US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX J: WATER SUPPLY ANALYSIS

TABLE OF CONTENTS

LIST OF FIGURES

THE WATER SUPPLY APPENDIX HAS BEEN REVISED FROM THE DEIS
INFORMATION REPEATED IN THE EIS HAS BEEN REMOVED
INSERTION OF LARGE TEXT IS IDENTIFIED; MINOR EDITS ARE NOT DENOTED

Summary of changes from the DEIS:

- **DEIS Section 1, Introduction, has been removed. FEIS, Section 3.13, Water Supply, has been updated to include background information.**
- **FEIS Section 1.1, Overview, has been revised to update information and for accuracy.**
- **The water storage graphs have been updated to include No-action Alternative data.**
- **The water storage volumes have been modified from the 75th percentile to the 80th percentile under each alternative for consistency with Oregon Water Resources Department methods regarding water availability to issue water rights.**
- **Information on the anticipated effects under each alternative has been removed to avoid redundancy with the analyses in FEIS Section 3.13.3, Environmental Consequences, and to focus this appendix on technical information supporting these analyses.**
- **DEIS Section 2.9, Interim Operations, has been updated.**

CHAPTER 1 - METHODS

1.1 OVERVIEW

Water rights issued by the State of Oregon includes the source of water, listed as either surface water, groundwater, or storage. Surface water includes the natural flow in the stream; groundwater is water naturally stored in the ground, e.g., aquifers; storage is water stored in a reservoir. The USACE dams and reservoirs are located on only a few tributaries of the Willamette River basin and hence cannot affect all the waterways in the basin. This analysis focuses on the river reaches downstream of WVS dams and reservoirs and on the mainstem Willamette River upstream of Willamette Falls.

The analysis uses HEC-ResSim output flow data at control points downstream of dams to assess effects to natural flow water rights.

Stored water released from USACE reservoirs is currently withdrawn from the rivers for irrigation purposes, and in the future will be withdrawn to serve municipal and industrial demands. Stored water is also used to support biological flow requirements. This analysis uses the modeled peak system-wide stored water achieved by June 1 that would be met or exceeded more than 80% of the time to assess impacts to storage allocations, and hence stored water users. The 80% metric was used to align with the Oregon Water Resources Department's (OWRD) criteria to issue new water rights.

Groundwater is pumped from underground wells and used for a range of purposes in the Willamette River Basin, including irrigation and municipal and industrial water supply. Effects to groundwater supply is not analyzed in this EIS. The only non-transient (i.e., year-round) groundwater well that is classified as hydrologically connected to surface water is at the head of Detroit Reservoir. The Detroit Water System source is listed as Mackey Creek and the Breitenbush River and serves a population of 100 (OHA, 2025). This well currently experiences effects from the annual cycle of drawdown and refilling of the reservoir for flood risk management operations. USACE has not been informed of any issues associated with this well to date; therefore, none of the proposed operations are expected to have an effect on water production from this well. In addition, rivers and streams downstream of the dams and reservoirs would remain flowing and therefore are not expected to lower the water table adjacent to the waterways.

1.2 DATA COLLECTION AND PREPARATION

1.2.1 Water Rights

OWRD maintains the Water Rights Information System (WRIS) database for water rights in Oregon. The water rights query tool was used to find water rights for municipal and industrial and irrigation uses as of July 2021. Data was grouped by sub-basin, e.g., North Santiam River

Basin. Water rights data were analyzed for duplicate point of diversion to ensure flows were not double counted.

1.2.2 HEC-ResSim Data

HEC-ResSim flow data at the control points downstream of dams and on the mainstem was used to compare flows between the action alternatives and the no action alternative to quantitatively assess impacts to natural flow water rights downstream of the dams. Non-exceedance plots are used to illustrate the general trends between an action alternative and the no action alternative.

Non exceedance plots comparing modeled alternatives to the NAA are provided in the sections below. Non exceedance plots show the probability that an elevation or flow does not exceed a given value on a given day. The colored lines indicate non-exceedance percentiles for the modeled alternative and the shaded regions indicate percentiles for the NAA. Note that the figures in Section 2.1 No-action Alternative only contain the colored lines which are the values for the No-Action Alternative. It is important to note that a line or shaded region on a plot does not represent a continuous year. The reservoir may have a relatively high elevation in the spring in the same year it has a relatively low elevation in the fall.

1.3 ALTERNATIVES ANALYSES

The analysis uses modeled output from HEC-ResSim to assess effects of the alternative operations and maintenance alternatives for the WVS.

The HEC-ResSim model includes a hard coded set of additional releases for consumptive uses, withdrawals of these same volumes, and a set of return flows associated with these withdrawals. Appendix B contains the full details of the HEC-ResSim model setup, including the rules for the consumptive uses. Each project releases a proportionate share of the M&I and irrigation stored water use. While the NAA HEC-ResSim model codes each year based on available storage and includes reductions in releases and withdrawals for consumptive uses based on the water year type determination, the action alternatives do not. Due to limitations with available rules in HEC-ResSim, the model was set up so that the full demand was released from the reservoirs when each individual reservoir elevation was above minimum conservation pool and the full demand was always withdrawn from the river reaches downstream of USACE dams, even if water was not being released to meet this withdrawal. Return flows associated with the demands were also included in the model. This condition is present in all action alternatives.

The NAA continues the current water management objectives, which attempt to manage reservoir levels to balance the needs of all authorized purposes. Water would be released from the reservoirs to satisfy demands of stored water for municipal and industrial uses at the 2050 demand level as the USACE assumed requirements in the WBR BiOp RPA were met and the cap of 11,000 acre-feet of contracts would no longer be in effect. See Appendix B for further details on distribution of these demands. There would be no increased releases for irrigation water

service contracts as the NAA assumes the current cap of 95,000 acre-feet on these contracts from the 2008 NMFS BiOp remains in place.

All action alternatives include the same level of M&I uses as the NAA, but also include an increase of irrigation demand for stored water. The 2050 demands level was also selected for irrigation demands in line with the M&I level of demand. The volume evaluated in the action alternatives is considered the existing level of irrigation use from natural flow and the total volume of Reclamation water service contracts expected to be in place by the year 2050, which includes the current volume of Reclamation issued water service contracts (82,765 acre-feet), existing withdrawals for which the natural flow water right would be junior to newly converted instream water rights (62,050 acre-feet), plus the 2050 level of demand for new Reclamation water service contracts (110,520 acre-feet), for a total of 255,335 acre-feet of stored water use.

As noted in Appendix B, Sections 2.3 and 2.4, the HEC-ResSim model used the 2010 Modified Flow dataset with an extension of the hydrology dataset to 2019. This extended hydrology data kept the same level of irrigation as in the 2010 dataset. The volume of BOR contracts as of October 2023 is 82,765 acre-feet, a difference of 32,534 acre-feet. This volume equates to a daily average of 76 cfs throughout the course of the contract period. The majority of the contracts are on the mainstem Willamette River, downstream of Salem, where flows in the summer are approximately 6,000 cfs during the lowest flow period of the summer. The difference in flows from 2008 to 2022 would be approximately 1.3 percent of the total flow in the river, which is less than what is considered an excellent gage error value by the USGS. Therefore, while the model itself quantitatively only considers effects of 222,201 acre-feet, the USACE is considering the effects of 255,335 acre-feet of stored water used for irrigation in the analyses contained in the EIS.

The irrigation storage allocation included 62,050 acre-feet for current irrigation natural flow water rights that would become junior to instream water rights once the minimum perennial streamflows are converted to instream water rights. As a junior water right holder, these entities would need a secondary source of water in years of low natural flow and are expected to seek a water service contract for use of stored water from BOR. This volume is not added into the HEC-ResSim model as the effects of the irrigation withdrawals are already included in the hydrology dataset as an existing use of water, as well as the release of stored water to meet instream flow targets.

1.3.1 Stored Water Users

The change in peak mid-May system-wide stored water volumes between the NAA and action alternative was calculated to assess effects to stored water users.

How often allocations would be affected is also related to how often biologically based minimum flow targets are met or not met. RPA 2 of the WBR BiOp requires the USACE to notify users how much available stored water will be available to meet storage agreements in any given year. This RPA is applicable to all alternatives, including the NAA. As noted above, since

the withdrawals for consumptive uses are hard coded into the model, water may be withdrawn in the model when it would not be available for withdrawal if flow targets are not being met.

1.3.2 Natural Flow Water Users

Effects to users reliant on natural flow water rights is based on modeled flow changes at control points downstream of the USACE dams. As each year will be a different hydrologic regime, it is not possible to calculate effects to specific water rights, it also speculative for USACE to determine which water rights would be curtailed and when, as each decision is made on a case-by-case basis by the state water master and adaptively based on real time in season adjustments and changes.

CHAPTER 2 - PHYSICAL EFFECTS ANALYSIS

2.1 NO-ACTION ALTERNATIVE

2.1.1 Storage Allocations

Figure 1 shows that 75% of the time, the maximum total volume of water stored in the WVS reservoirs would be at least 1.3 million acre-feet, resulting in enough stored water to meet the M&I and irrigation demands in most years. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

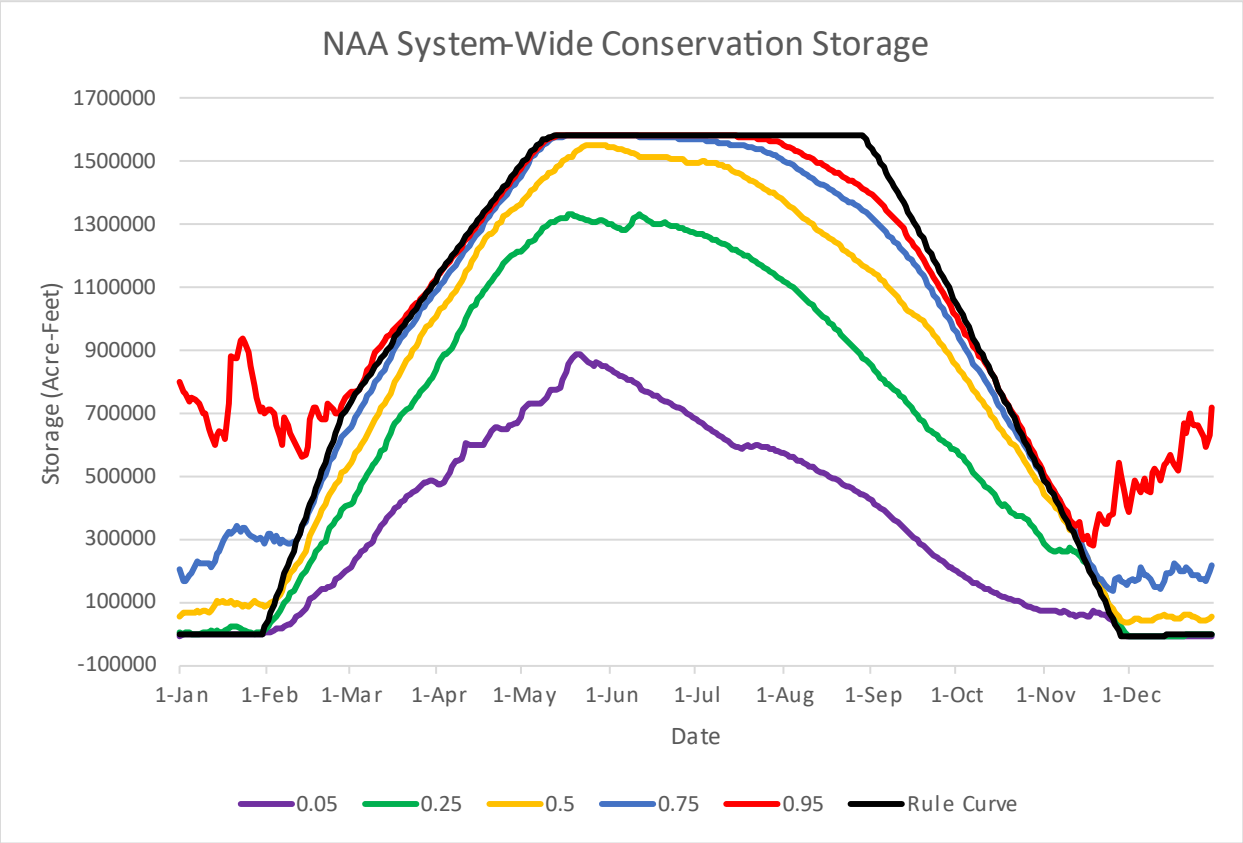

Figure 2-1. System-wide Conservation Storage under the No-action Alternative.

2.1.2 Natural Flow Water Rights

Flows downstream of the WVS dams would continue to support existing water rights in the same frequency as they do today. Not all natural flow water rights are fully met in all years and in all months under existing conditions and this would continue under the NAA due to hydrologic conditions beyond the control of the USACE. Figure 2 through Figure 9 show the non-exceedance flows for the calendar year for the river reaches affected by WVS dams.

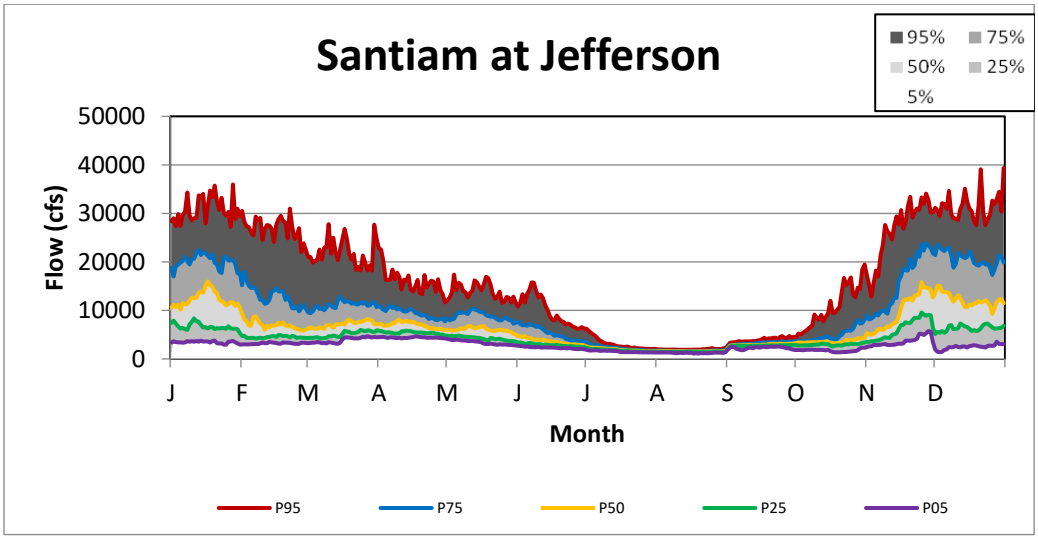

Figure 2-2. Non-exceedance Flows at Jefferson under the No-action Alternative.

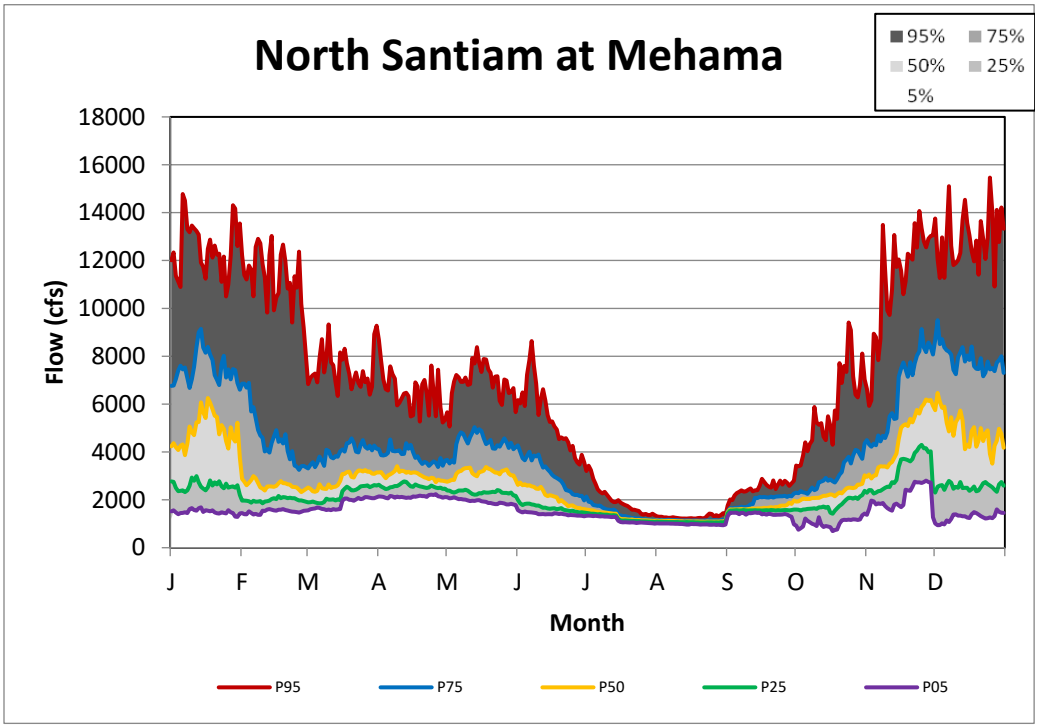

Figure 2-3. Non-exceedance Flows at Mehama under the No-action Alternative.

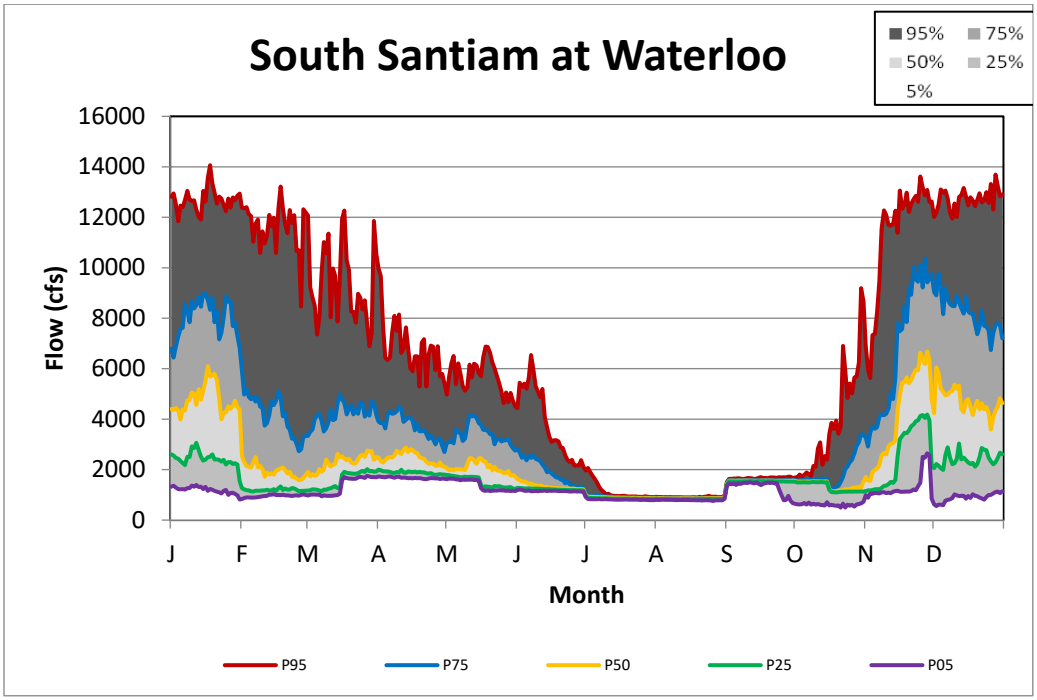

Figure 2-4. Non-exceedance Flows at Waterloo under the No-action Alternative.

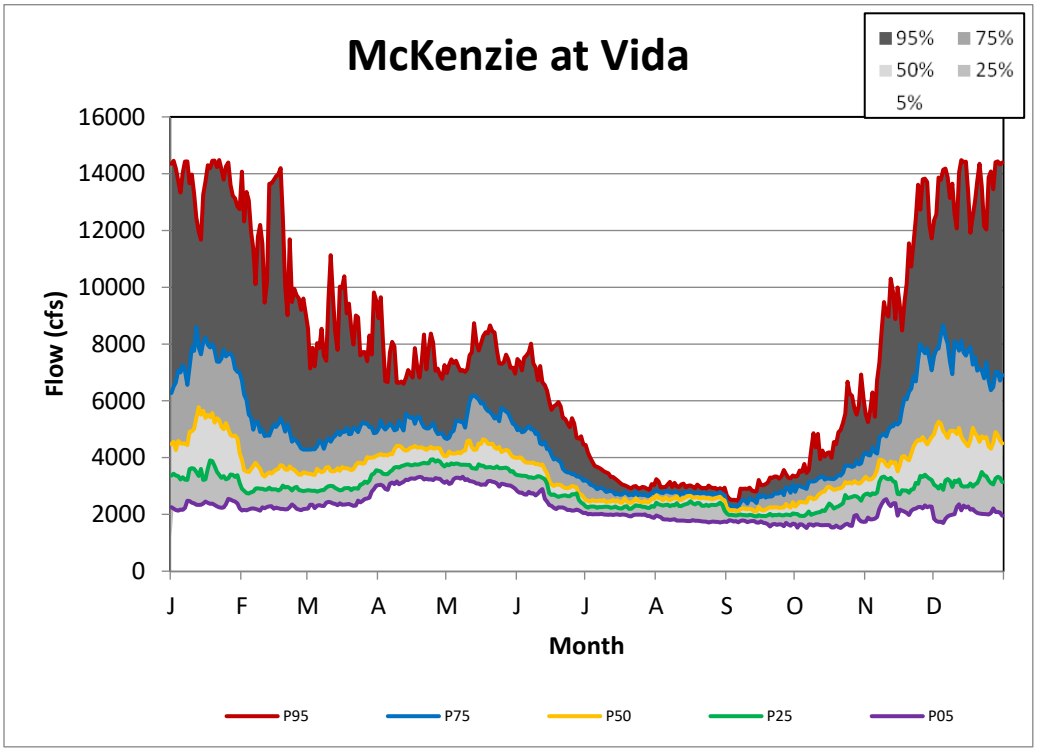

Figure 2-5. Non-exceedance Flows at Vida under the No-action Alternative.

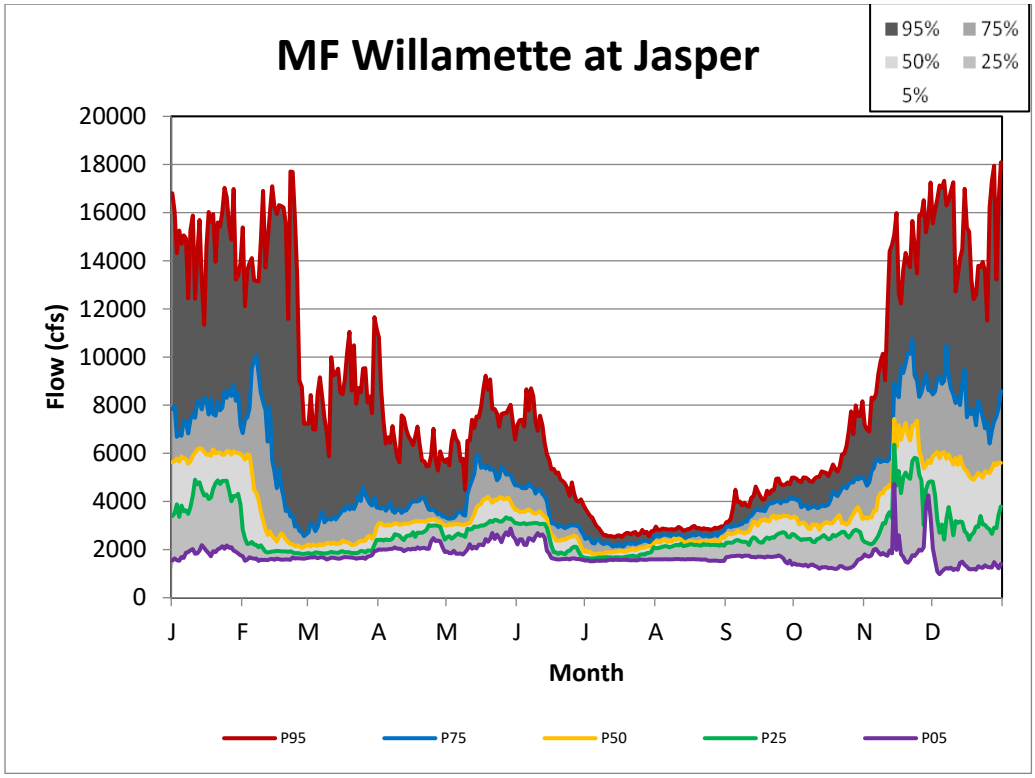

Figure 2-6. Non-exceedance Flows at Jasper under the No-action Alternative.

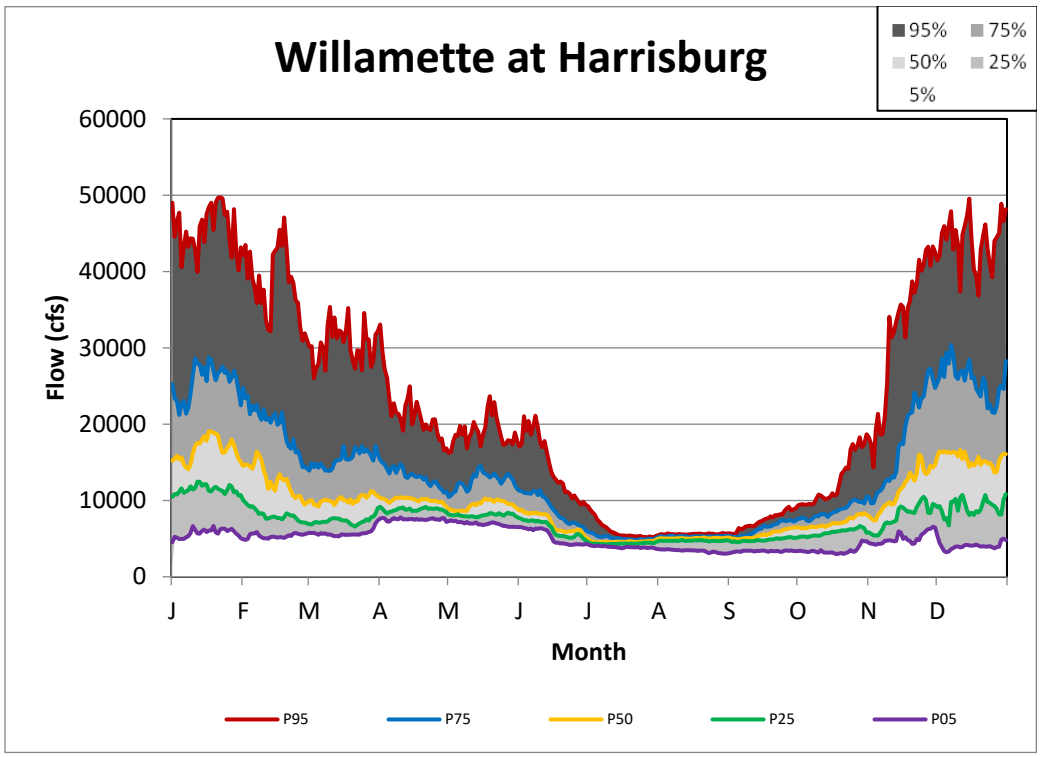

Figure 2-7. Non-exceedance Flows at Harrisburg under the No-action Alternative.

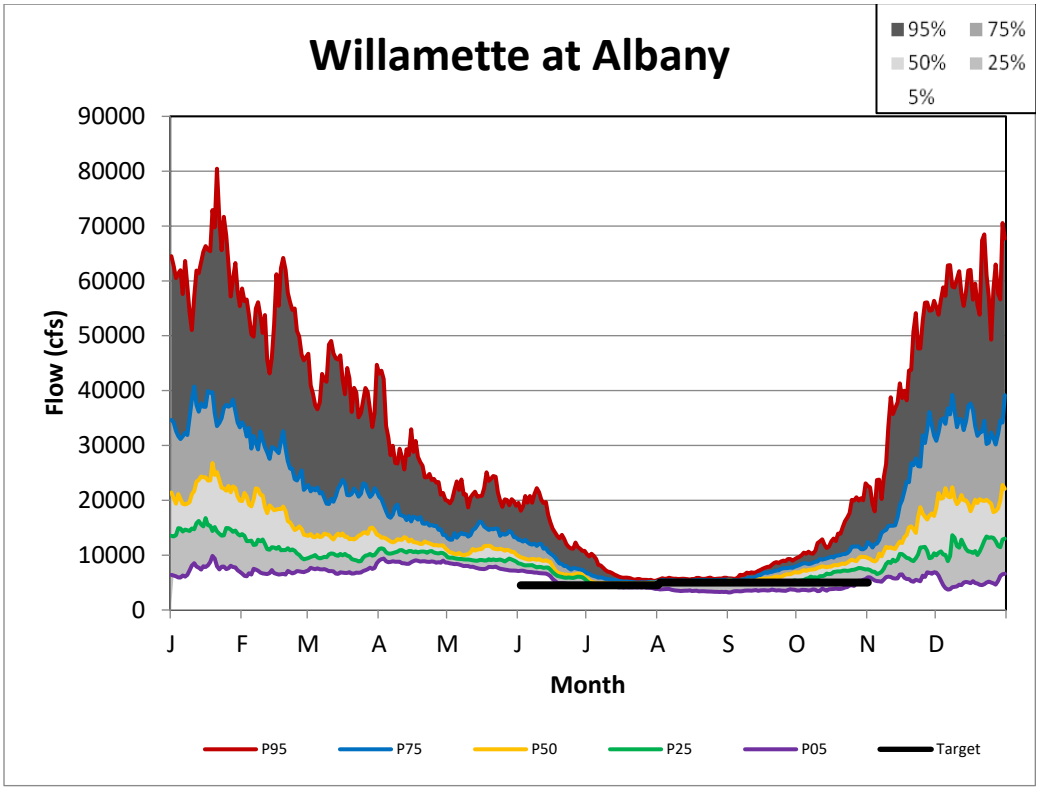

Figure 2-8. Non-exceedance Flows at Albany under the No-action Alternative.

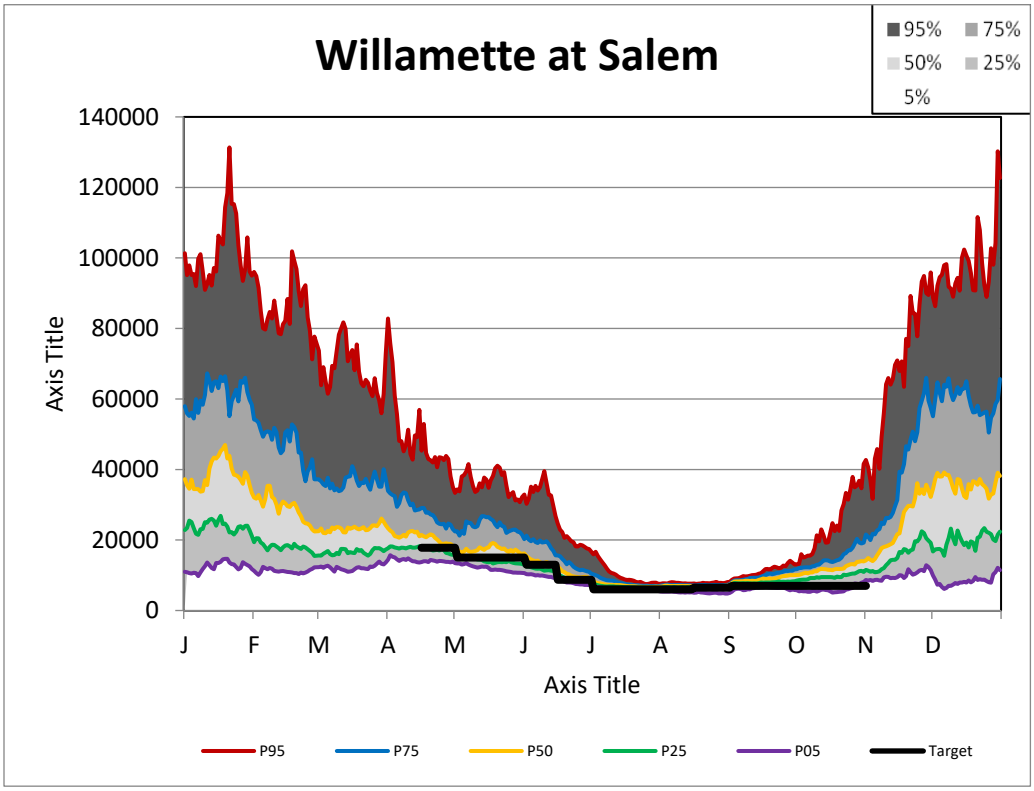

Figure 2-9. Non-exceedance Flows at Salem under the No-action Alternative.

2.2 ALTERNATIVE 1

2.2.1 Storage Allocations

Figure 10 shows that peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,497,000 acre-feet, an increase of 168,000 acre-feet in the dry years relative to the NAA. Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system.

