratton-Garvin, L.E., in preparation). This work was also completed to support implementation of the NMFS 2008 BiOp RPA.

Preliminary findings from the current modeling indicate:

1. Water temperatures increase going downstream from Albany to Salem to Willamette Falls;
2. Changes in streamflow differences between the No Action Alternative and the ARP are very small in April-May;
3. Changes in streamflow begin to be more noticeable in June-August and there would typically be more flow under the ARP than under the No Action Alternative; and
4. There would be essentially no predicted change between the No Action Alternative and the ARP in the first attainment of three consecutive days of water temperature at or above 15°C or 18°C.

6.5.3 No Action Alternative

Under the No Action Alternative, there would be no Corps action to reallocate WVP conservation storage and no changes to current operations to provide WVP stored water to meet the Congressionally-authorized purpose of M&I water supply. Reclamation would continue to issue water service contracts for stored water from WVP reservoirs and the environmental effects from the diversion and use of WVP stored water on agricultural lands would continue to occur. As resource agencies, conservation groups, and water users continue to identify improvements in water quality as a priority and systematically take actions to protect and improve water quality, the trend of slight improvement would be predicted to continue.

In addition, OWRD would subsequently not issue instream water rights for releases of WVP stored water intended to meet BiOp mainstem and tributary flow objectives. Lacking the instream water rights for protection, WVP stored water released for the benefit of ESA-listed fish would be available for use by existing water right holders per Oregon water law. If the flows were unprotected the flow would not be certain to maintain or improve water quality for ESA-listed fish.

6.5.3.1 Tributary Water Temperatures

As discussed on 6.5.1 above, analysis of temperature differences between the ARP and the No Action Alternative found that the ARP provided cooler temperatures than the No Action Alternative in the North and South Santiam rivers in July and August, and warmer temperatures in September and October, however these differences were small. Temperature differences between the ARP and No Action Alternative were estimated to be less the 1.5°C, and usually less than 0.5°C.

6.5.3.2 Mainstem Water Temperatures

As discussed in 6.5.2 above, findings from the analysis of mainstem water temperatures are:

1. Changes in streamflow differences between the No Action Alternative and the ARP are very small in April-May;
2. Changes in streamflow begin to be more noticeable in June-August and there would typically be more flow under the ARP than under the No Action Alternative; and
3. There would be essentially no predicted change between the No Action Alternative and the ARP in the first attainment of three consecutive days of water temperature at or above 15°C or 18°C.

6.5.4 Agency Recommended Plan

Under the ARP, M&I peak season needs for WVP stored water would gradually accumulate over the period of analysis as requests for water storage contracts were requested, granted, and utilized.

Within the Willamette River basin, users divert water from the free-flowing river segments because the centers of population, industry, and agriculture are all downstream of the reservoirs. When, under the ARP, there is an increased demand for WVP stored water the released stored water flows many river miles from the dam to the point of diversion, explaining the additional flow identified by the model in June-August. This is important when considering the potential effects to water quality because the demand for WVP stored water accumulates within predicted geographic regions (i.e., in areas of projected population growth).

To depict the spatial distribution of future M&I demands for WVP stored water, demands in Year 2070 were distributed by Reclamation contract reach. Figure 6-2 depicts this spatial distribution and the portion of demands within each reach (designated as 1 through 15 on the figure). As shown in the figure, 92 percent of the future M&I demand for WVP stored water would be released from the WVP for eventual diversion from the Willamette River in Reach 1.

Over the entire distance between the dam from which it was released and the point of diversion in Reach 1, 92 percent of the WVP stored water released for M&I use under the ARP would provide water quality benefits. The total length of Reclamation contract reaches 2 through 15 is approximately 345 miles; Reach 1 is approximately 110 miles in length. Thus, for approximately 92 percent of future M&I demand for WVP stored water, the increase in stored water released from the WVP to meet that demand would provide water quality benefits for at least 345 miles of tributary and mainstem river habitat before being diverted from the Willamette River within Reach 1.

While there would be slightly more flow under the ARP, it is not expected that water temperature, DO concentrations, nutrients, and bacteria would measurably increase or decrease in response to ARP implementation – changes in flow under the ARP are likely to not be sufficient to result in measurable changes to these parameters.

Figure 6-2
Spatial Distribution of M&I Demand for WVP Stored Water (2070)

6.6 ESA-Listed Fish Impacts

Under both the No Action Alternative and the ARP, exogenous conditions outside of any reallocation of WVP conservation storage[82] would lead to changes in the achievement of BiOp mainstem and tributary flow objectives from what the achievement of flow objectives would be at the base year of 2020.

The 2008 NMFS BiOp set minimum flow objectives[83] on the Willamette mainstem at both Albany and Salem and on select tributaries with WVP dams. An overview of the analytical methods used to evaluate flow objective performance under the No Action Alternative and the ARP is provided below[84]. More detailed analysis on impacts to ESA listed species is found in the Willamette Basin Review Feasibility Study Biological Assessment, June 2018.

BiOp Minimum Mainstem and Tributary Flow Objectives

Mainstem flow objectives at Albany and Salem vary depending on the volume of water stored in the WVP, which defines the classification of a water year. The four classifications are Abundant, Adequate, Insufficient, and Deficit. The water year classification is then used to determine mainstem flow objectives for April through October of that year.

The BiOp specifies two separate flow objectives at Salem: seven-day moving average flow, and instantaneous flow. As the seven-day moving average minimum flow objectives exceed the instantaneous minimum flow objectives by nearly 25 percent, the seven-day moving average flow objectives were used[85] in analyses of BiOp flow objective performance at Salem.

Evaluation of Flow Objective Achievement

The Willamette River basin was modeled using the Hydrologic Engineering Center (HEC) Reservoir System Simulation Program (ResSim)[86] to assess the performance of the No Action Alternative and the ARP in meeting BiOp flow objectives. ResSim is used to model reservoir systems whose operations are defined by a variety of goals and constraints. The model uses a rule-based description of the operational goals and constraints that reservoir operators must consider when making stored water release decisions.

The flow dataset used for analyses are from the "2010 Level Modified Streamflows" (BPA, 2011), a complete set of flows for the entire Columbia River basin developed jointly by the BPA, the Corps, and Reclamation. This dataset contains historical daily average flows from October 1928 through September 2008, with all years adjusted to the same level of irrigation depletions.

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[82] See FR/EA Appendix F (ResSim WVP and Live Flow Diversions for Base Year 2020, No Action 2070, and Agency Recommended Plan 2070 Model Runs).

[83] Minimum flow objectives are presented in Tables 3-2 and 3-3 of this FR/EA.

[84] FR/EA Appendix H (BiOp Flow Objective Performance of the No Action Alternative and Agency Recommended Plan Plan) provides additional details on the analyses described herein.

[85] Seven-day moving average minimum flow objectives for Salem are specified for April 1 through June 30. From July 1 to October 31, instantaneous minimum flow objectives for Salem were used in the analysis.

[86] Additional information on ResSim is available on the U.S. Army Corps of Engineers HEC website: (http://www.hec.usace.army.mil/).

Several rules in the model depend on water year classification. As described above, Insufficient and Deficit water years allow for reduced minimum flow objectives at Salem. The 80-year flow data set provides the following counts and frequencies of water types:

- Abundant 44 years (55 percent of the 80 simulated years);
- Adequate 14 years (17 percent of the 80 simulated years);
- Insufficient 11 years (14 percent of the 80 simulated years); and
- Deficit 11 years (14 percent of the 80 simulated years).

ResSim model runs and associated data used in the assessment of flow objective performance for the No Action Alternative and ARP are documented in:

- FR/EA Appendix C: Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows;
- FR/EA Appendix D: Flow Dataset Used for ResSim Analyses;
- FR/EA Appendix E: ResSim Analysis for 2008 Baseline Flow Dataset;
- FR/EA Appendix F: ResSim WVP and Live Flow Diversions for Base Year 2020, No Action 2070, and ARP 2070 Model Runs; and
- FR/EA Appendix G: ResSim Analysis for Base Year 2020, No Action 2070, and Agency Recommended Plan 2070.

Performance Evaluation Procedures and Metrics

Performance of the BiOp flow objectives was evaluated for the period April 1 through October 31 in each of the simulated years, which provides 214 simulated days over 80 simulated years – a total of 17,120 simulated days. Three metrics were developed as a means of evaluating flow objective achievement under the No Action Alternative and the ARP:

1. **Flow Objective Achievement on Each Simulated Day**. This simple metric provides a convenient summary of absolute flow objective achievement, though alone, it does not provide sufficient information to convey the degree to which a flow objective was met over the simulation period. For example, the flow objective at Salem is 6,000 cfs on July 4, and on a simulated July 4 day where the ResSim output average daily flow is 5,999 cfs, the flow objective is not achieved on that day.
2. **Percent of Flow Objective Volume of Water Met.** This metric provides a means of evaluating the overall degree to which flow objectives are met over a simulated year by calculating the ratio of the total volume of water and provided to the total volume of water specified by the flow objective. While ResSim modeled flows often exceed the flow objectives, this metric was limited to a maximum ratio of 100 percent in order to avoid the problem of excessive flows "averaging out" insufficient flows, which would overstate flow objective achievement on any given day.[87]
3. **Percent of Flow Objective Volume of Water Met on Missed Objective Days.** This metric evaluates the degree to which flow objectives are met for days on which the

[87] In addition to this metric, FR/EA Appendix G documents the extent to which average flow in each month exceeds the minimum flow objective at Salem.

flow objective is not fully achieved. It represents the ratio of the total volume of water provided over days for which the flow objective was missed to the total volume of water specified by the flow objective over missed flow objective days that the flow objective is not met.

Summary BiOp Flow Objective Performance Comparisons

Table 6-1 below provides a summary performance comparison of the No Action Alternative and the ARP at year 2070 in meeting mainstem and tributary flow objectives under expected demand conditions for WVP stored water releases and permitted M&I live flow diversions. Performance comparisons are shown for the period of record and Abundant, Adequate, Insufficient, and Deficit water year types. The table shows percentages for each, with values for the No Action Alternative provided first. For example, in a comparison of the percent of days over which the flow objective is met, performance may be indicated as 97/96, which denotes that No Action Alternative meets flow objectives 97 percent of the days, and the ARP meets flow objectives on 96 percent of the days.

Also included on the table is a graphic indicator of ✓, ⇧, ⇩, 🡅, or 🡇 where:

- ✓ indicates that there is no notable difference between the No Action Alternative and the ARP;
- ⇧ indicates a difference of less than two percent between the No Action Alternative and ARP performance with ARP performance superior to the No Action Alternative performance;
- ⇩ indicates a difference of less than two percent between the No Action Alternative and ARP performance with No Action Alternative performance superior to ARP performance;
- 🡅 indicates a difference of more than two percent between the No Action Alternative and ARP performance with ARP performance superior to the No Action Alternative performance; and
- 🡇 indicates a difference of more than two percent between the No Action Alternative and ARP performance with No Action Alternative performance superior to ARP performance.

Additional Results

FR/EA Appendix H (BiOp Flow Objective Performance of the No Action Alternative and Agency Recommended Plan) provides this table. In addition, FR/EA Appendix H provides an extensive series of tables and charts that evaluate the performance of the No Action Alternative and ARP for each of the mainstem and tributary flow objectives. Appendix H also summarizes flows on the mainstem downstream of Salem at the Oregon City gage location. This analysis shows the expected use and minimum flows at Salem still result in acceptable river conditions between Salem and Oregon City.

