4.0 Summary of Significant Findings

Significant findings summarized in this chapter are detailed in Chapters 5, 6, and 7 of this technical report, as well as in the Columbia River Instream Atlas (Ecology Publication 11-12-015), and (where identified) from other outside sources.

4.1 Surface Water Supply in the Columbia River Basin

Modeling forecast results for 2030 suggest that compared to historical (1977-2006) supplies:

- A small increase of around 3.0 (±1.2)% in average annual supplies will occur.[1]
- Timing changes will shift water away from the times when demands are highest. Unregulated surface water supply at Bonneville will decrease an average of 14.3 (±1.2)% between June and October by 2030, and increase an average of 17.5 (±1.9)% between November and May.
- Annual water supplies entering Washington are forecasted to increase for most rivers entering the eastern portion of the basin, and the direction of change is unclear for most rivers entering the northern portion of the basin.
    - Annual water supplies entering Washington will increase by approximately 3.7 (±1.3)% on average for the Columbia, Pend Oreille, Spokane, Clearwater, Snake, and John Day Rivers by 2030.
    - The direction of change for annual water supplies entering Washington is unclear for the Similkameen and Kettle Rivers, +1.4 (±1.9)% on average by 2030.

The regional survey of water managers throughout the Columbia River basin was used to complement modeling results. Given that modeling assumed similar management in 2030, and did not anticipate large new water supply projects outside of Washington, in upstream portions of the Columbia River basin, the survey was a useful tool. The survey revealed that efforts to improve flow or aquatic habitat conditions in portions of the Columbia River basin outside of Washington State typically involve relatively minor changes to management of winter or peak flows at existing projects. Little definitive action is currently being taken to build large water infrastructure projects due to a lack of funding and willingness to pay for water. Overall, the results of the survey confirmed that the current upstream management scheme could be used for modeling.

[1] When discussing modeled supply and irrigation demand results, "average flow conditions" refers to the 50th percentile (middle) value under the middle climate scenario. "Average" by itself refers to the average value over all climate scenarios and flow conditions, and a 90% confidence interval around that average.

The survey also indicated that a lack of regional and cross-jurisdictional communication hampers planning efforts. Improving communication may be a first step to creating more purposeful opportunities for partnership.

Annual surface water supplies within the Washington portion of the Columbia River basin are expected to increase for most tributaries of Washington:

- Walla Walla (7.2 ±1.9%)
- Palouse (5.9 ±3.6%)
- Colville (9.5 ±2.8%)
- Yakima (4.4 ±2.3%)
- Wenatchee (5.9 ±1.8%)
- Chelan (5.8 ±1.5%)
- Methow (7.7 ±2.3%)
- Okanogan (4.3 ±2.4%)
- Spokane (6.6 ±2.2%)

Within the Washington portion of the Columbia River basin, the Forecast shows a fairly consistent pattern in changes of surface water supply timing, with higher flows in late fall, winter and spring by 2030, and lower flows in the summer and early fall. Exact timing varies by watershed.

4.2 Cumulative Water Demands in the Washington State Portion of the Columbia River Basin

This section presents cumulative forecasted demands for the Washington state portion of the Columbia River basin. These results should be understood within a likely context of increasing demands across the entire Columbia River basin, particularly during summer low flow conditions.

Historical (1977-2006) out-of-stream diversion demands within the Washington State portion of the Columbia River basin for municipal and agricultural irrigation water (excluding irrigation conveyance losses) were estimated to be in the range of 6.3 (±0.1) million ac-ft. Forecasted increases in water demands in eastern Washington for 2010 to 2030 are summarized in Table 10. The Forecast anticipates

- 170,000 (±18,000) ac-ft per year of additional *total* (ground and surface) water agricultural irrigation demand. This number assumes no change in irrigated acreage, and no additional water supply development. This number represents demands for

surface and groundwater as applied to crops, plus the additional water needed to account for irrigation application inefficiencies.

- 430,000 (±14,000) ac-ft per year of additional *surface* water agricultural demand. This number includes new demands that will be met only by surface waters, and assumes that historical groundwater irrigation demands in the Odessa area will be new surface water demands in the future.
- 117,500 ac-ft per year in additional total diversion demands for municipal and domestic water.
- 500,000 ac-ft per year of unmet tributary instream flows, and 13.4 million ac-ft per year of unmet Columbia River mainstem instream flows, based on observed deficits during the 2001 drought year.
- No demand for new water storage for hydropower generation purposes.

Table 10. Forecast increases in demands by sector from 2010 to 2030 in eastern Washington.