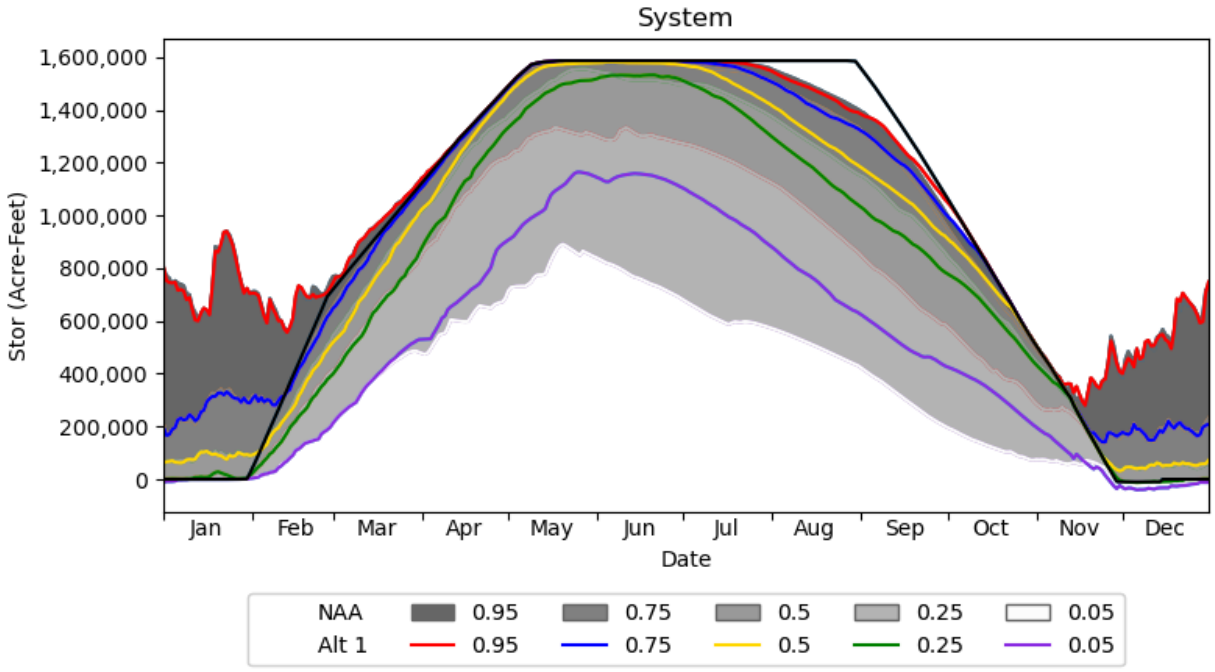

Figure 2-10. System-wide Conservation Storage under Alternative 1.

2.2.2 Natural Flow Water Rights

2.2.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March through June and again in September in dry years, and nearly equal in the summer and all years (Figure 11).

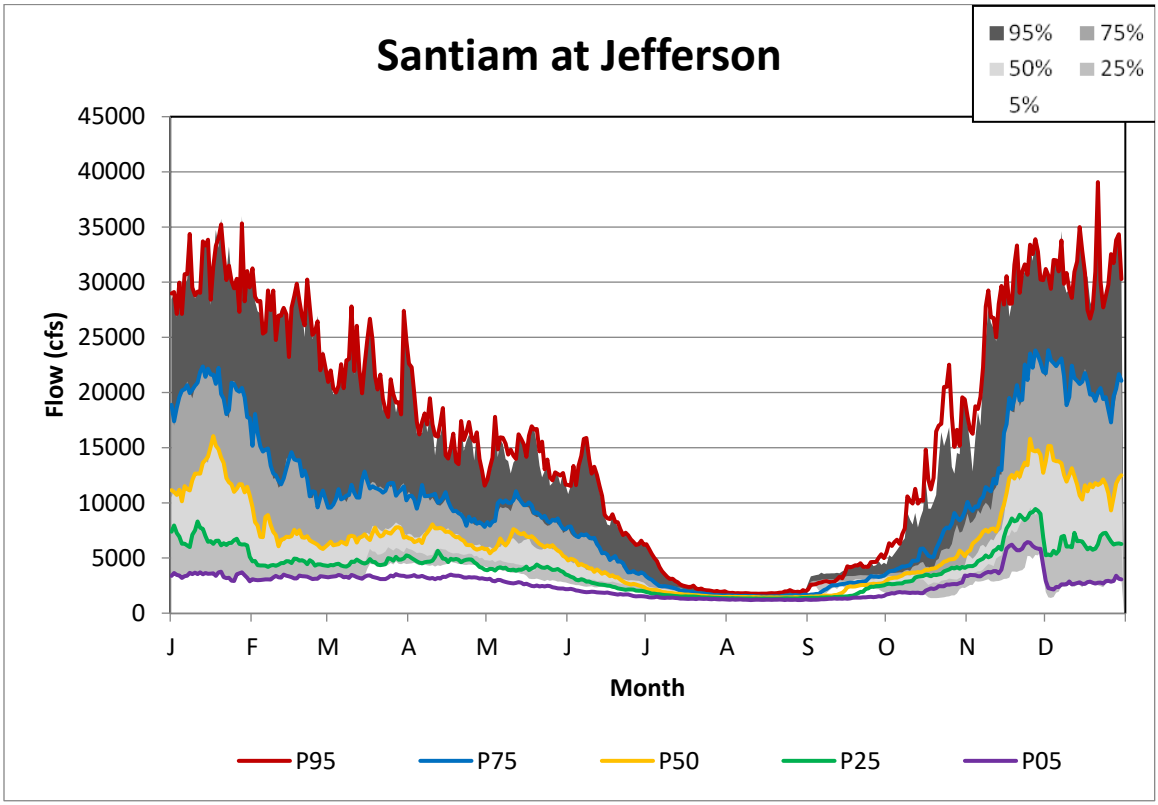

Figure 2-11. Non-exceedance Flows at Jefferson under Alternative 1.

North Santiam River

Operations affecting water supply in the North Santiam Basin include releasing flow according to the original House Document 531 flow regimes, which are less than the 2008 BiOp flow targets used currently and under the NAA.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is lower in the spring as compared to the NAA, reflecting the lower spring target flows compared to the NAA (Figure 12). Flows drop close to 1000 cfs during parts of the spring and summer during the driest years, resulting in Detroit Reservoir filling higher than in the NAA. The reservoir would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River

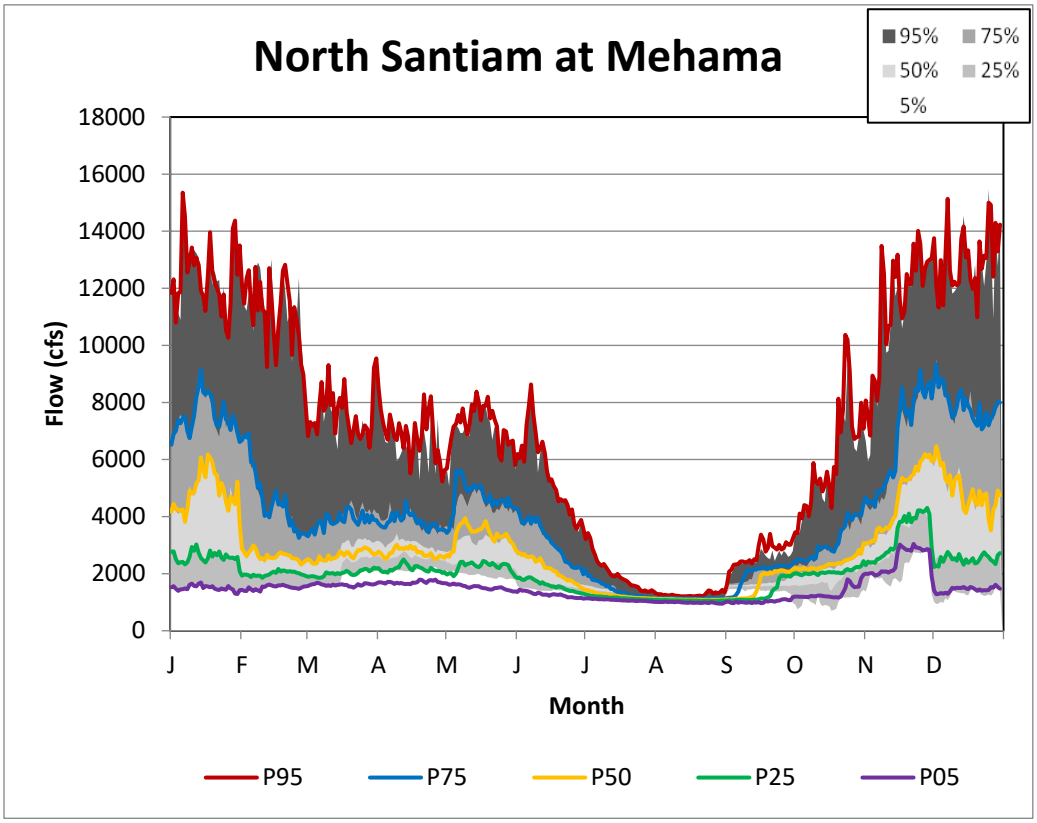

Figure 2-12. Non-exceedance Flows at Mehama under Alternative 1.

South Santiam River

Operations affecting water supply in the South Santiam Basin include releasing flow according to the original House Document 531 flow regimes.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March through June in drier years, but nearly equal during the summer most years (Figure 13).

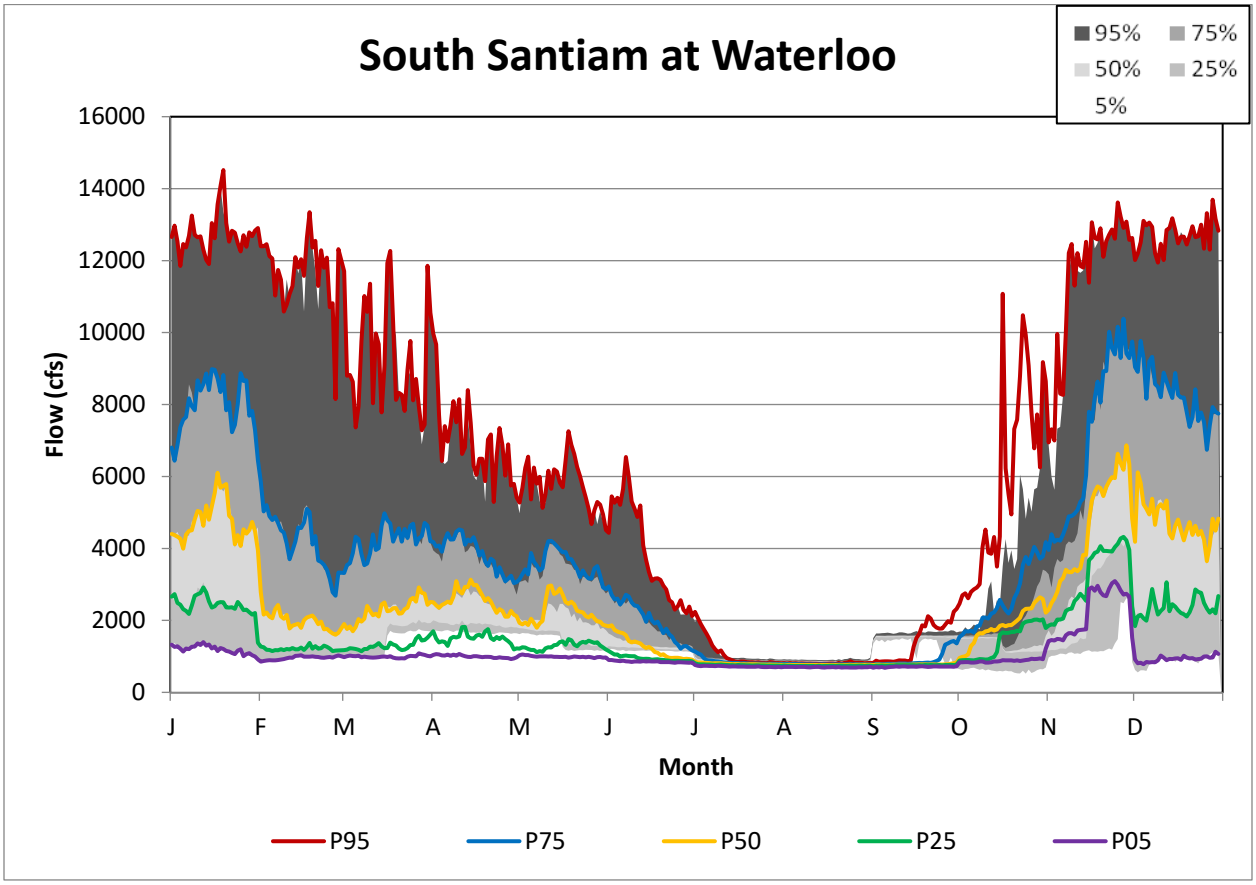

Figure 2-13. Non-exceedance Flows at Waterloo under Alternative 1.

2.2.2.2 McKenzie River

Operations affecting water supply in the McKenzie Basin include releasing flow according to the original House Document 531 flow regimes.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher mid-June through September in the dry years (Figure 14).

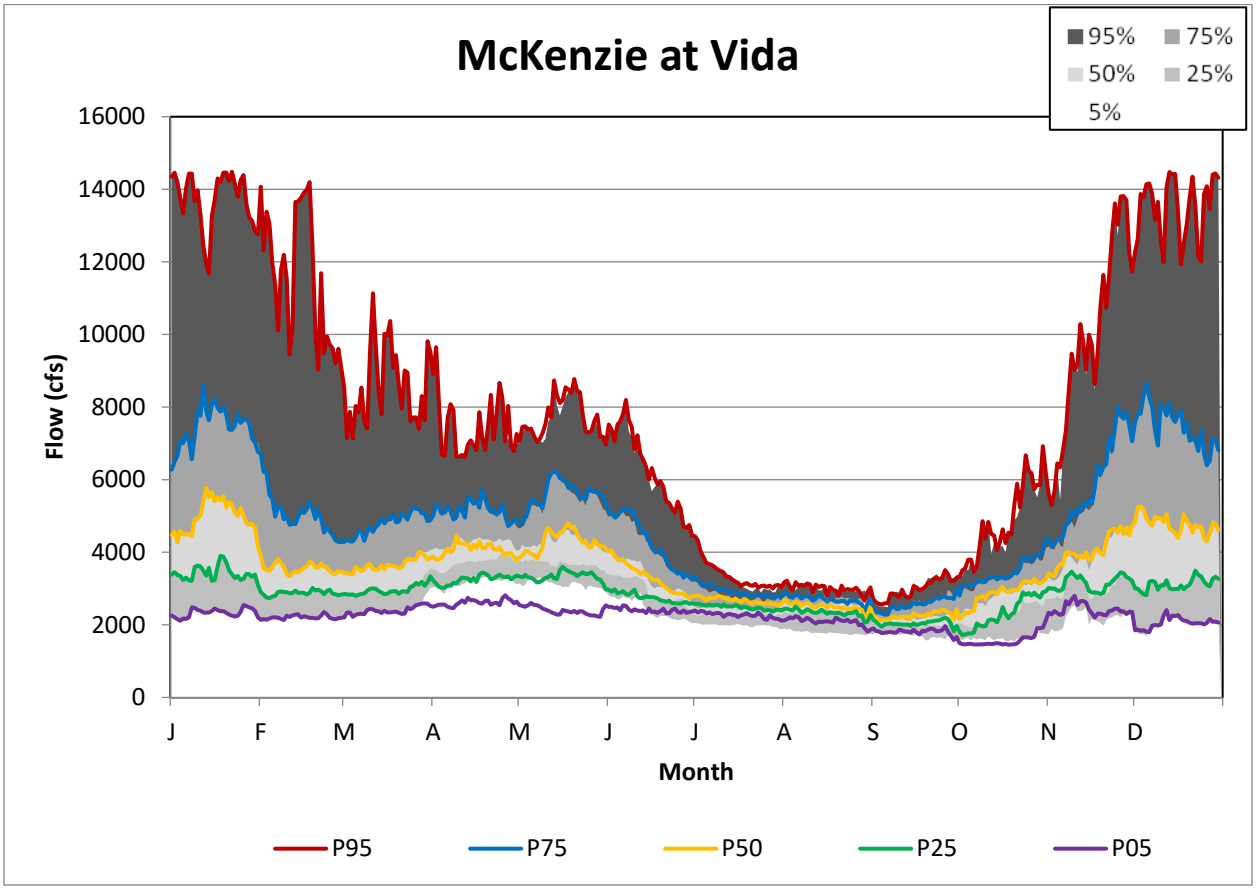

Figure 2-14. Non-exceedance Flows at Vida under Alternative 1.

2.2.2.3 Middle Fork Willamette

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June about 50% of the time, but higher than the NAA during the summer months (Figure 15).

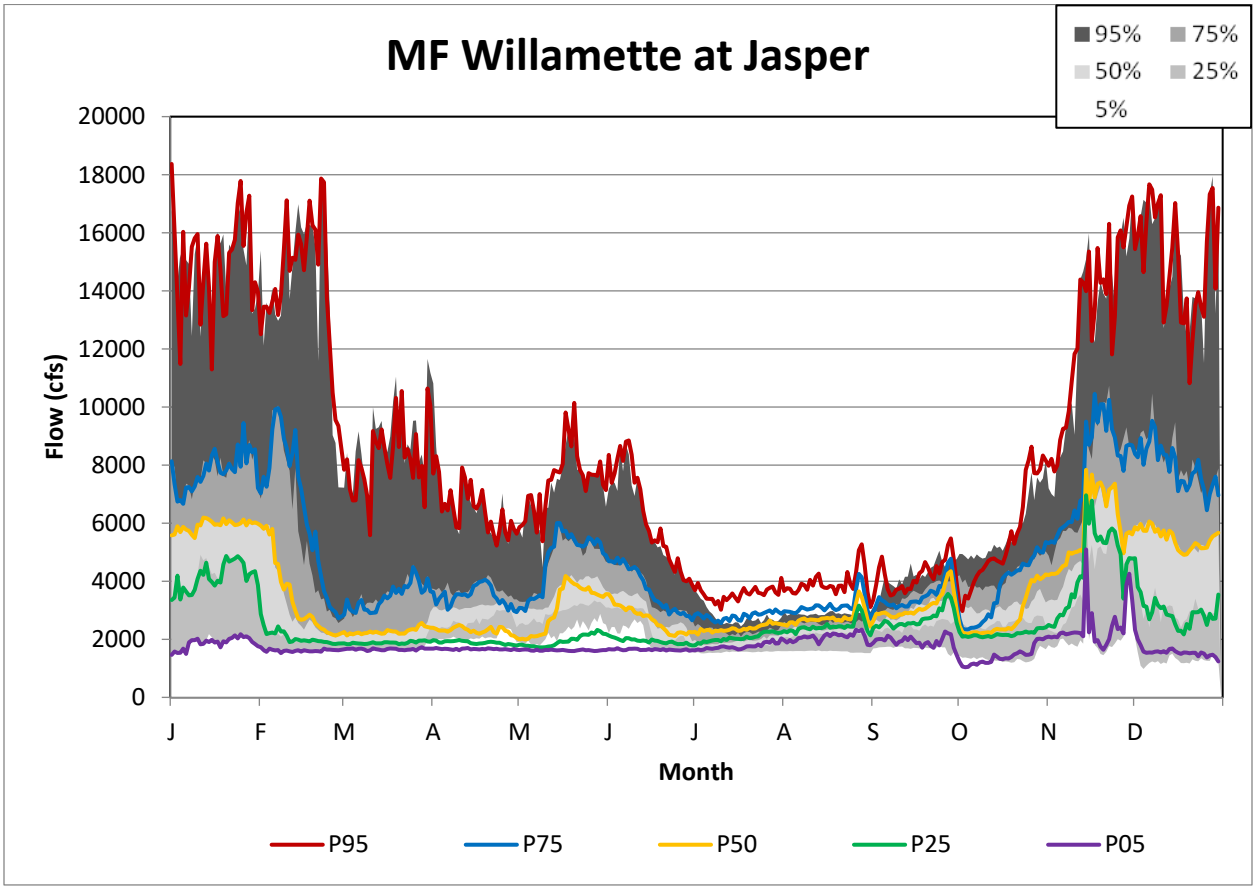

Figure 2-15. Non-exceedance Flows at Jasper under Alternative 1.

2.2.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing flow according to the original House Document 531 flow regimes.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. The flows are only lower during a portion of the spring, still staying above 4000 cfs, and only in the drier years (Figure 16).

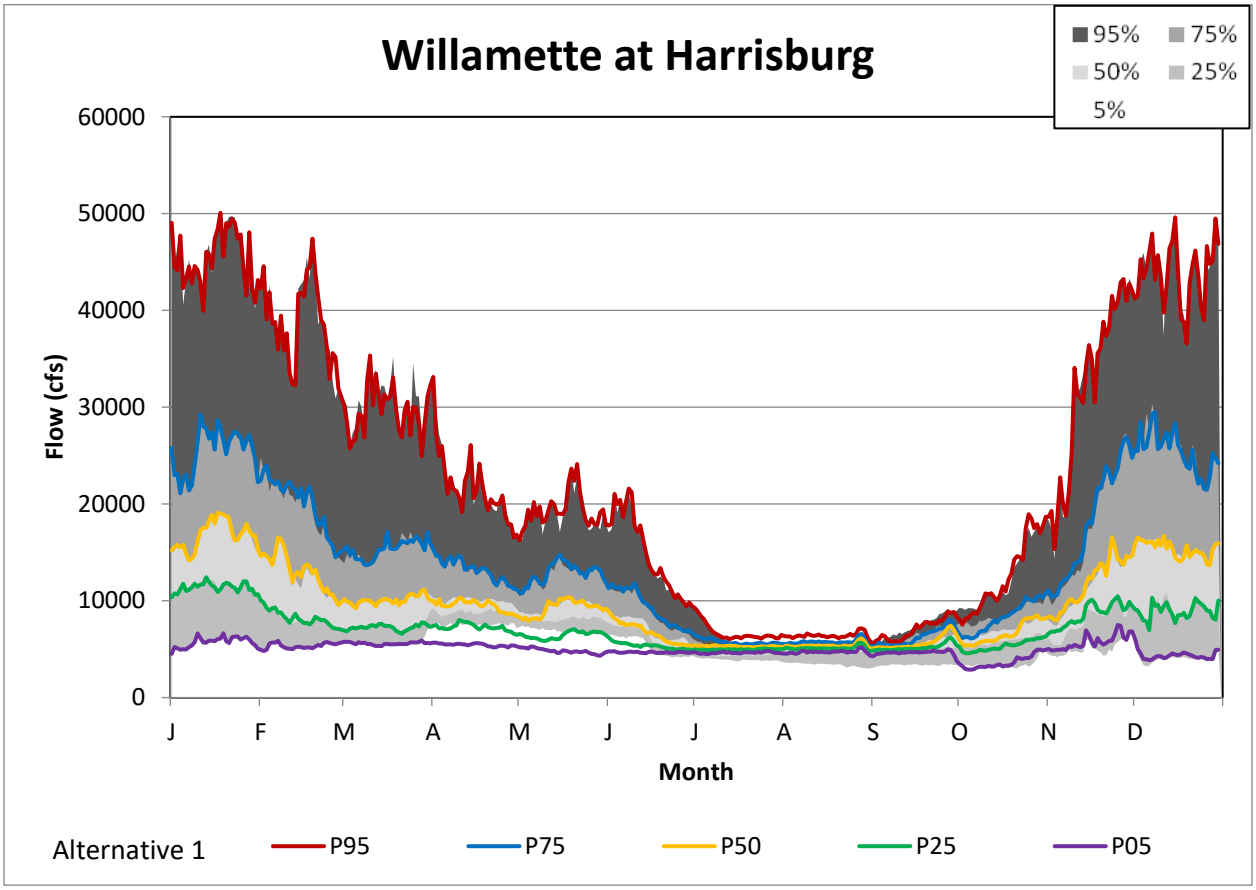

Figure 2-16. Non-exceedance Flows at Harrisburg under Alternative 1.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months, when water supplies are often at critical limits (Figure 17).

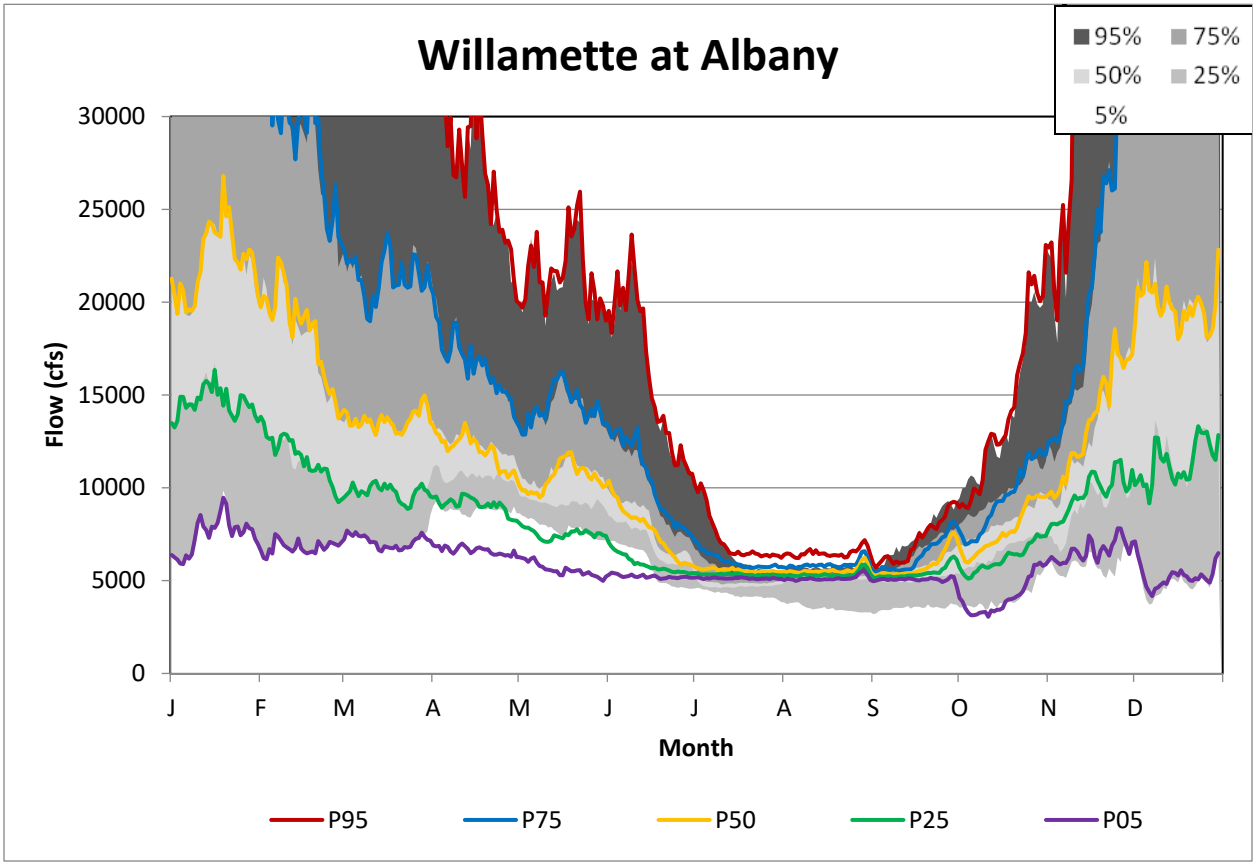

Figure 2-17. Non-exceedance Flows at Albany under Alternative 1.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months, when water supplies are often at critical limits (Figure 18).

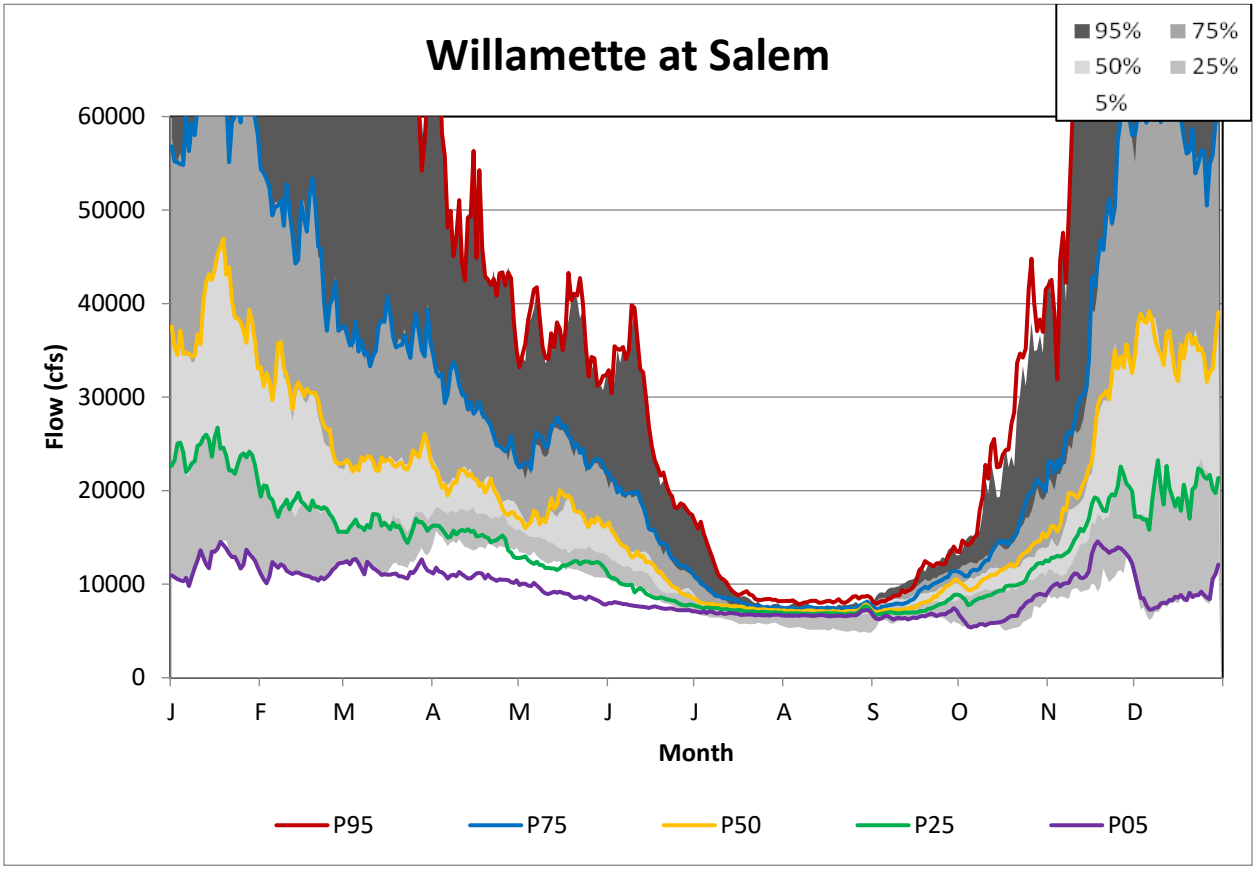

Figure 2-18. Non-exceedance Flows at Salem under Alternative 1.

2.3 ALTERNATIVE 2A

2.3.1 Storage Allocations

Figure 19 shows that under Alternative 2A peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,451,000 acre-feet, an increase of 122,000 acre-feet in the dry years relative to the NAA Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system.

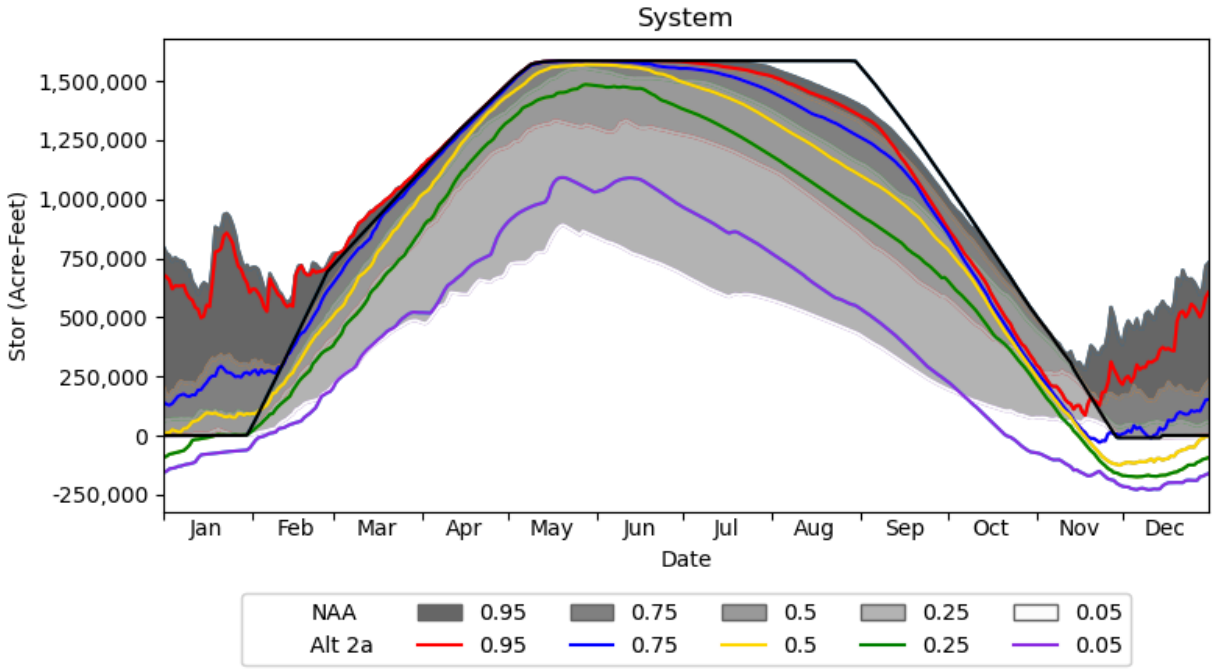

Figure 2-19. System-wide Conservation Storage under Alternative 2A.