Table 6-1:
Summary of Modeled BiOp Flow Objective Performance Comparison: No Action/ARP Expected WVP Releases and M&I Permitted Live Flow Diversions

	Performance Metric	All Years	Abundant 44 Yrs	Adequate 14 Yrs	Insufficient 11 Yrs	Deficit 11 Yrs
Salem Mainstem Flow Objective	Pct Days Flow Objective Met	⇧ 89/90	✓ 98/98	⇧ 87/88	⇧ 77/78	✓ 71/71
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ 99/99	✓ 97/97	✓ 95/95
Albany Mainstem Flow Objective	Pct Days Flow Objective Met	⇧ 90/91	✓ 98/98	⇧ 88/90	⇧ 79/81	✓ 70/70
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ 99/99	✓ 96/96	✓ 94/94
Willamette Falls Mainstem Flow Objective	Pct Days Flow Objective Met	✓ 95/95	⇩ +99/99	✓ 96/96	✓ 87/87	⇩ 83/82
	Pct of Flow Objective Volume Met	⇩ +99/99	✓ +99/+99	✓ +99/+99	✓ 99/99	✓ 98/98
Big Cliff Tributary Flow Objective	Pct Days Flow Objective Met	✓ 97/97	✓ +99/+99	✓ +99/+99	✓ 97/97	⇩ 86/85
	Pct of Flow Objective Volume Met	✓ 99/99	✓ +99/+99	✓ +99/+99	✓ 99/99	⇩ 95/94
Blue River Tributary Flow Objective	Pct Days Flow Objective Met	✓ +99/+99	✓ 100/100	✓ 100/100	✓ 100/100	⇩ 99/98
	Pct of Flow Objective Volume Met	✓ +99/+99	✓ 100/100	✓ 100/100	✓ 100/100	⇩ +99/99
Cougar Tributary Flow Objective	Pct Days Flow Objective Met	✓ 98/98	✓ 100/100	⇧ 99/+99	✓ 97/97	⇩ 89/88
	Pct of Flow Objective Volume Met	✓ 99/99	✓ 100/100	✓ +99/+99	✓ 99/99	✓ 94/94
Dexter Tributary Flow Objective	Pct Days Flow Objective Met	✓ 99/99	✓ 100/100	✓ 100/100	⇩ 99/98	⇩ 95/93
	Pct of Flow Objective Volume Met	⇩ +99/99	✓ 100/100	✓ 100/100	⇩ +99/99	⇩ 98/97
Fall Creek Tributary Flow Objective	Pct Days Flow Objective Met	⇩ 98/97	✓ 99/99	⬇ 98/95	⬇ 97/94	⇩ 95/93
	Pct of Flow Objective Volume Met	⇩ 98/97	✓ 99/99	⬇ 98/95	⬇ 98/95	⬇ 94/91
Foster Tributary Flow Objective	Pct Days Flow Objective Met	✓ 92/92	⇩ 97/96	⇩ 94/93	✓ 83/83	⇧ 77/79
	Pct of Flow Objective Volume Met	⇩ 97/96	✓ 99/99	⇩ 99/98	⇩ 94/92	⇩ 91/90
Hills Creek Tributary Flow Objective	Pct Days Flow Objective Met	⇩ +99/99	✓ 100/100	✓ 100/100	⇩ 99/98	⬇ 98/95
	Pct of Flow Objective Volume Met	✓ +99/+99	✓ 100/100	✓ 100/100	⇩ +99/99	⇩ 99/98

✓ - No notable difference between No Action and ARP performance

⇧ - < 2 % difference – ARP performance superior

⬆ > 2% difference – ARP performance superior

⇩ - < 2 % difference – No Action performance superior

⬇ > 2% difference – No Action performance superior

6.6.2 No Action Alternative

Under the No Action Alternative:

- The Corps would continue to operate the WVP to meet mainstem and tributary flow objectives as often as possible as described in the 2008 BiOp (NMFS, 2008);
- Reclamation would be expected to continue to issue irrigation water supply contracts up to, and eventually exceeding, the 95,000 acre-feet per year as described in RPA Measure 3. Formal consultation between NMFS and Reclamation on the potential effects of issuing AI water supply contracts from WVP stored water in excess of 95,000 acre-feet per year would depend on the listing and recovery status of ESA-listed species at the time of consultation as well as the specifics of Reclamation's proposed action at that time;
- Without a reallocation of WVP conservation storage, Reclamation would not apply for a change in character of use for their storage rights in order to match proposed reallocation of conservation storage for uses other than irrigation;
- Without a change in character of use for Reclamation's storage rights, a portion of WVP conservation storage would not be specifically allocated for F&W. OWRD would not issue instream water rights for the use of WVP stored water as described in the 2008 BiOp (RPA Measure 2.9).
- Thus, the Corps would not be able to facilitate OWRD's conversion of released stored water to instream water rights as described in RPA Measure 2.9;
- Without a conversion of stored water to instream water rights, releases of WVP stored water for the benefit of ESA-listed fish would continue to be unprotected and available for consumptive use by existing water right holders per Oregon water law.

Flow Objective Performance under the No Action Alternative

The following observations of the No Action Alternative's performance in meeting mainstem and tributary flow objectives can be made from Table 6-1:

- Salem Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years.
- Albany Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years.
- Willamette Falls Mainstem: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in abundant and deficit water type years.
- Big Cliff Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in deficit water type years.
- Blue River Tributary: Flow objectives are met at a 100 percent level in abundant, adequate, and insufficient water type years. No Action Alternative out-performs the ARP in deficit water type years.

- Cougar Tributary: Flow objectives are met at a 100 percent level in abundant water type years. The ARP out-performs the No Action Alternative in adequate water year types, and the No Action Alternative out-performs the ARP in deficit water year types.
- Dexter Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water type years. The No Action Alternative out-performs the ARP in insufficient and deficit water year types.
- Fall Creek Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in adequate, insufficient, and deficit water year types.
- Foster Tributary: Flow objectives are never met at a 100 percent level. The No Action Alternative out-performs the ARP in adequate and abundant water year types, and the ARP out-performs the No Action Alternative in deficit water year types.
- Hills Creek Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water year types, and the No Action Alternative out-performs the ARP in inadequate and deficit water year types.

6.6.3 Agency Recommended Plan

Under the ARP:

- The Corps would continue to operate the WVP to meet mainstem and tributary flow objectives as often as possible as described in the 2008 BiOp (NMFS, 2008);
- Reclamation would be expected to continue to issue irrigation water supply contracts up to, and eventually exceeding, the 95,000 acre-feet per year as described in RPA Measure 3. Formal consultation between NMFS and Reclamation on the potential effects of issuing AI water service contracts from WVP stored water in excess of 95,000 acre-feet per year would depend on the listing and recovery status of ESA-listed species at the time of consultation as well as the specifics of Reclamation’s proposed action at that time;
- With a reallocation of WVP conservation storage, Reclamation would apply for a change in character of use for their storage rights in order to match proposed reallocation of conservation storage for uses other than irrigation;
- With a change in character of use for Reclamation’s storage rights, a portion of WVP conservation storage would be specifically allocated for F&W. OWRD could issue instream water rights for the use of WVP stored water as described in the 2008 BiOp (RPA Measure 2.9).
- The Corps would be able to facilitate OWRD’s conversion of stored water to instream water rights as described in RPA Measure 2.9;
- With a conversion of WVP storage space, stored water releases from the fish and wildlife allocation space would be protected and not available for consumptive use by existing water right holders per Oregon water law.

Flow Objective Performance Under the ARP

The following observations of the ARP's performance in meeting mainstem and tributary flow objectives can be made from Table 6-1:

- Salem Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years.
- Albany Mainstem: Flow objectives are never met at a 100 percent level, and the ARP out-performs the No Action Alternative in adequate and insufficient water type years.
- Willamette Falls Mainstem: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in abundant and deficit water type years.
- Big Cliff Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in deficit water type years.
- Blue River Tributary: Flow objectives are met at a 100 percent level in abundant, adequate, and insufficient water type years. No Action Alternative out-performs the ARP in deficit water type years.
- Cougar Tributary: Flow objectives are met at a 100 percent level in abundant water type years. The ARP out-performs the No Action Alternative in adequate water year types, and the No Action Alternative out-performs the ARP in deficit water year types.
- Dexter Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water type years. The No Action Alternative out-performs the ARP in insufficient and deficit water year types.
- Fall Creek Tributary: Flow objectives are never met at a 100 percent level, and the No Action Alternative out-performs the ARP in adequate, insufficient, and deficit water year types.
- Foster Tributary: Flow objectives are never met at a 100 percent level. The No Action Alternative out-performs the ARP in adequate and abundant water year types, and the ARP out-performs the No Action Alternative in deficit water year types.
- Hills Creek Tributary: Flow objectives are met at a 100 percent level in abundant and adequate water year types, and the No Action Alternative out-performs the ARP in inadequate and deficit water year types.

6.7 Effects on Authorized Purposes

6.7.1 Flood Risk Management

6.7.1.1 No Action Alternative

Flood risk management will remain a primary purpose for the WVP in the future. The projects would continue to be operated as they are now without changes to the conservation or flood storage seasons, or the flood control, power, conservation, and full pool elevations specified by each project's water control diagram.

6.7.1.2 Agency Recommended Plan

There would be no difference from the No Action Alternative

6.7.2 Hydropower Production

To the extent power production in the Willamette Valley is already optimized as part of the federal power system, any change in operations may entail non-optimal power production. Hydropower impacts were jointly estimated by Portland District and BPA. Portland District staff performed WVP operations simulations under the No Action Alternative and under the ARP. A detailed analysis is provided in FR/EA Appendix J (Hydropower Impacts Analyses). The expected value of hydropower production for the WVP during April through October over a 50-year planning horizon was calculated for the No Action Alternative and the ARP.

6.7.2.1 No Action Alternative

The expected value of hydropower production for the WVP during April through October over a 50-year planning horizon was calculated for the No Action Alternative to be an average value of approximately $26,020,000.

6.7.2.2 Agency Recommended Plan

The difference between the value of energy under the ARP and the value of energy of under the No Action Alternative yields the estimate of the hydropower impact of the ARP in dollar terms. The expected value of hydropower production for the WVP during April through October over a 50-year planning horizon was calculated for the ARP to be approximately $25,992,000. Hydropower revenues under the ARP amount to a decrease of $28,000 annually.

6.7.3 Agricultural Irrigation Water Supply

6.7.3.1 No Action Alternative

Under the No Action Alternative, Reclamation would be expected to continue to issue irrigation water contracts up to, and eventually exceeding, the 95,000 acre-feet per year of WVP stored water as described in RPA Measure 3 (NMFS, 2008). No specific allocation of WVP conservation storage would be made for AI under the No Action Alternative.

As of 2017, Reclamation had issued irrigation water supply contracts for approximately 75,000 acre-feet of water per year, leaving approximately 20,000 acre-feet per year of WVP stored water available for new contracts before triggering the analyses and consultation described in RPA Measure 3. Based on the estimated rate of increase in demand for irrigation water, the need would be projected to exceed the 95,000 acre-feet per year limit of WVP stored water after 2025.

6.7.3.2 Agency Recommended Plan

The availability of AI water under the ARP would be limited to the specific allocation for AI. Reclamation considers entering into water service contracts discretionary agency decisions subject to their review under the requirements of the National Environmental Policy Act (USBOR, 2012). Because they separately fulfill their NEPA obligations on each water service contract they issue and do not require decisions from this feasibility study to continue their water service contracting actions, implementing the ARP would not affect their ongoing program implementation. The availability of AI water under the ARP would be essentially unchanged from that described under the No Action Alternative, though the ARP provides a specific allocation for AI in order to efficiently balance the reallocation of WVP conservation storage.

6.7.4 Municipal & Industrial Water Supply

6.7.4.1 No Action Alternative

Under the No Action Alternative, M&I systems and SSI facilities would not have access to WVP stored water as a source of peak season water supply as M&I agreements can only be written when WVP conservation storage is specifically allocated to M&I use. Peak season water supply deficits for M&I (M&I systems and SSI combined) would be met through sources other than WVP stored water at a cost more than twice the cost of using WVP stored water (see Section 4).

6.7.4.2 Agency Recommended Plan

Under the ARP, M&I systems and SSI facilities would have access to WVP stored water as a supply source to cover anticipated peak season supply deficits. Access to WVP stored water would yield aggregate cost savings of over 50 percent when compared to the aggregate costs of meeting peak season supply deficits through sources other than WVP stored water (see Section 4). Further, providing an allocation of WVP conservation storage for M&I use would help to fulfill intent of the language included House Doc. 531, Volume 5. Paragraph 198 ("*Ample storage in individual reservoirs, therefore, would be available at relatively low cost for domestic use when current facilities can no longer meet the demand.")*.