Demand Type	Estimated Volume (acre feet)	Source
2030 New Irrigation Demand[a]	170,000	WSU Integrated Model
2030 New Municipal and Domestic Demand (including municipally-supplied commercial)	117,500	WSU Integrated Model
Unmet Columbia River Instream Flows[b]	13,400,000	Ecology data, McNary Dam, 2001 drought year
Unmet Tributary Instream Flows[c]	500,000	Ecology data, tributaries with adopted instream flows, 2001 drought year
2030 New Hydropower Demand	0	WSU Surveys and Planning Forecast Review
Alternate Supply for Odessa	164,000	Odessa Draft Environmental Impact Statement (October 2010)
Yakima Basin Water Supply (pro-ratables, municipal/domestic and fish)	450,000	Yakima Integrated Water Resource Management Plan (April 2011)
Unmet Columbia River Interruptibles	40,000 to 310,000	Ecology Water Right Database (depending on drought year conditions)

[a] Additional irrigation demands were modeled assuming an equivalent land base for irrigated agriculture, under a scenario of medium growth in the domestic economy, and medium growth in international trade. Acreage currently irrigated by groundwater in the Odessa was assumed to be new surface water demand in 2030, and thus is not reflected in changes in total demand, which includes both surface and groundwater. Increases in total demand are thus due to the combined impacts of climate change, and changes in crop mix driven by growth in the domestic economy and international trade.

[b] Unmet Columbia River instream flows are the calculated deficit between instream flows specified in Washington Administrative Code (WAC) and 2001 (drought condition) actual flows at McNary Dam.

[c] Unmet tributary instream flows are the combined deficits between current instream flows specified in WAC and 2001 actual flows at Walla Walla River near Touchet, Wenatchee River at Monitor, Entiat River near Entiat, Methow River near Pateros, Okanogan River at Malott, Little Spokane River near Dartford, and Colville River at Kettle Falls.

New irrigation and municipal demands do not include improvements in conservation, which could decrease the new demands that need to be met, but might also have complex impacts on return flows. For example, if all municipal and domestic users were able to conserve 10% of their water supplies by 2030, then new municipal demand might drop from 117,500 acre-feet to about 105,000 acre-feet. However, many municipal conservation techniques are non-consumptive in nature. For example, fixing leaky pipes and installing low flow showers and toilets reduce diversions, but with a corresponding reduction in water returned (via wastewater treatment plants or underground). Alternatively, some conservation measures, such as reducing lawn size, do reduce consumptive use. In addition, conservation is often less expensive than new water supply development.

In addition to these new demands by sector, other studies suggest several areas of unmet demand, some of which are not reflected in these totals. These other studies used different methods of calculating demand, and thus, should not be directly compared to the totals above.

- The draft Environmental Impact Statement for Odessa suggests a preferred alternative of supplying 164,000 ac-ft per year of surface water to current groundwater users in this area. This amount is not included in the total irrigation demands above, which shows changes in total (combined groundwater and surface water) demand between the historical period (which includes Odessa) and 2030.
- The Yakima Integrated Water Resource Management Plan suggests that 450,000 ac-ft per year will be needed for pro-ratable, municipal-domestic and fish needs. These demands overlap partially with the demands shown above.
- The Ecology Water Right Database indicates that in years in which the mainstem Drought Program is run, there are 40,000 to 310,000 ac-ft per year of unmet needs by interruptible water users, depending on the drought year conditions. These amounts are currently unmet, so are not reflected in the numbers above.

Together, these current and new demands are likely to exacerbate water supply issues in some locations, particularly during the summer.

4.3 Water Demands in the Columbia River Basin by Sector

4.3.1 Agricultural Water Demands

The agricultural portion of the Forecast focused on irrigation water demands. The 2030 forecast of demand for irrigation water across the entire Columbia River basin (seven U.S. States and British Columbia) was 13.6 million ac-ft under average flow conditions, assuming an equivalent land base for irrigated agriculture in the future (Table 11). The range of estimates was from 13.1–14.1 million ac-ft during wet and dry years, respectively (20th and 80th percentile).[2] This

[2] On average, one in five years will be wetter than the 80th percentile, or dryer than the 20th percentile.

irrigation demand was roughly 2.5% above modeled historic levels under average flow conditions. Conveyance losses, that occur as water is transported through irrigation ditches and canals, were estimated separately.