2.3.2 Natural Flow Water Rights

2.3.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer and fall in most years due to the fall drawdown operation at Green Peter Dam (Appendix B, Hydrologic Processes Technical Information, Figure B-164)(Figure 20).

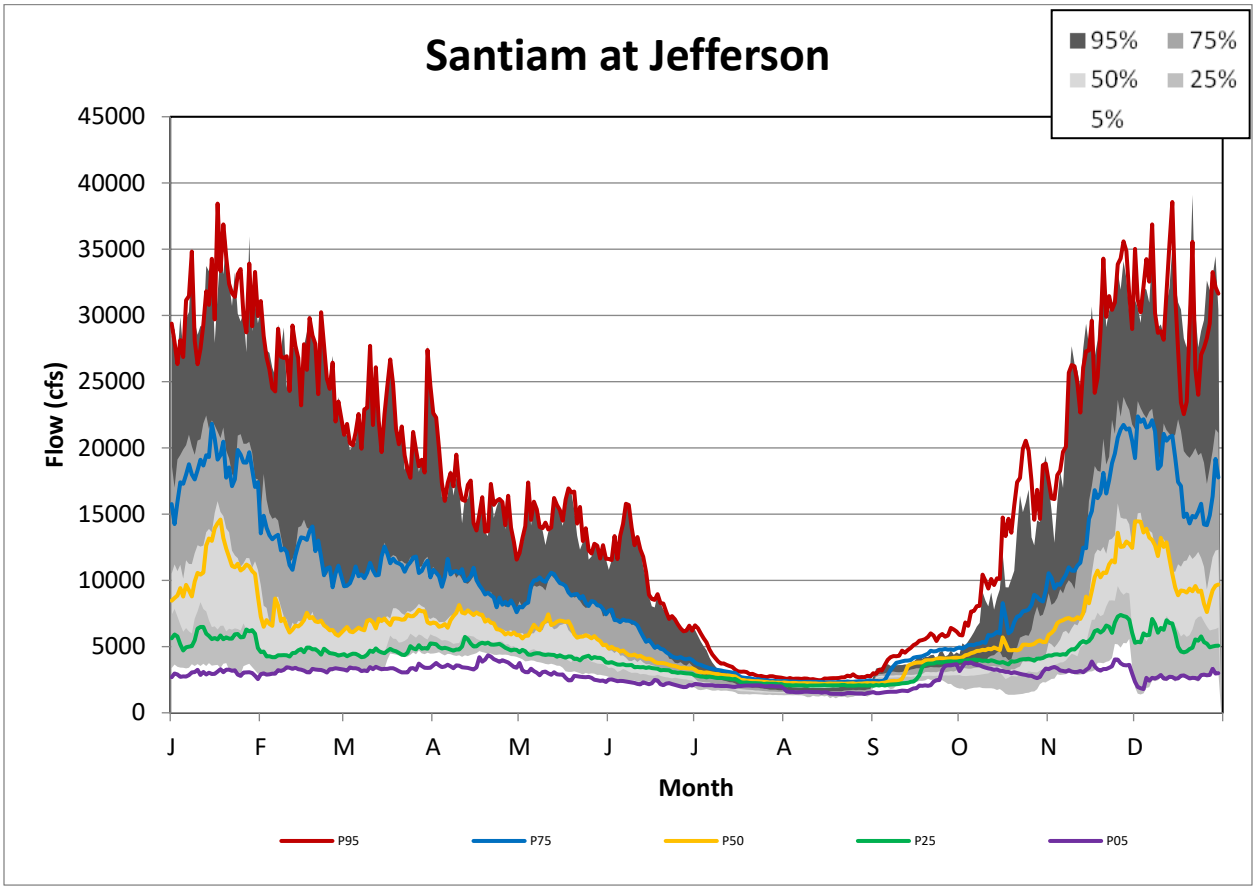

Figure 2-20. Non-exceedance Flows at Jefferson under Alternative 2A.

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve (Figure 21).

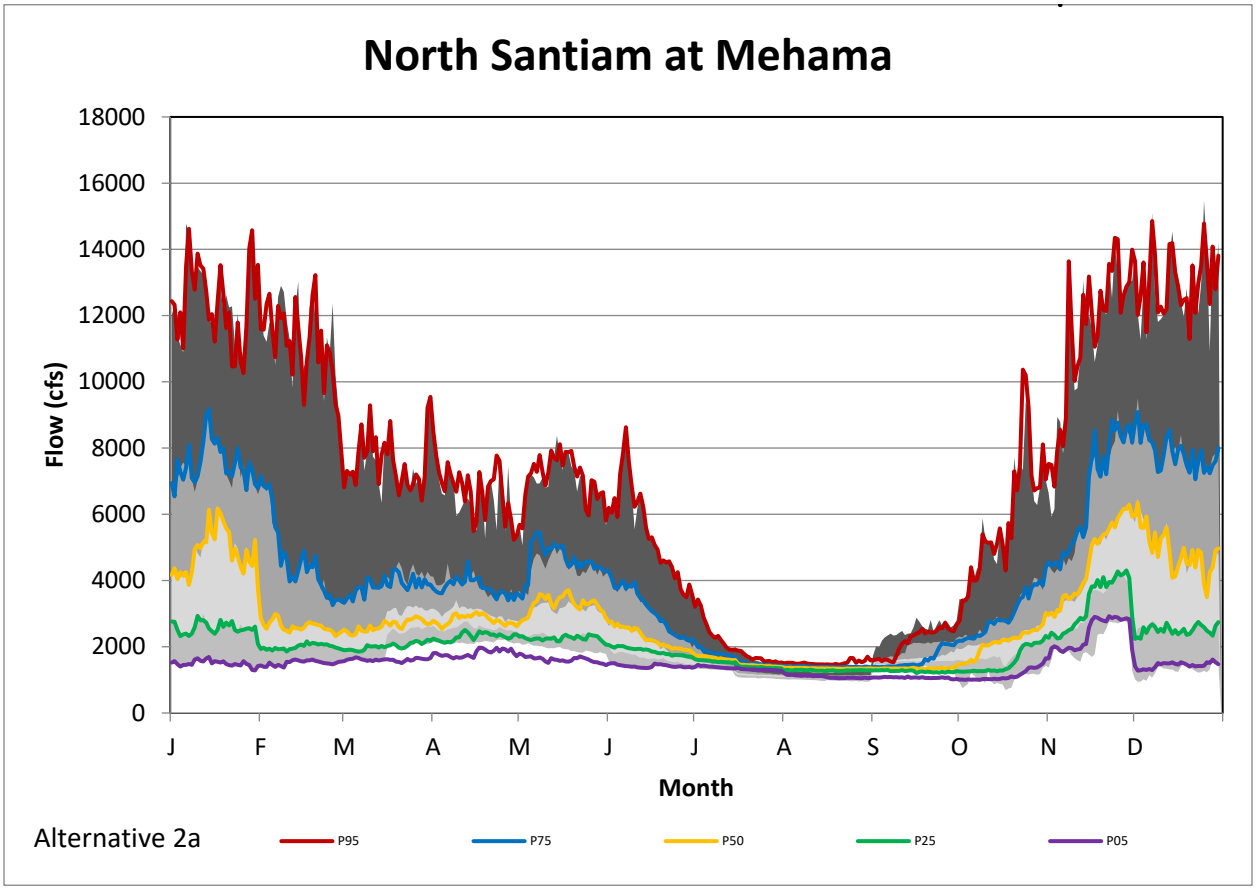

Figure 2-21. Non-exceedance Flows at Mehama under Alternative 2A.

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher in fall in all years due to the fall drawdown operation at Green Peter Dam (Appendix B, Hydrologic Processes Technical Information, Figure B-165)(Figure 22).

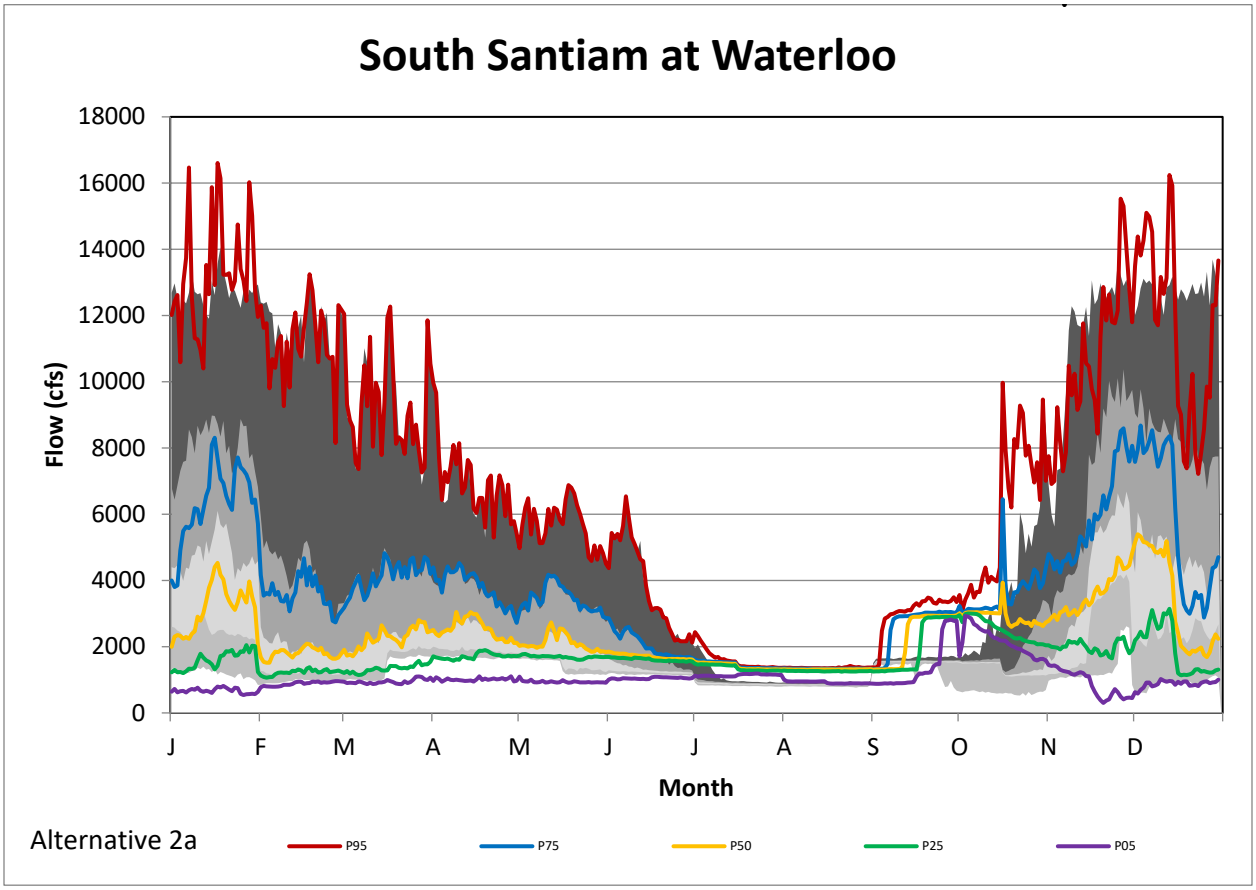

Figure 2-22. Non-exceedance Flows at Waterloo under Alternative 2A.

2.3.2.2 McKenzie River

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher in August and September in the driest years (Figure 23).

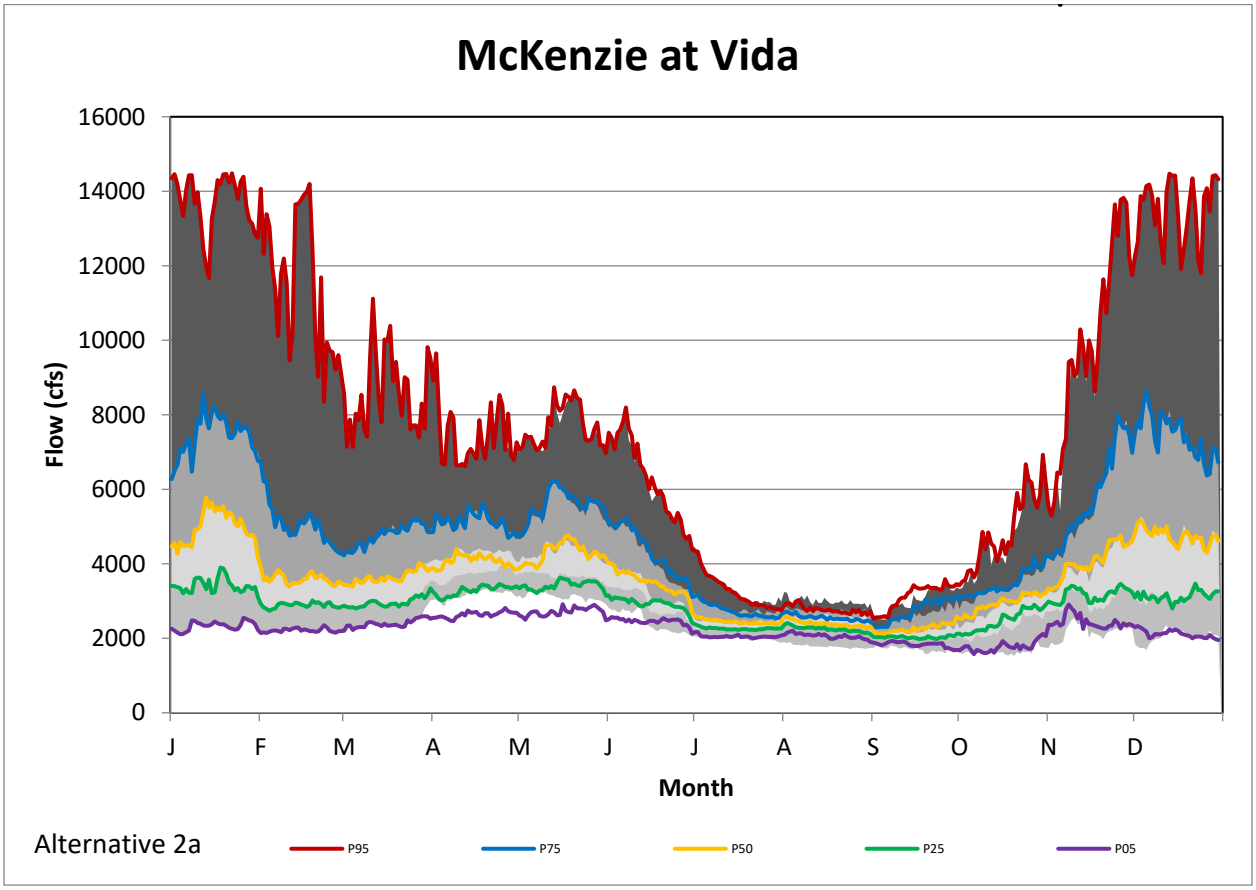

Figure 2-23. Non-exceedance Flows at Vida under Alternative 2A.

2.3.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA during the summer months (Figure 24).

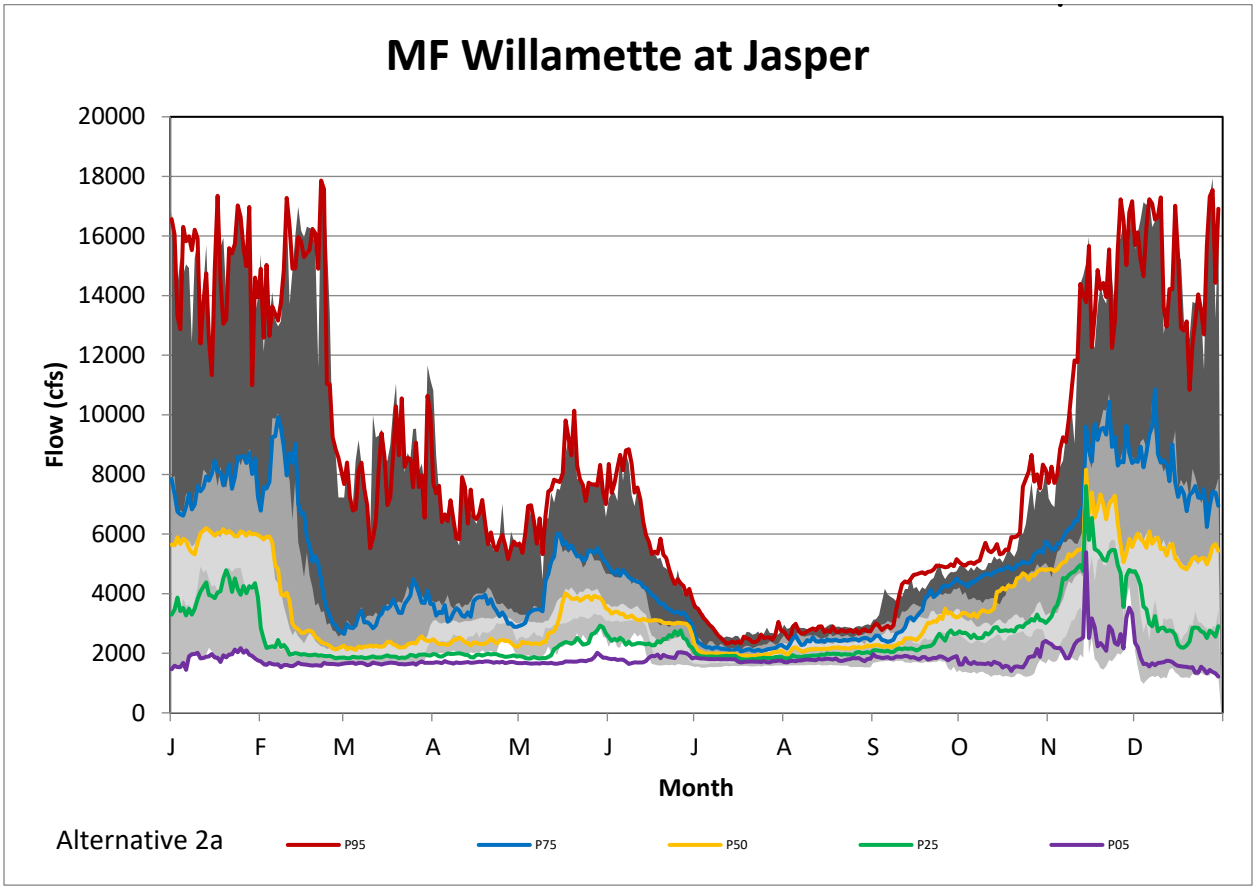

Figure 2-24. Non-exceedance Flows at Jasper under Alternative 2A.

2.3.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, and the fall drawdown at Green Peter for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months (Figure 25).

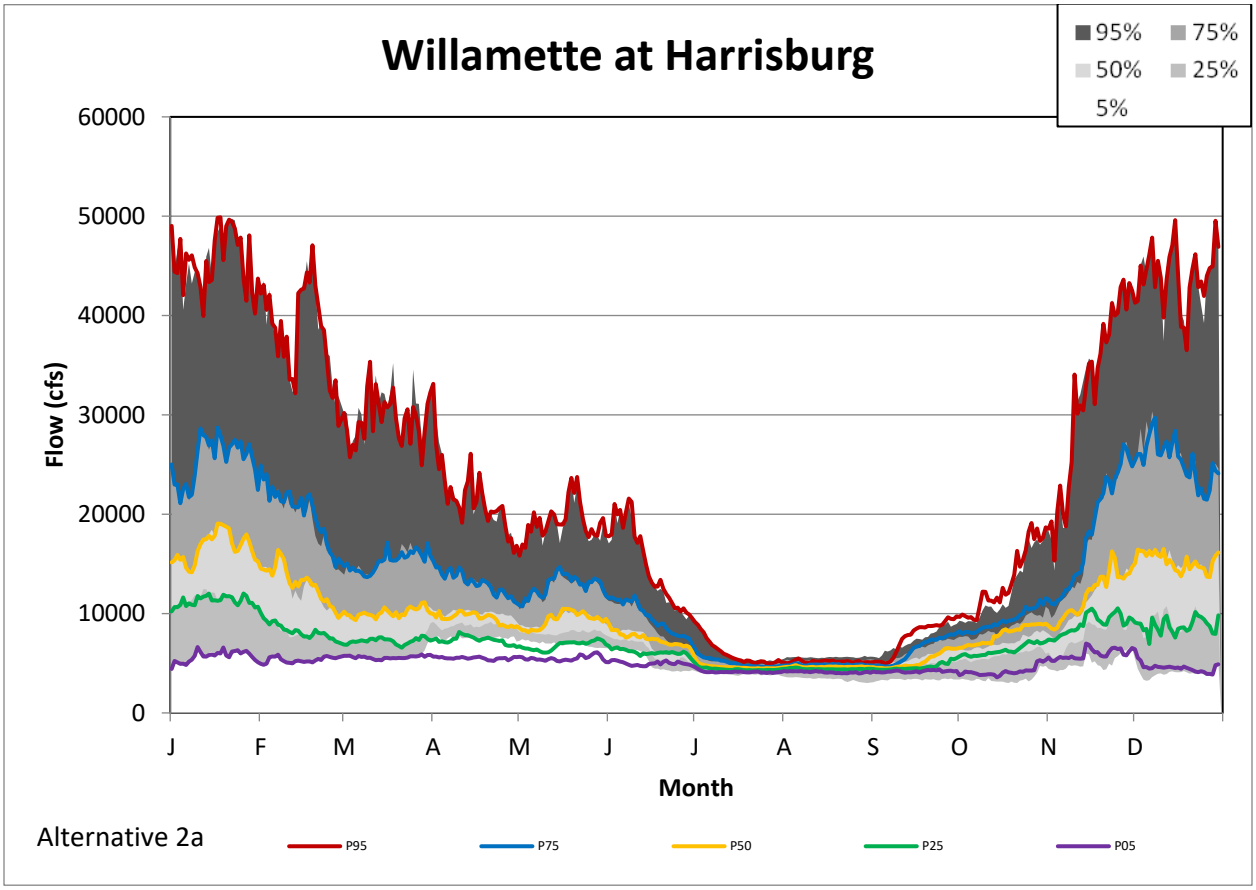

Figure 2-25. Non-exceedance Flows at Harrisburg under Alternative 2A.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June in the drier years, but higher than in the NAA during the summer months (Figure 26).

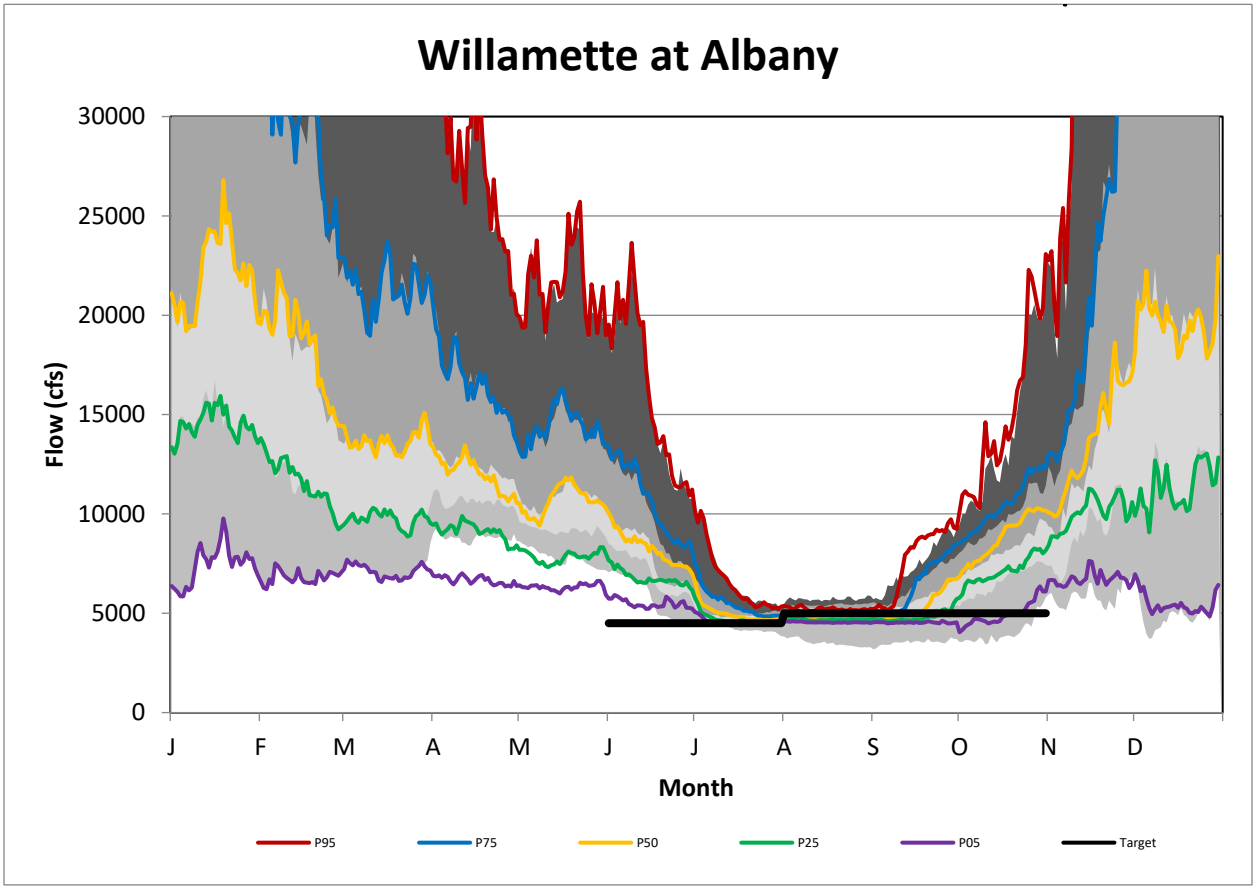

Figure 26. Non-exceedance Flows at Albany under Alternative 2A.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months (Figure 27).

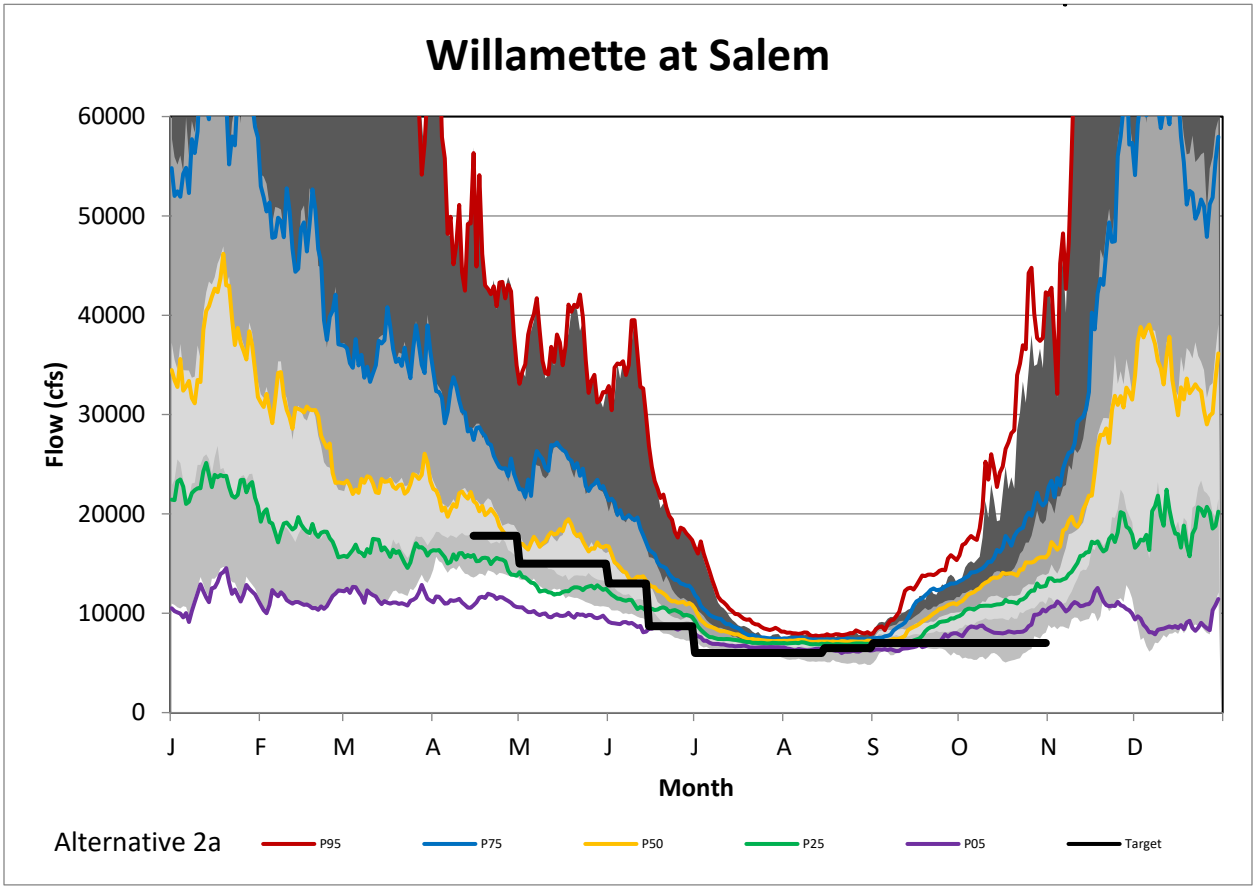

Figure 2-26. Non-exceedance Flows at Salem under Alternative 2A.

2.4 ALTERNATIVE 2B

2.4.1 Storage Allocations

Figure 28 shows that under Alternative 2B peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,265,000 acre-feet, a decrease of 64,000 acre-feet in the dry years relative to the NAA. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

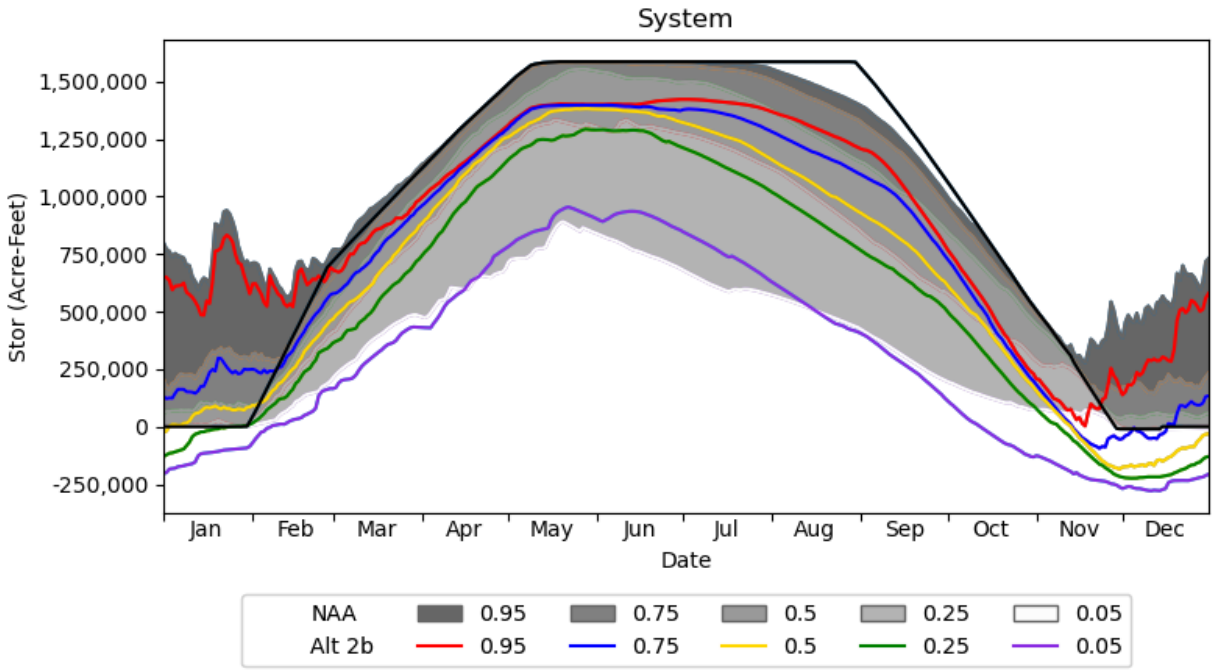

Figure 2-27. System-wide Conservation Storage under Alternative 2B.

2.4.2 Natural Flow Water Rights

2.4.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer and fall in most years due to the fall drawdown operation at Green Peter Dam (Figure 29).

