US Army Corps
of Engineers
Portland District

Willamette Basin Review Feasibility Study

APPENDIX C

Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows

June 2018

Appendix C
WBR – Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows

This document details the calculation steps used to obtain the total water volume from the Willamette Basin projects that is used to meet the minimum flow targets at Salem and Albany on the Willamette River mainstem and the minimum tributary flows downstream of the USACE dams in the basin. These targets are defined in two Biological Opinion reports [References 2 and 4] by NOAA Fisheries and the U.S. Fish and Wildlife Service, which collectively are called the BiOp. The total volume calculations are also parsed into different flow components, which are the water that comes from reservoir storage, the water that was passed through the projects to meet the mainstem flows, any volume shortages in the meeting the mainstem flow needs, and other incidental water volumes as well. These water volumes are calculated for 79 years of flow data for the Basin by using the program ResSim to model current reservoir operations and then processing the simulation output data. The water volume computations are presented in this report for all years in the dataset analyzed, and then, since the results are different for every year in the dataset, the water volumes are summarized in a percentile form.

This report also presents the calculations for the stored water volume at each project that is considered remaining storage, which is that volume of water in storage that was not released to meet minimum flow needs but was evacuated during the fall draft. These remaining water volumes are summed from the individual project analyses to obtain a basin total water volume remaining in storage. This calculation reflects the volume of water in the basin that could have been released earlier in the season while still leaving enough water in storage to meet the minimum flow requirements.

The amount of data presented in this document is quite large, and a number of detailed explanations are given in a step-by-step process to fully outline the approach to this set of complex calculations.

Significant details in this document include the following:

- An introduction to the report, including some definitions used in this report to obtain the needed volume calculations. (Section 1)
- A list of the BiOp minimum flow targets for the mainstem Willamette River, at Albany and Salem, which are a function of the water year type. A comparison of the regulated versus unregulated flow at Salem is provided for context. (Section 2)
- A description of the flow dataset used and a listing of the water year type for the flow dataset years. (Section 3)
- A brief description of the ResSim model that was used, and how the BiOp flows are met through rule sets in the program. (Note that the ResSim model and rules are

thoroughly documented in Appendix E, ResSim Analysis for 2008 Baseline Flow Dataset.) (Section 4)

- A detailed breakdown of the calculations for one project and one water year. This is the section containing the most thorough details of all computations, including special cases for the lowest flow water year types. (Section 5)
- All calculated water volume components for all projects, for 79 years, is tabulated and graphed. Percentile summaries are provided as well. Note that obtaining these percentile summaries was the reason to perform these calculations in the first place, as these percentile values will be used for the Willamette Basin Review Feasibility study. (Sections 6 through 16)
- Willamette Basin total BiOp flow volume calculations. Summary information is provided in a variety of graphs and figures. (Section 17)

This report will answer the following questions:

- How much stored water in the reservoirs is released specifically to meet BiOp Needs? This information is presented as specific volumes for the years in the dataset (1929-2007) and as a percentage range of reservoir refill in the basin.
- How much water is passed through the dams, without being stored, specifically to meet BiOp targets? This is presented as specific volumes for the years in the dataset (1929-2007).
- How much stored water volume remains that was not used to meet BiOp Needs? This remaining water volume may be available for other purposes. This information is presented as specific volumes for the years in the dataset (1929-2007).
- Water volume computations will be for individual projects and rolled up for Willamette Basin totals as well.

Contents

1 Introduction

The 2008 National Marine Fisheries Service Biological Opinion (BiOp, Reference 2) set minimum target flows on the Willamette mainstem at both Albany and Salem and also prescribed minimum flow requirements on tributaries with USACE dams. Although the Corps has changed the project operations within the basin to accommodate these targets, no water volume calculations have been made previous to this report to determine how much water is required to meet these minimum flows. This report represents the most detailed water volume accounting study for the Willamette Basin that the Corps has done to date.

The amount of stored water in Willamette Basin USACE projects used to meet the BiOp minimum flow targets on the mainstem Willamette River is needed for the Willamette Basin Review Feasibility Study to determine water volumes required for fish and wildlife purposes. This value was determined through a series of calculation steps that are documented here. The process begins with a baseline simulation from a ResSim model of the basin, where the model represents the way that the projects are operated by the Corps as of 2016. The baseline is a continuous simulation from October 1928 through September 2008 using a daily time step and operation rule sets that incorporate all current reservoir operations year-round. This continuous simulation is *not* a reproduction of what happened over those years; rather, it is a representation of *what would happen now* in a water year similar to each of these historical water years with the current operations of the Willamette reservoirs.