Table 11. Top of crop agricultural demands under the baseline economic scenario (medium domestic economic growth and medium growth in international trade), excluding conveyance losses, in the Columbia River basin in the historical and 2030 forecast period. Estimates are presented for average years, with range in parentheses representing wet (80th percentile) and dry (20th percentile) years.

	Historical (1977-2006) million ac-ft per year	**2030 Forecast million ac-ft per year**	**% Change**
Entire Columbia River Basin	13.3 (12.6-13.9)	13.6 (13.1-14.1)	2%
Washington Portion of the Columbia River Basin	6.3 (6.0-6.5)	6.5 (6.2-6.6)	2%

Seasonal timing of forecasted water supply and irrigation water demand is shown in Figure 42, with irrigation demands taking a larger proportion of water supplies in summer months by 2030. Instream, hydropower and municipal water demands will also need to be met from these water supplies.

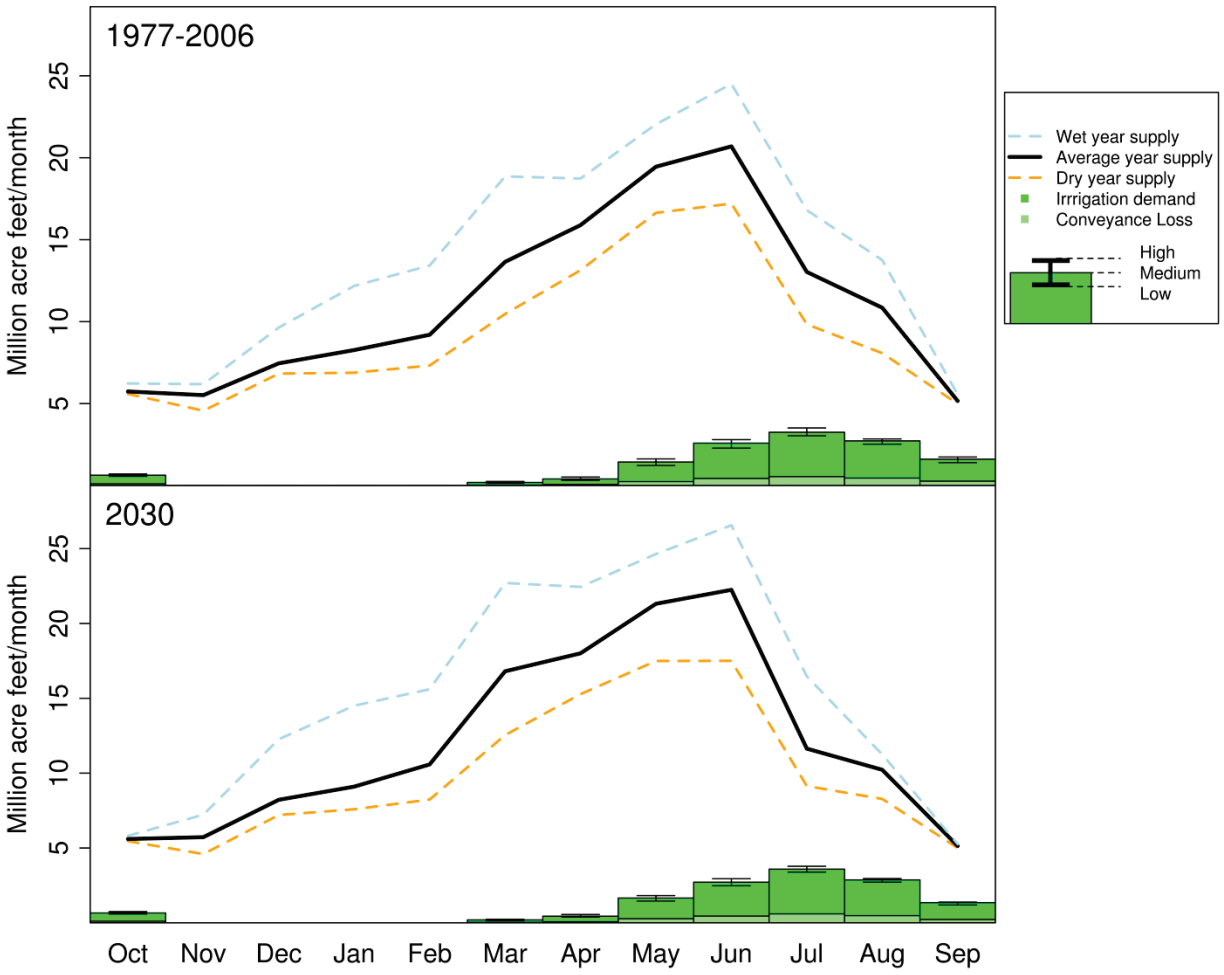

Figure 42. Comparison of regulated surface water supply and surface water irrigation demands for the historical (top) and 2030 forecast (bottom) periods under the medium-growth, medium-trade economic scenario across the entire Columbia River basin, including portions of the basin outside of Washington State. Wet (80th percentile), dry (20th percentile), and average (50th percentile) flow conditions are shown for both supply and demand.