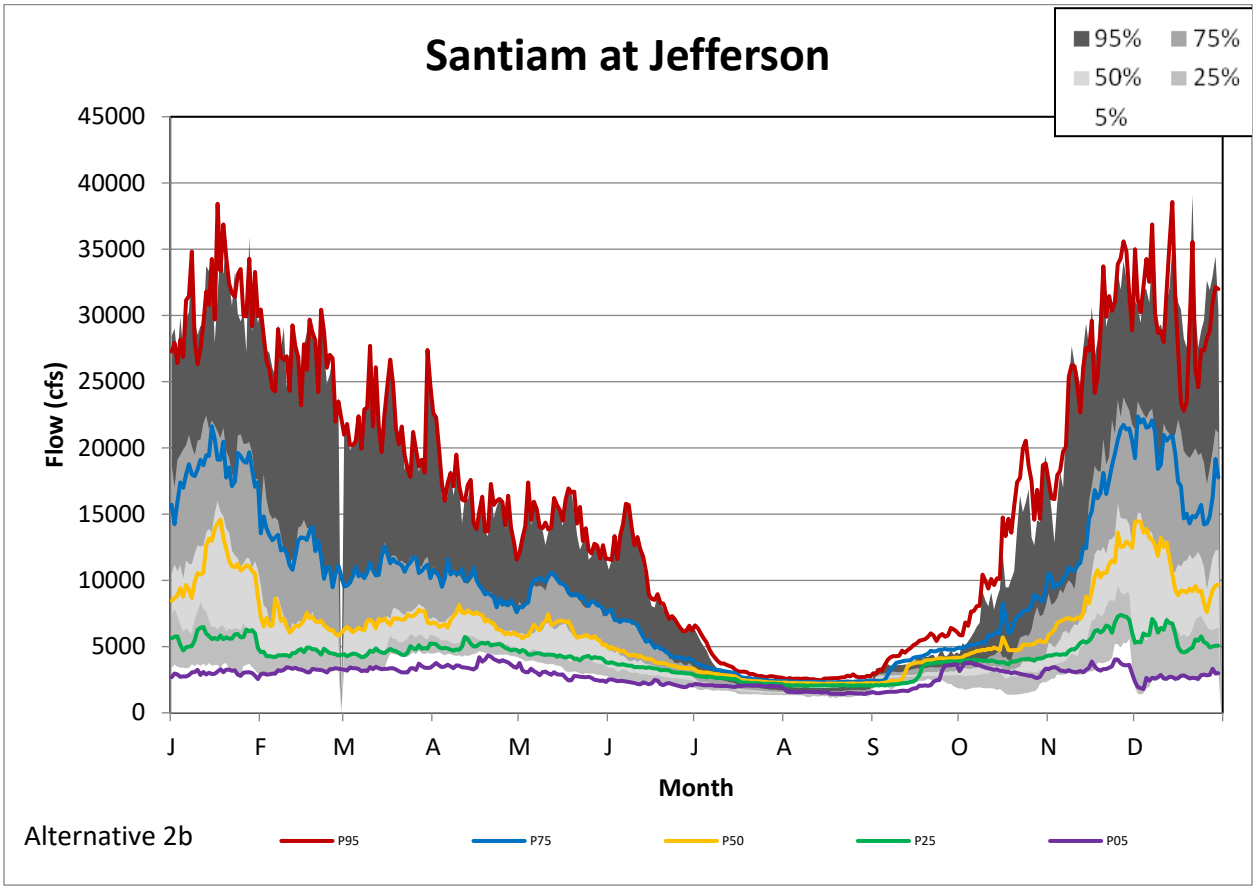

Figure29. Non-exceedance Flows at Jefferson under Alternative 2B.

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve (Figure 30).

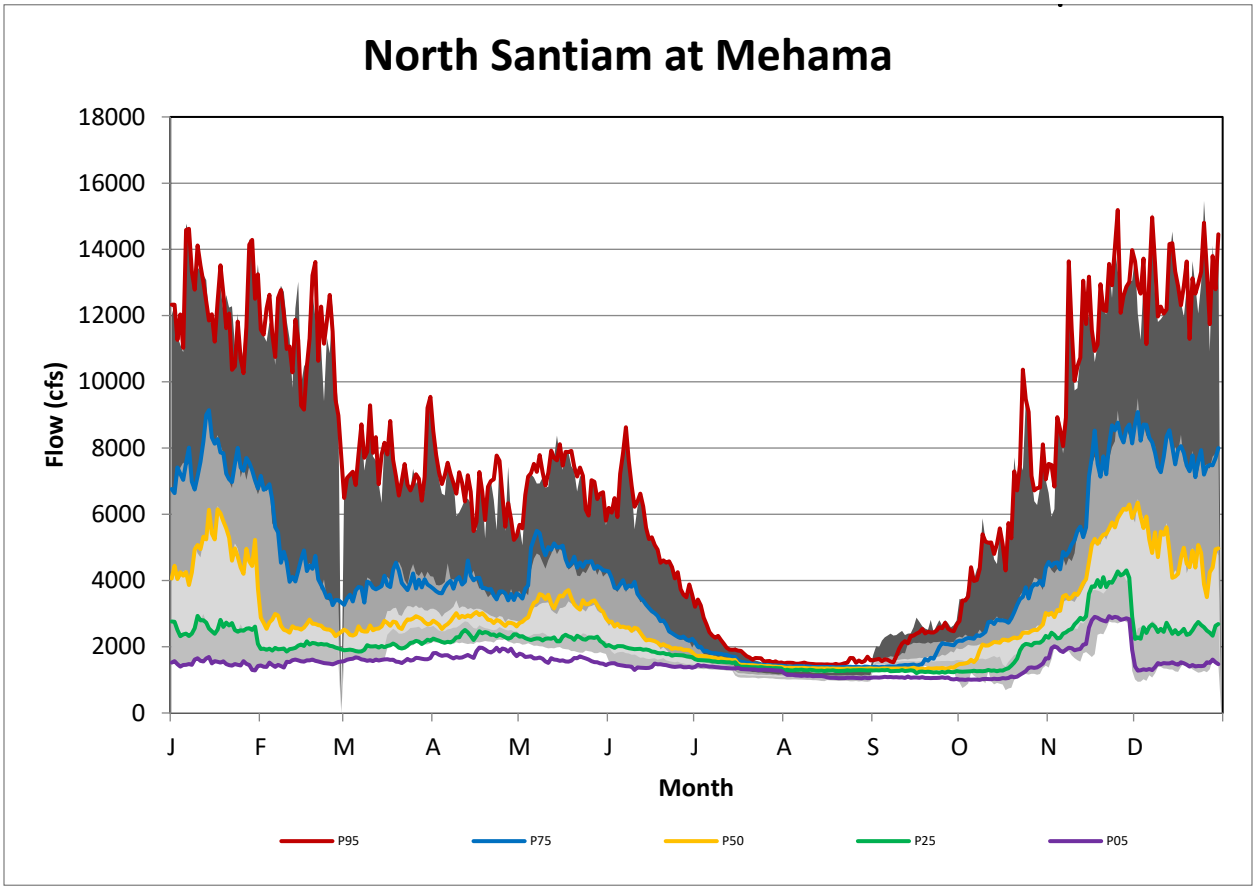

Figure 2-28. Non-exceedance Flows at Mehama under Alternative 2B.

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher in the summer and fall in all years due to the fall drawdown operation at Green Peter Dam (Appendix B, Hydrologic Processes, Figure B-165)(Figure 31).

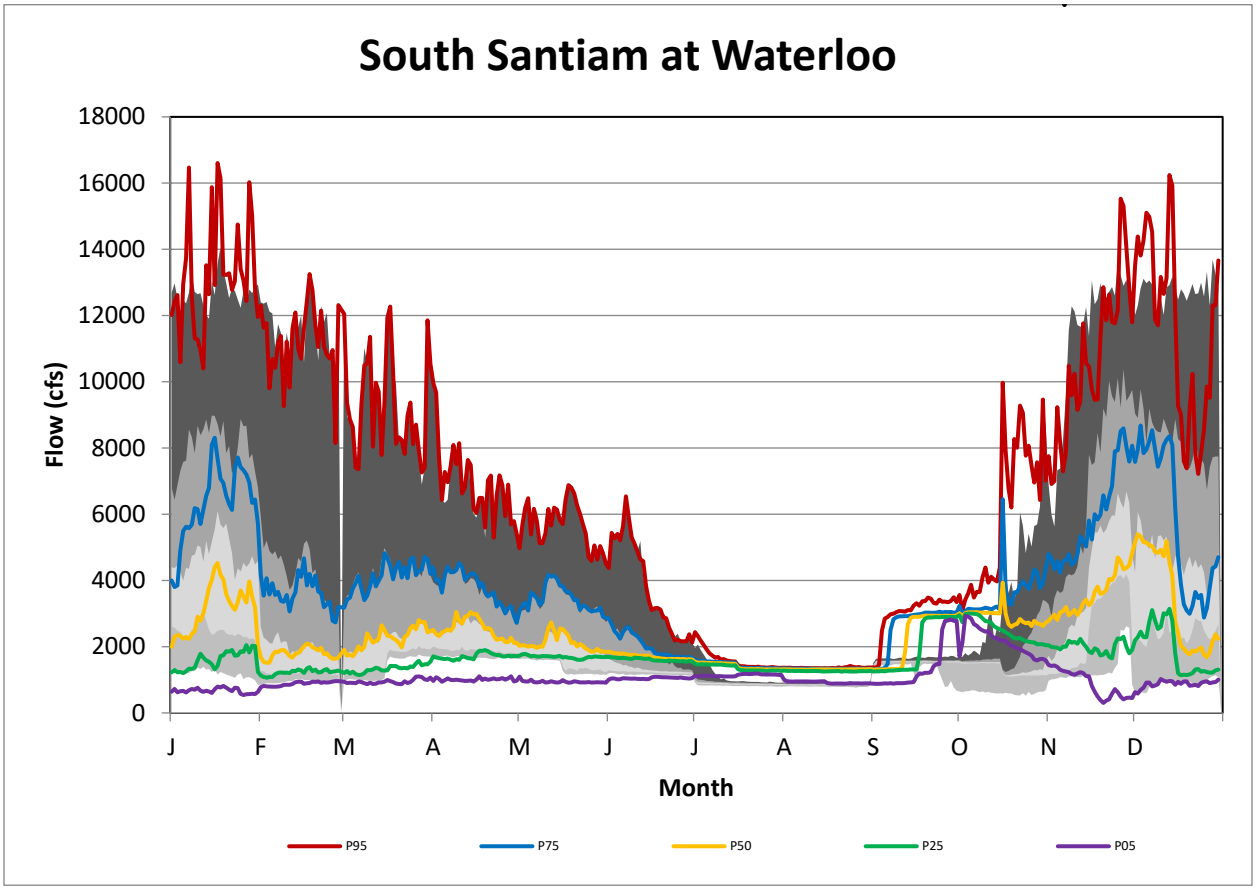

Figure 2-29. Non-exceedance Flows at Waterloo under Alternative 2B.

2.4.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and drawing down the reservoir to the diversion tunnel in the spring and fall for fish passage.

The spring drawdown at Cougar affects the flow at Vida on the McKenzie River differently by season and by hydrologic conditions. Flows at Vida in the driest years are lower than the NAA from April through late summer. During wetter years, flows at Vida will be higher than the NAA until late May. As there would be no conservation storage to augment flows, summer flows would be lower than the NAA in the wettest years but nearly equal during most years (Figure 32).

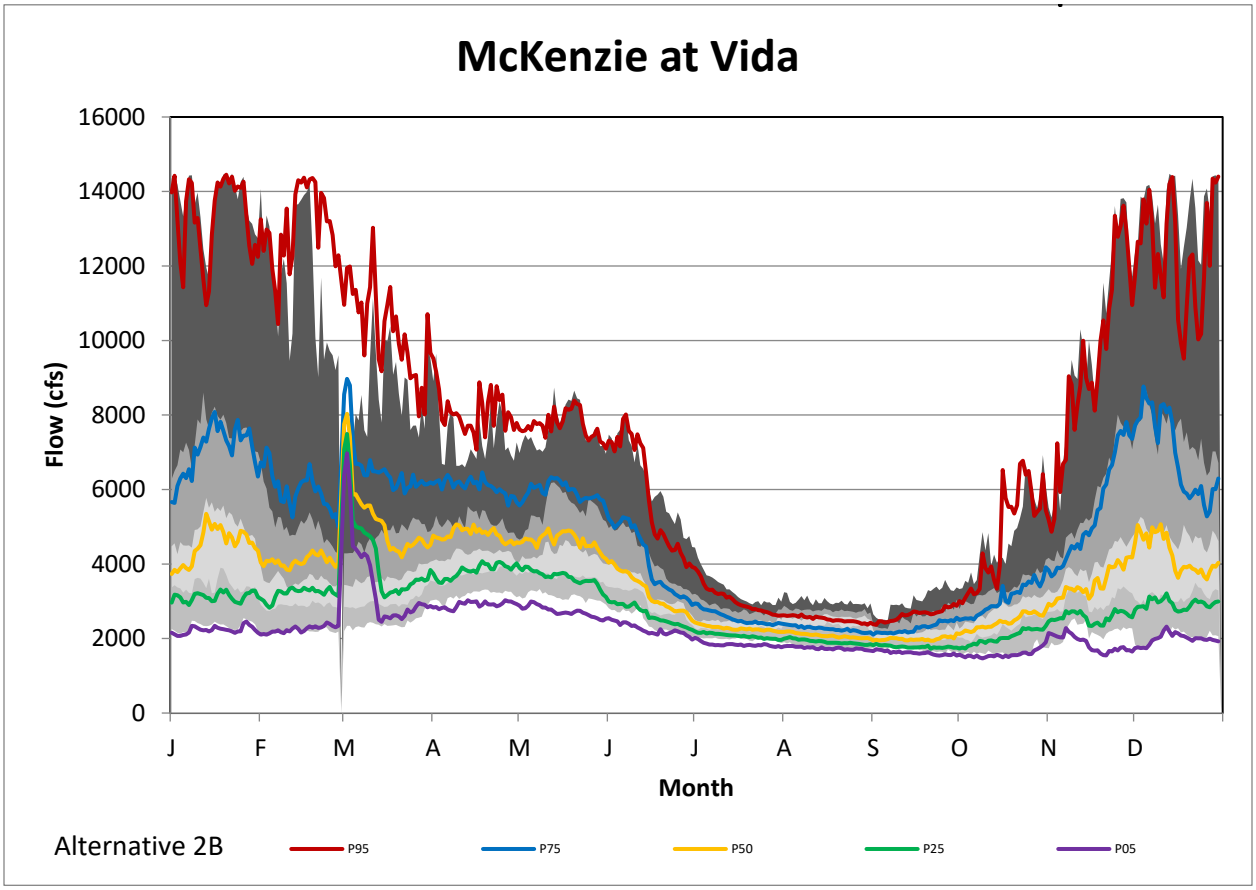

Figure 2-30. Non-exceedance Flows at Vida under Alternative 2B.

2.4.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA in the driest years, and nearly equal most years, during the summer months (Figure 33).

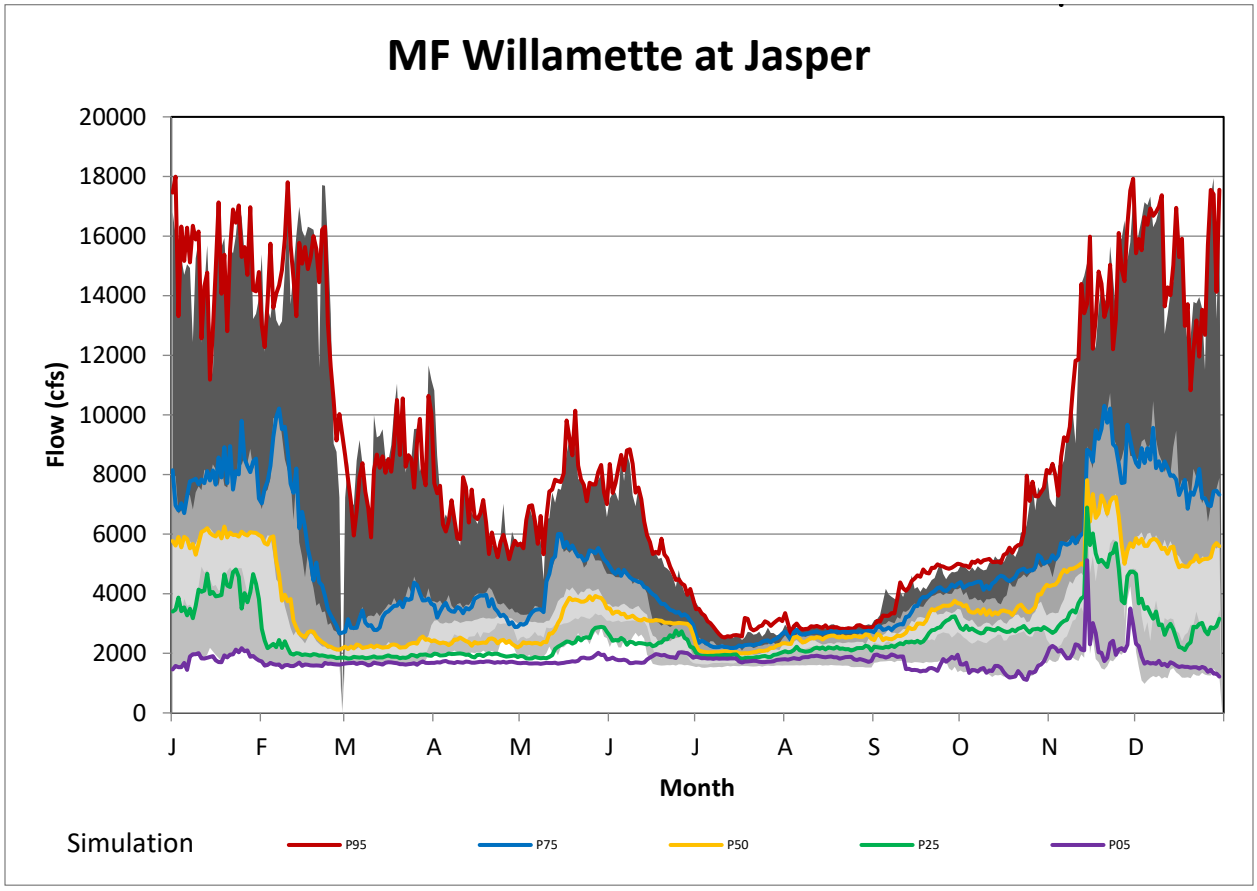

Figure 2-31. Non-exceedance Flows at Jasper under Alternative 2B.

2.4.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, fall drawdown at Green Peter for fish passage, and spring and fall drawdowns at Cougar for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months (Figure 34).

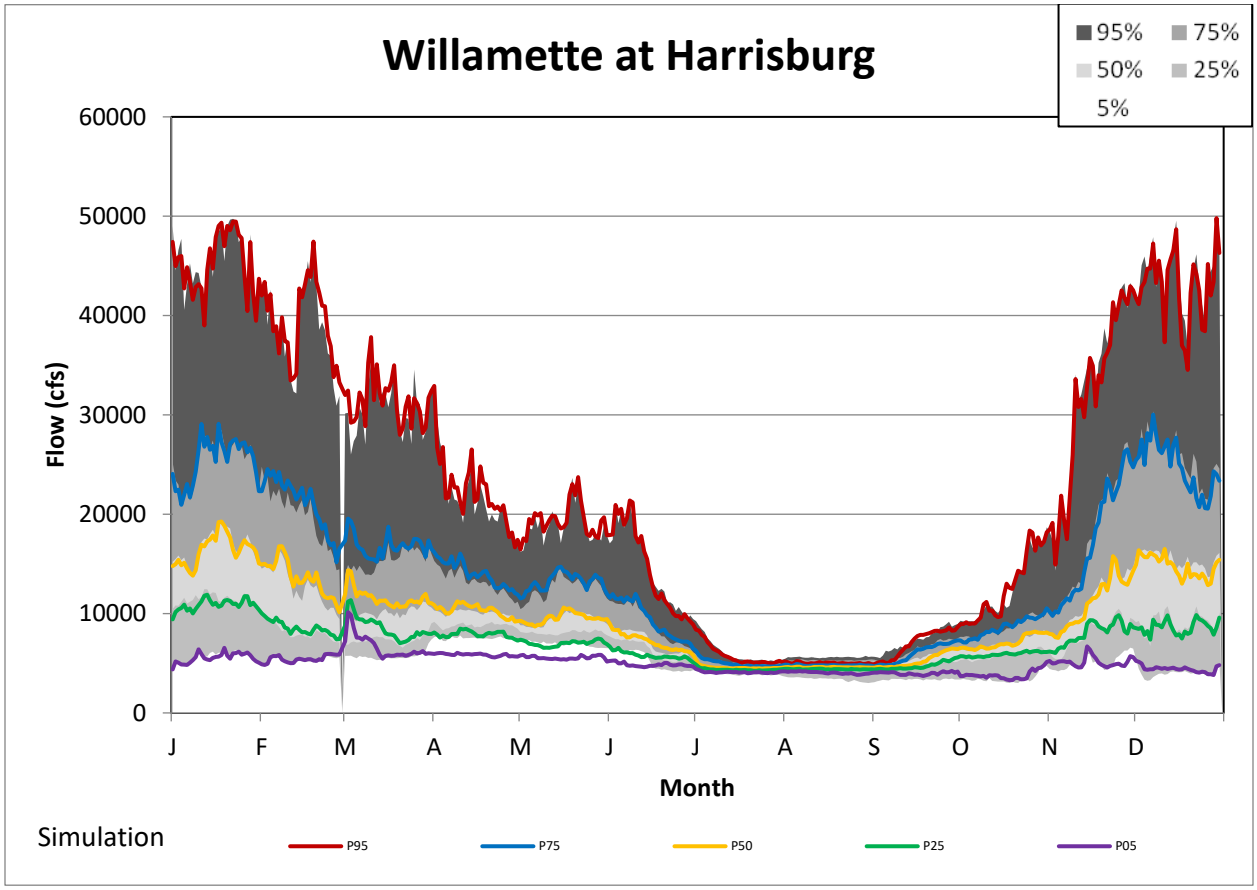

Figure 2-32. Non-exceedance Flows at Harrisburg under Alternative 2B.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. Flows are lower during a portion of the spring, staying above 4500 cfs even in the driest years (Figure 35).

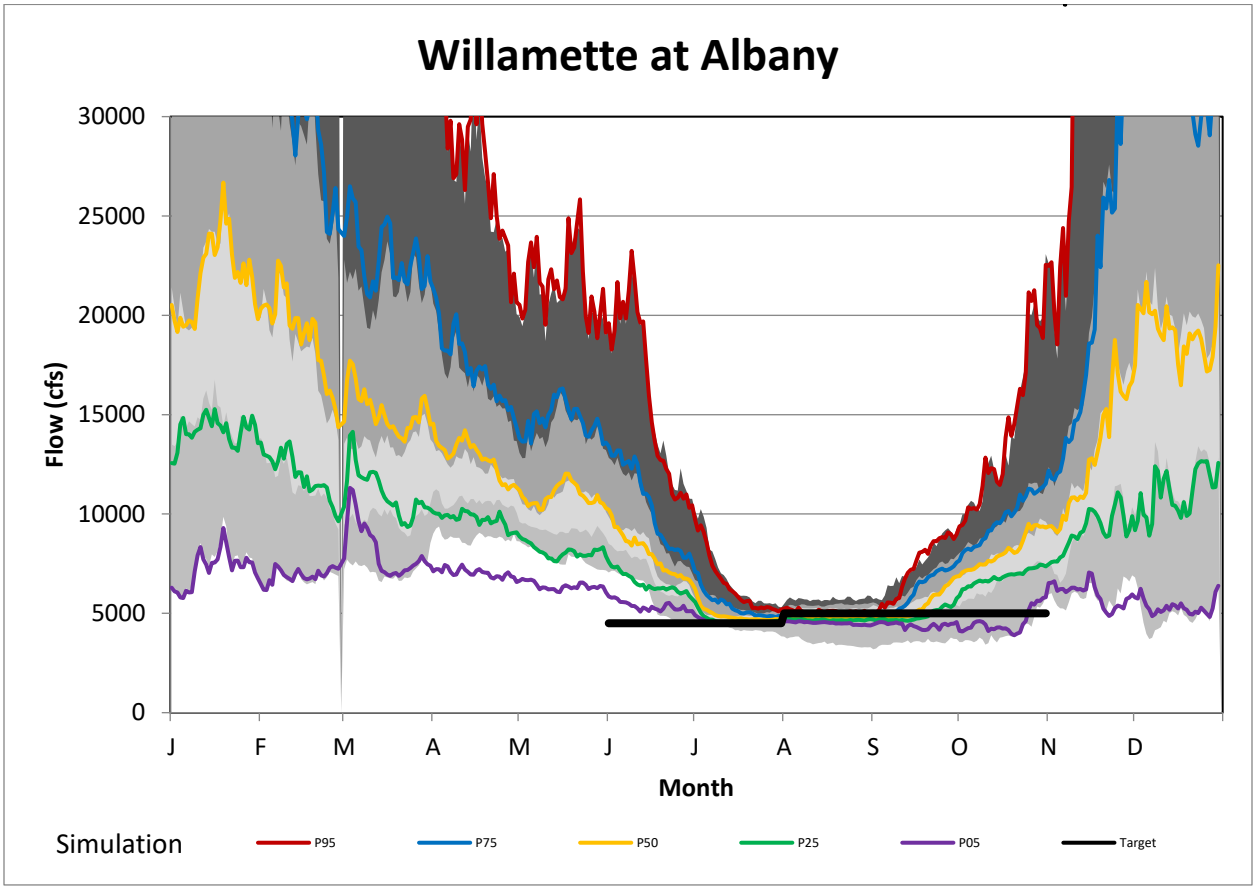

Figure 2-33. Non-exceedance Flows at Albany under Alternative 2B.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 6000 cfs even in the driest years (Figure 36).

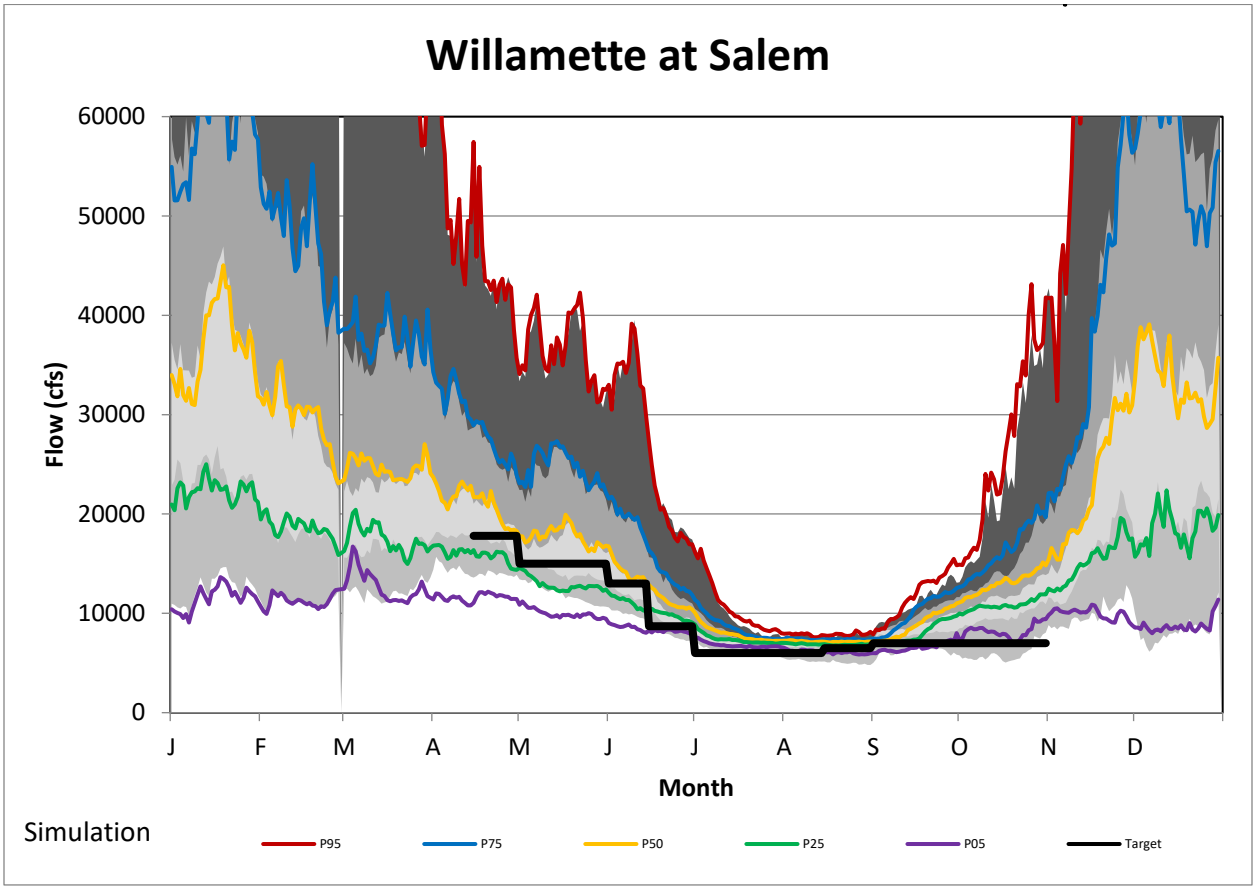

Figure 2-34. Non-exceedance Flows at Salem under Alternative 2B.

2.5 ALTERNATIVE 3A

2.5.1 Storage Allocations

Alternative 3A is an operational fish passage alternative, combining spring spill and drawdowns with fall drawdowns at 6 of the 11 storage projects. These combined operations significantly affect system-wide refill of the conservation storage, resulting in system-wide stored water being only 44% of the refill volume in the NAA, or 590,000 acre-feet, as shown below in Figure 37. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. This lack of storage is significantly higher under alternatives 3A and 3B. The amount available would be determined on an annual basis based on realized storage volumes across the system but will have a pronounced effect on water available for consumptive uses.

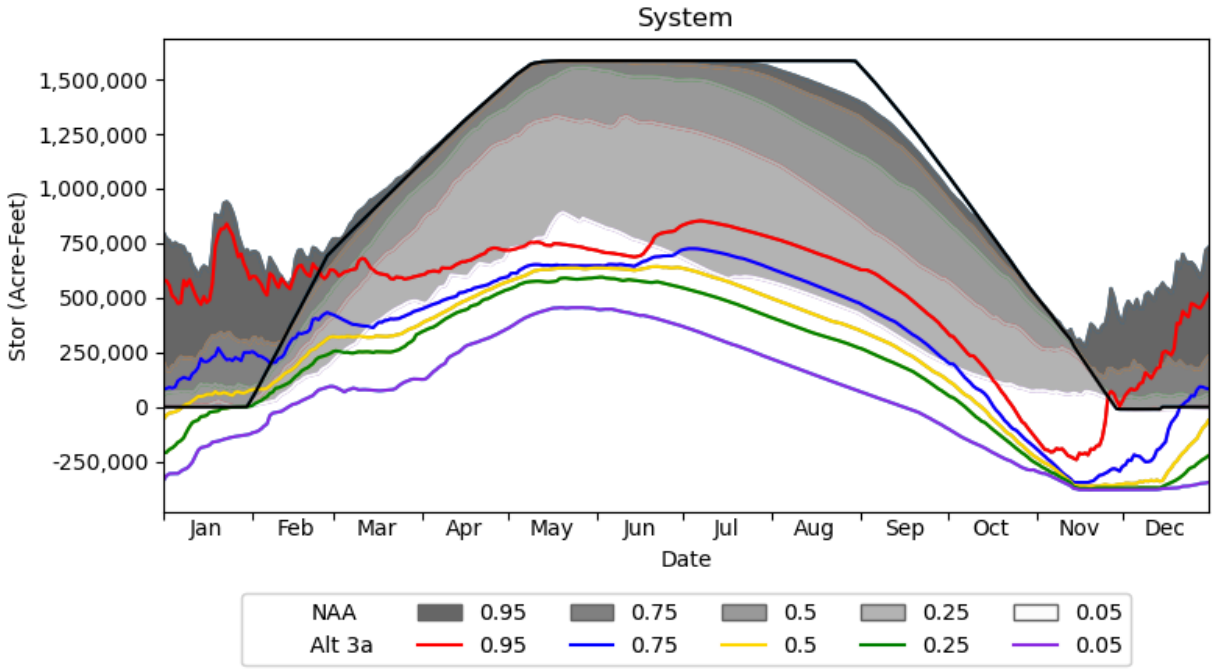

Figure 2-35. System-wide Conservation Storage under Alternative 3A.

2.5.2 Natural Flow Water Rights

2.5.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, in Alternative 3A are affected by the combination of a spring drawdown operation at Detroit and fall drawdown operations at both Detroit and Green Peter. Flows are slightly higher than the NAA from mid-March to mid-June except in the driest years. Flows in the summer are nearly equal to the NAA. Flows in the fall are lower than the NAA about half the time (Figure 38).