6.7.5 Reservoir and Riverine Recreation

Under the No Action Alternative and the ARP, there are expected to be no impacts to riverine recreation, because there would be no reduction in WVP stored water releases that would impair downstream recreation. Impacts to reservoir-related recreation are analyzed in FR/EA Appendix I (Reservoir-Related Boating Recreation Benefits Impact Analyses).

6.7.5.1 No Action Alternative

Under the No Action Alternative, FR/EA Appendix I cites a total of 3,791 ramp days available at WVP reservoirs during the May 1 through September 30 period, and a total of 595,700 boating visitors – both Year 2070 values. The value of the reservoir-related boating recreation experience[88] under the No Action Alternative in 2070 is estimated at $5,417,400.

6.7.5.2 Agency Recommended Plan

Under the ARP, FR/EA Appendix I cites a total of 3,761 ramp days available at WVP reservoirs during the May 1 through September 30 period, and a total of 593,675 boating visitors – both Year 2070 values. The value of the reservoir-related recreation experience[89] under the ARP in 2070 is estimated at $5,393,100 – a reduction of $24,300 from the No Action Alternative.

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[88] Recreation experience was monetized using the Unit Day Value method. See FR/EA Appendix I for more information.

[89] Recreation experience was monetized using the Unit Day Value method. See FR/EA Appendix I for more information.

While there is a recreation benefit loss of $24,300 in 2070, this value is not the impact to benefits that would be seen in the base year of 2020 or in the intervening years between 2020 and 2070. Impacts of the ARP in the base year 2020 are $0, because the releases of WVP stored water to serve M&I peak season demands begin at zero in the year 2020. As such, the average annual recreation benefit loss from ARP implementation is the average of the 2070 impact, and the 2020 impact, or $12,150.

6.7.6 Navigation

6.7.6.1 No Action Alternative

As stated in Section 2.10, Navigation was an authorized purpose of the WVP, but due to a lack of commercial navigation traffic in the upper Willamette River, the WVP was de-authorized for navigation by the Water Resources Development Act of 1986. Reservoir discharges are no longer regulated for navigation above Willamette Falls Lock (USACE, 2015f). Under the No Action Alternative there would be no change from the existing condition where there could be no effect upon navigation because this project purpose was de-authorized.

6.7.6.2 Agency Recommended Plan

Under the ARP, there would be no change from the existing condition where there could be no effect upon navigation because this project purpose was de-authorized.

6.8 Cumulative Effects

This section analyzes the potential cumulative impacts that may occur following implementation of the ARP when considered with other past, present, and reasonably foreseeable actions. Cumulative effects are defined as, "the impact on the environment which results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40C.F.R.§1508.7). Cumulative impacts could result from individually minor actions, but which could collectively have a measurable impact over a period of time in a specific geographic area. These actions include on-site or off-site projects conducted by government agencies, businesses, or individuals that are affecting or would affect the same environmental resources as would be affected by the proposed action.

The geographic boundaries and cumulative effects vary for each resource, but the boundary for this analysis has been limited to the Willamette River and tributaries downstream of the 13 Corps dams. Only those resources assessed in detail (see Section 6.3.5) were evaluated in the cumulative effects analysis. Resources excluded from analysis include resources at the reservoirs (shoreline and aquatic habitats, wetlands, fisheries, water quality, aesthetics, and erosion), downstream (downstream riparian habitats, aesthetics, navigation, wildlife, and erosion), and effects typically associated with construction activities (air quality; geology; hazardous, toxic, and radioactive waste; noise; occupational safety; soils; topography; traffic; race, poverty, and environmental justice).

6.8.1 Past, Present, and Reasonably Foreseeable Actions

The Council on Environmental Quality (CEQ) issued a memorandum on June 24, 2005 regarding analysis of past actions. This memorandum states, *"…agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without* *delving into the historical details of individual past actions.*" Thus, this section characterizes the existing conditions of the affected resources and discusses how the indirect effects from implementing the ARP (there are no direct effects from implementing the ARP) may contribute to impacts from present and reasonably foreseeable future actions.

6.8.1.1 Past Actions

WVP Construction and Operation

Existing conditions in the Willamette River watershed include the past construction of the 13 Corps dams and reservoirs as well as the downstream Bank Stabilization program. Construction of the 13 Corps dams and reservoirs in the Willamette basin fundamentally changed the character of the watershed, moderating flood flows during the winter by strategically storing and releasing water to manage flood risk. In addition to flood risk management, the dams and reservoirs function to maintain downstream flows throughout the summer via the strategic release of water to supplement downstream inflows. Given the year-round maintenance of downstream flows, OWRD and Reclamation have issued a number of water rights and irrigation contracts over time to meet authorized purposes and downstream uses (USACE, 2014).

Willamette River Bank Protection Program

The Flood Control Acts of 1936, 1938, and 1950 authorized the Corps to develop and implement the Willamette River Bank Protection Program and the construction of 450,000 linear feet of river bank protection works (USACE, 2009). In 1971, the Senate and House Committees on Public Works expanded the program's scope to a total of 510,000 linear feet.

The Corps maintains about 489,800 linear feet of erosion protection at 230 locations in the system above river mile (RM) 59.6. These projects are mostly rock revetments constructed of heavy quarry stone placed on riverbanks to keep them from being eroded by the force of flowing water, wind, and/or wave action. Although bank protection structures occur below RM 59.6, they are not part of the WVP and are not maintained by the Corps. New erosion areas are associated primarily upstream or downstream of existing revetments or on the outside bends of unprotected reaches. The ongoing Willamette River Floodplain Restoration Study will identify opportunities for correcting bank erosion problems in the future.

Bureau of Reclamation Water Marketing Program

As of 2017, there were about 75,000 acre-feet of WVP stored water water contracted for irrigation through Reclamation's water marketing program. Through the formal consultation process, NMFS identified required measures to minimize the effects of diversions by Reclamation's contractors on ESA-listed fish and their habitat (USBOR, 2009). These measures continue to be implemented and include requiring existing contract water diverters to install screens and other fish passage devices within a specified timeframe; requiring screening of all new contract diversions; and ensuring that water released to serve contractors does not prevent meeting minimum flow objectives by reducing the volume of stored water diverted by contract holders in deficit water years (USBOR, 2009).

The overall purpose for these measures is to avoid jeopardizing ESA-listed fish and to avoid destroying or adversely modifying their critical habitat while also allowing for continued water marketing and contracting by Reclamation to meet current and future irrigation needs in the

Willamette River basin. These measures serve to cumulatively diminish the environmental effects to listed species from Reclamation's water marketing program in the Willamette River basin.

WVP Recreational Boating Access

Boat ramps at WVP reservoirs typically include at least one boat ramp at each reservoir that is sufficiently long/deep so that regardless of how drawn down the conservation pool level in the reservoir, boaters could still have access. In addition, the Corps maintains a real-time reservoir and river level information system, displaying the current water elevation of the WVP reservoirs, the amount of water flowing into and out of the reservoirs, and detailed water elevation and flow information, including how water levels relate to boat ramp elevations.[90] The availability of continued boating access during lower pool levels and the ability for recreationists to evaluate the water level condition in all of the WVP reservoirs help maintain recreation visitation and use benefits.

6.8.1.2 Present Actions

Willamette River Floodplain Restoration Study

The Willamette River Floodplain Restoration Study evaluated alternatives for restoring natural floodplain functions in the lower Coast and Middle Forks of the Willamette River (USACE, 2013). This study was conducted in phases due to the large size and complexity of the Willamette River basin. Phase 1 of the study involved the development of a framework level plan for the entire Willamette River basin and Phase 2 produced the 2013 feasibility study of floodplain restoration opportunities in the lower Coast and Middle Forks of the Willamette River.

Ongoing efforts at restoring the Willamette River floodplain have examined restoration of wetland and shallow water habitats; excavation of connector channels via backwater channels; removal of invasive species; plantings with native wetland, riparian and floodplain vegetation; placement of large wood in floodplain, installation of engineered log jams in the river, removal of debris and revetment materials, and installation of culverts at road-crossings (USACE, 2013).

BPA's Willamette River Basin Wildlife Habitat Protection and Enhancement

The Bonneville Power Administration (BPA) has formed a long-term agreement with the state of Oregon to permanently resolve longstanding issues regarding the protection, mitigation, and enhancement of wildlife affected by the construction and operation of federal dams in the Willamette River basin and to provide for important fish habitat protection and restoration (BPA, 2010). The Agreement established goals for mitigating the effects of the construction, inundation and operation of the WVP. Under the terms of the Agreement, Oregon and the BPA agreed to acquire at least an additional 16,880 acres of wildlife mitigation property to protect 26,537 acres (or more) by the end of 2025 (NWPCC, 2015). To accomplish this mitigation objective, the parties established the Willamette Wildlife Mitigation Program, managed by ODFW.

The program provides for continued acquisition of wildlife habitat and it encourages habitat projects with dual wildlife and fish benefits selecting the most biologically valuable and cost-effective habitat projects, assuring lasting value for Oregon, BPA ratepayers, and the region. As

[90] http://www.nwd-wc.usace.army.mil/nwp/teacup/willamette/

of 2015, mitigation actions were underway or completed at 23 legacy properties (9,657 acres) and 19 agreement properties (4,197 acres) (NWPCC, 2015). The agreement requires that at least 10-percent of funding gores to projects that provide "habitat protection or restoration with significant benefits for both wildlife and ESA-listed anadromous fish species under the NMFS Willamette Biological Opinion (NWPCC, 2015). These ongoing actions attempt to directly mitigate the effects of the continued operation of the WVP dams and reservoirs.

Adult Fish Collection Facility Rebuild

In partial fulfillment of the 2008 BiOp RPA, the Corps has rebuilt adult fish collection facilities at Foster Dam on the South Santiam, near Minto Dam (not a WVP facility) on the North Santiam River, and is completing construction at the Fall Creek Dam in order to improve collection and transport of wild spring Chinook and winter-run steelhead upstream of the respective dams.

6.8.1.3 Reasonably Foreseeable Future Actions

Bureau of Reclamation Water Marketing Program

Reclamation administrates a water marketing program whereby landowners and/or institutional entities may contract for a supply of WVP stored water for irrigation. Under this program, Reclamation typically executes an irrigation water service contract that would provide for the release and/or diversion up to a quantity of stored water annually within one of the Reclamation contract reaches. After a contract is entered into by Reclamation, and in order to make that water available to the contract holder, the Corps would alter releases from an upstream WVP reservoir (or reservoirs). The terms of the contract specify how many acres of land (i.e., not more than) on which the diverted water would serve.

For minor amounts of irrigation water, Reclamation evaluates an applicant's proposal to determine whether extraordinary circumstances (516 DM 2 Appendix 2 and 43 CFR 46.215) that could be environmentally significant are present (USBOR, 2017a). If there are no extraordinary circumstances, Reclamation approves the contract and categorically excludes[91] their approval from the need to prepare an environmental assessment or environmental impact statement.

If there are extraordinary circumstances, or the volume being sought exceeds the "minor amounts" threshold, Reclamation would prepare an environmental assessment to evaluate the environmental significance of issuing the water supply contract.

In addition, NMFS and USFWS issued BiOps (NMFS, 2007; USFWS, 2007) to complete ESA Section 7 consultation and Magnuson-Stevens Act (MSA) consultation on the WVP. Reclamation's water marketing program was also included in those consultations. If the amount of contracted water in the entire water marketing program exceeds 95,000 acre-feet of WVP stored water, Reclamation must re-initiate consultation with NMFS and USFWS (USBOR, 2017a). The terms of the BiOps include non-discretionary Terms and Conditions for protection of ESA-listed fish and their habitats.

[91] 516 DM 6 Appendix 9.4 D(4) - Approval, execution, and implementation of water service contracts for minor amounts of long-term water use or temporary or interim water use where the action does not lead to long-term changes and where the impacts are expected to be localized.

Willamette Fish Operations Plan

The *Willamette Fish Operations Plan* (WFOP) is developed annually by the Corps in coordination with the BPA and regional federal, state and Tribal fish agencies and other partners through the *Willamette Fish Passage Operations & Maintenance* (WFPOM) coordination team (USACE, 2017). The WFOP describes year-round operations and maintenance (O&M) activities to protect and enhance anadromous and resident fish species listed as endangered or threatened under the ESA, as well as non-listed species of concern. The WFOP guides Corps actions related to fish protection and passage at the 13 WVP dams.