Within the Washington State portion of the Columbia River basin, results were similar (Figure 42):

- Forecast increases in irrigation water demand were an average of 170,000 (±18,000) ac-ft per year, roughly 1.9% above historical conditions, assuming an equivalent land base for irrigated agriculture, and a crop mix influenced by medium growth in the domestic economy and international trade.
- Considering only the climate impacts of temperature and precipitation variations on the irrigation demand, there would be a 3.7% increase in demand. When economic

impacts resulting in a new crop mix are considered in addition to the climate impacts the increase in demand reduces to 1.9%.

Modeling under alternate economic scenarios was used to give information about the potential range of future water demands from irrigated agriculture, if growth in the domestic economy and international trade were higher or lower than anticipated.[3] Higher income growth leads to an expansion of high value crops like fruits and vegetables at the expense of low value crops. Similarly, stronger growth in exports has a disproportionate impact on higher value crops, although wheat and alfalfa are also sensitive to fluctuations in trade. Production patterns were generally more sensitive to assumptions about trade than to assumptions about economic growth. One exception was wine grapes where most of the growth in demand is expected to come from domestic consumers rather than international exports.

- The low, medium and high economic scenarios forecast increases of 200,000 (±17,000) ac-ft, 170,000 (±18,000) ac-ft and 140,000 (±18,000) ac-ft over historical demands under average flow conditions within the Washington portion of the Columbia River basin.
- These estimates assumed no change in the land base for irrigated agriculture, thus differences in the agricultural water demand between different scenarios were due to changes in crop mix and crop water demands under future climate conditions.

Additional scenarios considered the potential impacts of additional water capacity in specific locations corresponding to projects proposed by OCR. Under some scenarios, new water was provided at no cost to users, while in other scenarios, users were charged per unit fees to recover some development costs.

- The development of roughly 200,000 ac-ft of annual water capacity (the medium scenario considered) caused demand for irrigation water to increase by 46,400 (±640) ac-ft per year over baseline 2030 demands (under the medium economic scenario) in the Washington portion of the basin.

4.3.2 Municipal Water Demands

Municipal demands, including domestic and municipally-supplied industrial, are likely to increase throughout the entire Columbia River basin over the next 20 years. By 2030, U.S. Census estimates show population growth in Idaho (25.6%), Oregon (26.2%), and Montana (5.6%). Although some new municipal demands will likely be met by deep groundwater supplies, others will likely come from shallow groundwater or surface water. These additional

[3] Domestic economic growth was 1.3-1.8% under low and high scenarios, while international trade included scenarios of low and high growth in trade for specific crop groups (e.g. vegetables, wheat, etc.).

demands will likely reduce inflows into some parts of Washington. For example, an Idaho study of the Spokane River basin projected an additional demand on the river of 31 cfs by 2060.[4]

Within eastern Washington, the Forecast found that:

- Domestic and industrial diversion demands in rural and urban areas (excluding self-supplied industries) were forecasted to be 569,000 ac-ft per year in 2030, an estimated 26% increase over 2010. Consumptive demands are approximately 51% of this amount.
- Per capita water demands varied considerably throughout eastern Washington, with an average total demand (including system losses) of approximately 277 gallons per capita per day (gpcd).[5]

4.3.3 Instream Water Demands

Across the Columbia River basin, the Forecast found that:

- Decreases in surface water supplies in summer and early fall may increase the challenge of meeting water needs for fish across the Columbia River basin by 2030.
- Re-negotiation of the international Columbia River Treaty could change the amounts and timing of water available to meet instream needs in the Columbia River mainstem.
- Quantification of tribal water rights, while outside the scope of this Forecast, could also change surface water supplies for meeting instream demands in unpredictable ways.

Within eastern Washington, the forecast of demand for water to support instream flows found the following:

- In many rivers in eastern Washington, stream flows are below state or federal instream flow targets on a regular basis, particularly in late summer. Surplus water exists in many of these same rivers at other times of year.
- Decreases in surface water supplies in tributaries in summer and early fall may lead to more weeks when instream flows are not met by 2030. This may result in a higher frequency of curtailment of interruptible water right holders in basins with adopted instream flow rules.