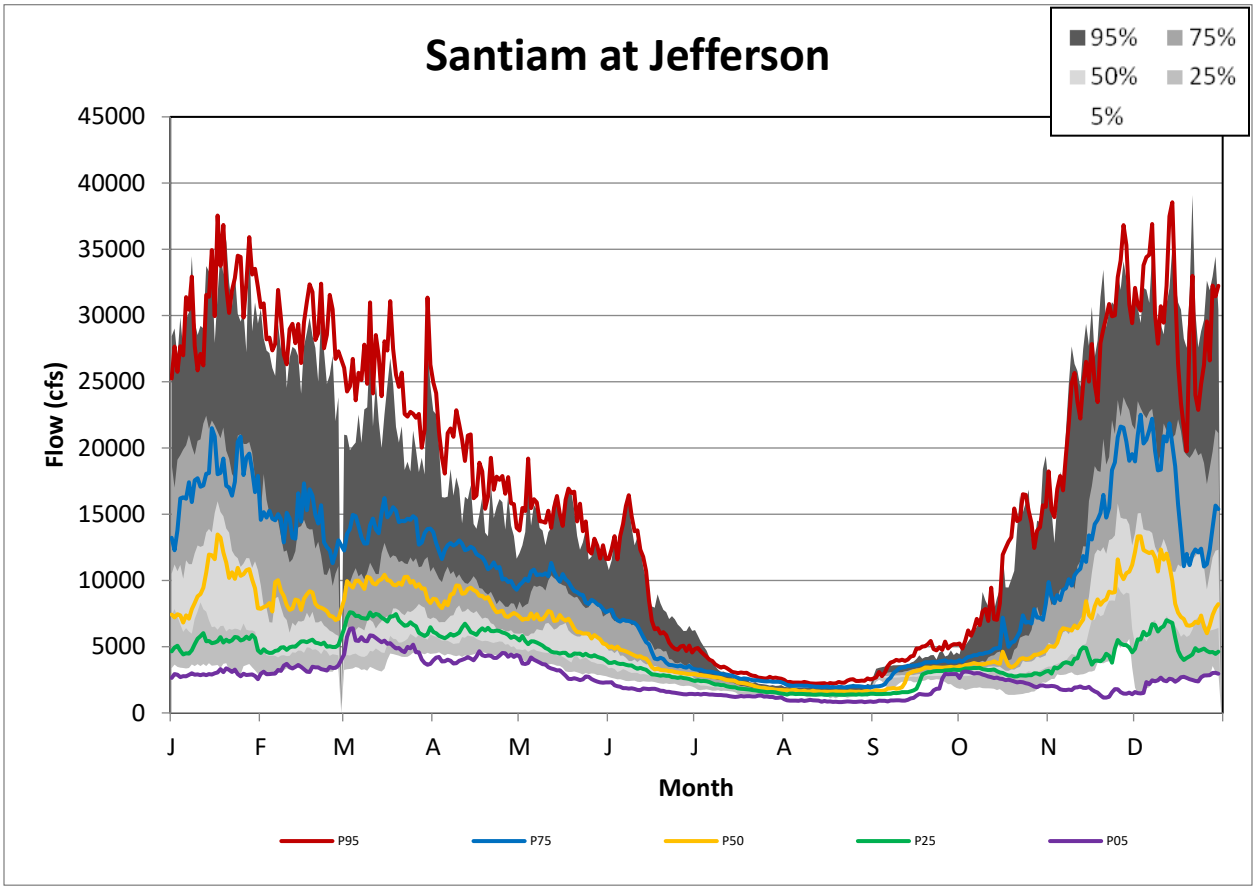

Figure 2-36. Non-exceedance Flows at Jefferson under Alternative 3A.

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and drawing down the reservoir in the spring and fall for fish passage.

Under Alternative 3A, Detroit reservoir would be held below minimum conservation pool and as noted in Section 3.2.5.5, would very rarely fill into the conservation pool, nearly eliminating the ability to augment naturally low flows. Due to the spring drawdown and need to pass inflows instead of storing water, flows at Mehama in the spring, from March through early to late May, depending on the type of water year, are higher under Alternative 3A as compared to the NAA. Starting in June, flows drop lower than in the NAA as there is little to no water in the conservation pool to augment naturally low flows. Flows at Mehama could drop to less than 750 cfs for extended periods about 50% of the time. This could cause curtailment of water rights for M&I water supply and irrigation and would cause issues at the City of Salem's drinking water intake facility, which requires a minimum flow of 750 cfs for the intake structure to operate (Figure 39).

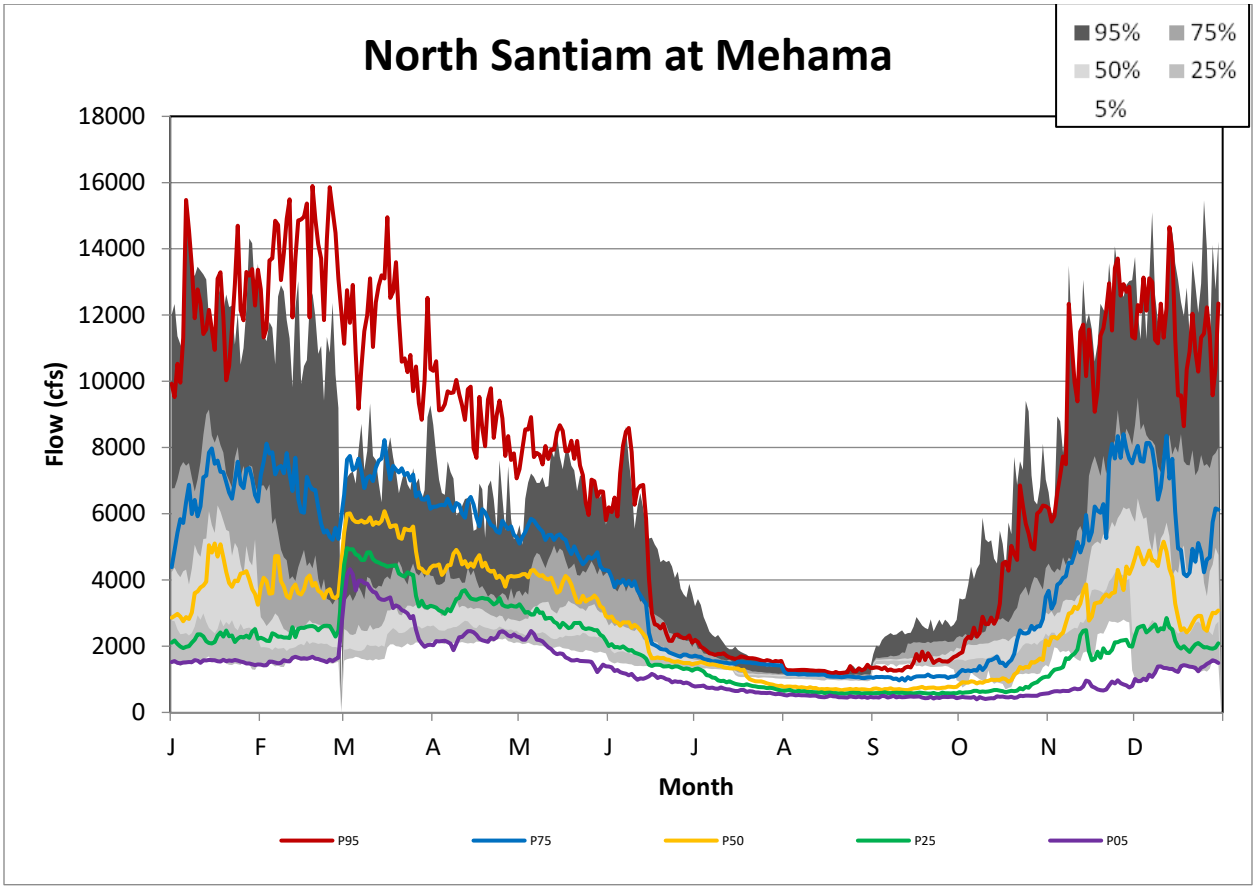

Figure 2-37. Non-exceedance Flows at Mehama under Alternative 3A.

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced flow targets, but higher in the summer and fall in all years due to the fall drawdown operation at Green Peter Dam (Figure 40).

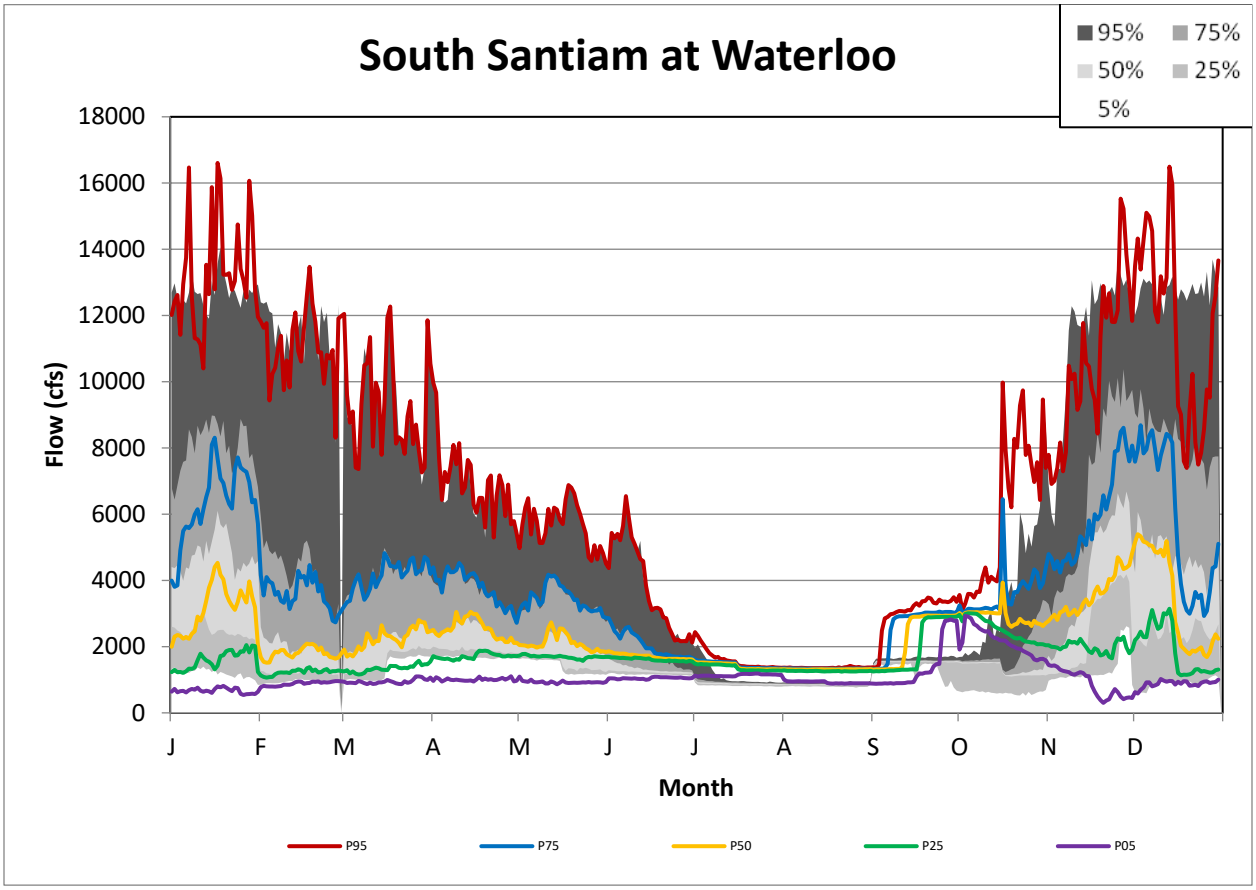

Figure 2-38. Non-exceedance Flows at Waterloo under Alternative 3A.

2.5.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and drawing down the reservoir to the regulating outlets in the spring and fall for fish passage.

Flows at Vida are higher in the spring than in the NAA for all but the driest years, as the reservoir needs to pass inflows to keep the pool drawn down for the fish passage operation in both the spring and fall. Flows in the summer are nearly equal to the NAA, but lower in the fall. This is due to not needing to empty the reservoir in preparation for the winter flood management season (Figure 41).

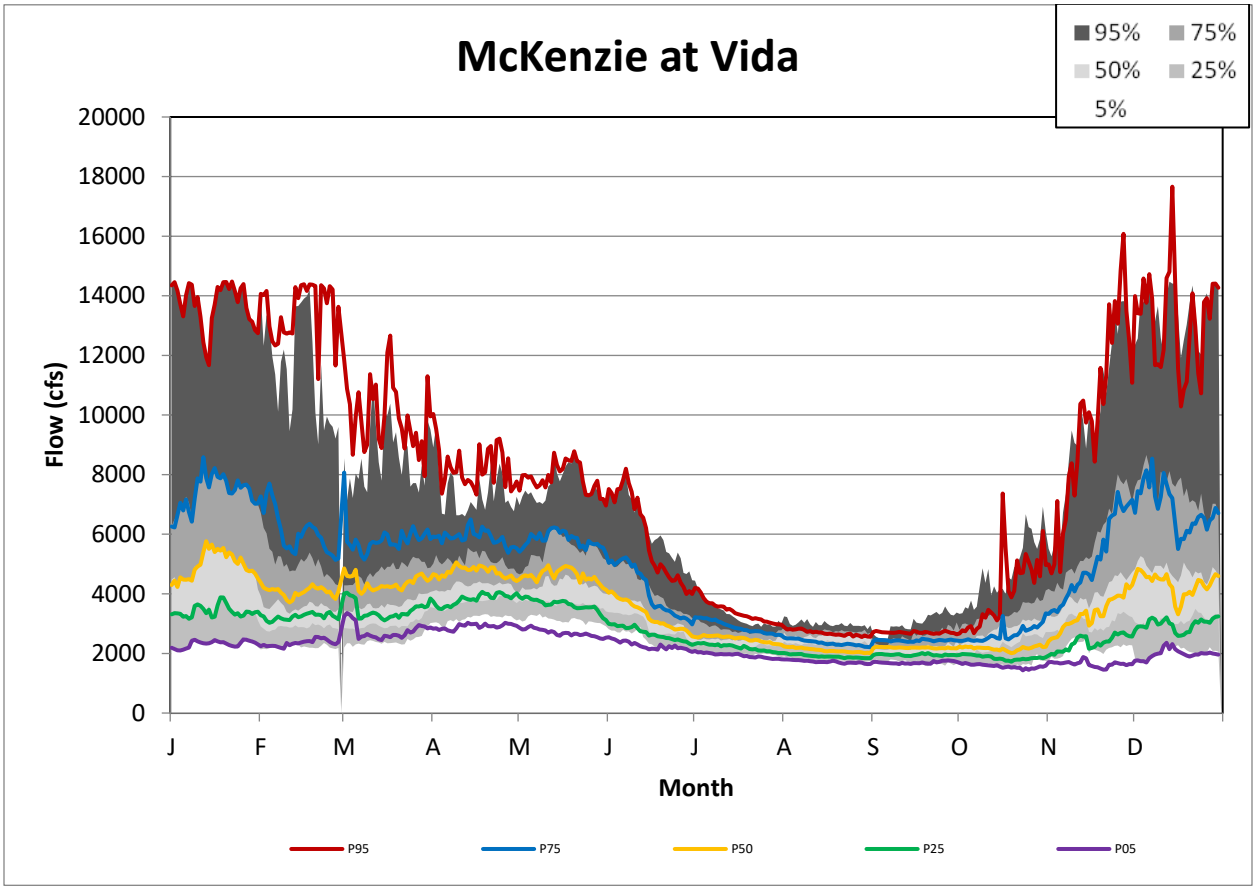

Figure 2-39. Non-exceedance Flows at Vida under Alternative 3A.

2.5.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary and available, and drawing down Lookout Point reservoir in the spring and fall and drawing down Hills Creek reservoir in the fall for fish passage.

Flows at Jasper are higher than in the NAA through mid-May for all years, and through mid-June for wetter years, due to the spring drawdown operation at Lookout Point which prevents storing of water into the conservation pool until mid-June. When the reservoir does start storing water, flows in the Middle Fork Willamette drop drastically most years, closer to what would be realized during dry years in both Alternative 3A and the NAA. Flows during the driest years are nearly equal to the NAA conditions during spring and most of summer, until September when there isn't water in the conservation pools to supplement naturally very low flows (Figure 42).

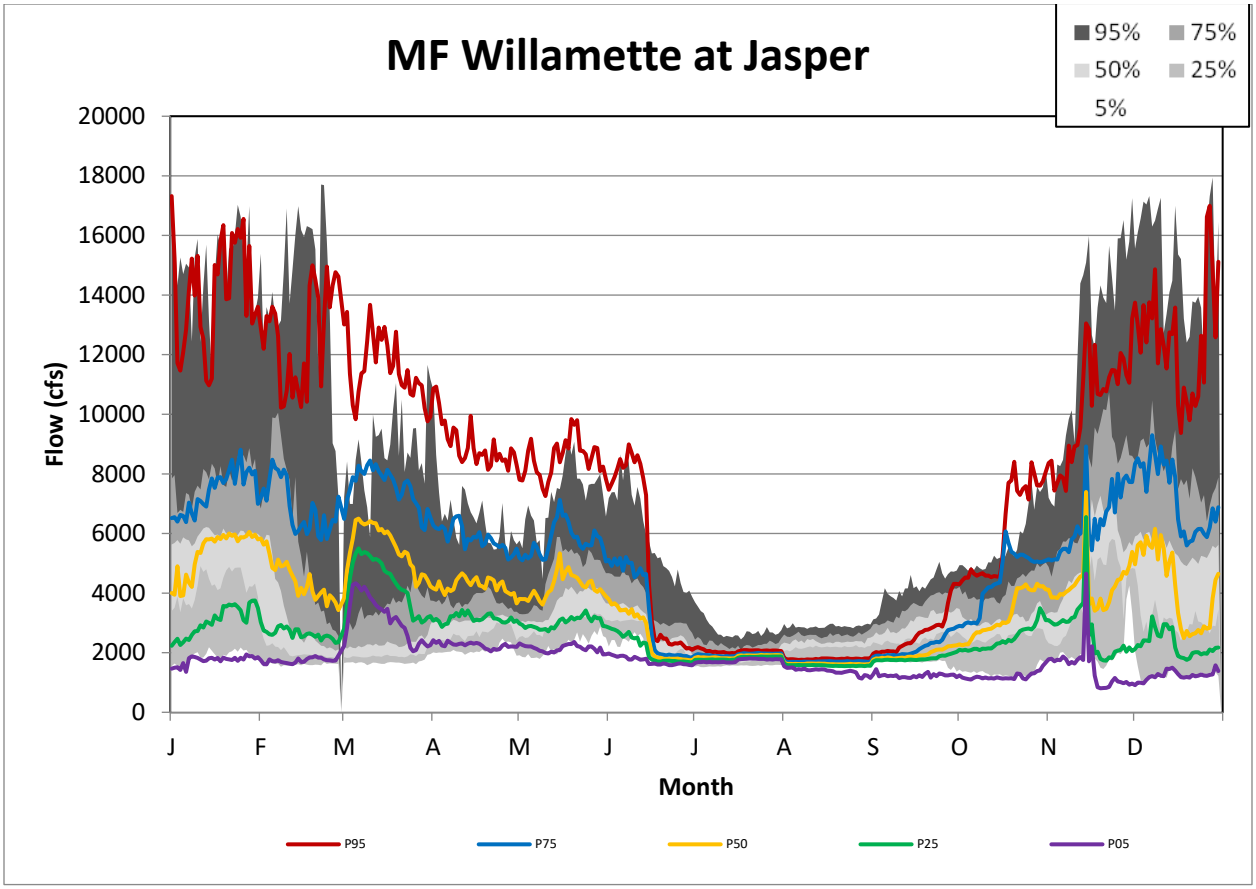

Figure 2-40. Non-exceedance Flows at Jasper under Alternative 3A.

2.5.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, drawing down Detroit, Cougar, and Lookout Point reservoirs in the spring and fall for fish passage, and drawing down Green Peter and Hills Creek reservoir in the fall for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, staying above 5000 cfs, and only in the driest years (Figure 43).

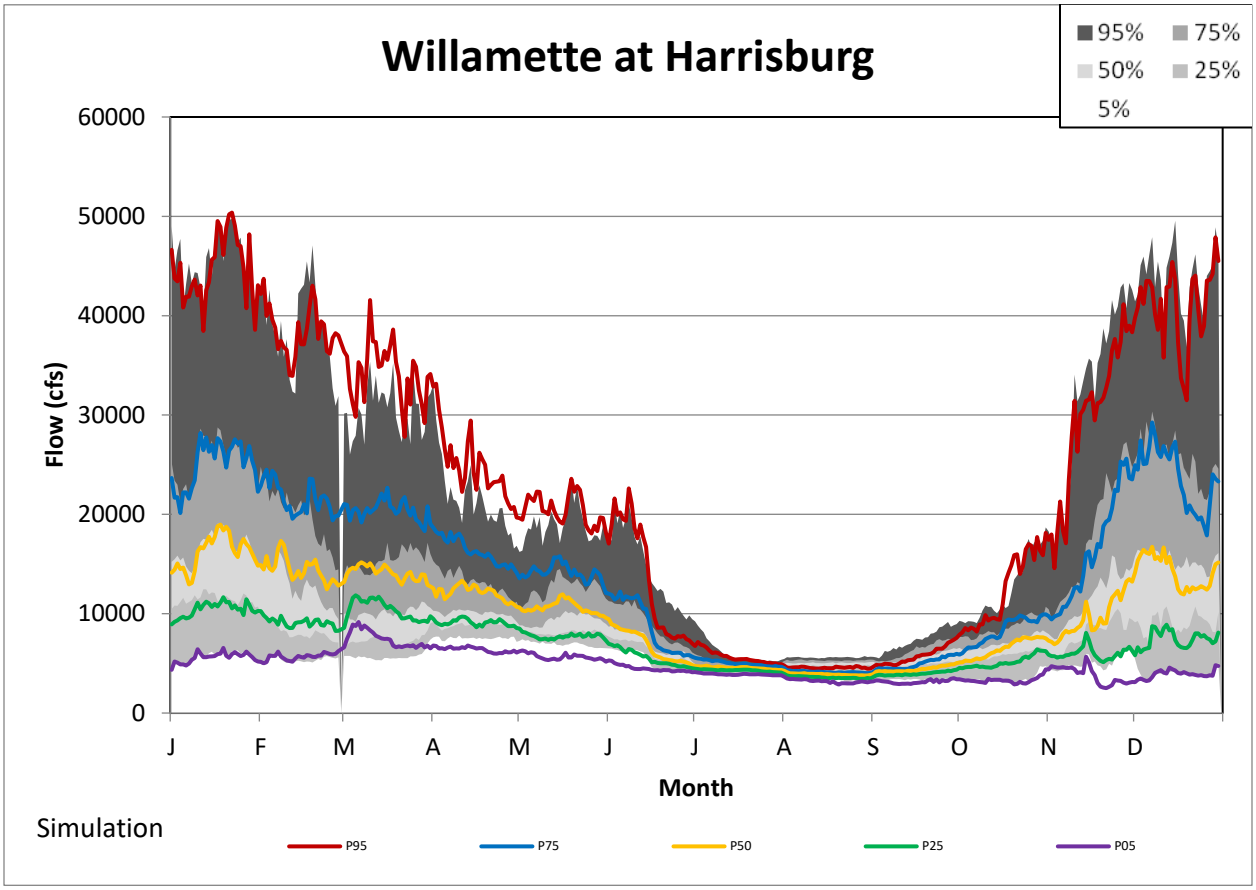

Figure 2-41. Non-exceedance Flows at Harrisburg under Alternative 3A.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June during the driest years and nearly equal to the NAA flows during the summer months. Flows are only lower during a portion of the spring, staying above 3000 cfs, and only in the driest years (Figure 44).

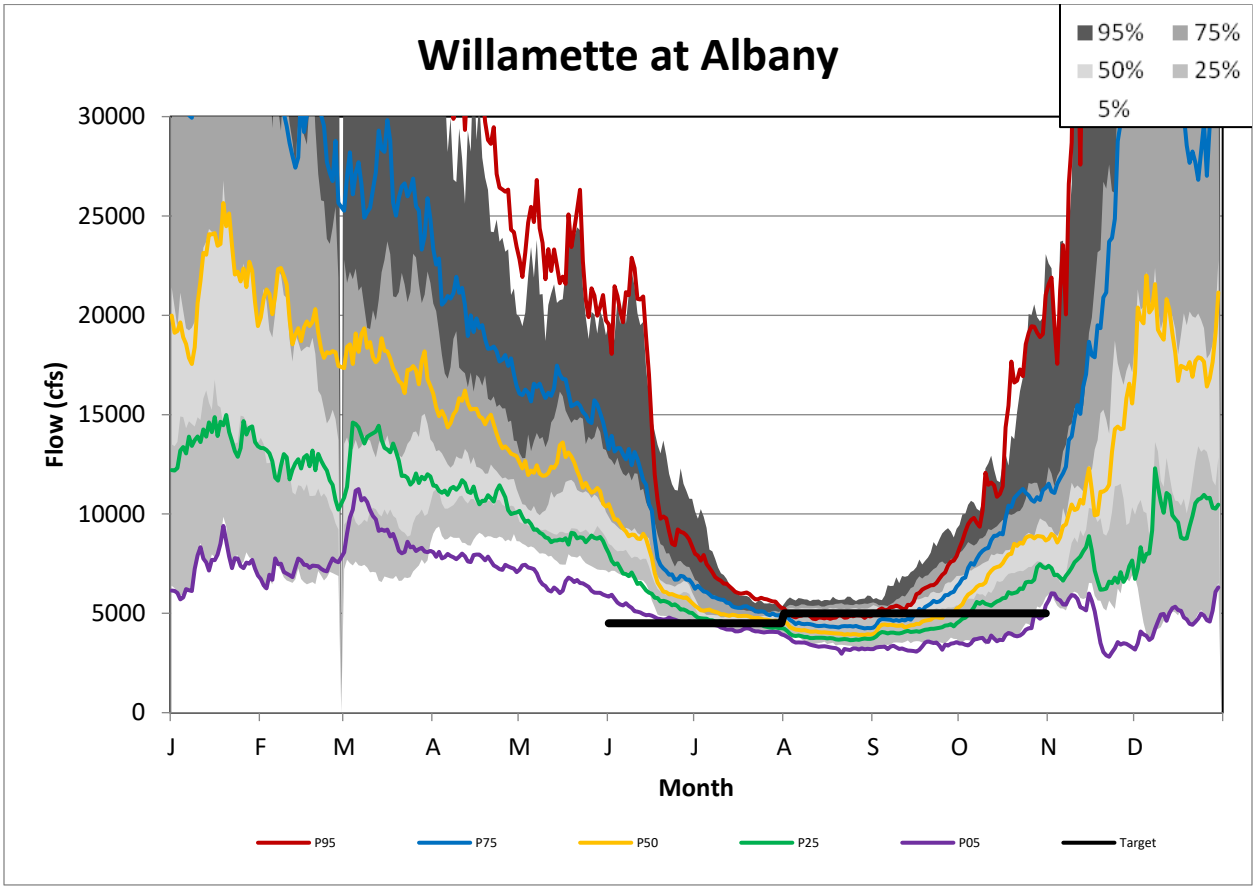

Figure 2-42. Non-exceedance Flows at Albany under Alternative 3A.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June during the driest years and lower during the summer for most years. Flows would still stay above 6000 cfs most of the time (Figure 45).

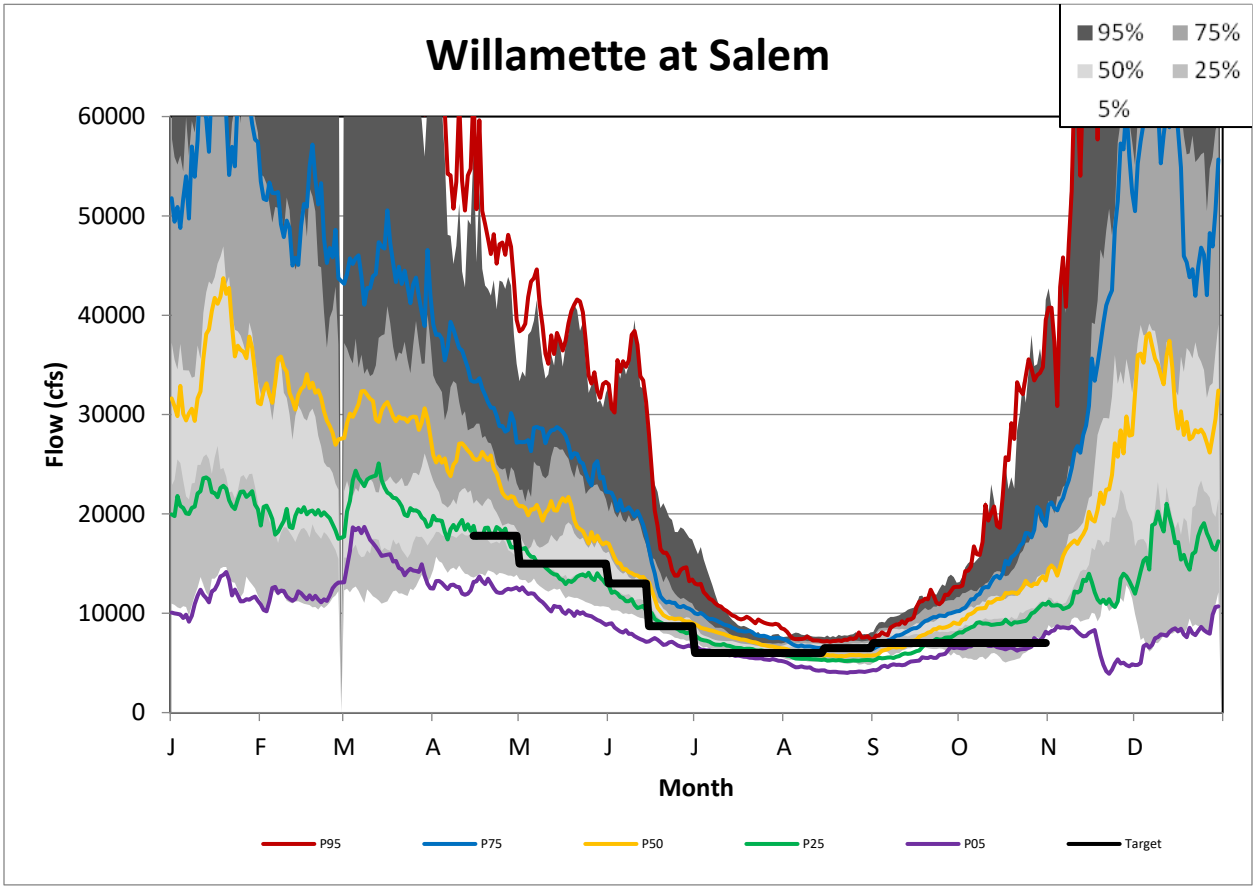

Figure 2-43. Non-exceedance Flows at Salem under Alternative 3A.

2.6 ALTERNATIVE 3B

2.6.1 Storage Allocations

Alternative 3B is also an operational fish passage alternative, combining spring spill and drawdowns with fall drawdowns at 6 of the 11 storage projects. These combined operations significantly affect system-wide refill of conservation storage, resulting in system-wide stored water being only 50% of the refill volume in the NAA, or 669,000 acre-feet, as indicated in Figure 46. Stored water would not be available to meet M&I storage agreements and irrigation water service contracts in the driest years. This lack of storage is significantly higher under Alternatives 3A and 3B.

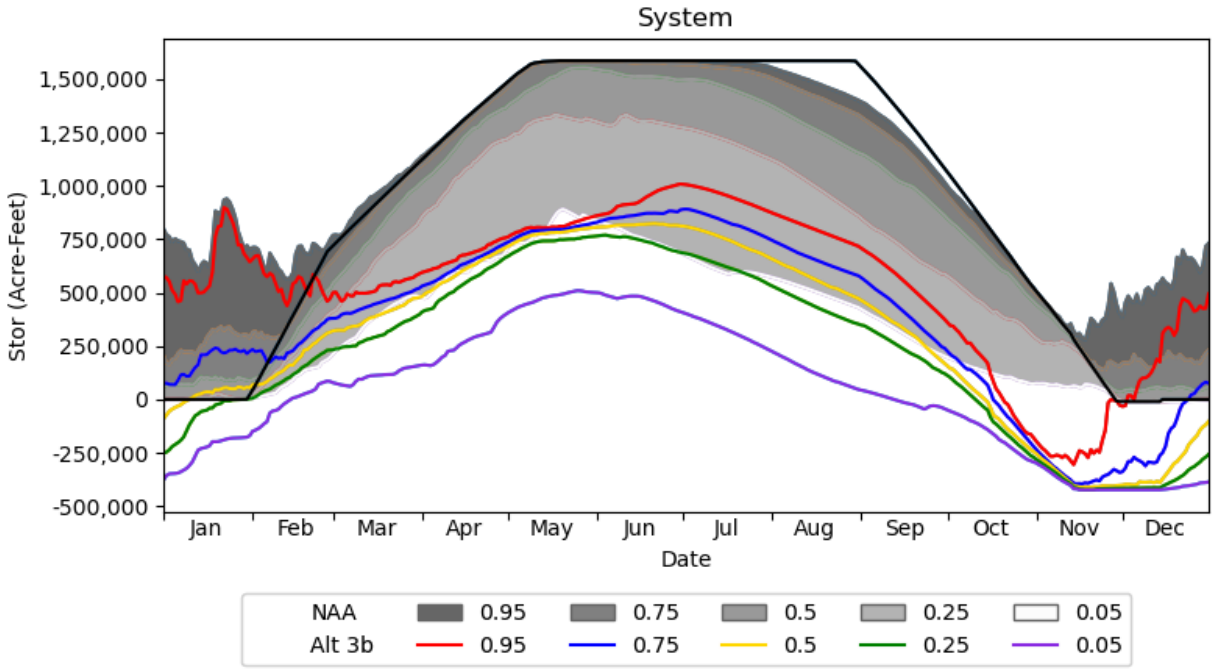

Figure 2-44. System-wide Conservation Storage under Alternative 3B.