The WFOP is developed in accordance with the NMFS BiOp RPA Measure 4.3 (NMFS, 2008) for the operation and maintenance of WVP dams and fish passage facilities to minimize impacts to fish. The WFOP is revised as necessary to incorporate changes to project O&M as a result of new facilities or changes in operational procedures. Revisions incorporate changes adopted through coordination with NMFS and USFWS as part of the ESA Section 7 consultation, Recovery Plan, or Incidental Take permit processes, and through consideration of other regional input and plans (USACE, 2017).

Sustainable Rivers Program

The following text is summarized from a report titled, "Implementation of Environmental Flows in the Willamette Valley" (USACE, 2015e). The Sustainable Rivers Program (SRP) began in 2002 as a partnership between The Nature Conservancy (TNC) and the Corps with the objective of developing, implementing, and refining a framework for beneficial flows downstream of WVP dams (USACE, 2015a). SRP efforts in the Willamette River basin focus on modifying dam releases within existing operational constraints to improve the overall downstream ecosystem health and resiliency by enhancing channel habitat, modifying channel features, and scouring and flushing of channels. The releases that provide these benefits are termed environmental flows (E-flows).

Environmental flow implementation falls under the range of flood risk management operations outlined in the Water Control Manuals (USACE, 2015e). Flood risk management operations occur primarily in the wintertime period (December through February) and E-flow releases are not to be performed if they conflict with flood risk management operations. The E-flows are an opportunity-driven operation that does not reduce WVP stored water during the summer months. This means that E-flow operations will not affect the availability of WVP stored water for the conservation season, and the use of stored water to meet AI or M&I demands does not affect the ability of the system to provide E-flows as the opportunity arises. As such, the E-flow operations do not need to be modeled in the Base Year 2020, No Action 2070 or ARP 2070 ResSim simulations.

6.8.1.4 Cumulative Effects Summary

Climate and Climate Change

Climate change, population growth, and income growth have the potential to significantly affect the availability and use of water in the Willamette River basin, but how these changes would affect water scarcity is uncertain (Jaeger et al., 2017). This study has incorporated current Corps guidance on incorporating climate change impacts to inland hydrology in civil works studies, designs, and projects (USACE, 2016h). Corps projects, programs, missions, and operations have generally proven to be robust in the face of natural climate variability over their operating life spans. Recent scientific evidence shows, however, that in some geographic locations and for some impacts relevant to Corps operations, climate change is shifting the climatological baseline about which natural climate variability occurs (USACE, 2016h).

More extreme seasonal conditions of rainfall and runoff (flooding or drought) may become more prevalent and these conditions may be exacerbated by future changes in the health and sustainability of important species and demands for energy and water. Improved knowledge of these changes is important because the assumptions of stationary climatic baselines and a fixed range of natural variability as captured in the historical hydrologic record may no longer be appropriate for long-term project planning. However, projections of specific climate changes and their associated impacts to local-scale project hydrology that may occur in the future can be highly uncertain, requiring guidance on their interpretation and use (USACE, 2016h).

Water Quality

Figure 6-2 showed the spatial distribution of future M&I demands for WVP stored water to illustrate the distribution of 2070 demands by Reclamation contract reach. Similarly, Figure 6-3 depicts the spatial distribution of future AI demand for WVP stored water, illustrating that although the majority (59 percent) of AI demand is within Reach 1, the remaining AI demand is more widely distributed throughout the remaining contract reaches than M&I demand.

Figure 6-4 shows the spatial distribution of the combined (M&I and AI) demand for WVP stored water by contract reach. More than 70 percent of the combined AI and M&I demands for WVP stored water would be diverted from the Willamette River within Reach 1. No other contract reach shows more than five percent of the combined demand for WVP stored water diverted for consumptive use. Because water quality problems in the Willamette River have largely been associated with periods of low flow (Griffith, 1983), approximately 70 percent of future M&I and AI demand for WVP stored water would provide water quality benefits for the entire length of tributary and mainstem river habitat before being diverted from the Willamette River within Reach 1.

The USEPA conducted extensive watershed modeling to assess the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in twenty different watersheds, including the Willamette River (USEPA, 2013). The modeling projected future changes in urban and residential development as of the year 2050 in order to estimate the potential effects to water quality including total suspended solids, total phosphorus, and total nitrogen (USEPA, 2013). The results predicted virtually no changes for the water quality parameters at the single modeled location at the Willamette River just before its confluence with the Columbia River.

Given the long-term trends of improving water quality in the Willamette River discussed in Section 2.3, the spatial distribution of 70-percent of the future diversions within contract reach 1, and the results of the USEPA's analysis, the cumulative effect to water quality parameters (water temperature, DO concentrations, nutrients, and bacteria) would not be predicted to be substantially altered.

Figure 6-3
Spatial Distribution of AI Demand for WVP Stored Water (2070)

Figure 6-4
Spatial Distribution of M&I and AI Demand for WVP Stored Water (2070)

Reach	Upstream Reservoir
1	All reservoirs
2	All reservoirs on North and South Santiam Rivers
3	Big Cliff, Detroit
4	Foster, Green Peter
5	All reservoirs except Santiam reservoirs
6	Fern Ridge
7	All reservoirs except Santiam and Fern Ridge
8	Blue River, Cougar
9	All except Santiam, Long Tom, and McKenzie reservoirs
10	Fall Creek, Dexter, Lookout Point, Hills Creek
11	Dexter, Lookout Point, Hills Creek
12	Fall Creek
13	Dorena, Cottage Grove
14	Dorena
15	Cottage Grove

Reach	Percent Demand
1	71.0%
2	2.4%
3	3.3%
4	4.6%
5	3.2%
6	3.7%
7	3.3%
8	2.1%
9	0.9%
10	0.7%
11	4.1%
12	0.1%
13	0.5%
14	0.0%
15	0.0%

ESA-Listed Fish

Following issuance of the 2008 NMFS and USFWS BiOps, the Action Agencies have been implementing the RPA. Implementation includes research, monitoring and evaluation (RM&E) efforts that work to improve understanding of ESA-listed species and their responses to management actions including: temperature control; flow modifications; hatchery reforms and upgrades; fish passage; and habitat restoration projects as characterized in Sections 6.8.1.2 (Present Actions) and 6.8.1.3 (Reasonably Foreseeable Future Actions). Implementing the ARP would be predicted to not impair the Corps ability to implement the RPA as described in the 2008 BiOp (NMFS, 2008).

The Corps continues to implement components of the RPA including:

- Construction of three new adult fish facilities at Cougar, Minto, and Foster as described in Section 6.8.1.1 (Past Actions) for collection and transport to upstream habitats;
- Interim operations for downstream fish passage;
- Temperature improvement implemented at several dams;
- Improvements to adult fish release sites at spawning grounds above the dams; and
- Research to fill data gaps supporting alternative selection and design (USACE, 2015f).

Habitat-based ongoing actions and future habitat improvement under the Willamette River Floodplain Restoration Study and habitat protection or restoration under the BPA's Willamette River Basin Wildlife Habitat Protection and Enhancement (as described in Section 6.8.1.2 Present Actions) set priorities and provide important habitat improvement benefits for both wildlife and ESA-listed anadromous fish species (NWPCC, 2015).

Reasonably foreseeable future actions include the Corps continuing to balance Congressionally-directed multiple project purposes with the operation of the WVP. Reclamation would continue to administer the water marketing program utilizing WVP stored water to meet demand for irrigation and would continue to enforce terms and conditions in their water service contracts for protection of ESA-listed fish and their habitats.

The Willamette Fish Operations Plan describes year-round operations and maintenance (O&M) activities to protect and enhance anadromous and resident ESA-listed fish, as well as non-listed species of concern. Annual development of the Willamette Fish Operations Plan allows the Corps to continually incorporate changes to project O&M as a result of new facilities or changes in operational procedures as well as emerging results from scientific investigations. The annual preparation of this comprehensive plan to address emerging issues facilitates adaptive management to minimize the negative cumulative effects and enhance or improve the positive cumulative effects.

7 M&I User Cost, Financial Feasibility, and Yield

7.1 Derivation of M&I User Cost

The purpose of this section is to derive the price charged for M&I use of WVP stored water. Per ER 1105-2-100, the methodology used to calculate the price of reallocated storage is the highest of the revenues or benefits foregone, replacement cost, or the updated cost of storage of the federal project. Of the authorized purposes described throughout this FR/EA, only hydroelectric power and recreation are anticipated to incur a change in revenues (hydroelectric power) or benefits (recreation) as result of ARP implementation. Flood risk management benefits will not change under the ARP, and are therefore not evaluated.

7.1.1 Hydropower Revenues Foregone

Changes in hydropower revenues foregone have been addressed in Section 6.7.2 above. Results of the analysis are repeated below.

The expected value of hydropower production for the WVP during April through October over a 50-year planning horizon was calculated for conditions under the No Action Alternative and the ARP. The difference between the value of energy generated under the ARP and the value of energy generated of under the No Action Alternative yields the estimate of the hydropower impact of the ARP in dollar terms. These values are provided in Table 7-1. As shown in the table, hydropower revenues decrease by $28,000 under the ARP.

The modeling of alternatives for the period April-October resulted in the shifting of water from winter months into the study period (i.e., deeper drafts from baseline). This shift could have a negative power impact in the winter months of November-March. The impacts on winter power are outside of the study period and not quantified.

Table 7-1
Annual Changes in Hydropower Revenues for the WVP Conservation Season

Operational Scenario	Value of Hydropower Produced
No Action Alternative	$ 26,020,000
Agency Recommended Plan	$ 25,992,000
Lost Hydropower Revenue	**$ 28,000**

7.1.2 Recreation Benefits Foregone

Implementation of the ARP would affect conservation storage pool elevations and/or the timing of pool draw down. Reallocation of WVP conservation storage could change existing reservoir pool elevations throughout the summer conservation use season. Many activities occur at WVP recreation facilities, but the only recreation activity that could be directly affected by implementation of the ARP would be recreational boating, though any effects would occur gradually over the next 50 years.

The Unit Day Value (UDV) method[92] for estimating recreation benefit impacts was used in this analysis to monetize the change in recreation benefits between the conditions under the No Action Alternative and conditions under the ARP. FR/EA Appendix I (Reservoir-Related Boating Recreation Benefits Impact Analyses) provides a summary of visits, ramp days available, and UDV comparisons for the No Action Alternative and the ARP. Total monetary changes in recreation benefits are provided in Table 7-2 below.

Table 7-2
Changes in Annual Recreation Benefits for the WVP Conservation Season

Operational Scenario	UDV Benefits
No Action Alternative 2070	$ 5,417,400
Agency Recommended Plan 2070	$ 5,393,100
Reduced Recreation Benefits 2070	**$ 24,300**
Average Annual Reduced Recreation Benefits	**$ 12,150**

7.1.3 Updated Cost of Storage

The updated cost of storage for M&I water supply was determined by first computing the Joint Use costs at the time of construction by subtracting the specific costs from the total construction cost and multiplying the result by the ratio of storage (acre-feet) to total usable storage (acre-feet). In this computation, total usable storage includes space set aside for sediment distribution and summer flood storage. The cost allocated to the total usable storage on this basis was escalated to FY20 price levels by use of the Corps of Engineers Civil Works Construction Cost Index System (CWCCIS) maintained in EM 1110-2-1304 (31 Mar 2019) – Table A-2, Feature Code Dams. Since the CWCCIS dates back only to 1967, the ENR Construction Cost Index was used to update the cost of older projects to the 1967 time frame. Costs were indexed from the midpoint of the physical construction period to the beginning of the fiscal year in which the project became operational. Table 7-3 below lists select variables used in calculating the updated cost of storage for the eleven storage projects and the updated cost of construction and price per acre-foot of usable storage for the WVP as a whole.

System pricing was assessed because the Corps will charge a system price based on the cost of the entirety of WVP total usable storage, not the cost associated with an individual reservoir. This reflects the reality of operating the projects as a system and maintains operational flexibility in meeting the authorized purposes. Approval to use the system pricing approach was received on 16 June 2016 and confirmed during the Tentatively Selected Plan milestone meeting on 5 July 2017. Table 7-3 shows a total system price of $2,789 per acre-foot, and was calculated as total system cost / total usable storage ($4,684,355,920 / 1,679,600 acre-feet of storage).