In addition to the stored water calculations, the water volume that is passed through the projects, without having been stored, to meet the mainstem targets is calculated. Water volume shortages, remaining storage values, and water passed through for other reasons are calculated here as well to present the full picture of water passing through the USACE projects.

This report uses some specific terminology for the water accounting ideas presented. The list below is a definition of some of the terms used in this report and to illustrate the significance of each.

- *Local Flows* – this is the water that flows into the tributaries or the mainstem that never flows through a Corps dam. The Corps has no control over any of this flow, but it contributes significantly to the flow targets at Albany and Salem.
- *Passed Inflow* – water flowing into a Corps reservoir that is released as it arrives without contributing to a storage increase in the reservoir. If 500 cfs flows into a reservoir on a given day, and the dam releases 500 cfs that day, the water is considered to have passed through without being stored. This is water that is controlled by the Corps, even though it was not stored, since it is released by a dam.
- *Stored Water Release* – water released from a dam that is in addition to any passed inflow. If 500 cfs flows into a reservoir on a given day, and the dam releases 600 cfs, then 100 cfs came from stored water in the reservoir and 500 cfs came from passing inflow.
- *BiOp Need* – the amount of water required to meet minimum flows specified in the BiOp report. A BiOp Need is calculated from the simulation results as a daily average

flow for every day and for every project, and the flow is also converted to a volume equivalent. The phrase "BiOp Need" will be used informally throughout this report to mean several things - a daily value of project specific's share (usually expressed as the flow needed, not the water volume), the total share a project should contribute (expressed as a water volume), or the total need within the basin (expressed as a water volume). The following examples identify the different ways this phrase is used:

a) When the mainstem control points at Albany and Salem do not need any supplemental water, the USACE dams should still release their required minimum tributary flows. In this case, the BiOp Need *at each project* is to release its minimum tributary flow. If Dam A's minimum tributary flow is 100 cfs and Albany and Salem do not need any supplemental water on Day X, the BiOp Need on Day X at Dam A is 100 cfs, which is a water volume of 198 acre-feet. (100 cfs * 3600 sec/hour * 24 hr/day * 43,560 ft^3/acre-ft.)
b) If Albany or Salem do not have enough local flow on Day Y to meet the target minimum flow on that day, the reservoirs must release additional water to supplement the local flow on the mainstem. If ResSim computes that Dam A from the example above should release an additional 500 cfs to provide Dam A's share to help Albany's or Salem's flow to increase, so the BiOp Need on that day for Dam A becomes 600 cfs, or 1188 acre-feet. ([500+100] cfs * 3600 sec/hour * 24 hr/day * 43,560 ft^3/acre-ft.) (Note that the reach routing in the ResSim model accounts for travel time, and the program releases extra water in time for it to travel to the location where flow is supplemented.)
c) No reservoir is ever expected to satisfy the full supplemental flow requirement at Albany or Salem on their own. Each reservoir is considered to have a *share* of the mainstem flow target that they should meet. Therefore a BiOp Need is calculated for each project separately, and then these individual project BiOp Needs are summed to obtain the total Willamette Basin BiOp Need.
d) The BiOp Need is not the same for every year. The BiOp Need is not the flow required at a location, but rather the additional flow released for that location to have at least its minimum flow. When flow levels are high in the basin, the BiOp Need will be low. When flow levels are very low, the BiOp Need will be higher.
e) The computed BiOp Need at a project may not be met by the release. The project release may be less than the calculated need, in which case there is a shortage in meeting the BiOp Need. If Dam A in example b) above can only release 50 cfs, then its shortage is 550 cfs or 1091 acre-feet on Day Y.

The distinction between the above three terms is important because the total volume of water in the BiOp minimum flow targets at Salem, from April through the end of October, is 4.22 million acre-feet (Maf), and the Corps reservoirs, when full, hold only 1.6 Maf of water. The reservoir storage cannot by itself meet the BiOp flow requirements at Salem, but it can supplement the local flows at Salem by redistributing the timing of flows – store extra inflow when possible to release later when inflows are low. Furthermore, the USACE dams are operated to draft every fall to their minimum conservation zone in preparation for regulation of winter flood events, so no water is carried over to use the following year.

This report contains numerous graphs, Figures, and descriptions to support the methodology adopted by the Corps to obtain this storage information. It also documents other relevant storage and flow information needed to fully quantify the water volumes needed to support the mainstem flow targets outlined in the BiOp.