2.6.2 Natural Flow Water Rights

2.6.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, in Alternative 3B are affected by the combination of a spring drawdown operation at Green Peter and fall drawdown operations at both Detroit and Green Peter. Flows are very similar to those expected under Alternative 3A: slightly higher than the NAA from mid-March to mid-June except in the driest years when flows would be lower than the NAA starting in late April. Flows in the summer are nearly equal to the NAA. Flows in the fall are lower than the NAA about half the time (Figure 47).

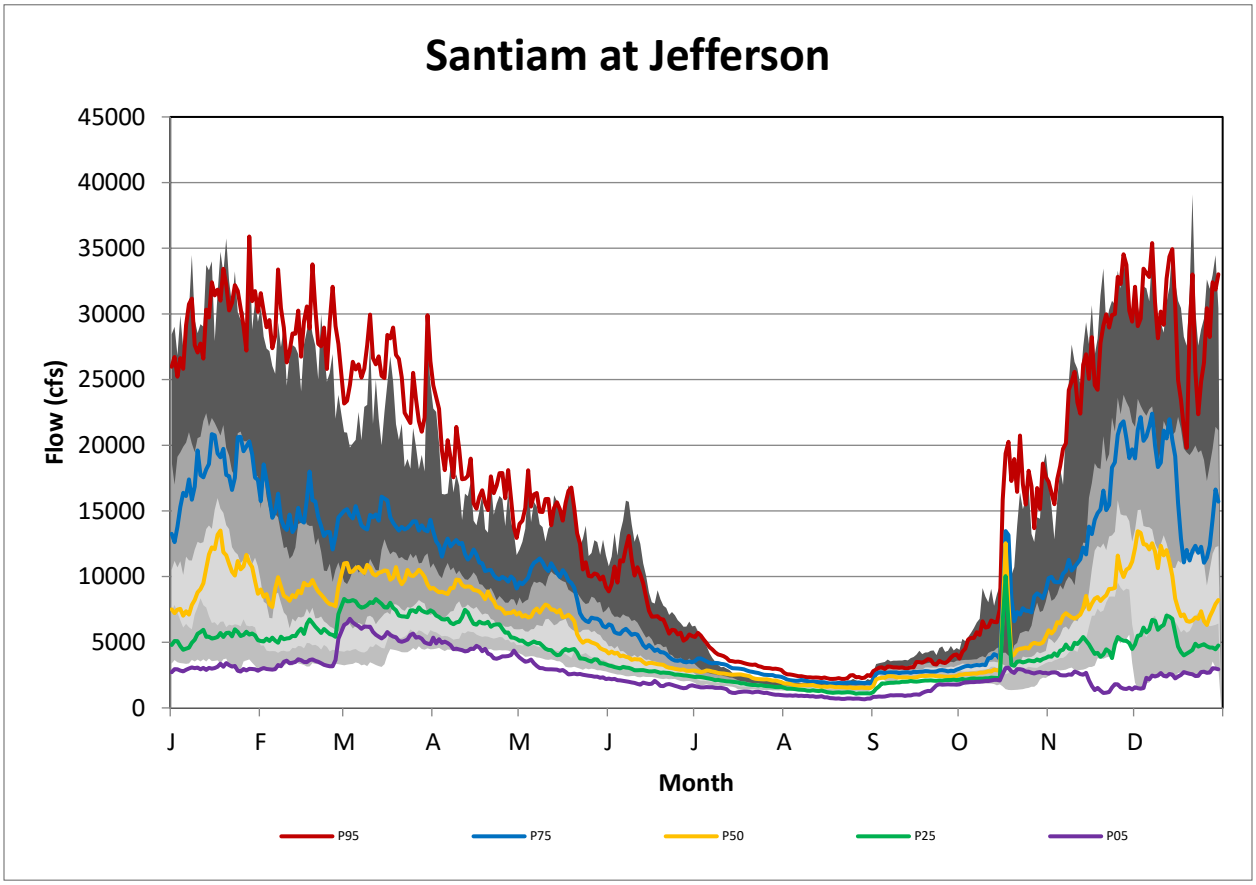

Figure 2-45. Non-exceedance Flows at Jefferson under Alternative 3B.

North Santiam

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Flows in September would be higher in all but the driest years as the reservoir is drafted for the fall drawdown operation for fish passage. Real time water management of the reservoir would be capable of managing flows in the North Santiam River in the driest years (Figure 48).

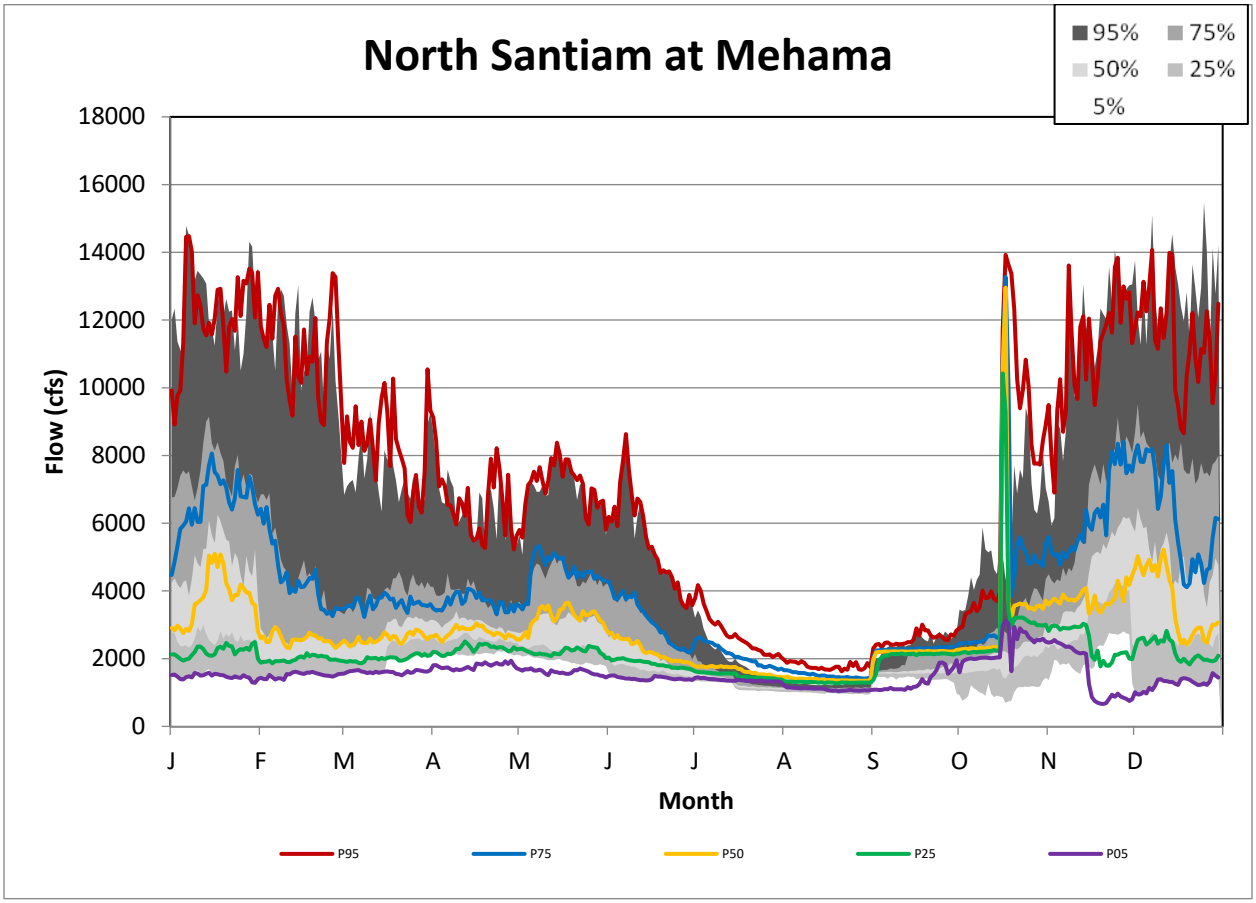

Figure 2-46. Non-exceedance Flows at Mehama under Alternative 3B.

South Santiam

Under Alternative 3B, Green Peter reservoir would be held below minimum conservation pool, rarely filling into the conservation pool, nearly eliminating the ability to augment naturally low flows in the summer. Due to the spring drawdown and need to pass inflows instead of storing water, flows at Waterloo in the spring, from March through early to late May, depending on the type of water year, are higher under Alternative 3B as compared to the NAA. Starting in June (May for driest years), flows drop lower than in the NAA as there is little to no water in the conservation pool to augment naturally low flows. Flows at Waterloo could drop to near 100 cfs for extended periods about 25% of the time (Figure 49). This could cause curtailment of water rights.

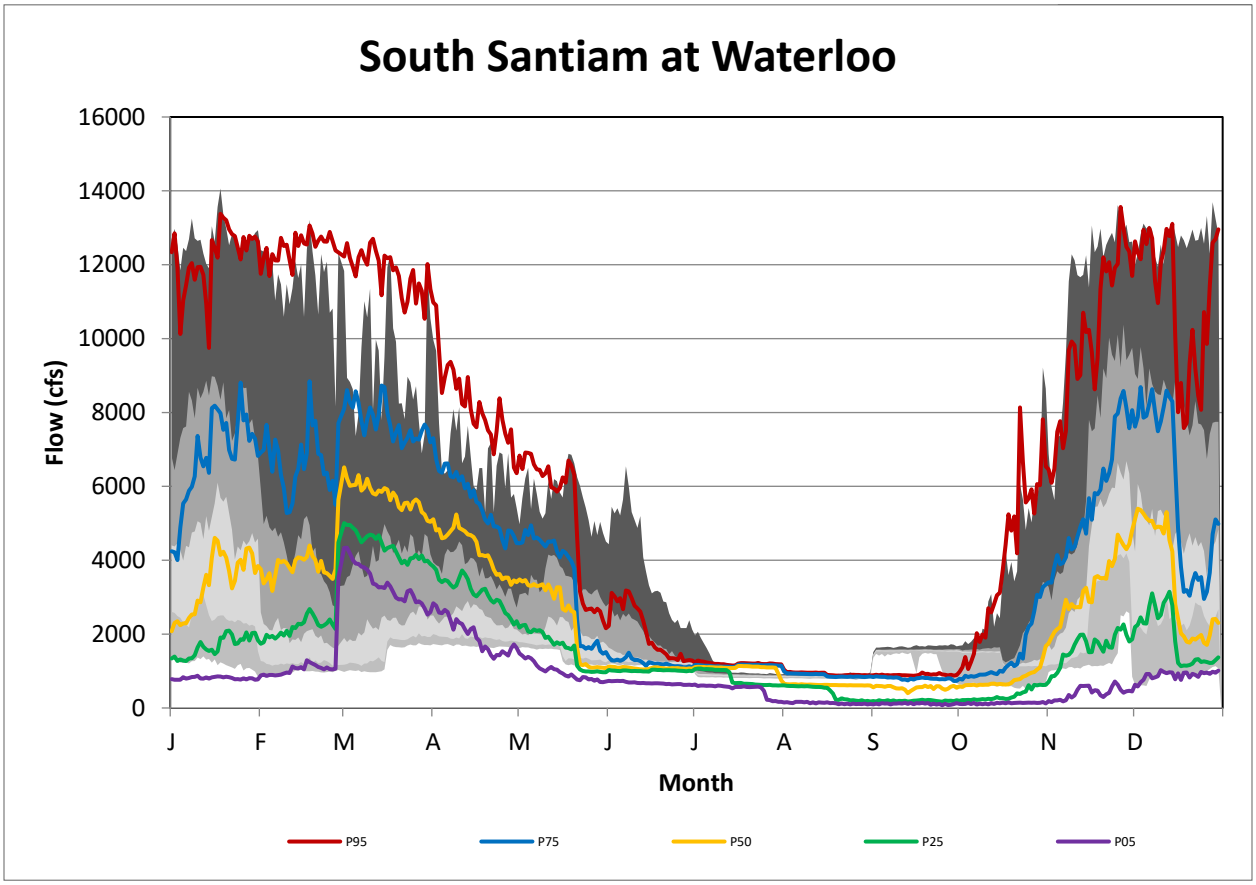

Figure 2-47. Non-exceedance Flows at Waterloo under Alternative 3B.

2.6.2.2 McKenzie

Even though Alternative 3B has a deeper spring drawdown operation at Cougar reservoir, flows at Vida are very similar to those expected to occur under Alternative 3A (i.e., higher in the spring than in the NAA for all but the driest years) as the reservoir needs to pass inflows to keep the pool drawn down for the fish passage operation in both the spring and fall (Figure 50). Flows in the summer are nearly equal to the NAA, but lower in the fall. This is due to not needing to empty the reservoir in preparation for the winter flood management season.

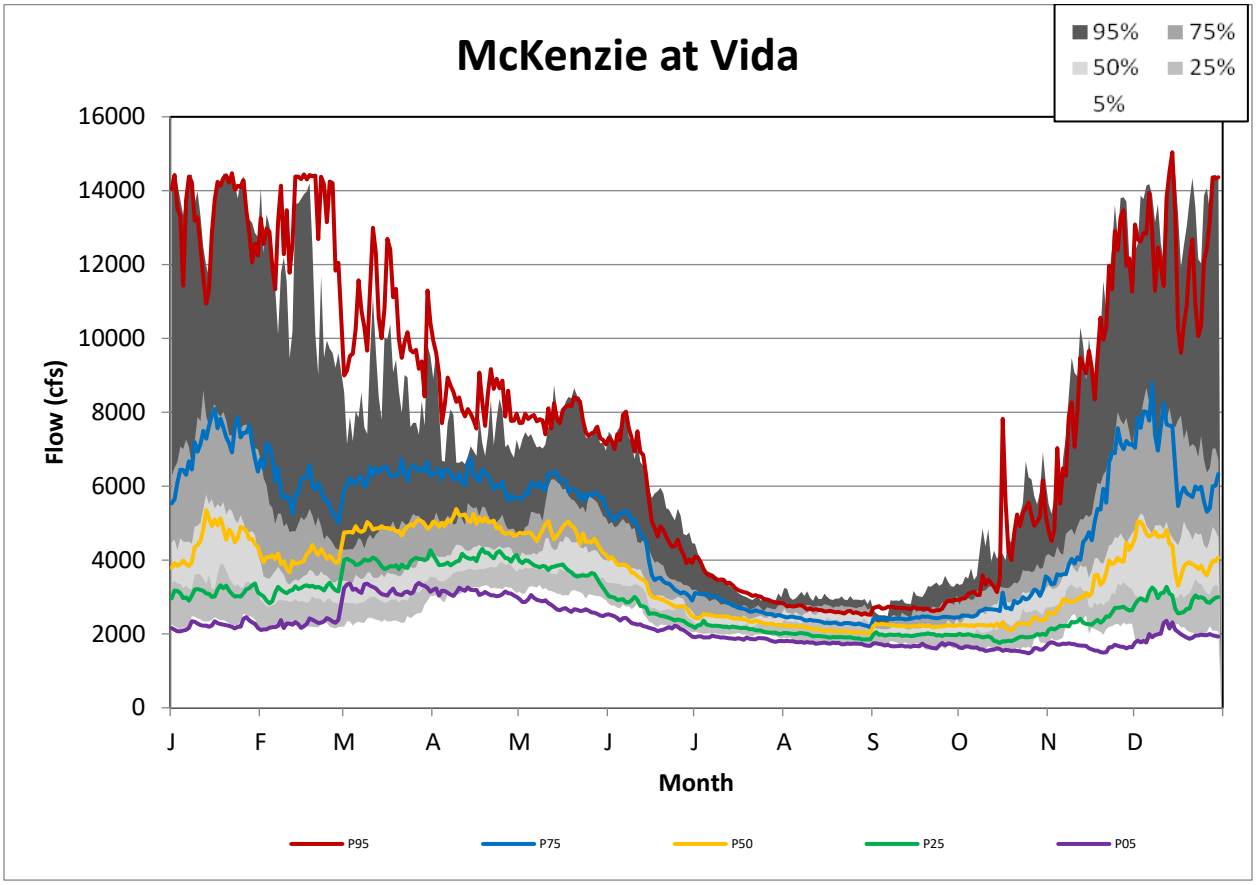

Figure 2-48. Non-exceedance Flows at Vida under Alternative 3B.

2.6.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary and available, and drawing down Lookout Point reservoir in fall and drawing down Hills Creek reservoir in the spring and fall for fish passage.

Flows at Jasper would be higher than in the NAA spring through fall in about 50% of years. For drier years, flows would be slightly less than the NAA April through mid-June, but then slightly higher until late August. During the driest years, flow would again be lower than then NAA, going down close to 1000 cfs at times (Figure 51).

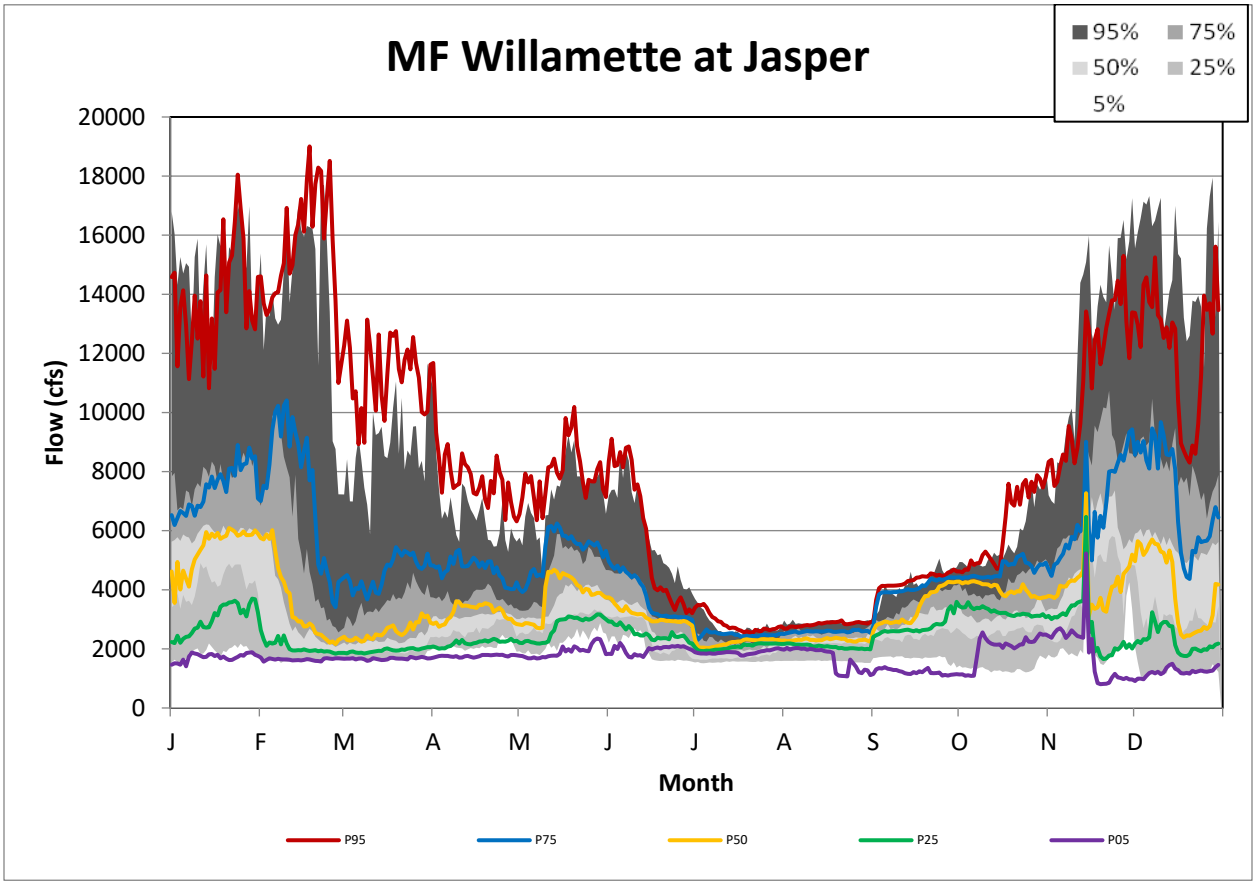

Figure 2-49. Non-exceedance Flows at Jasper under Alternative 3B.

2.6.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools at Lookout Point and Hills Creek, as necessary and available, drawing down Detroit and Lookout Point reservoirs in the fall for fish passage, and drawing down Green Peter, Cougar, and Hills Creek reservoirs in the spring and fall for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months for all years. Flows are only lower during a portion of the spring, still staying above 5000 cfs during that time-period, and only in the driest years (Figure 52).

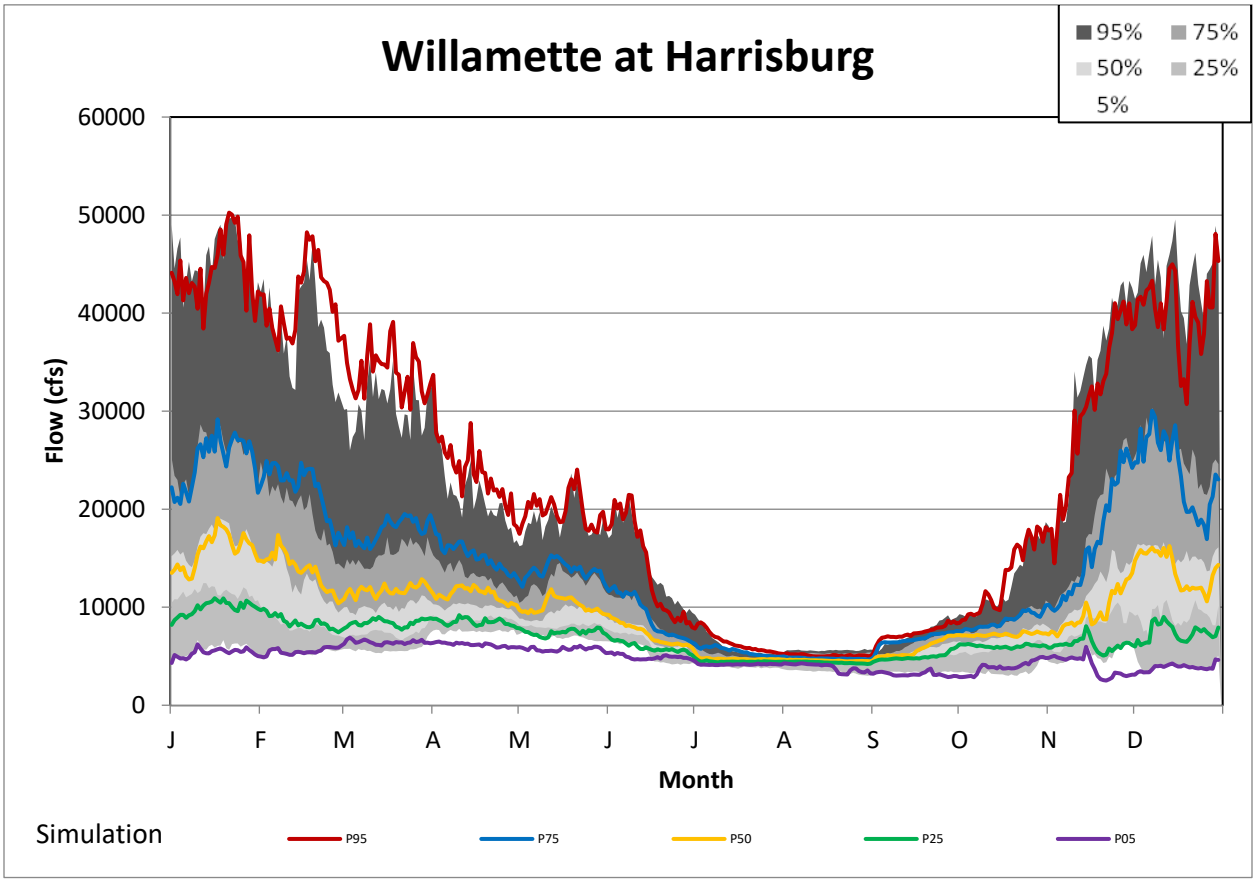

Figure 2-50. Non-exceedance Flows at Harrisburg under Alternative 3B.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June during drier years. Flows in the summer would be equal to or higher than in the NAA during the summer months, with flows dipping below NAA levels sporadically in late September and early October. Flows are only lower during a portion of the spring, staying above 6000 cfs during this period, and only in the driest years (Figure 53).

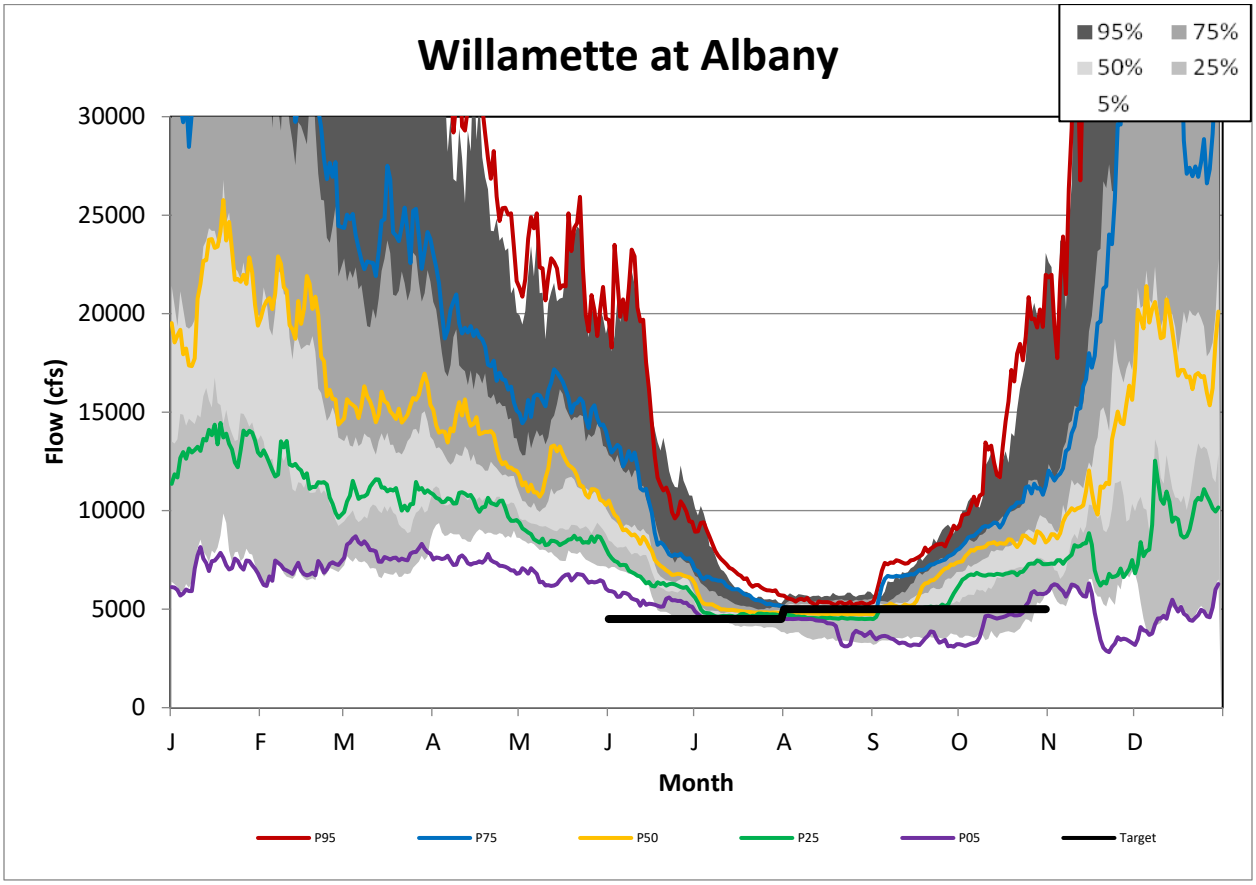

Figure 2-51. Non-exceedance Flows at Albany under Alternative 3B.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June and September during the driest years. Flows would still stay above 6000 cfs most of the time (Figure 54).

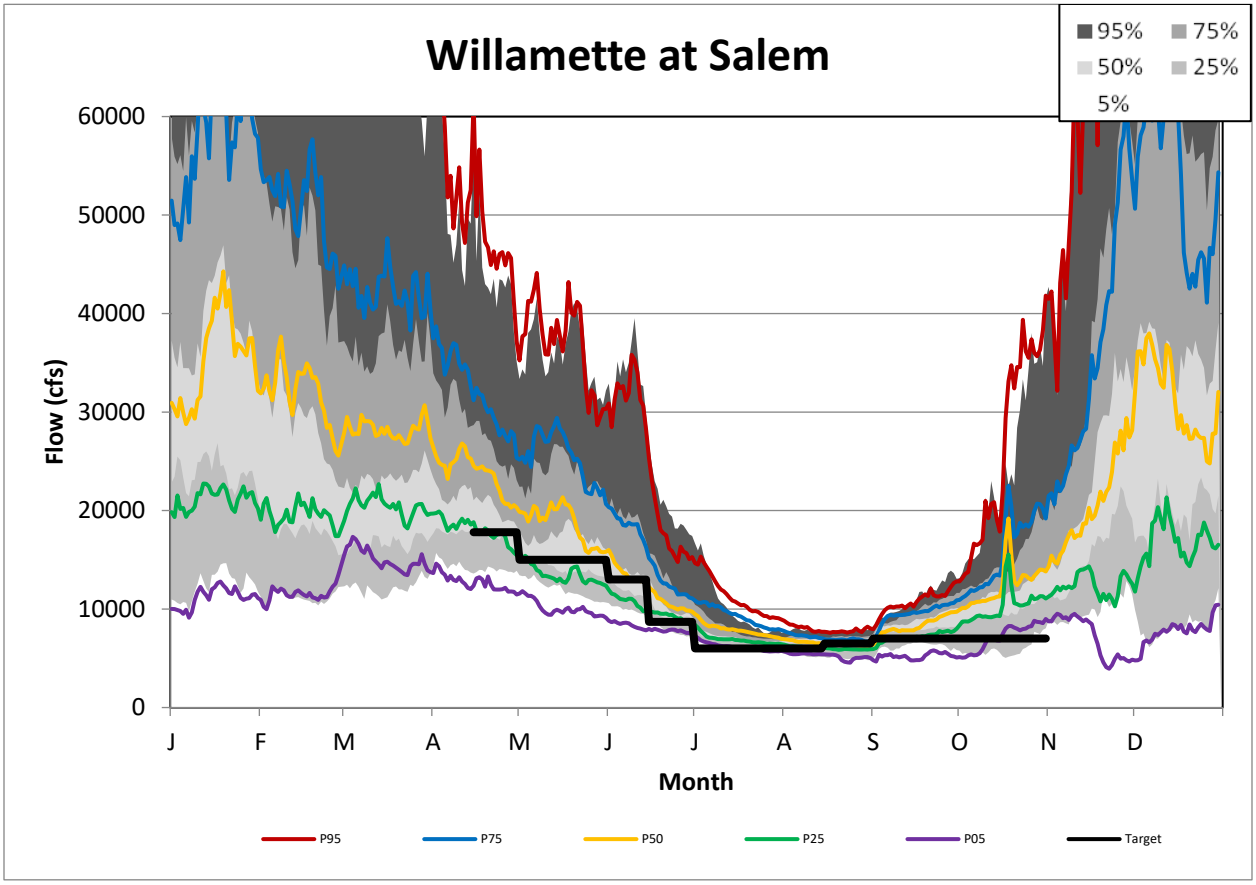

Figure 2-52. Non-exceedance Flows at Salem under Alternative 3B.

2.7 ALTERNATIVE 4

2.7.1 Storage Allocations

Figure 55 shows system-wide stored water would be 1,451,000 acre-feet, an increase of 122,000 acre-feet at the 75% exceedance level compared to the NAA, resulting in more reliable use of stored water, including for municipal and industrial water supply and irrigation than realized in the NAA. Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system.