[4] 31 cfs = 22,443 ac-ft/year

[5] 277 gallons per day = 0.429 cfs = 311 ac-ft/year

- An evaluation of fish, flows, and habitat in eight fish critical basins, available in the Columbia River Instream Atlas (Ecology Publication 11-12-015), will help target investments to maximize the positive impact on fish populations.

4.3.4 Hydropower Demands

Across the Columbia River basin, the forecast of hydropower demands found the following:

- Demand for water storage to supply hydropower facilities is anticipated to remain unchanged in 2030. Utilities expect to be able to meet projected steady growth in peak winter and summer energy demands through conservation and integration of other energy sources, including those required under Washington's passage of Initiative 937.
- Several power entities are concerned that climate change and the possible renegotiation of the international Columbia River Treaty will affect hydropower generation capacity.

4.4 Water Demands in Washington State Watersheds

Surface water supplies and water demands were forecasted for each WRIA in eastern Washington. Major results for each WRIA are presented in Chapter 6, Tier II Results. Cumulatively, the following results were found:

- The greatest concentration of current and future agricultural irrigation and municipal water demands are in the southern and central Columbia basin, including Lower Yakima (37), Lower Crab (41), and Esquatzel Coulee (36), as well as Rock-Glade (WRIA 31), Walla Walla (32), Lower Snake (33), Naches (38), Upper Yakima (39), and Okanogan (49). Irrigation dominates the demand for water in these WRIAs.
- Unmet demand due to curtailment of interruptible and pro-ratable water rights or insufficient water at the watershed scale was forecasted for Walla Walla (WRIA 32), Yakima (37, 38, & 39), Wenatchee (45), Methow (48), Okanogan (49), Little Spokane (55), and Colville (59).
- Unmet demand for surface water was forecasted for the Odessa due to existing groundwater declines in Palouse (WRIA 34), Esquatzel Coulee (36), Lower Crab (41), Grand Coulee (42), and Upper Crab (43).

4.5 Surface Water Supply and Demand on Washington's Columbia River Mainstem

Modeled historical and 2030 forecast surface water supplies were compared to state-level instream flow targets and the Federal Columbia River Power System Biological Opinion (FCRPS BiOp).

- Under normal flow conditions, modeled regulated surface water supplies *prior to* meeting cumulative demands were close to Washington State instream flow regulations in fall/early winter at Priest Rapids Dam (both historical and 2030 forecast), and in July and August at Priest Rapids Dam and McNary Dam (for the 2030 forecast).
- Under normal flow conditions, modeled regulated surface water supplies *prior to* meeting cumulative demands were not sufficient to meet target flows under the FCRPS BiOp in April, July, and August at McNary Dam, and from November – January at Bonneville Dam. Imbalances were smaller in the 2030 forecast than the historical case for the late winter/spring months, and larger for the late summer.
- Along the mainstem, there are 379 interruptible water rights, the majority of which are agricultural surface water rights. These water users are particularly vulnerable to the potential impacts of water shortages.

4.6 Conclusion

Collectively, these results suggest that meeting water demands will be more challenging by 2030 as increased demands are placed on limited supplies. Solutions will require combinations of conservation, water banking/marketing, and new supplies based on groundwater and/or storage of water in peak runoff seasons.

For solutions requiring additional investment in water supply infrastructure, the Forecast's results suggest that at prices in the range of those currently being charged by the Office of Columbia River for new water it may be feasible to recover some or all water supply costs from new users without significantly decreasing the quantity of water demanded by users.

Projects associated with the medium water capacity scenario of an additional 200,000 ac-ft per year for out-of-stream uses were estimated to lead to total employment impacts (including indirect and induced effects) of 6,600 jobs. State and local tax impacts were estimated at about $37 million. These estimates do not subtract the jobs and taxes associated with production if land associated with the new capacity was previously under dryland cultivation. These estimates include economic activity generated from downstream processing of agricultural products that occurs within Washington. While not quantified, it is recognized that maintenance of and improvement to instream flows would also have positive economic impacts on tourism and recreation, generating additional jobs and tax revenues.

This Forecast improves our understanding of future surface water supplies and instream and out-of-stream demands, and will serve as a capital investment planning tool to maintain and enhance the region's economic, environmental, and cultural prosperity. Future forecasts will build upon and expand this knowledge to include assessments of groundwater supplies, the Columbia River Treaty and other pertinent issues.