The results presented here are from a simulation whose particulars (operation set names, Lookback details, etc.) are documented in Table 1.1. Note especially that although the simulation name is "*Baseline-14April2017*", it will most often be referred to in this report as the "Baseline" for brevity. The flow dataset used was the 2010 Modified Flow dataset [Reference 1]. The details of the choice of the flow dataset used and the operation set descriptions for each project in the baseline simulation are documented in the report listed as Reference 2.

This report is organized with some brief descriptive sections and some very detailed technical sections as well. Sections 2 through 4 are the descriptive sections: Section 2 has a definition of what the four water year types in the Willamette Basin are that govern the BiOp flow targets, as well as a description of the unregulated and regulated flow at Salem to provide some context for the purposes of regulating for Salem flow targets; Section 3 is a short section that specifies the water year types for the flow dataset used for the computations in this report; and Section 4 describes some of the basics of the rules within the Baseline ResSim simulation that are important to the calculations presented in this report. Section 4 is slightly technical for this reason, but it is not meant to be a full description of the operation sets within the Willamette model (see Reference 3 for those full details).

Section 5 contains the Basic Methodology for all the calculations in this report, and is the most detailed technical section in the report. It lays the foundation for all of the computations performed to calculate the water volume components in later report sections. This is the section that should be referred to for any of the "how-to" or "why" questions that might come up on the water volume components specifics. This section focuses on one particular project (Blue River Dam) for one specific year (model year 1929) in order to fully quantify the water volume component calculations. Later sections that are project specific will not repeat the details presented in Section 5, but Section 5 should be referred back to for a better understanding of any of the calculations presented in the project specific sections.

One of the key components to the technical details is the concept of the "BiOp Need" assessed at each project, which was defined earlier in this section. This is covered in great detail in Section 5. In addition to the BiOp Need, the shortage, inflow passed for meeting the BiOp Need, stored water released to meet the BiOp Need, inflow passed for other reasons, and remaining storage drafted at the end of the season that was not used for meeting the BiOp Need are all computed for Blue River for 1929.

Sections 6 through 16 are project specific sections organized as listed below. These sections include many graphs and tables, along with some project specific technical details as needed. All of these sections rely heavily on the technical details of the Basic Methodology presented in Section 5. Data in each of these sections are presented for each model year chronologically and sorted by the BiOp Need calculated for the project. Project specific water volume results rolled up to monthly totals are presented as well. Information for water volume information broken out by water year type is also presented.

- Section 6 has the water volume component calculations for Blue River.
- Section 7 has the water volume component calculations for Cougar.
- Section 8 has the water volume component calculations for Dorena.
- Section 9 has the water volume component calculations for Cottage Grove.
- Section 10 has the water volume component calculations for Fall Creek.
- Section 11 has the water volume component calculations for Hills Creek.
- Section 12 has the water volume component calculations for Lookout Point.
- Section 13 has the water volume component calculations for Fern Ridge.
- Section 14 has the water volume component calculations for Green Peter.
- Section 15 has the water volume component calculations for Foster.
- Section 16 has the water volume component calculations for Detroit.

The results from Sections 6 through 16 are then rolled up for basin-wide totals in Section 17. These water volume accounting details in this report will answer the following questions, based on the Baseline ResSim model:

- How much stored water in the reservoirs is released specifically to meet BiOp targets?
- How much water is passed through the dams, without being stored, specifically to meet BiOp targets?
- How much stored water is released at the end of the conservation season that was not used to meet minimum target flows? This can be considered the remaining stored water volume that may be available for other purposes.
- Water volume computations will be for individual projects and rolled up for Willamette Basin totals as well.

This report is full of concepts, terminology, and calculations that are likely to be unfamiliar to most readers. The report is laid out with some basic information presented first, and then dives into many technical details. While most of the water volume computation methods are the same for each dam in the basin, there are some exceptions. Most often, the exceptions will be described in that project specific section, rather than in the initial definition of a concept. The flow of the report is to lead the reader into a phased understanding of the concepts and the calculation methodology. By the end of the report, all of the exceptions and nuances will have been covered so that a complete description of the water volume components and BiOp Need are documented.

Table 1.1. Summary of Baseline Simulation Particulars.