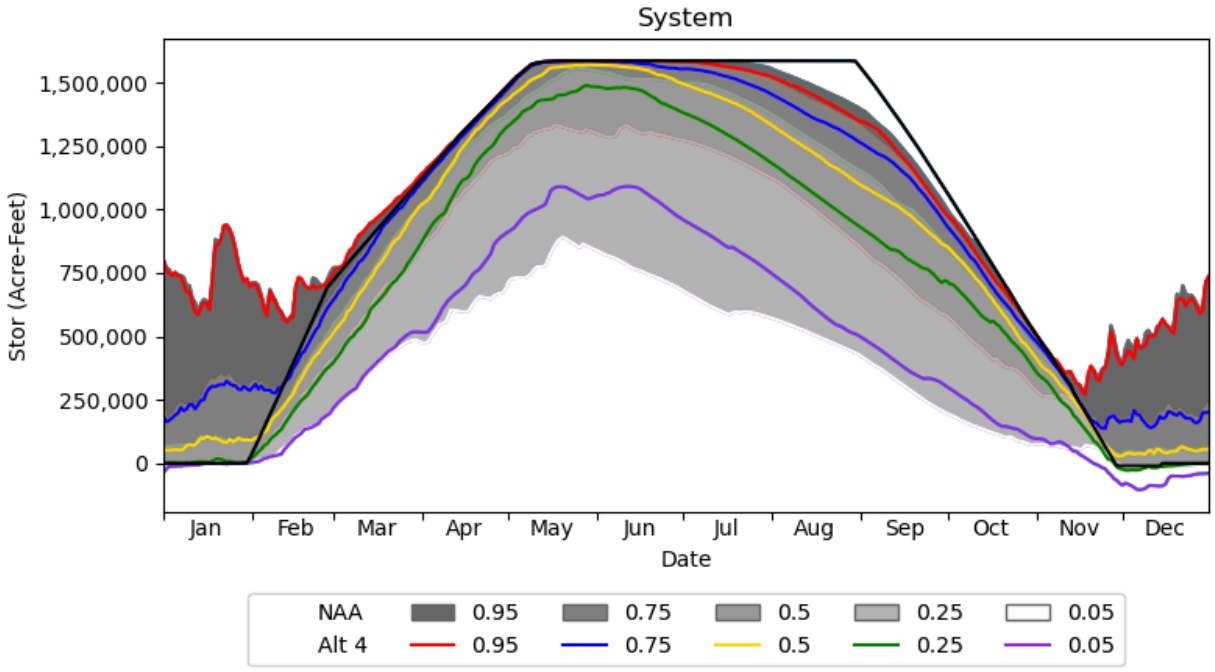

Figure 2-53. System-wide Conservation Storage under Alternative 4.

2.7.2 Natural Flow Water Rights

2.7.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher, or nearly equal, in the summer and fall in most years. Flows are only lower during a portion of the spring and only in the driest years (Figure 56).

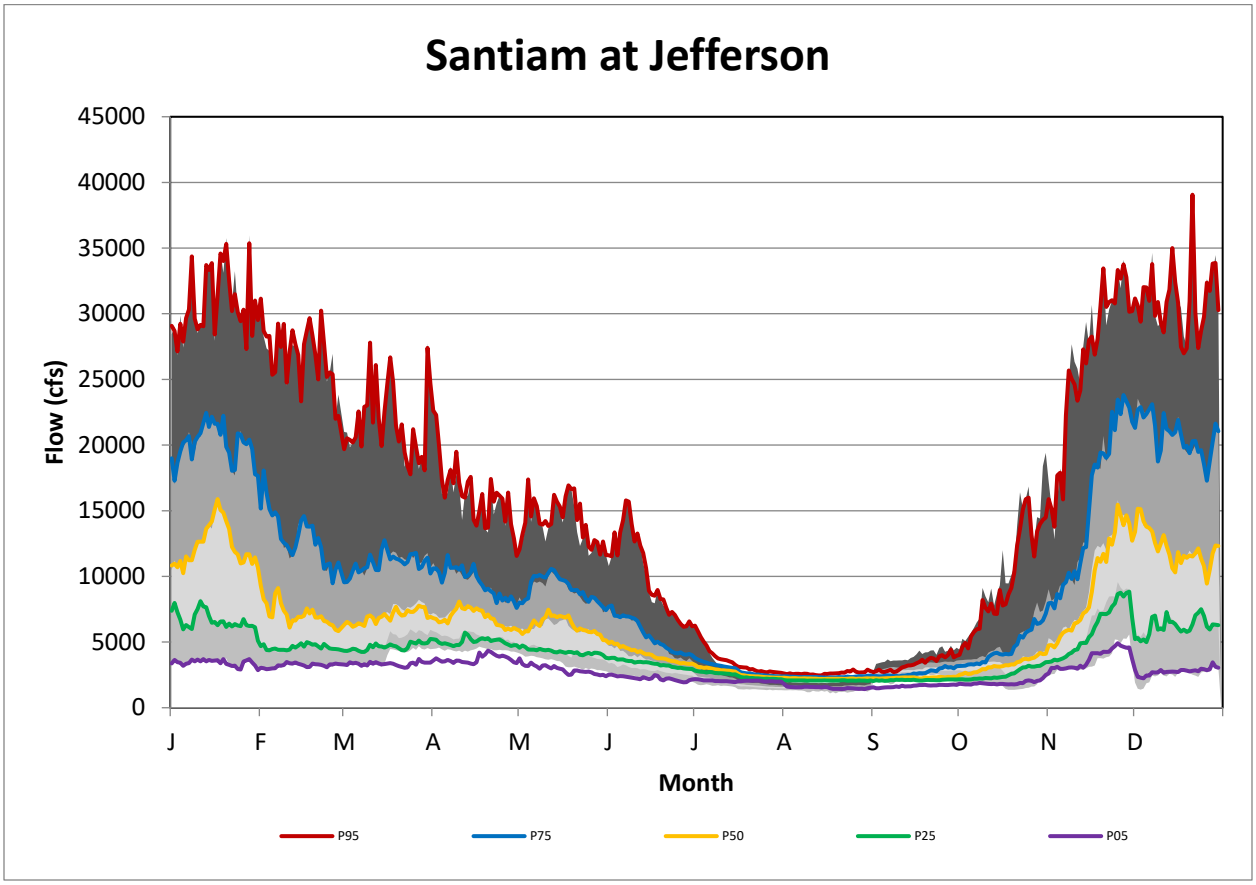

Figure 2-54. Non-exceedance Flows at Jefferson under Alternative 4.

North Santiam

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower, dry year target flows from Detroit as compared to the NAA (Figure 57). Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River.

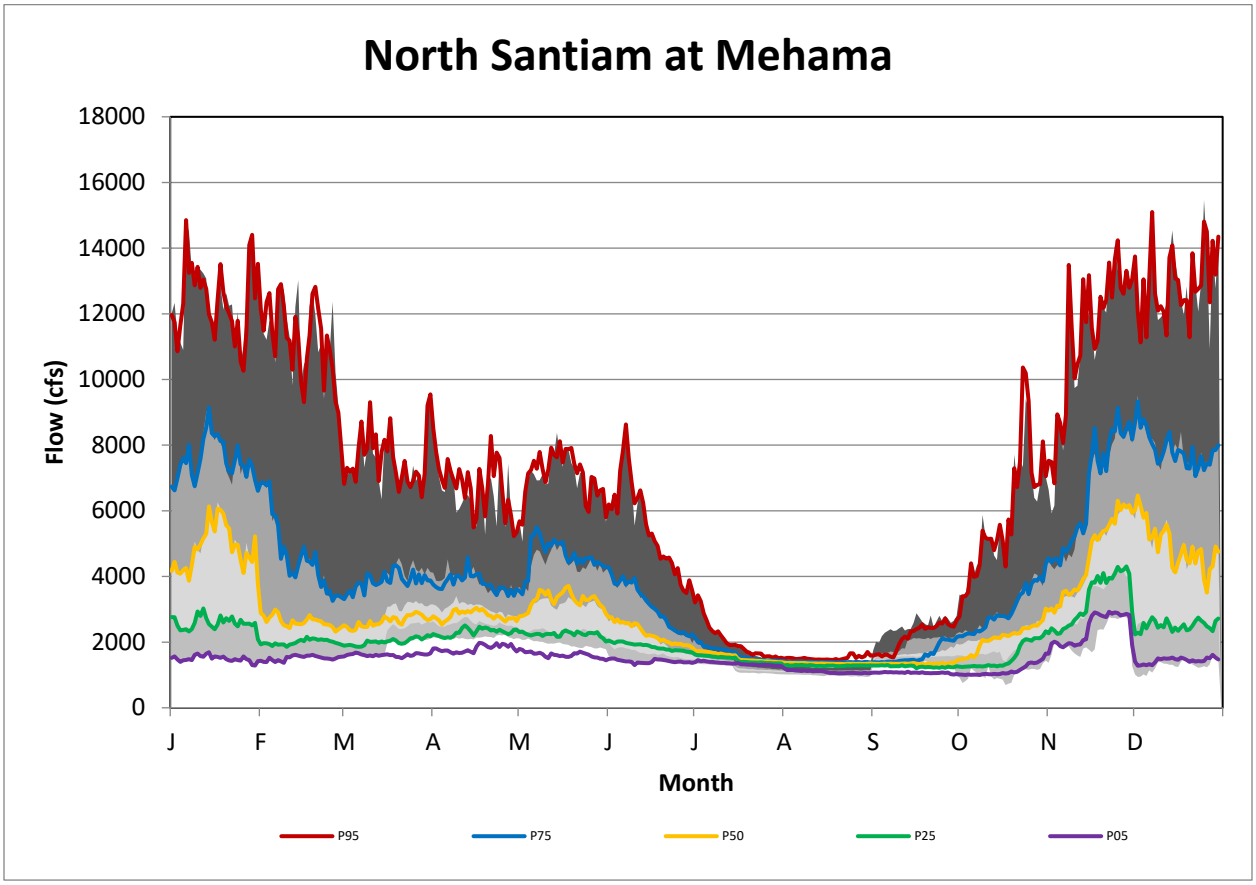

Figure 57. Non-exceedance Flows at Mehama under Alternative 4.

South Santiam

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher through the summer during most years (Figure 58). As the flows are only lower during a portion of the spring and only in the driest years, Alternative 4 would have a negligible effect on water supply in the South Santiam River.

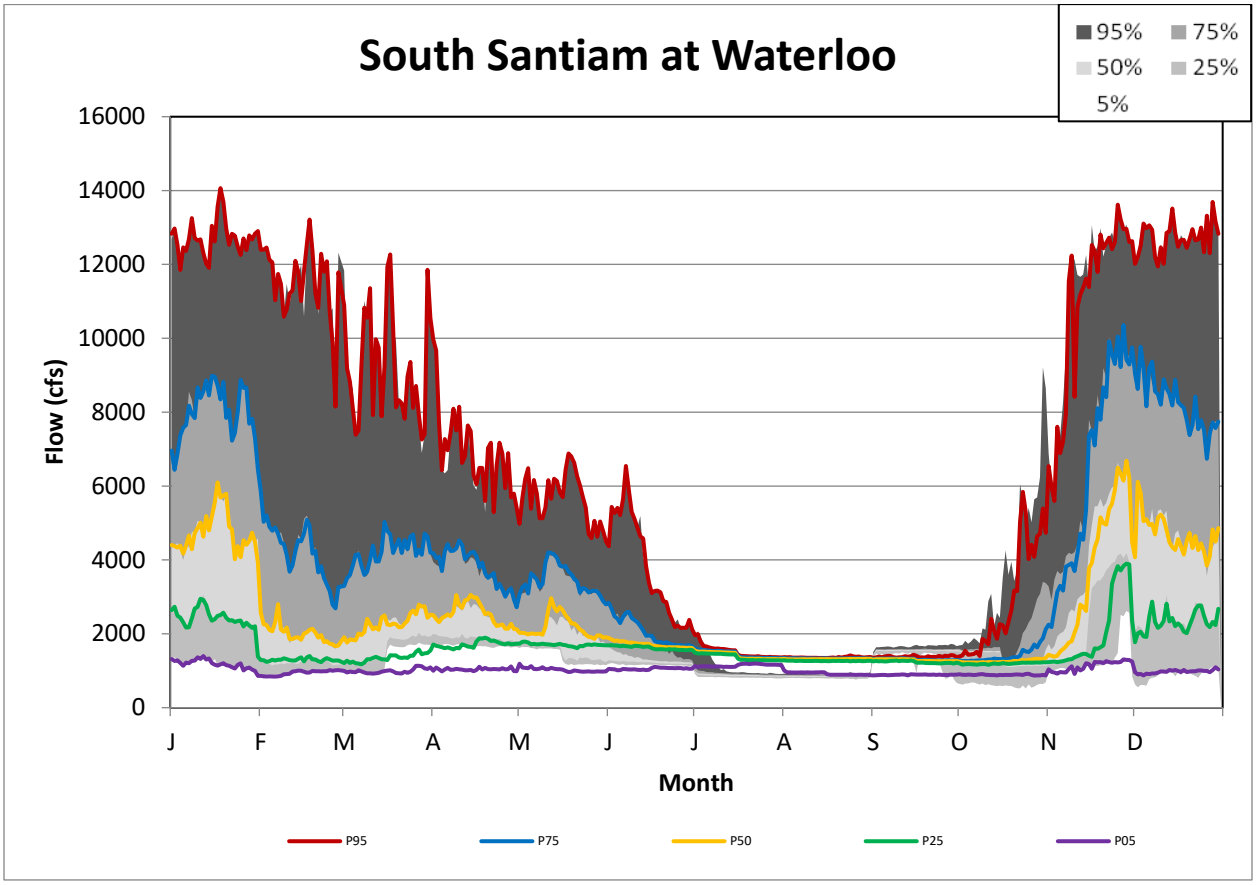

Figure 2-55. Non-exceedance Flows at Waterloo under Alternative 4.

2.7.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher in August and September in the driest years (Figure 59).

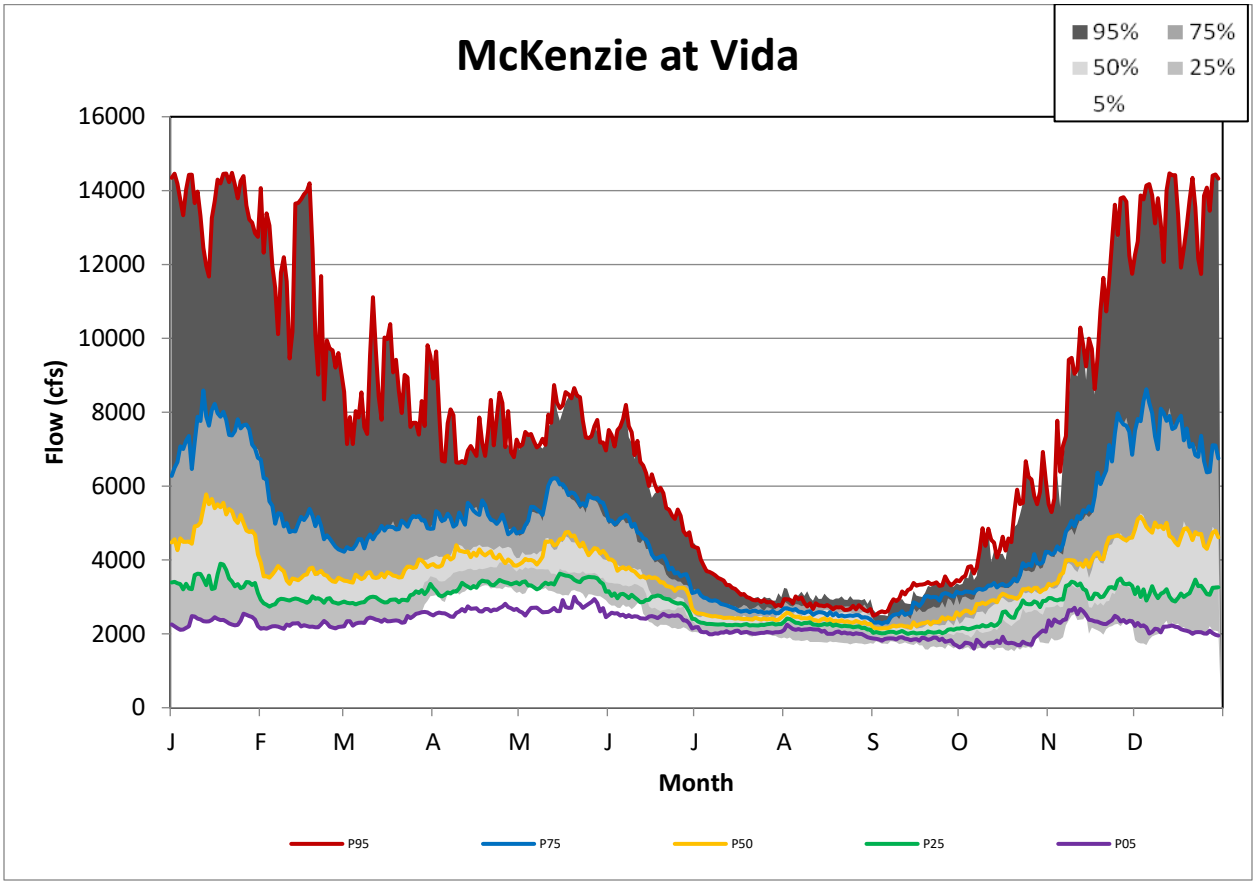

Figure 59. Non-exceedance Flows at Vida under Alternative 4.

2.7.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA during the summer months (Figure 60).

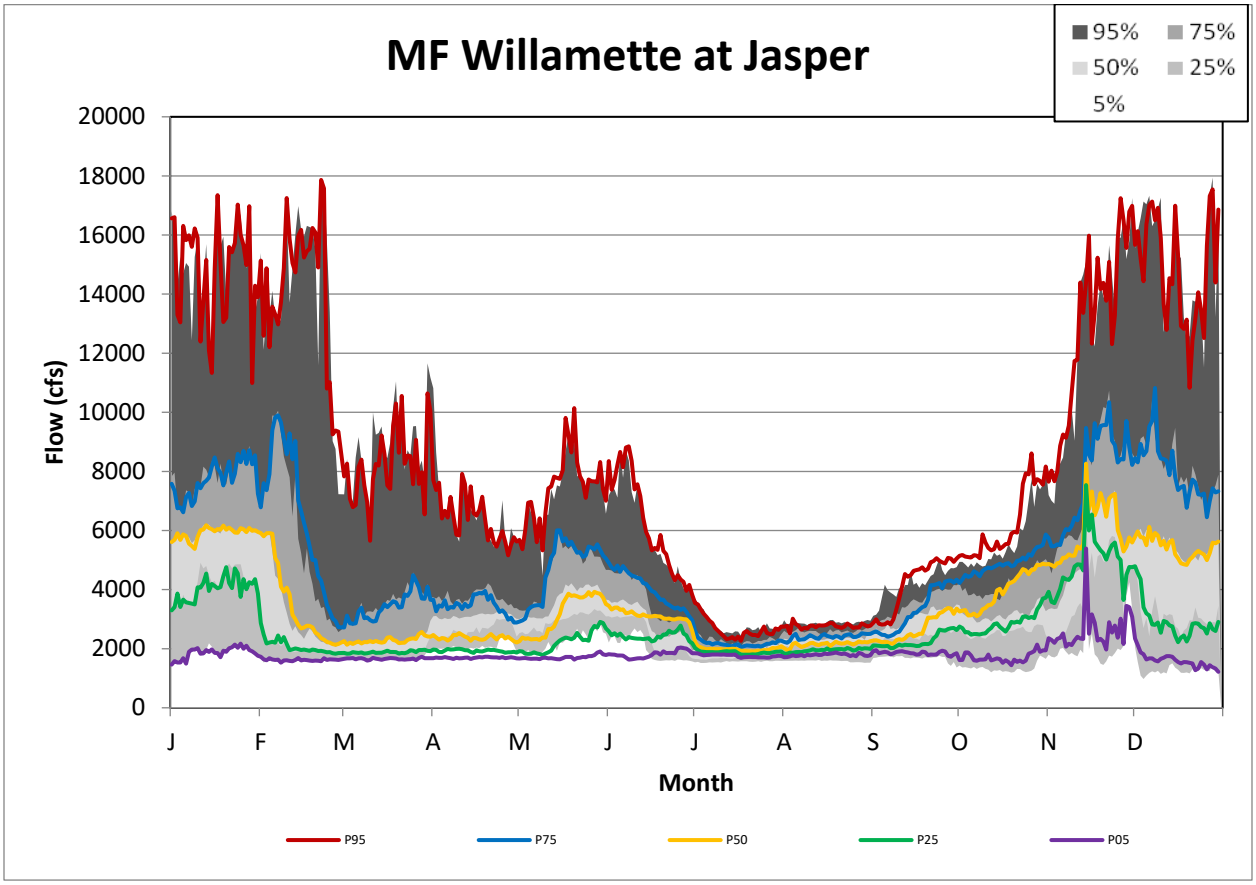

Figure 2-56. Non-exceedance Flows at Jasper under Alternative 4.

2.7.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the inactive and power pools, as necessary and available.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 4000 cfs, and only in the driest years (Figure 61).

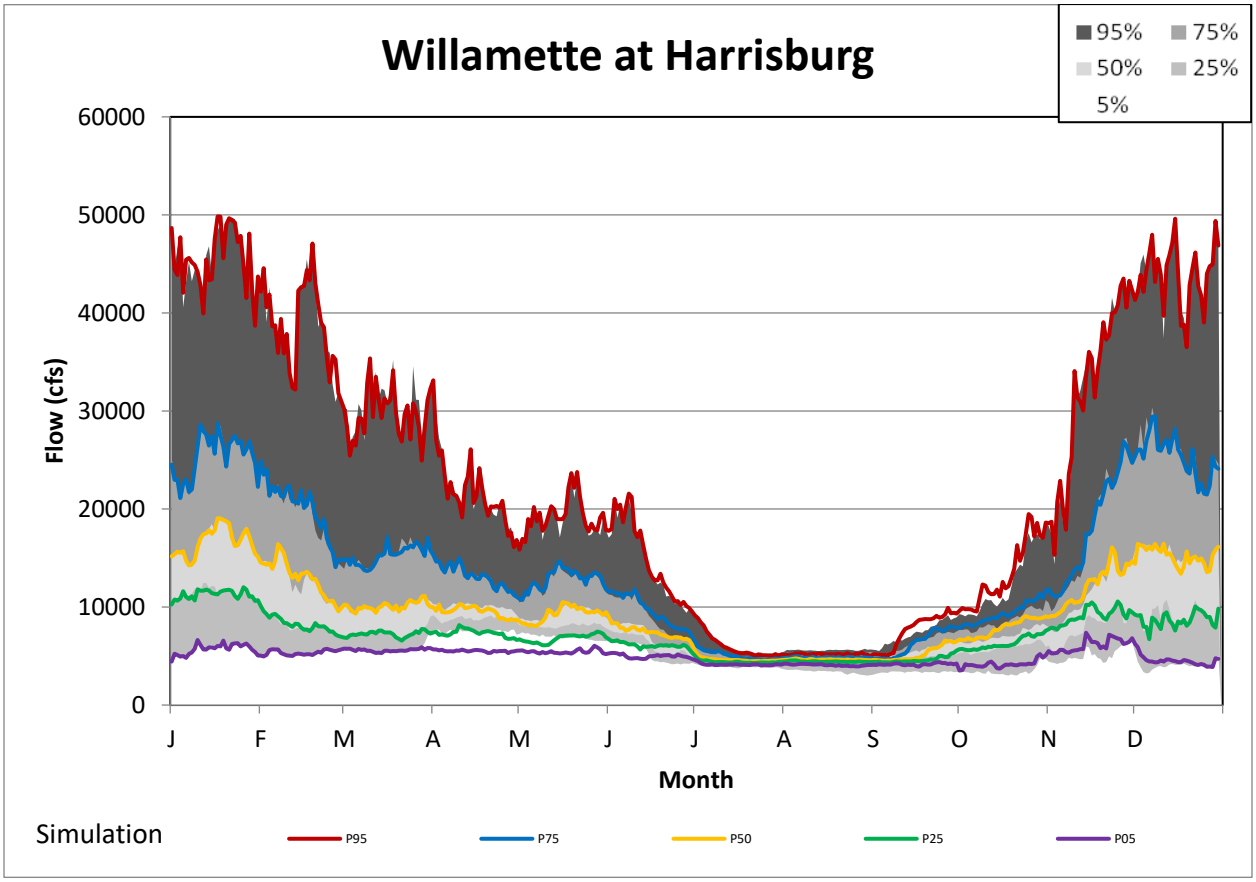

Figure 2-57. Non-exceedance Flows at Harrisburg under Alternative 4.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 4500 cfs, and only in the driest years (Figure 62).

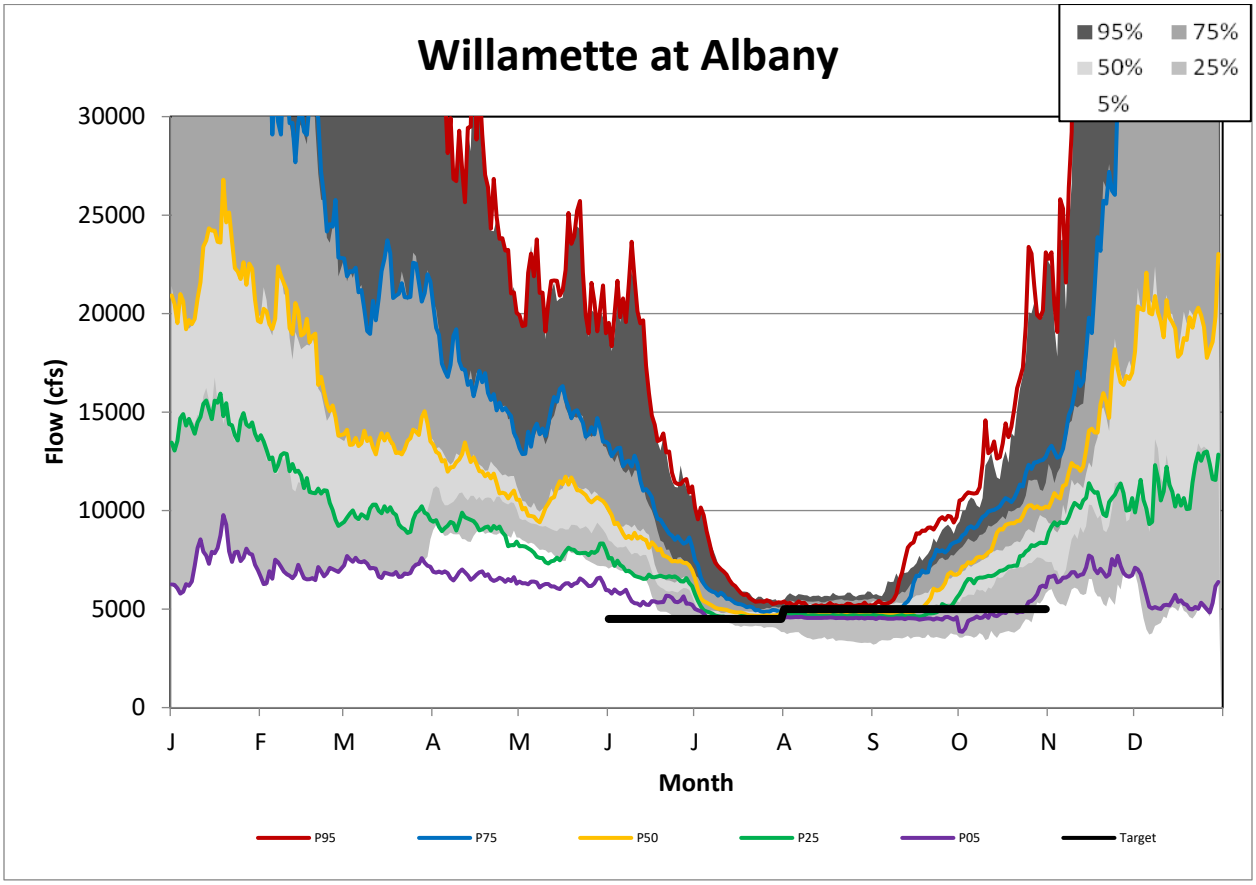

Figure 2-58. Non-exceedance Flows at Albany under Alternative 4.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years (Figure 63).

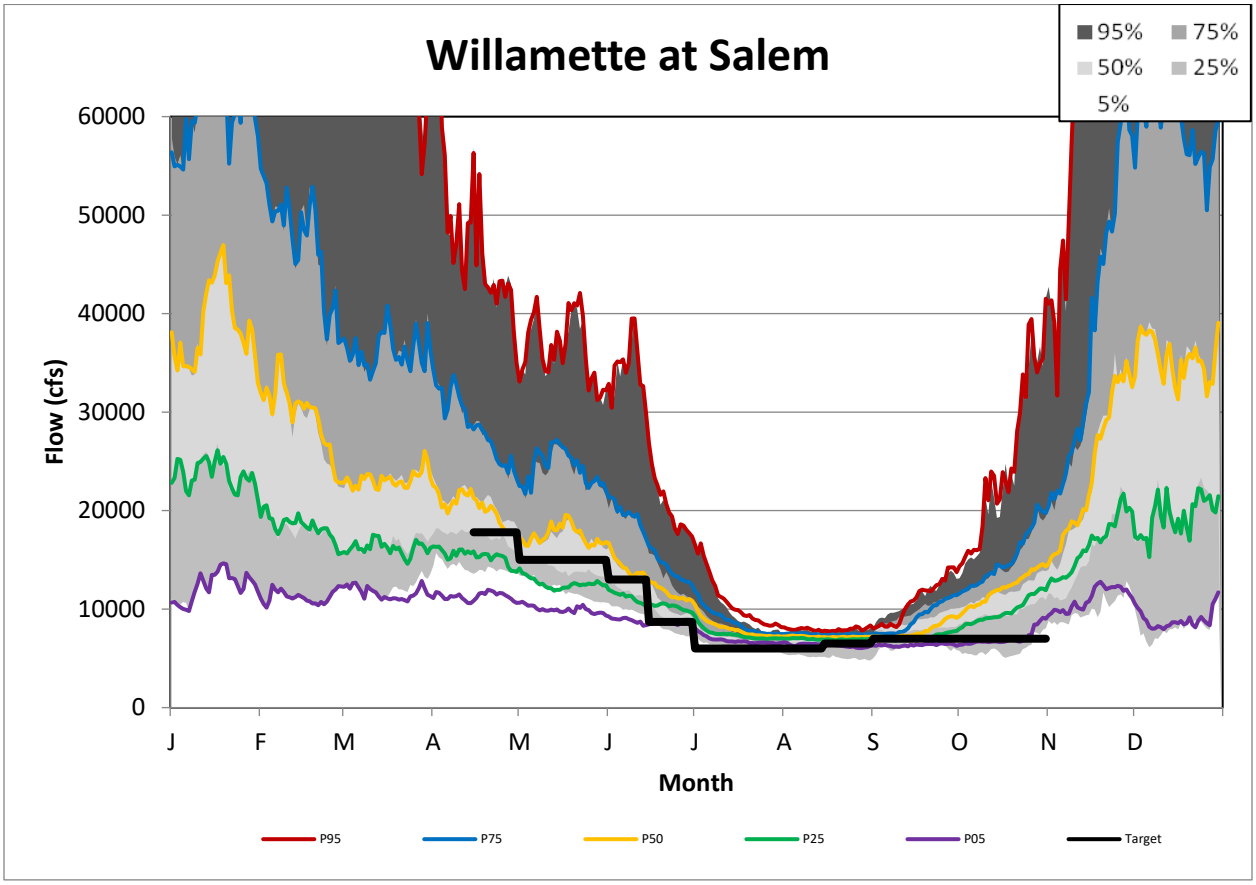

Figure 2-59. Non-exceedance Flows at Salem under Alternative 4.

2.8 ALTERNATIVE 5

2.8.1 Storage Allocations

Figure 64 shows system-wide stored water would be approximately 1,230,000 acre-feet, a decrease of 98,536 acre-feet at the 75% exceedance level compared to the NAA. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

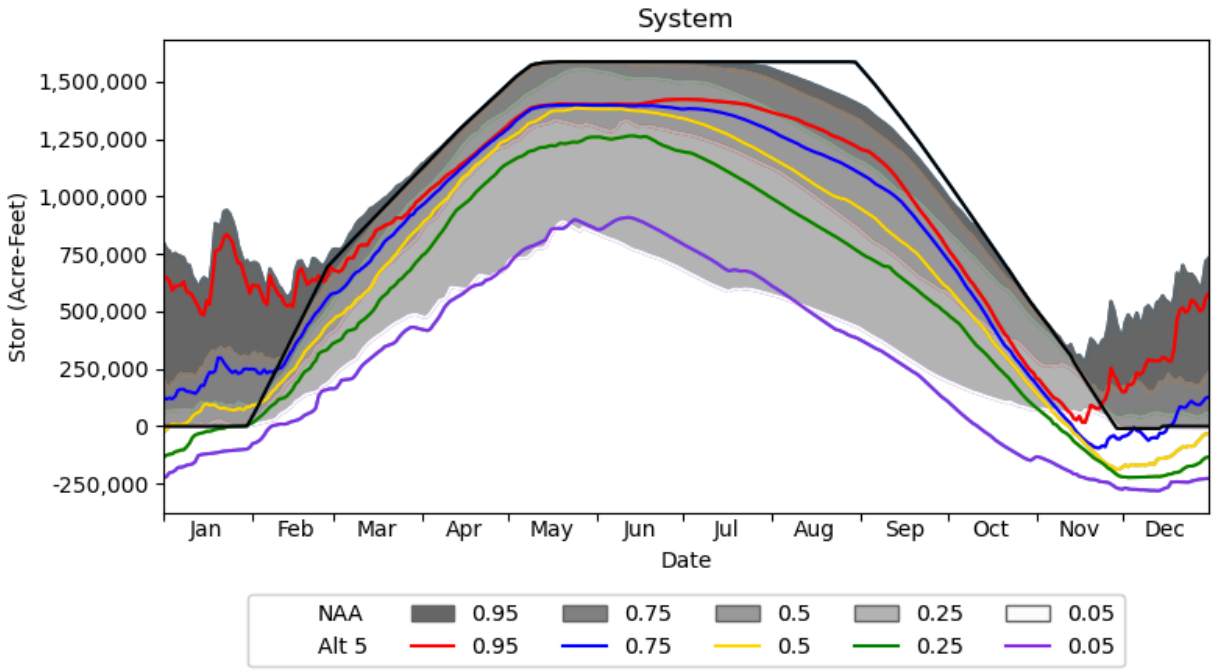

Figure 2-60. System-wide Conservation Storage under Alternative 5.