[92] See FR/EA Appendix I (Reservoir-Related Boating Recreation Benefits Impact Analyses) for a description of the UDV method, UDV points assignment, and UDV analysis of the No Action Alternative and the ARP.

Table 7-3
WVP Updated M&I Cost of Storage Components – Capital Costs

Project	Total Usable Storage (AF)	Initial Const. Cost (Joint Use) ($)	Indexed FY 2020 Const. Cost (Joint Use) ($)	Cost Per Acre-Foot of Usable Storage ($)
Blue River	85,500	29,381,230	277,584,700	
Cottage Grove	29,800	2,276,000	84,928,200	
Cougar	147,800	49,262,900	575,562,500	
Detroit	300,700	41,405,200	781,599,800	
Dorena	70,500	13,306,000	415,907,300	
Fall Creek	115,500	20,099,700	206,734,700	
Fern Ridge	94,500	2,296,000	85,674,600	
Foster	29,700	18,673,300	192,063,500	
Green Peter	268,200	47,734,500	490,971,500	
Hills Creek	200,200	39,168,300	473,125,200	
Lookout Point	337,200	62,054,390	1,100,201,900	
Total	**1,679,600**	**325,657,520**	**4,684,355,920**	**2,789**

The capital cost for 159,750 acre-feet, the combined storage capacity for all eleven projects, is $445,542,750 (159,750 x $2,789), and carries an annualized cost of $16,503,000 (50 years at the FY20 discount rate of 2.75 percent, rounded to the nearest 1,000).

7.1.4 Identification of M&I User Cost

The methods of determining an appropriate M&I user cost for WVP stored water are summarized in Table 7-4 below. The table shows that the updated cost of storage would be the M&I user cost, as the updated cost of storage exceeds the total value of benefits and revenues foregone.

Table 7-4
Annual System-Wide User Cost Computation Comparison

User Cost Calculation Method	Average Annual Value
Benefits Foregone	$12,150
Revenues Foregone	$0
Subtotal Revenues & Benefits Foregone	**$12,150**
Updated Cost of Storage	**$16,503,000**

7.2 Payments for M&I Use of WVP Conservation Storage

The annual payment for M&I use of WVP conservation storage is calculated based on a 30 year repayment period. The capital cost for 159,750 acre-feet of storage is $ 445,542,750 (159,750 x $2,789), as noted above. The annual payment, as calculated in FY2020 using a finance period of 30 years at an interest rate of 2.75 percent[93] is $22,003,000 (rounded), or a 30-year annual cost of $137.73 per acre-foot.

An annual O&M cost is also due every year and is based on the O&M expense for the WVP in the Government fiscal year most recently ended. FY19 O&M costs for the WVP were $35,467,000. The requested amount of storage, 159,750 acre-feet, is 10.05 percent of conservation storage, which yields an initial O&M cost of $3,561,400 ($35,467,000 x 10.05%), or $22 per acre-foot. The annual O&M cost charged to the users will be recalculated each year based on the previous year's O&M cost.

Costs for repair, rehabilitation, and replacement (RR&R) will be charged as these costs are incurred and will be based on the percentage of conservation storage contracted to each agreement holder. Agreement holders are encouraged, but not required, to establish a fund in the event future RR&R costs occur during the agreement period. Payment is required for RR&R costs incurred while the contract is in place.

It should be noted that O&M, RR&R and any dam safety modification costs would be borne by the agreement holders on a proportionate basis as described above for the entire duration of the contract, though annual payments for storage of water ($22,003,000 per year, or $137.73 per acre-foot of storage per year) are expected to be completed within 30 years. In a letter dated April 25, 2017, the Sponsor acknowledged they understand water users are responsible for a portion of the dam safety modification costs.

Table 7-5 lists the various costs and payments for an M&I water storage agreement entered into in FY20.

[93] EGM 20-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2020, Enclosure 3: Water Supply Interest Rates based on PL 99-662

Table 7-5
Payments for M&I Water Storage Agreement

Acre-feet of WVP Stored Water	159,750
Capital Cost of Water	$ 445,542,750
Repayment Period	30 Years
Repayment Rate **	2.75%
Annual Payment	$ 22,003,000
FY19 O&M Cost *	$ 3,561,400
Total Annual Payment *	$ 25,564,400
Annual Payment per acre-foot of Water *	$ 160.03

*O&M costs are updated annually; therefore these values will vary slightly each year.

**Based on EGM20-01, dated 31 October 2019

7.3 Test of Financial Feasibility

As a test of financial feasibility, the annual cost of storage should be compared to the cost of the most-likely, least-costly alternative that the applicant would undertake in the absence of utilizing the federal project. This should be an alternative that would provide water of equivalent quality and quantity.

Unit costs of Alternative 3 for 159,750 acre-feet of WVP conservation storage were used in the analysis for comparison with the costs of the ARP[94]. It should be noted that all costs are annualized over a period of 50 years at the FY20 discount rate of 2.75 percent, which differs from the M&I annual payment costs shown above in Table 7-5. As shown in Table 7-6, the reallocation of storage has a substantial cost advantage over the next least cost for providing a source of water supply for M&I peak season demand in the future.

[94] Figures shown in Table 7-6 differ slightly from the figures shown in Table 4-6 due to the use of rounded acre-feet amounts specified in Reallocation Alternative C.

Table 7-6
Comparison of Costs and Benefits: Federal and Non-Federal Plans

	ARP Annual Unit Costs	ARP Annual Costs* ($)	Non-federal Annual Unit Costs	Non-federal Annual Costs* ($)
WVP Cost of Storage Annualized Cost per Acre-Foot (159,750 acre-feet of storage)	$137.73	16,503,000	n/a	n/a
WVP Operation and Maintenance Annual Cost per Acre-Foot (159,750 acre-feet of storage)	$22.29	3,561,400	n/a	n/a
Infrastructure Cost to Access WVP Annual Cost per Acre-Foot (159,750 acre-feet of storage)**	$48.08	7,680,842		
Non-Federal Measure: Intercon Annual Cost per Acre-Foot (32,900 acre-feet)	n/a	n/a	$457.38	15,038,000
Non-Federal Measure: ASR Annual Cost per Acre-Foot (126,850 acre-feet)	n/a	n/a	$353.13	45,892,000
Annual M&I Water Supply Cost (peak season, 159,750 acre-feet)		**27,745,000**		**60,930,000**
Annual M&I Supply Benefits		**33,185,000**		

*Amortized over 50 years at the FY20 discount rate of 2.75 percent

** Updated using EM 1110-2-1304 – 31Mar2019, Table A-2, CWBS 08 Indexed from FY19 to FY20

7.4 Yield

Based upon the seasonal availability of WVP stored water and the system operations of WVP reservoirs, calculating dependable yield using the standard methods is not possible. Use of reliability in lieu of dependable yield for M&I water supply agreements from the WVP was discussed and approved by the vertical team at the 16 June 2017 In-Progress Review meeting.

This study uses reliability in lieu of dependable yield for M&I water supply agreements from WVP reservoirs. Reliability was only assessed instead of determining the total amount of conservation storage available to consumptive uses. This is because irrigation contracts are not contracts for storage, meaning the irrigation users only pay for the water they use in any given year.

Calculating a dependable yield for the WVP using the standard method is not possible for several reasons, including seasonal conservation pools that are emptied every fall/winter for flood operations, operation of the eleven storage reservoirs as a system, and the Oregon water rights system where the conservation pool is filled only once per year and therefore continuous summer inflows are not part of the conservation pool or M&I storage account.

The M&I agreement holders recognize that the agreement will provide storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility for the quality, availability or treatment of the water.

7.4.1 Impact of Future Dam Safety Modifications on Yield

Future dam safety modifications at multiple WVP dams could necessitate temporarily lowering the conservation storage pools as interim risk reduction measures (IRRMs) are implemented. As such, the availability of storage for water supply cannot be guaranteed due to the condition of WVP dams and risks that exceed agency tolerable guidelines. Complex studies are required, which may be followed by risk reduction actions. The sponsor is aware of dam safety implications for IRRMs, potential timelines, and the temporary loss of conservation / water supply storage and cost sharing in IRRM construction repairs, as noted in the sponsor's letter dated April 25, 2017.

7.4.2 Impact of Climate Change on Yield

It is assumed that reservoir operations can be adapted to address climate change (e.g., adjustment of rule curves), but it may not be possible to mitigate all climate change impacts on reservoir operations which could affect reliability. Flood risk management would still remain the highest priority in any rule curve changes.

7.5 Cost Allocation

The benefits described in the original Cost Allocation Report and supporting information do not change significantly under the ARP; therefore, the cost allocation will not be updated.

8 Plan Implementation

This Feasibility Study is at the Agency Recommended Plan phase. This study report has undergone simultaneous public review, policy review, Agency Technical Review and Independent External Peer Review. From the Agency Decision, the report undergoes rigorous review of cost, engineering, environmental and economic benefits and culminates in a Report to the Chief of Engineers (Chief's Report). The Chief's Report contains the Chief of Engineer's recommendation and signifies the completion of the Corps' feasibility study process.

The Chief's Report is forwarded to the Assistant Secretary of the Army for Civil Works (ASA(CW)). The ASA(CW) will review the documents to determine the level of administration support for the Chief of Engineers recommendation. The report is then transmitted to the U.S. Office of Management and Budget (OMB) under the ASA(CW) signature. OMB will then provide a letter to ASA(CW) either clearing the release of the report to Congress subject to whatever changes OMB deems necessary or objecting release.

Depending on the extent of changes in the recommendations it may be necessary to provide an opportunity for the sponsor, interested federal agencies, and other parties to review and comment on the changes prior to transmitting the report to Congress.

8.1 Division of Implementation Responsibilities

The selected plan includes the reallocation of Joint Use storage to specific purposes and an adaptive management plan for management of stored water when the reservoirs do not fill. The annual adaptive management plan to manage stored water in the conservation pool under the Agency Recommended Plan is described in Section 5.4.2.

Once the reallocation and adaptive management plan are approved, additional actions will be necessary to fully achieve the study goals, as described in Section 1.11.

8.1.1 U.S. Army Corps of Engineers

The Corps is responsible for the M&I water supply program on behalf of the federal government. After conservation storage is reallocated, the Corps will enter into individual agreements with municipal and/or industrial entities for conservation storage space in the WVP. Most of the agreements will not list a specific reservoir as the eleven storage projects are operated as a system; hence the Corps will determine the source of the water provided, which may change in any given week, month, or year. The Corps is solely responsible for the sale of WVP conservation storage to M&I entities, will handle all agreements with M&I entities, and will receive payments to the U.S. Government from M&I entities for WVP conservation storage.

The Corps currently works with Reclamation on the use of water from WVP reservoirs for the purpose of irrigation. Reclamation is responsible for the sale of water stored in federal projects for irrigation, handles all irrigation contracts, and receives payments to the U.S. Government for irrigation water. The Corps determines water availability and releases from the Corps dams to satisfy these contracts. This arrangement is expected to continue is in the same manner as it does currently.

Once the action is approved by Congress, the Corps will update the Water Control Manuals and the Drought Contingency Plan to reflect the updated storage allocations and the adaptive management plan. Federal funding for updating the Water Control Manuals and Drought

Contingency Plan will be through the Operations and Maintenance budget process. The estimated federal cost to update the manuals is $62,000.

This project will not include any construction activities at the WVP reservoirs, so there should be no costs incurred for design and construction associated with the reallocation action.

8.1.2 U.S. Bureau of Reclamation

Reclamation holds water rights certificates from OWRD to store water for irrigation purposes as described in Section 1.11.1. In order for potential water supply uses (e.g., M&I, F&W) to realize benefits from the reallocation of storage, the character of use on the two storage certificates issued by OWRD must be changed from irrigation to multi-purpose Joint Use storage for the full volume of existing storage covered by the certificates to reflect the multipurpose nature of the WVP's conservation storage or the two storage certificates must be changed to reflect the reallocated volumes specified in the selected plan. Reclamation must request that OWRD change the character of use on the storage certificates. If Reclamation does not request that OWRD change the storage water rights certificates to affect a change in character of use, even if the USACE completes the reallocation of storage (i.e., completes this study), OWRD could not issue secondary water rights for the use of stored water for either F&W or M&I.