2.8.2 Natural Flow Water Rights

2.8.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer due to higher summer flow targets, and higher in fall in most years due to the fall drawdown operation at Green Peter Dam (Figure 65).

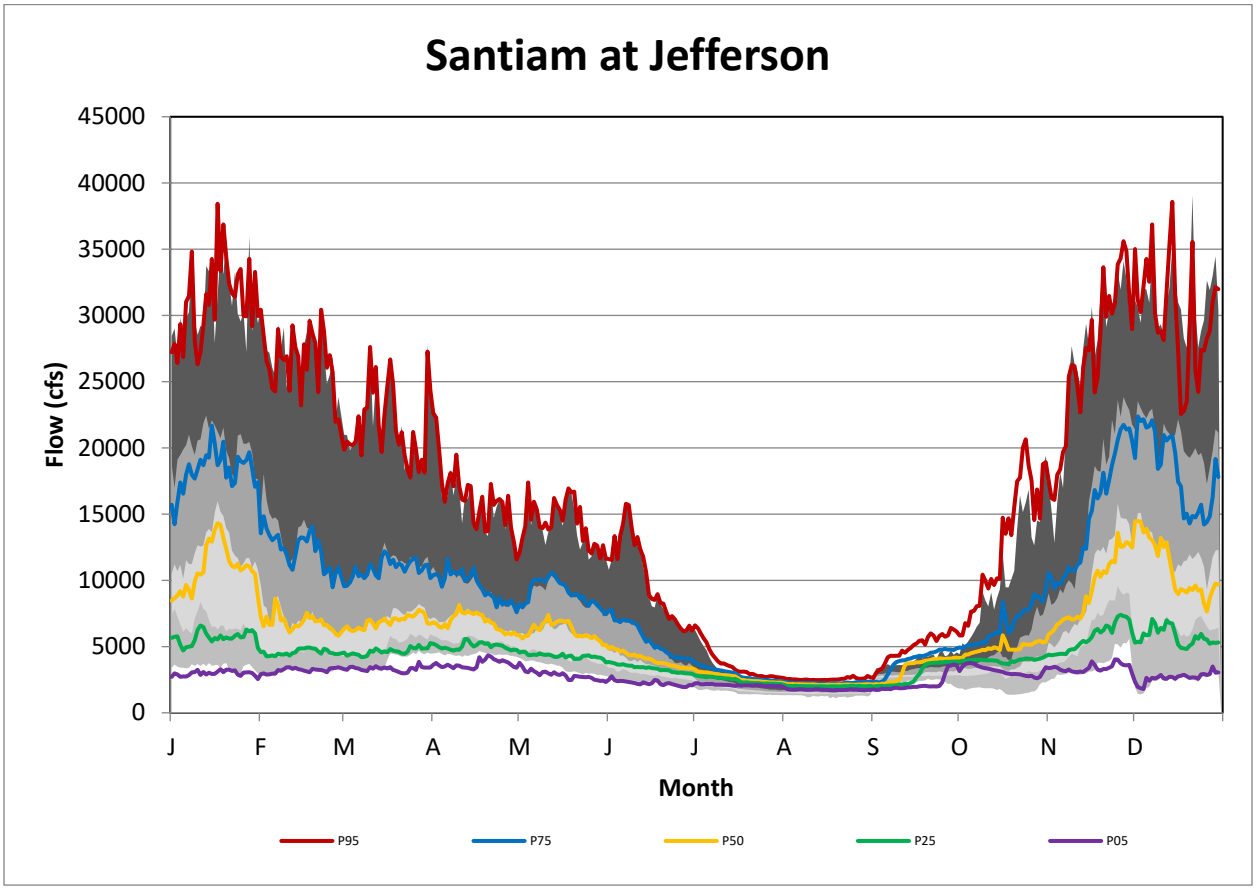

Figure 65. Non-exceedance Flows at Jefferson under Alternative 5.

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the drier years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA for dry years (Figure 66). Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River.

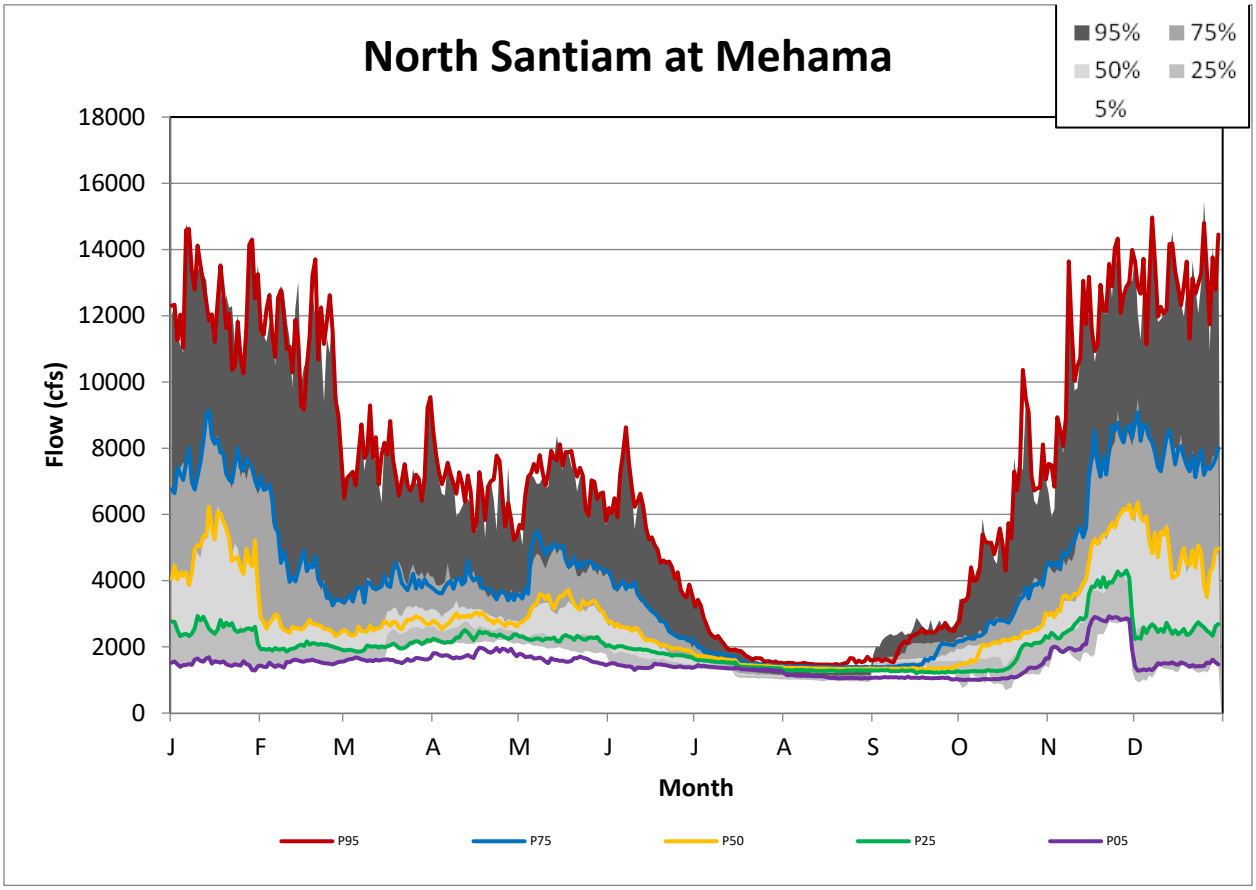

Figure 66. Non-exceedance Flows at Mehama under Alternative 5.

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced tributary flow target, higher in the summer most years due to a higher flow target than in the NAA, and much higher in September and the first half of October in all years due to the fall drawdown operation at Green Peter Dam (Figure 67).

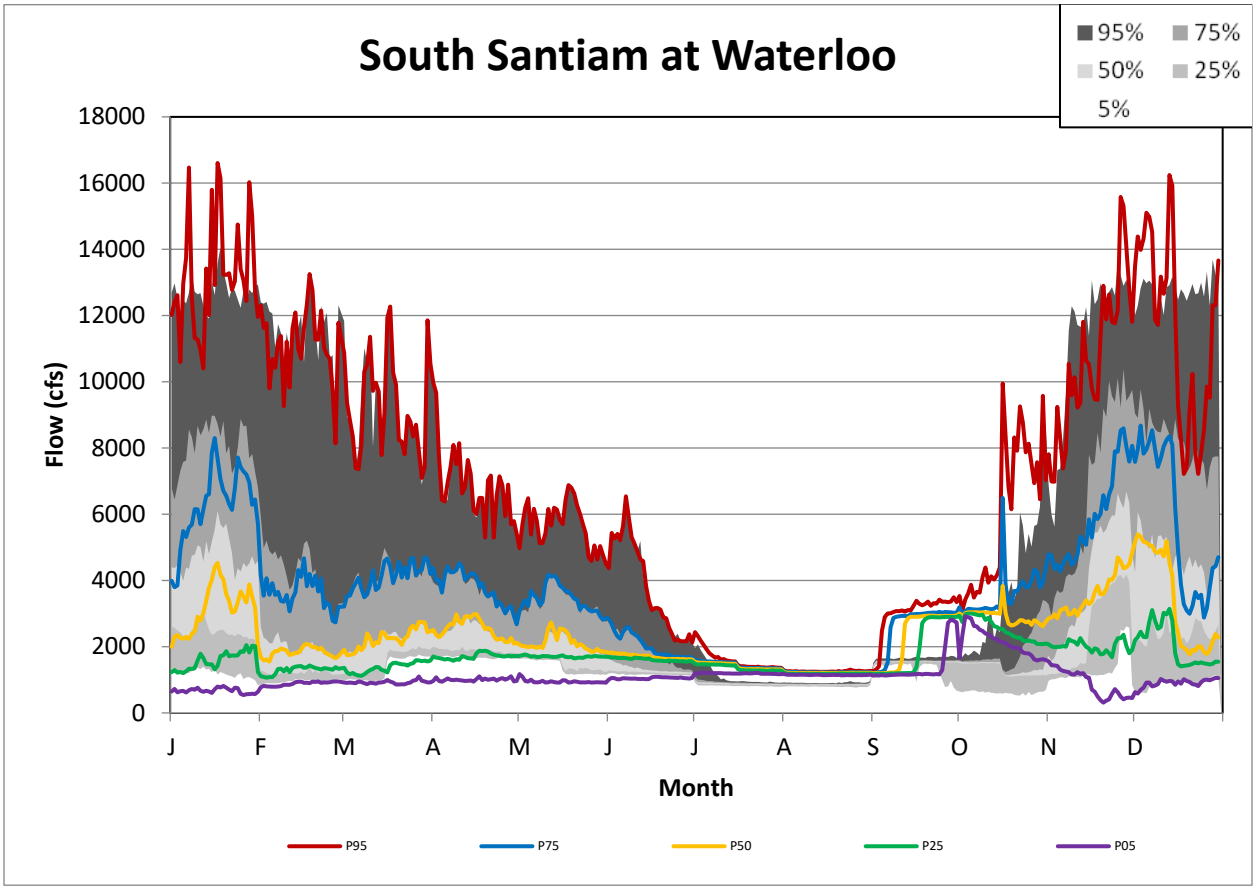

Figure 67. Non-exceedance Flows at Waterloo under Alternative 5.

2.8.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the modified integrated temperature and habitat flow regime and drawing down the reservoir to the diversion tunnel in the spring and fall for fish passage.

The spring drawdown at Cougar affects the flow at Vida on the McKenzie River differently by season and by hydrologic conditions. Flows at Vida in the driest years are lower than the NAA from April all year except for about the first two weeks of March when the Cougar reservoir is drafted for the spring drawdown operation for fish passage (Figure 68). During wetter years, flows at Vida would be higher than the NAA until early June when Cougar reservoir is nearly empty and there is not stored water available to augment streamflow on the McKenzie nor in the mainstem Willamette River. As there would be no conservation storage to augment flows, summer flows would be lower than the NAA in the wettest years but same as the NAA during most years.

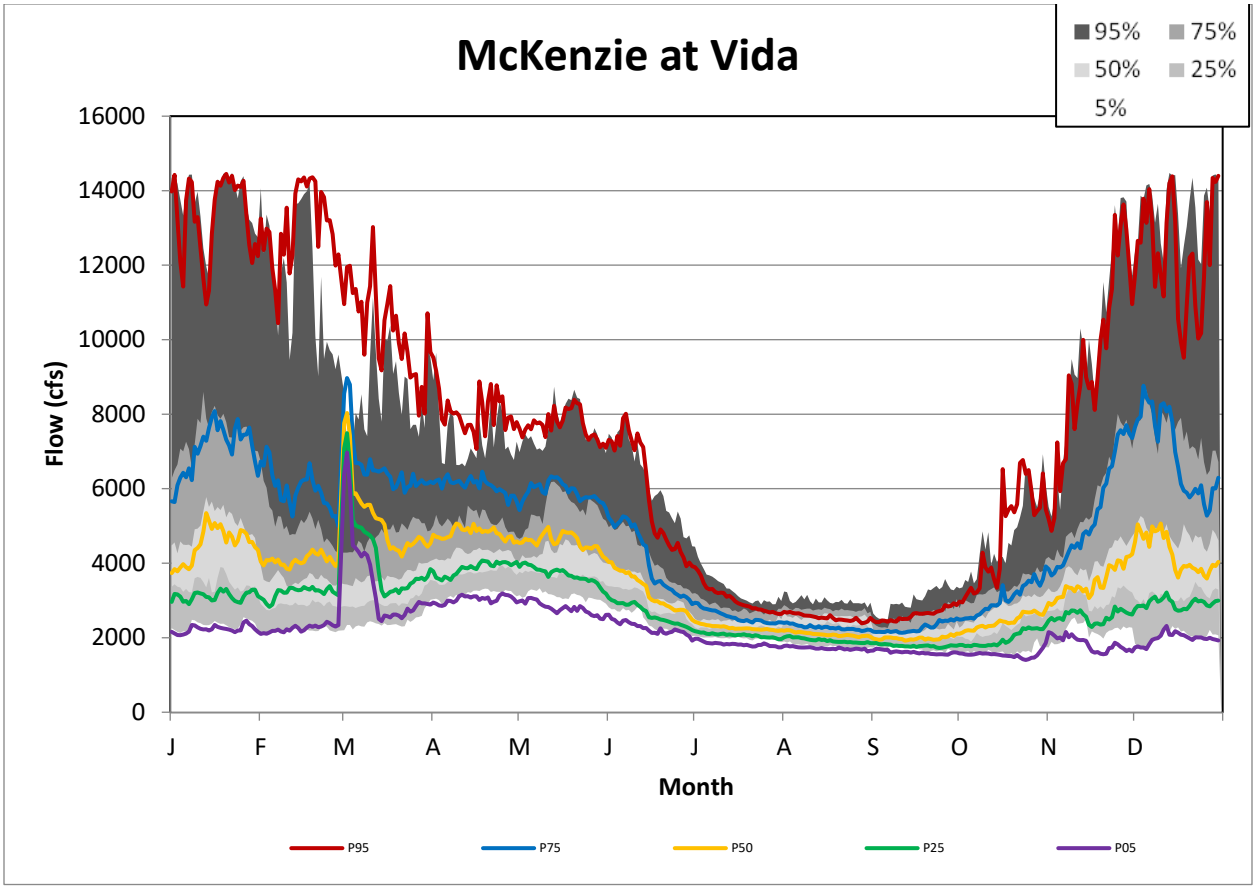

Figure 2-61. Non-exceedance Flows at Vida under Alternative 5.

2.8.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA in the driest years, and nearly equal most years, during the summer months (Figure 69).

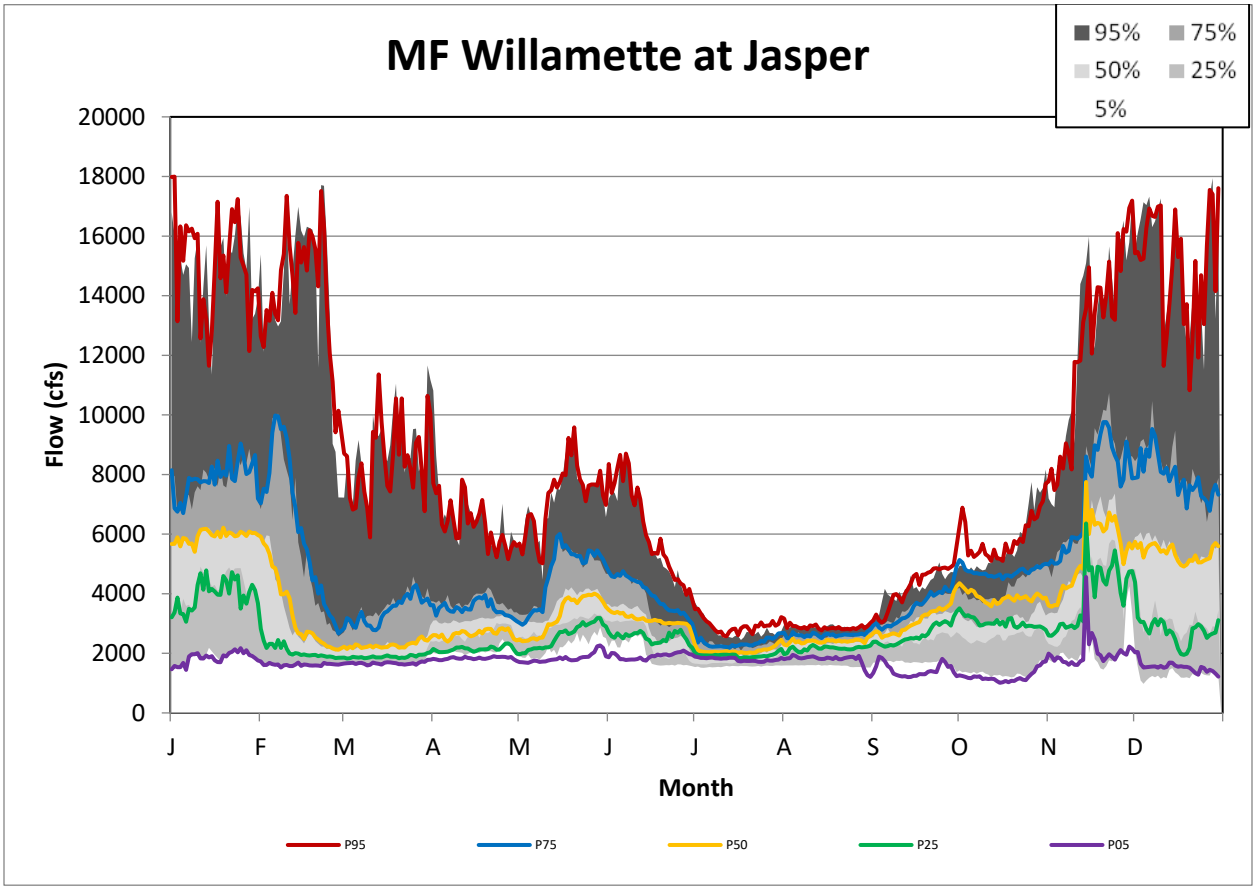

Figure 2-62. Non-exceedance Flows at Jasper under Alternative 5.

2.8.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the inactive and power pools, as necessary and available.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during drier years, but higher or equal to the NAA during the summer months, except for the wettest years when the flows in the late summer are slightly less than in the NAA (Figure 70). The low flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years.

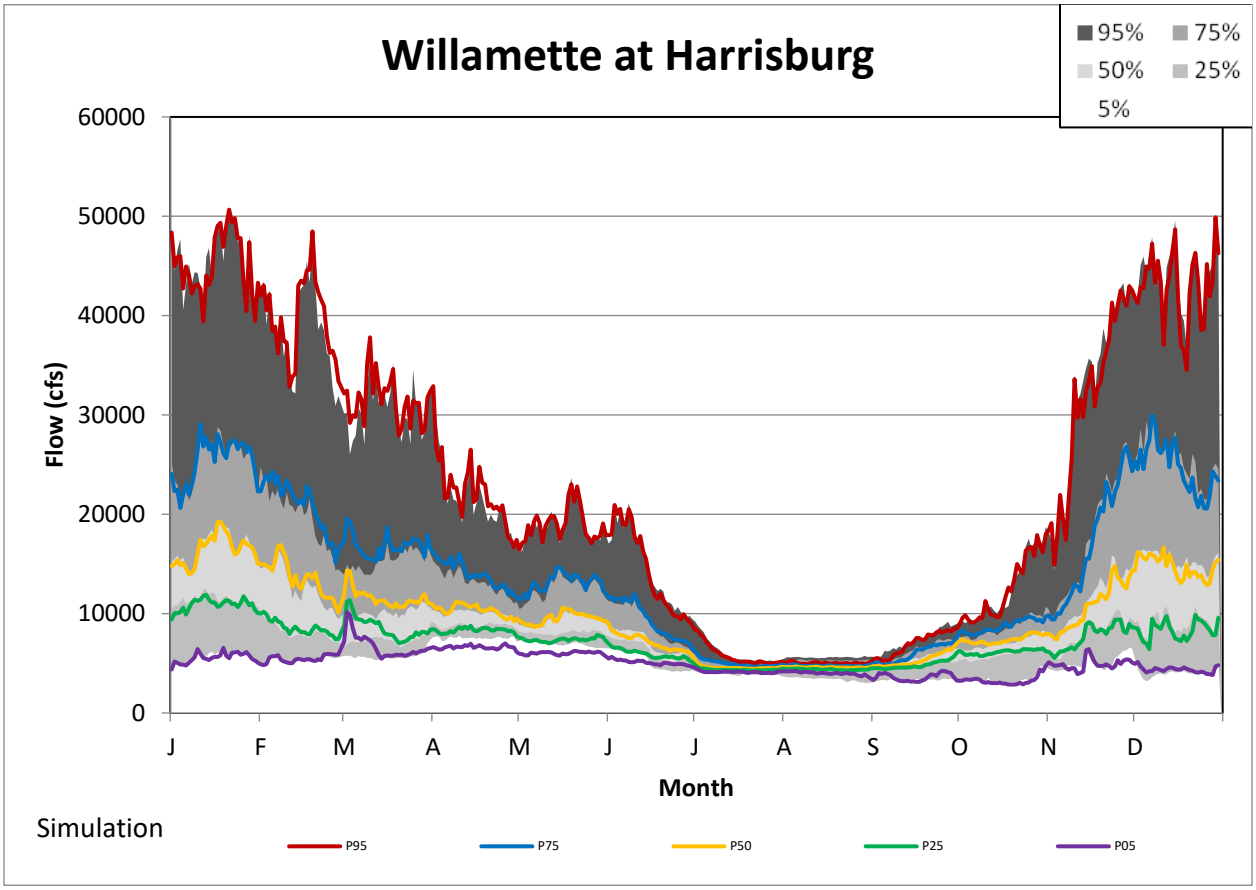

Figure 70. Non-exceedance Flows at Harrisburg under Alternative 5.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years (Figure 71).

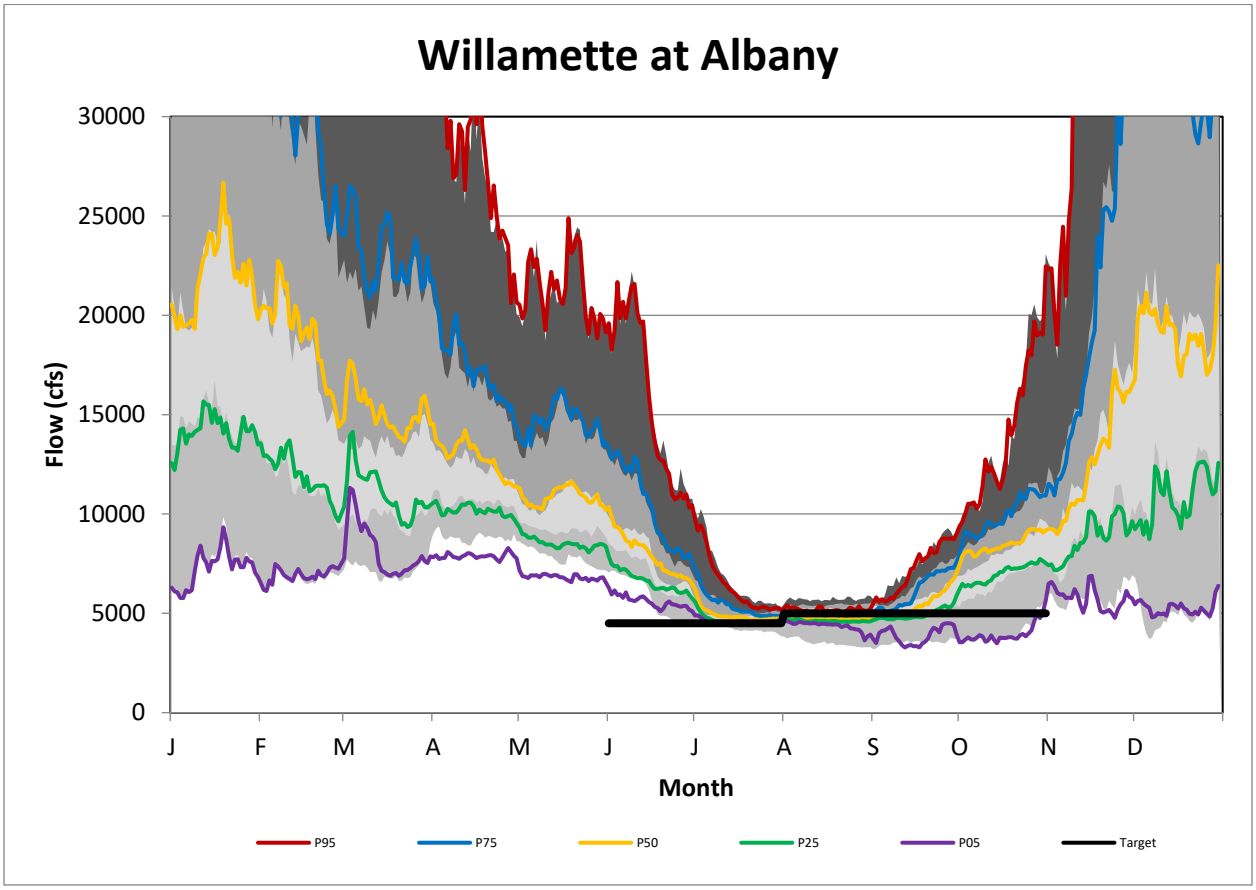

Figure 2-63. Non-Exceedance Flows at Albany under Alternative 5.

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years (Figure 72).

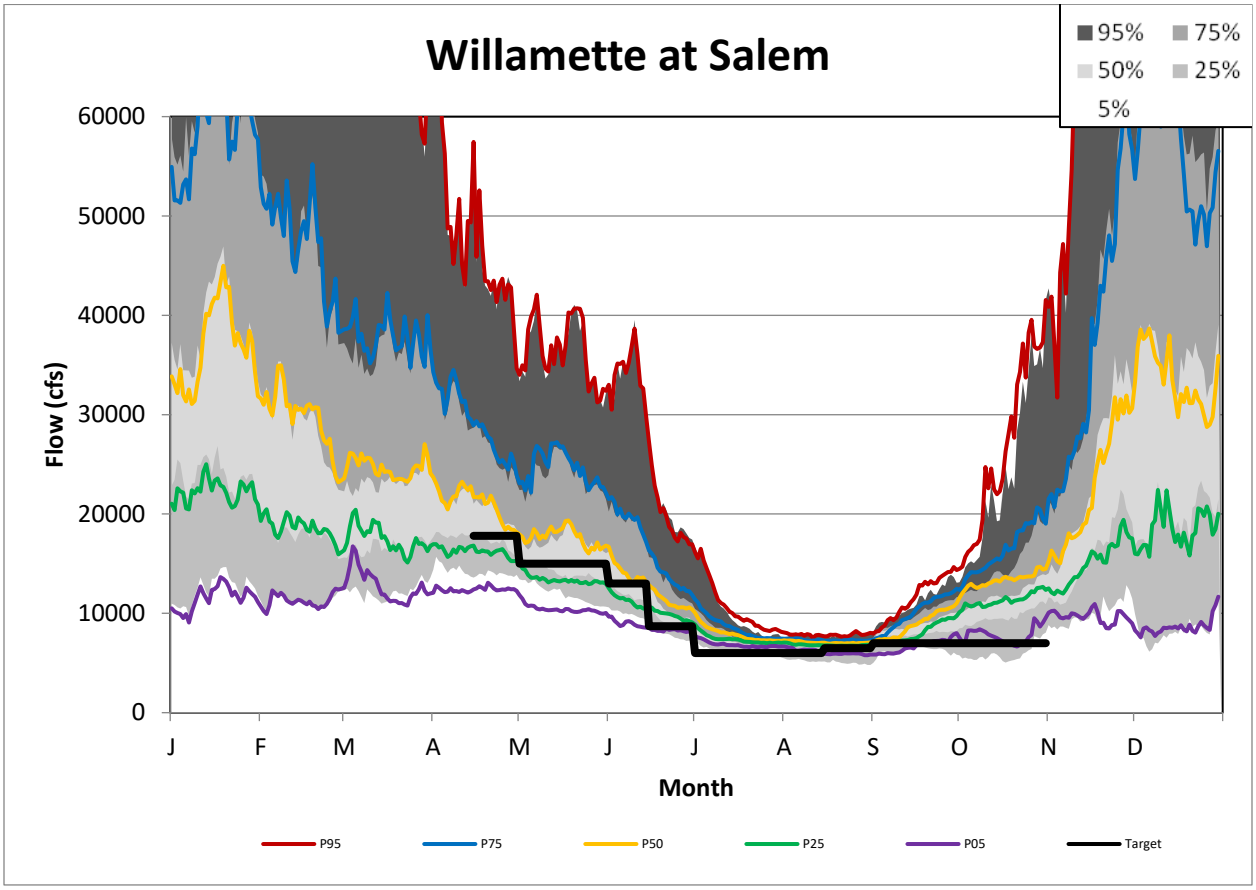

Figure 2-64. Non-exceedance Flows at Salem under Alternative 5.

2.9 INTERIM OPERATIONS (NOTE – FIGURES ARE NOT INCLUDED IN THIS VERSION)

2.9.1 Storage Allocations

Interim Operations affecting available stored water include delayed refill at Cougar Reservoir and release of water to meet biological targets, either the 2008 Biological Opinion targets in the first few years of implementation and then modified flow targets. Figure 64 shows system-wide stored water would be approximately 1,230,000 acre-feet, a decrease of 98,536 acre-feet at the 75% exceedance level compared to the NAA, based on modeling that used flow targets from the modified habitat and temperature flow regime. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

2.9.2 Natural Flow Water Rights

2.9.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer due to higher summer flow targets, and higher in fall in most years due to the fall drawdown operation at Green Peter Dam (Figure 65).

North Santiam

Interim operations affecting water supply in the North Santiam Basin include releasing water for the 2008 Biological Opinion flow targets in the first few years of implementation and then a modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, would be slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the drier years, as compared to the NAA, reflecting the lower modified spring target flows from Detroit as compared to the NAA for dry years (Figure 66). Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River. During the first few years of implementation, use of the 2008 Biological Opinion flow targets would result in lower reservoir levels during dry years than as shown in Figure XY, including drafting into the power pool to augment flows for biological purposes.

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced tributary flow target, higher in the summer most years due to a higher flow target than in the NAA, and much higher in September and the first half of October in all years due to the fall drawdown operation at Green Peter Dam (Figure 67).

2.9.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the modified integrated temperature and habitat flow regime and drawing down the reservoir to the diversion tunnel in the spring and fall for fish passage.

The spring drawdown at Cougar affects the flow at Vida on the McKenzie River differently by season and by hydrologic conditions. Flows at Vida in the driest years are lower than the NAA from April all year except for about the first two weeks of March when the Cougar reservoir is

drafted for the spring drawdown operation for fish passage (Figure 68). During wetter years, flows at Vida would be higher than the NAA until early June when Cougar reservoir is nearly empty and there is not stored water available to augment streamflow on the McKenzie nor in the mainstem Willamette River. As there would be no conservation storage to augment flows, summer flows would be lower than the NAA in the wettest years but same as the NAA during most years.

2.9.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA in the driest years, and nearly equal most years, during the summer months (Figure 69).

2.9.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the inactive and power pools, as necessary and available.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during drier years, but higher or equal to the NAA during the summer months, except for the wettest years when the flows in the late summer are slightly less than in the NAA (Figure 70). The low flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years.

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years (Figure 71).

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. Flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years (Figure 72).

References

OWRD. 2018. Water Rights in Oregon, an Introduction to Oregon's Water Laws. Oregon Water Resources Department. Salem, OR.

USACE. 2019. *Willamette Basin Review* Feasibility Study. Integrated Feasibility Report and Environmental Assessment. December 2019. US Army Corps.