Reclamation is responsible for the irrigation contract water marketing program on behalf of the federal government and will continue this activity after implementation of the selected plan. Reclamation is responsible for the sale of water stored in federal projects for irrigation, handles all irrigation contracts, and receives payments to the U.S. Government for irrigation water.

8.1.3 Oregon Water Resources Department

After Reclamation makes the request for a change of use on the storage certificates, OWRD must initiate the review process for the transfer application as described in Section 1.11.2. Only after Reclamation requests the change in character of use for the two storage certificates and OWRD issues a change in character of use for the two water storage rights certificates, can OWRD respond to requests for, and issue applicants secondary water rights. Each of the preceding actions by Reclamation (i.e., requesting the change in character for the storage certificates) and OWRD (i.e., issuing the changes in character of use for the storage certificates) must occur before applicants can solicit OWRD to issue them a secondary water right for the use of WVP stored water. In order to utilize WVP stored water, entities must request, and be issued, secondary water rights by OWRD.

8.1.4 WVP Stored Water Users

The consumptive water users are responsible for the operation, maintenance, and repair of infrastructure, treatment and distribution facilities associated with the use of WVP stored water. The users are also responsible for seeking agreements with the Corps for M&I storage and contracts with Reclamation for irrigation water. Users would also be responsible for obtaining secondary water rights from OWRD to use the stored water.

8.2 Implementation Costs

With respect to implementation costs, this project will not include any construction activities at the WVP reservoirs, so there should be no costs incurred for design and construction associated with the reallocation action. Future M&I water agreement holders would be responsible for future water control updates related to use of M&I storage allocations. The Federal Government will be responsible for funding the updates to capture the AI and F&W allocations. Estimated costs for updating the manuals are shown in Table 8-1 below. The water users are responsible for the operation, maintenance, and repair of infrastructure, treatment, and distribution facilities associated with WVP stored water. They are also responsible for their share of the operation, maintenance, repair, rehabilitation, and replacement costs of the WVP reservoirs.

Table 8-1
Agency Recommended Plan Implementation Costs

Implementation Cost	Non-Federal Share ($)	Federal Share ($)
Water Control Manual Updates	0	52,500
Master Water Control Manual Update	0	9,500
Total Cost	**0**	**62,000**

8.3 Views of the Non-Federal Sponsor

OWRD is the non-Federal sponsor for the Willamette Basin Review Feasibility Study. The Department has expressed willingness to continue acting as the non-federal sponsor, as well as support to carry out completion of the study.

OWRD is the state agency with legal authority and responsibility for protection and management of Oregon's water supplies. Carrying out the Willamette Basin Review Feasibility Study can help the state directly address water supply needs and resource management objectives for the Willamette River basin. Undertaking the Willamette Basin Review Feasibility Study is consistent with state's recommendation of improving access to existing sources of stored water to supply long term water needs. This feasibility study has been a high priority for the state since the early 1990s and continues to be recognized as a priority under the state's 2012 Integrated Water Resources Strategy.

There is significant state and local interest in the basin to better plan for the use of reservoir storage to meet current and future water needs. OWRD, representing the State of Oregon, concurs with the proposed alternative of using stored water to meet multiples uses, including municipal, industrial, agriculture, and fish and wildlife and considers the potential outcomes of this study an improvement over the status quo. OWRD, working with other agencies, looks forward to continuing to provide input on storage reallocations and water management implementation guidelines currently recommended in this report.

8.4 Risk and Uncertainty

As described above, once the reallocation and adaptive management plan are approved, additional actions will be necessary to fully achieve the study goals. A summary of implementation risks is provided in Table 8-2 below.

Table 8-2
Implementation Risk Summary

Risk Name	Risk Summary	Evaluation	Risk Management
Request Storage Certificate Change of Use	Reclamation holds water rights certificates from OWRD to store in the Corps reservoirs. In order for potential water supply uses to realize benefits from the reallocation of storage, the character of use on the two storage certificates issued by OWRD must be changed from irrigation to multi-purpose or additional uses must be added (e.g., M&I, F&W).	Reclamation must request that OWRD change the character of use on the storage certificates. If Reclamation does not request that OWRD change the character of use on the storage water rights certificates, even if the USACE completes the reallocation of storage (i.e., completes this study), OWRD could not issue secondary water rights for the use of stored water for either F&W or M&I.	Reclamation's Columbia-Cascades Area Office Deputy Area Manager indicated the agency would be willing to change the purpose of use on the two storage certificates (USBOR, 2017). The Corps will work with Reclamation and OWRD on this transfer.
Issue Storage Certificate Change of Use	After Reclamation requests that OWRD issue a change in character of use for its two water storage rights, OWRD must review the transfer application and determine if it will be approved.	The review includes a determination of whether or not the proposed change in character of use would injure other water rights. In addition, the transfer must undergo a public review process where protests could be filed, potentially challenging an approval determination. OWRD may condition the approval order to eliminate potential injury to other water rights. If conditions would not eliminate injury, the application would be denied.	The considerations OWRD needs to make in order to issue the change in character of use for the two water storage rights has been considered in this study process. Corps will continue to coordinate with OWRD.
Conversion of MPSFs into Instream Water Rights (ISWRs)	OWRD will pursue the conversion of MPSFs into ISWRs for the purpose of protecting the flows from unauthorized diversion below the WVP reservoirs.	The conversion process allows for uncontested proposed ISWRs to be certificated. Contested ISWRs shall go through a contested case hearings process.	The considerations OWRD needs to make in order to convert the MPSFs has been considered in this study process. Corps will continue to coordinate with OWRD.
Issuance of Secondary Water Rights for Protection of Instream Flows	For any storage remaining after conversion of the MPSFs, ODFW will request that OWRD issue secondary water rights from storage as instream water rights for the protection of flows downstream.	Once OWRD has approved the change in character of use for Reclamation's storage rights, ODFW can make this request. The actions necessary to protect releases of WVP stored water for instream purposes are not within	This FR/EA will serve to facilitate the actions by the other agencies that are necessary to establish water rights for instream

		the purview of the Corps; however, the Corps will facilitate this per NMFS 2008 BiOp RPA Measure 2.9 (Protecting Stored Water Released for Fish).	purposes. Corps will continue to coordinate with OWRD and ODFW.

9 Public Involvement and Agency Consultation

9.1 Public Scoping

As part of the FR/EA processes, the Corps announced and hosted public meetings on the scope the proposed project by engaging state, local, and federal agencies, Tribal governments, and the public in the early identification of concerns, potential effects and possible alternative actions that should be evaluated (USACE, 2016g). The Corps' formal scoping period ran from March 02, 2016 through April 16, 2016; throughout the scoping period, comments on the recommended scope of the evaluation were be submitted to the District. To facilitate public participation in the study, the Corps conducted a series of public information scoping sessions March 15, 2016 at the Pringle Community Hall in Salem, OR and on March 16, 2016 at the City Hall/Library Meeting Room in Springfield (Eugene), OR. At these sessions, informational poster boards were available for review. Corps and OWRD staff were present to discuss project goals, environmental concerns, and the decision-making process.

As part of this public scoping phase, the study project team received about a dozen comments. Below is a summary of comments received, grouped by theme. These comments affirmed issues identified by the USACE and cooperating agencies to be addressed in the analyses and reflected in the FS/EA.

Climate Change

- *Need to address how climate change along with land use/development will affect future water supply.*
- *Allocation should be made to ameliorate impacts from climate change.*
- *Fish and wildlife allocations should take into account changes in natural flows due to climate change.*

Prioritization of Uses

- *How will water uses be prioritized during dry years?*
- *How will storage contracts be prioritized?*
- *Allocation for agriculture should be a high priority.*

Water Rights

- *Corps should work closely with the Water Resources Department during future water rights determinations.*
- *Allocations for fish and wildlife flows should satisfy conversion of the state's minimum perennial streamflows.*
- *Need to include future withdrawals/development of existing water rights in the model and evaluation.*
- *Cost of contract water must be transparent and not prohibitive to small cities.*

Fish and Wildlife Flows

- *Allocations should be made for environmental flows, not just fish and wildlife species.*
- *Fish and Wildlife flows should be a high priority.*
- *Demands should include needs for wildlife refuges.*

- *Fish and Wildlife flows are not just minimum flows, but should incorporate a full range of flows.*

9.2 Study Progress Stakeholder Meeting

In addition to the public scoping meetings in March of 2016, the Portland District, in coordination with the OWRD hosted a stakeholder meeting in March of 2017 to brief interested parties on the status of the study. In attendance were stakeholder representatives from state and federal resource agencies, agriculture, municipalities, and conservation interests. Attendees are shown on Table 9-1.

Table 9-1
Stakeholder Meeting Attendees

Association of Oregon Counties
City of Cottage Grove
City of Creswell
City of Creswell
City of Hillsboro
City of Salem
Freshwater Simulations
GeoSyntec
GSI Water Solutions (2 representatives)
HDR Engineering
Jordan Ramis
National Marine Fisheries Service (2 representatives)
Oregon Association of Nurseries
Oregon Dept. of Agriculture (3 representatives)
Oregon Dept. of Environmental Quality
Oregon Dept. of Fish and Wildlife (2 representatives)
Oregon Farm Bureau (3 representatives)
Oregon Freshwater Simulations
Oregon State University (3 representatives)
Oregon Water Resources Department (2 representatives)
Oregon Winegrowers Association
Santiam Water Control District
Special Districts Association of Oregon
Tualatin Valley Water District (2 representatives)
U.S. Army Corps of Engineers (7 representatives)
U.S. Forest Service-Willamette MRRD (2 representatives)
U.S. Geological Survey
University of Oregon
Water Resources Commission
WaterWatch (3 representatives)

9.3 List of Agencies Consulted

9.3.1 Federal Agencies

U.S. Department of the Interior:

Regional Director, Pacific Region, U.S. Fish and Wildlife Service
Area Manager, U.S. Bureau of Reclamation
District Manager, Eugene District, U.S. Bureau of Reclamation
Vice President Environment, Fish and Wildlife, Bonneville Power Administration.

U.S. Forest Service:

Forest Supervisor, Willamette National Forest, and
Forest Supervisor, Umpqua National Forest.

National Marine Fisheries Service:

Assistant Regional Administrator, Oregon/Washington Coastal Area Office

9.3.2 State Agencies

Oregon Water Resources Department

Oregon Department of Environmental Quality

Oregon Department of Fish and Wildlife

Oregon Department of Agriculture

State Historic Preservation Office

9.3.3 Native American Tribes

Chair of the Cow Creek Band of Umpqua Indians

Chair of the Cowlitz Indian Tribe

Chair of the Confederated Tribes of the Grand Ronde Community of Oregon

Chair of the Confederated Tribes of the Siletz Indians

Chair of the Confederated Tribes of the Warm Springs Reservation of Oregon

10 Compliance with Environmental Laws and Regulations

Making a determination to reallocate storage in WVP reservoirs from Joint Use to specific volumes dedicated to the project purposes of fish & wildlife, irrigation, and municipal and industrial water supply uses would not occur until the ARP achieves environmental compliance with the applicable laws and regulations as described below. Environmental compliance for the ARP would be achieved upon coordination of this FR/EA with appropriate agencies, organizations, and individuals for their review and comment.

<u>American Indian Religious Freedom Act (AIRFA) of 1978, 42 U.S.C. § 1996.</u>

In compliance.

The American Indian Religious Freedom Act (AIRFA) calls for the U.S. government to respect and protect the rights of Indian tribes to the free exercise of their traditional religions. The courts have interpreted this Act as requiring agencies to consider the effects of their actions on traditional religious practices. Federal agencies must make reasonable efforts to ensure religious rights are accommodated. AIRFA does not protect Native American religions beyond the guarantees of the First Amendment and there is no affirmative relief provision under the Act. It merely provides that any subsequent federal laws enacted take into consideration religious practices of Native Americans. Implementing the ARP would not adversely affect the protections offered by this Act.

<u>Bald and Golden Eagle Protection Act, 16 U.S.C. §§ 668, 668a-668d.</u>

In compliance.

The Bald Eagle Protection Act contains requirements on Corps projects concerning bald eagles. Implementing the ARP would not adversely affect bald or golden eagles or their habitat. Because of the overt inability of the ARP to effect change to water surface elevations within the reservoirs and downstream of the WVP reservoirs that would be different from the range of conditions currently observed, implementation of the ARP would not adversely affect bald or golden eagles or their habitat.

<u>Clean Air Act, as amended, 42 U.S.C. §§ 7401-7671q.</u>

In compliance.

The purpose of this Act is to protect public health and welfare by the control of air pollution at its source, and to set forth primary and secondary National Ambient Air Quality Standards to establish criteria for states to attain or maintain. No emissions would occur as a result of implementing the ARP.

<u>Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. §§ 1251-1388.</u>

In compliance.

The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters (33 U.S.C. § 1251). The Corps regulates discharges of dredge or fill material into waters of the United States pursuant to Section 404 of the Clean Water Act. Section 404 requires authorization to place dredged or fill material into water bodies or wetlands. If a Section 404 authorization is required, a Section 401-water quality certification from Oregon

Department of Environmental Quality is also needed. Pursuant to Section 402 of the Clean Water Act, the ODEQ implements the National Pollutant Discharge Elimination System (NPDES) permit program under agreement with the U.S. Environmental Protection Agency (EPA). For each permit, ODEQ uses a series of water quality models to determine if the facility has the reasonable potential to cause or contribute to the exceedance of a water quality standard.

The proposed reallocation of WVP conservation storage would not require earth moving actions of any type to implement by the Corps, and would have no direct effects as a result. However, although not reasonably foreseeable, the reallocation of storage could allow the eventual installation of M&I water intakes sometime in the future. Although none are currently proposed, future water supply intakes would likely be subject to separate regulatory review when proposed.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). 42 U.S.C. §§ 9601-9675.

Not applicable.

Typically CERCLA is triggered by (1) the release or substantial threat of a release of a hazardous substance into the environment; or (2) the release or substantial threat of a release of any pollutant or contaminant into the environment that presents an imminent threat to the public health and welfare. Implementing the ARP would not cause any release or threatened release of hazardous substances that would require action under CERCLA.

Endangered Species Act, as amended. 16 U.S.C. §§ 1531-1544.

In compliance.

Section 7 (16 U.S.C. § 1536) states that all federal departments and agencies shall, in consultation with and with the assistance of the Secretary of the Interior (USFWS) and the Secretary of Commerce (NMFS), ensure that any actions authorized, funded, or carried out by them do not jeopardize the continued existence of any threatened or endangered (T&E) species, or result in the destruction or adverse modification of habitat of such species which is determined by the Secretaries to be critical.

A BA is required of the action agency when a proposed action involves major construction projects and is recommended for all other federal actions. The BA presents an evaluation of available information and a determination whether the action is likely to have an effect on an ESA-listed species or its critical habitat. The BA is provided to the appropriate resource agency (NMFS/USFWS) responsible for the species in question.

Depending on the extent of the action and the nature of the effects, the resource agency reviews the BA and available information and determines whether a formal consultation under Section 7 is necessary. If formal consultation is deemed necessary, a formal BiOp will be prepared by NMFS, USFWS, or both agencies (depending on the species in question). Informal consultation involves a "finding" by the action agency that the project or activity is not likely to adversely affect the ESA-listed species or critical habitat and would include a letter of concurrence from the NMFS and/or the USFWS.

The Corps submitted a BA to the NMFS July 2, 2018, and to the USFWS on July 13, 2018. The BA determined that the proposed action may affect, but is not likely to adversely affect Upper Willamette River spring Chinook salmon and winter steelhead, bull trout, Bradshaw's Desert

Parsley, Nelson's Checker-mallow, and Fender's Blue Butterfly. The BA further determine the proposed action would have no effect on other ESA-listed species.

The USFWS concurred with the Corps' not likely to adversely affect determination on July 26, 2019. (See Appendix N)

The NMFS concluded that the proposed action is likely to jeopardize the continued existence of ESA-listed Upper Willamette River Chinook salmon and Upper Willamette River steelhead, and also concluded that the proposed action is likely to result in the adverse modification of critical habitat for these species.

NMFS' biological opinion (Appendix M) included a Reasonable and Prudent Alternative (RPA) to the proposed action that, if implemented by the Corps, will offset the effects of the proposed action such that the effects are not likely to jeopardize Upper Willamette River Chinook salmon and Upper Willamette River steelhead or adversely modify their designated critical habitat. The Reasonable and Prudent Alternative Measures outline several features of implementation:

RPA 1: The Corps will retain sufficient local authority to modify the reallocation without further congressional action.

RPA 2: The Corps will defer entering into any new water storage contracts for municipal and industrial (M&I) use beyond an agreed upon cap at projected 2025 deficit demands of 11,000 acre-feet until in-stream flows are protected by the state.

RPA 3: When the Corps enters into a new water storage supply agreement for M&I uses in the WVP, the agreement will specify restrictions that are consistent with the 2008 BiOp requirements for new and renewed water use contracts issued by the Bureau of Reclamation (BOR).

RPA 4: The Corps will work to meet 2008 BiOp flows and in the event that forecasts indicate that flows won't be met, the Flow and Water Quality Management Team (FWQMT) will convene to adaptively manage the system and determine how curtailment may occur.

RPA 5: The Corps will prepare an annual "Willamette Basin Year in Review Report" to document its accomplishment of the Willamette Basin Project Conservation Release Season Operating Plan (the Annual Conservation Plan) for the previous water year. The Corps will also participate in an annual coordination meeting with NMFS to discuss the annual report before finalizing an Annual Conservation Plan for the next water year.

The Corps acknowledged receipt of these measures on June 26 2019.

Environmental Justice (E.O. 12898).

In compliance.

Federal agencies shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. Because of the inability of the ARP to effect change to water surface elevations different from the range of conditions currently observed with the WVP reservoirs and downstream, and because implementation of the ARP does not involve any construction actions, there would be no disproportionately high and adverse human health or environmental effects to minority or low-income populations.

Fish and Wildlife Coordination Act, as amended, 16 U.S.C. §§ 661-665, 665a, 666, 666a-666c.

In compliance.

The FWCA requires governmental agencies, including the Corps, to coordinate activities so that adverse effects on fish and wildlife would be minimized when water bodies are proposed for modification. The Corps received a declination letter from the USFWS on December 1, 2016. There are no new intakes or water supply infrastructure proposed as part of the Corps' action to implement the ARP. Future M&I water supply contracts require review by the Corps prior to allowing placement of infrastructure. If a regulatory permit is necessary, the Corps would complete NEPA evaluations and comply with all appropriate environmental laws and regulations, including the Fish and Wildlife Coordination Act.

Magnuson-Stevens Fishery Conservation and Management Act of 1976

In compliance.

The National Marine Fishery Service (NMFS) is responsible for consultations conducted under Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) regarding essential fish habitat (EFH) consultation requirements. Section 305(b)(2) of the MSA requires federal agencies to consult with NMFS if their actions may adversely affect EFH. NMFS included their assessment of the ARP on EFH as part of formal consultation (BA/BiOp process) under Section 7 of the Endangered Species Act and determined the project would adversely affect habitat for Chinook and coho salmon. NMFS adopted the RPA measures as conservation measures under MSA. The Corps accepted these measures on June 26, 2019.

Migratory Bird Treaty Act

In compliance.

The Migratory Bird Treaty Act of 1918 (MBTA) is the domestic law that affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over utilization. Executive Order 13186 (2001) directs executive agencies to take certain actions to implement the act. Implementation of the ARP would have no effect on migratory birds.

National Environmental Policy Act (NEPA), as amended, 42 U.S.C. §§ 4321-4347.

In compliance.

This environmental assessment (EA) has been prepared in accordance with the CEQ's NEPA implementing regulations (40 C.F.R. § 1508.9) and the Corps' NEPA regulations (33 C.F.R. Part 230) to "briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" (40 CFR 1508.9). Once the District Commander has reviewed the FR/EA and comments received during public review, the District Commander will decide to either sign a finding of no significant impact or prepare an environmental impact statement.

National Historic Preservation Act, as amended, 54 U.S.C. §§ 300101-307108.

In compliance.

This Act instructs federal agencies having direct or indirect jurisdiction over a proposed federal or federally-assisted undertaking to take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. The reallocation of storage will not change the maximum and minimum conservation pool levels; however, as increased water is released to meet downstream needs starting in early summer, the reservoir elevations may be slightly lower earlier in the summer from the current operations. The earlier timeframe of annual draw-down will happen slowly over a 50 year period as users enter contracts for stored water.

The Corps determined that this action will have no adverse effect to historic properties. Therefore, under Section 106 of the NHPA, the Corps is currently consulting with the Oregon SHPO and affected Tribes, including the Cow Creek Band of Umpqua Indians, the Confederated Tribes of the Grand Ronde Communities of Oregon, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes of the Siletz Indians. Consultation letters were submitted to the Oregon SHPO and the Tribes on July 19, 2019. The District sent a clarifying letter to SHPO dated September 13th, 2019. On September 26, 2019, SHPO provided a letter concurring with the Corps' no effect determination. The Cow Creek Band of Umpqua Indians and Confederated Tribes of the Warm Springs Reservation Oregon responded with no concerns. The Confederated Tribes of the Grand Ronde Communities of Oregon and the Confederated Tribes of the Siletz Indians did not respond.

Native American Graves Protection and Repatriation Act, 25 U.S.C. §§ 3001-3013.

In compliance.

The Native American Graves Protection and Repatriation Act (NAGPRA) addresses certain Native American and Native Hawaiian cultural items. In part, it establishes a process to follow in the event of an inadvertent discovery of human remains, funerary, sacred, and other objects of cultural patrimony from sites located on land owned or controlled by the federal government. The Corps has made the determination that the proposed reallocation of storage is in compliance with the NAGPRA – there are no known Native American burial sites located within the project area.

Rivers and Harbors Act of 1899, 33 U.S.C. §403.

In compliance.

Section 10 of the Rivers and Harbors Act prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army. There are no new intakes or water supply infrastructure proposed as part of the proposed reallocation of storage. In addition, future water supply infrastructure would likely require regulatory review by the Corps prior to allowing placement of infrastructure. In this process, the Corps would complete appropriate NEPA evaluations and comply with all appropriate environmental laws and regulations, including Section 10 of the Rivers and Harbors Act, if applicable.

Floodplain Management (E.O. 11988).

In compliance.

Section 1 requires each agency to provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally-undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. The Federal Emergency Management Agency's Eight Step Planning Process for Floodplain/Wetland Management was used to evaluate compliance with E.O. 11988. The first step of the process is a determination of whether or not the action will have the potential to affect a wetland or floodplain, which it will not. As such, the proposed reallocation of storage in WVP reservoirs would be in incompliance with E.O. 11988.

Protection of Wetlands (E.O. 11990).

In compliance.

Federal agencies shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agencies responsibilities. Each agency, to the extent permitted by law, shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands, which may result from such use. In making this finding, the head of the agency may take into account economic, environmental and other pertinent factors. Each agency shall also provide opportunity for early public review of any plans or proposals for new construction in wetlands.

The proposed reallocation of storage in WVP reservoirs would not require earth moving actions of any type by the Corps to implement. Changes to releases during the conservation season may lead to lower heights of reservoir water surface elevations in some years, but the water surface elevations that are the top and bottom of the conservation pool for each reservoir would remain unchanged by the proposed reallocation of storage. The pool elevations for the top and bottom of the conservation pool are a function of flood risk reduction operations, so wetlands would be unaffected because the annual drawdown to empty the conservation pool would continue and the springtime process to refill conservation storage would occur as it does currently.

Future M&I water supply intakes and water distribution infrastructure would typically require regulatory review and would need to comply with appropriate environmental laws and regulations, including E.O. 11990.

Wild and Scenic Rivers Act, as amended, 16 U.S.C. §§ 1271-1287.

In compliance.

This Act establishes that certain rivers of the Nation, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. All rivers federally designated as Wild and Scenic in the Willamette River basin are upstream of WVP reservoirs and would not be affected by implementing the ARP.

11 District Engineer's Recommendation

I have given careful consideration to all significant aspects of this study in the overall public interest, including economic feasibility, as well as social and environmental effects. I recommended that storage in the Willamette Valley Project reservoirs be reallocated from existing Joint Use conservation storage to specific storage for agricultural irrigation, fish and wildlife, and municipal and industrial water supply storage. This reallocation is for the long-term benefit of the people and environment in the Willamette River basin, Oregon. I also recommend that USACE retain discretion to modify the allocations for each of the three specific purposes as necessary to ensure compliance with biological opinions associated with reinitiation of the 2008 Endangered Species Act (ESA) consultation and future ESA consultations related to the storage and release of water from the WVP.

The recommended plan does not include any modifications which would negatively affect the purposes for which the Willamette Valley Project was authorized, surveyed, planned, or constructed, nor would it involve structural or major operational changes. A draft Finding of No Significant Impact (FONSI) is provided as an attachment to this report.

Questions on this draft Feasibility Report/Environmental Assessment can be directed to Mr. Eric Stricklin, Chief of Planning and Project Management Branch, Portland District, at (503) 808-4757, or Mr. Douglas Komoroski, Project Manager, at (503) 808-4782. Questions on the environmental resources analysis or EA, can be directed to Mr. David Griffith, Chief of the Environmental Planning Section, at (503) 808-4773.

Aaron L. Dorf
Colonel, Corps of Engineers
District Engineer

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13 Glossary

Acre-foot (AF): the volume of water required to cover one acre to a depth of one foot and is equivalent to 43,560 cubic feet or 325,850 gallons.

Action Agencies: The three federal agencies that have participated in the ESA Section 7 consultation with NMFS and the USFWS on the continued operation of the Willamette Valley Project. The three agencies are the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration.

Bankfull: The level of discharge from a reservoir at which any further increase in the discharge would result in water moving into the floodplain.

BOR Reaches: The 15 reaches used by the US Bureau of Reclamation to distinguish locations for contracts for stored water from the USACE reservoirs in the Willamette Valley. These reaches indicate which reservoirs can supply water to satisfy the contracts.

Conservation Storage: The specified volume of a reservoir or set of reservoirs dedicated to water storage for use in meeting water needs, including municipal, domestic, agricultural irrigation, fish and wildlife flow augmentation, and recreation.

Cost of M&I Storage: The cost of authorized M&I water supply storage in new and existing projects will be the total construction cost allocated to the water supply storage space. This cost will include (as appropriate) interest during construction and interest after the ten-year interest free period. This cost will also include (as appropriate), the costs of water supply conduits and the cost of past expenditures for items such as repair, replacement, rehabilitation and reconstruction. The share of the users cost of storage represented in the repayment agreement will be the same ratio as the share of the users storage space is to the total water supply storage space.

Cubic foot per second (CFS): is the rate of discharge representing a volume of one cubic foot passing a given point during one second and is equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute. The volume of water represented by a flow of one cubic foot per second for 24 hours is equivalent to approximately 86,400 cubic feet, approximately 1.983 acre-feet or approximately 646,272 gallons.

Duty: Often referred to in combination with a specified maximum instantaneous withdrawal rate for irrigation (the maximum flow of water in cubic feet per second or gallons per minute). Duty represents the maximum volume of water in acre-feet per acre per year that may be diverted under irrigation water rights in Oregon.

Expected Demand: The amount of the calculated demand expected to be used based on existing use rates. This applies to both consumptive uses, but not fish and wildlife purposes.

Flood Stage: The water surface elevation at which hazards to life, property or commerce begin to occur. The issuance of flood (or in some cases flash flood) warnings is linked to flood stage.

Instream Use: Any use that supports benefits derived from keeping water flowing in-channel. Most often the term describes the public uses defined in ORS 537.332: recreation, pollution abatement, navigation, and an array of environmental purposes, including fish and wildlife preservation. Instream uses are eligible for protection under state law through instream water rights.

Instream Water Right: A water right held in trust for the people of the State of Oregon by the Water Resources Department. Instream water rights allocate water for a variety of instream uses listed in ORS 537.332.

Live flow: (1) The streamflow generated by a watershed prior to any human use; (2) The flow of a stream minus any augmentation from water released by upstream reservoirs.

Minimum Perennial Streamflow: An amount of water allocated in Oregon by administrative rule to support fish, recreation, and water quality needs at a specific stream point or reach. As precursors to instream water rights, "minimum flows" were assigned a priority date and managed conjunctively with other water rights, except they could be waived. Most have been converted to instream water rights, as required by ORS 537.356, though minimum perennial streamflows for Willamette River tributaries downstream of WBV projects have not.

Municipal and Industrial (M&I) : M&I water supply has been defined by the Corps to mean water supply for uses customarily found in the operation of municipal water systems and for uses in industrial processes.

Peak Demand: The highest amount of water that could be used by a given sector, based on water rights or system capacities.

Reallocation: the reassignment of the use of existing storage space in a reservoir project (or system of reservoirs) to a higher and better use.

Reservoir: a natural or artificial lake or pond in which water is collected for beneficial use or purpose. Oregon Administrative Rule 690-250-0010(13).

RPA Measure 2.9: Reasonable and Prudent Alternative, Measure 2.9, provided in *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation*. "*Consultation on the Willamette River Basin Flood Control Project"*. Text of RPA Measure 2.9 reads:

> In coordination with the OWRD and ODFW, the Action Agencies will facilitate conversion of stored water to an instream flow water right. Oregon adopted minimum perennial streamflows for Willamette tributaries in Oregon's Willamette Basin Program (Table 1 in ORS 690-502). After being converted to water rights under Oregon law, OWRD can protect the minimum perennial stream flows from illegal diversion. The State of Oregon is solely responsible for administering and enforcing state water rights.
>
> Additionally, the Action Agencies will identify stored water in addition to the minimum perennial streamflows that could be allocated from reservoirs to enhance salmon and steelhead survival. The Action Agencies will proceed with necessary actions to allocate and protect water for this purpose. In particular, USACE and Reclamation will coordinate with OWRD on several tasks to accomplish this measure:

1) identify current water storage at USACE reservoirs that could be allocated to instream flow for ESA listed fish;

2) determine how to legally transfer flow for instream purposes; and

3) proceed with the necessary analyses to implement the agreed upon transfers.

The tasks necessary to accomplish this action may require approval from Congress. This effort will begin immediately. By the end of 2009, the Action Agencies will have coordinated with all appropriate agencies and determined the path forward in order to accomplish this action.

RPA Measure 3: Reasonable and Prudent Alternative, Measure 3, provided in *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation*. "*Consultation on the Willamette River Basin Flood Control Project*". Text of RPA Measure 3 reads:

Reclamation and the USACE will continue the existing irrigation contract water marketing program for the Willamette Project. Reclamation will issue new contracts, except as specified in RPA Measure 3.1 below regarding new contracts in the N. and S. Santiam subbasins, and provided that the total water marketing program, including existing contracts, does not exceed a total of 95,000 acre feet. In the event that future irrigation demand exceeds 95,000 acre-feet, Reclamation and the USACE will reevaluate the availability of water from conservation storage for the water marketing program and reinitiate consultation with the Services if they propose to issue additional contracts.

In addition, all contracts will be subject to the availability of water, as determined by USACE. Therefore water may not be available for some or all of each year in order to meet ESA requirements and other project obligations for instream flows (e.g. minimum flows to protect water quality). Reclamation may issue notices, orders, rules, or regulations governing water service as necessary to comply with the requirements of the ESA, including appropriate biological opinions and Incidental Take Statements.

RPA Measure 3.1: Reasonable and Prudent Alternative, Measure 3.1, provided in *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation*. "*Consultation on the Willamette River Basin Flood Control Project*". Text of RPA Measure 3.1 reads:

New Contract Issuance: Reclamation will not issue irrigation water service contracts in the North Santiam River and the South Santiam River that would in total exceed the current total of 11,574 ac ft (85 cfs) and 1,096 ac ft (7 cfs) respectively.

Rule Curve: The rule curve shows the maximum elevation to which the Corps can fill a reservoir during various times during the year, with the exception of real-time flood operations.

Secondary Use Permit: Oregon law maintains a distinction between the oft-coupled activities of impounding water and then using it, by requiring two different permits. Issued by OWRD, the secondary use permit provides an applicant the authorization required to apply stored water to a place of use.

Single Source Redundancy: an M&I backup water supply that provides an alternative source of water so that municipalities have a degree of system resilience to reduce outage risk.

Stored Water: water held in conservation storage.

Stored Water Right: any water impounded in a reservoir under the provisions of an established right to store water. In Oregon, the right to store water (under this provision) is different from the right to use water. Oregon Administrative Rule 690-250-0010(10).

Surplus Water: water available at any reservoir that the Assistant Secretary of the Army (Civil Works) determines is not required during a specified time period to accomplish an authorized federal purpose or purposes of that reservoir, for any of the following reasons: (i) because the authorized purpose or purposes for which such water was originally intended have not fully developed; or (ii) because the need for water to accomplish such authorized purpose or purposes has lessened; or (iii) because the amount of water to be withdrawn, in combination with any other such withdrawals during the specified time period, would have virtually no effect on operations for authorized purposes. Proposed Definition from 81 Fed. Reg. 91556, 91589 (Dec. 16, 2016).

Transfer: An authorization issued by the OWRD to change a water right's type of use, character of use, place of use, or point of diversion.

Water Control Diagram: Graphic representations of reservoir water levels; used to guide reservoir operations.

Water Use Permit: A provisional authorization issued by OWRD allowing a party to divert or pump a specific amount of water for a specific use at a specific location. If water is put to beneficial use within the time period allowed by law and in accordance with any permit terms, OWRD finalizes the permission in the form of a water right certificate.

14 List of Acronyms

ADD	Average Daily Demand
AI	Agricultural Irrigation
APE	Area of Potential Effect
ARP	Agency Recommended Plan
ASR	Aquifer Storage and Recovery
BA	Biological Assessment
BiOp	Biological Opinion
BOR	U.S. Bureau of Reclamation
B.P.	Before Present
BPA	Bonneville Power Administration
BLM	Bureau of Land Management
CAP	Continuing Authorities Program
CDL	Cropland Data Layer
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
cfs	Cubic Feet Per Second
COP	Configuration / Operation Plan
Corps	U.S. Army Corps of Engineers
DPS	Distinct Population Segment
DWD	Diverted Water Demand
E-flow	Environmental Flows
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FCSA	Feasibility Cost Share Agreement
FMWQT	Flow Management Water Quality Team
FR/EA	Feasibility Report and Environmental Assessment
FS	Feasibility Study
F&W	Fish and Wildlife
GI	General Investigation Program
GIS	Geographic Information System
GPCD	Gallons Per Capita Day

HEC	Hydrologic Engineering Center
HGMP	Hatchery Genetic Management Plan
MAF	million acre-feet
M&I	Municipal and Industrial
MDD	Maximum Daily Demand
MGD	million gallons per day
MPSF	Minimum Perennial Streamflow
NED	National Economic Development
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OEA	Oregon Office of Economic Analysis
OHA	Oregon Health Authority
OWQI	Oregon Water Quality Index
OWRD	Oregon Water Resources Department
POU	Place of Use
POR	period of record
PWB	Portland Water Bureau
Reclamation	U.S. Bureau of Reclamation
ResSim	Reservoir System Simulation Program
RM&E	Research, Monitoring, and Evaluation
RPA	Reasonable and Prudent Alternative
SHPO	State Historic Preservation Office
SSI	Self-Supplied Industrial
TCP	Traditional Cultural Property
TSP	Tentatively Selected Plan
UDV	Unit Day Value
UGB	Urban Growth Boundary

USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWR	Upper Willamette River
WATER	Willamette Action Team for Ecosystem Restoration
WCP	Willamette Conservation Plan
WFOP	Willamette Fish Operations Plan
WFPOM	Willamette Fish Passage Operations & Maintenance
WMCP	Water Management and Conservation Plan
WRIS	Water Rights Information System
WSMP	Water System Master Plan
WVP	Willamette Valley Project