ResSim Version	HEC-ResSim 3.2.0.1197 Dev Build 64-bit
Watershed	NWP_Willamette
Network	Willamette-2010Mod-SSARR
Configuration	Existing
Alternative	BetBase
Inflow File Name	Final Flows WBR – from 2010 Mod Flows and Hybrids.dss
Rule Curve File	Willamette_Rule_Curves.dss
External Variables File	diversion.dss and Water Year Type for 2010 Mod Flows.dss
Simulation Name	**Baseline-14April2017 a.k.a the "Baseline"***
Simulation Start	04 Oct 1928 at 2400
Simulation Lookback	01 Oct 1928 at 2400
Simulation Ending	30 Sep 2008 at 2400

Project	**Operation Set Name**	**Lookback Elevation**	**Lookback Flows (cfs)**
DET	DET better Baseline	Rule Curve	Power Plant 1500.0, Spillway and ROs 0.0
BCL	IRRM and Early Imp	1193.0 ft.	Power Plant 1573.0, Spillway 0.0
GPR	Better GPR Baseline	Rule Curve	Power Plant 1500.0, Spillway and RO 0.0
FOS	Better FOS Baseline	Rule Curve	Power Plant 1500.0, Spillway 0.0
CGR	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 400.0, Spillway and RO 0.0
BLU	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Spillway 0.0
HCR	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 400.0, Spillway and ROs 0.0
LOP	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 1200.0, Spillway and ROs 0.0
DEX	Early Imp	693.0 ft.	Power Plant 1200.0, Spillway 0.0
FAL	FIS and Early Imp 728	Rule Curve	RO 200.0, Spillway 0.0
COT	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Uncontrolled Spillway 0.0
DOR	FIS Flood OPs & Early Imp	Rule Curve	RO 100.0, Uncontrolled Spillway 0.0
FRN	Improved Baseline	Rule Curve	RO 30.0, Spillway and Sluice Gate 0.0

*Note on simulation name: The date 14Apr2017 is included in the simulation name to indicate the date the simulation was run. The cumbersome name "Baseline-14April2017" is abbreviated to the "Baseline" in this report.

2 Mainstem Willamette BiOp Flow Targets and Water Year Type Definition

The target flows at Albany and Salem specified by the 2008 BiOp depend on the type of water year. Every water year is classified by one of four types, ranging from Deficit years, with the lowest stored water volume, to Abundant, with the highest stored water volume.

The water year type is based on the maximum total conservation storage in all USACE Willamette Basin projects between the dates of May 10 through May 20 for each year. The total conservation storage present in the projects on each of the days for May 10 through May 20 is tabulated, and the maximum value in that period is the storage used to define the water year type. In real-time reservoir regulation, an initial estimate of the water year type is determined on April 1 each year, and flow management decisions throughout the conservation season may include changes to water year types based on forecasts. For ResSim modeling of the Baseline, the water year type is hard coded into an external file and there are no changes to this value mid-season. The definitions shown in Table 2.1 of water year types are used in the BiOp and the Baseline simulation.

Figure 2.1 below shows the total conservation storage rule curve in the Willamette projects for every day of the year and a graphical representation of the water year type. The maximum possible system conservation storage is about 1.6 Maf.

The Salem BiOp minimum flow targets are listed in Table 2.2. Figure 2.2 shows the unregulated flow (without any dams) at Salem from the 2010 Modified Flow dataset, which is the dataset used for the WBR project (see Section 3 for further discussion on the flow dataset). The upper graph in the Figure is for the full year, and the lower graph is a zoom-in on the April through October time period. The graph data is from the time series record “SLM5M” from the flow dataset. Note that SLM5M includes all water in the basin to Salem, which is all inflows at project locations and all local flows that come into the river downstream of the dams, inclusive of the locals arriving at Salem as well.

The heavy black line in both graphs for Figure 2.2 is the minimum Salem BiOp flow target for most years, which are the Adequate and Abundant water year types, as shown in Table 2.2. The lower graph also shows the Salem BiOp flow target for the Deficit water year, plotted as a heavy red line.

The data from the time series record SLM5M is plotted in both graphs as non-exceedance percentiles, and no line represents any particular year. The percentile values were obtained by sorting the full time series (Oct 1928 to Sep 2008) into flows by day of the year, and then calculating the percentile for each day separately. All January 1 values are grouped together, and then all January 2 values are grouped together, and so on. For example, on January 1, five percent of the Salem unregulated flows are at or below 5819 cfs, and twenty-five percent of the unregulated flows at Salem on January 1 are 19,513 cfs or less. The non-exceedance percentiles are plotted for the 5%, 25%, 50% (which is also the median value on that day), 75%, and the 95% flows. If the 100% non-exceedance values were plotted, that would be the same as the maximum value for that day of the year.

Table 2.1. Definition of Water Year Types in the Willamette Basin.

Water Year Type	Total Willamette Conservation Storage between 10-20 May
Abundant	Greater than 1.48 Maf
Adequate	Between 1.20 and 1.48 Maf
Insufficient	Between 0.90 and 1.20 Maf
Deficit	Less than 0.90 Maf

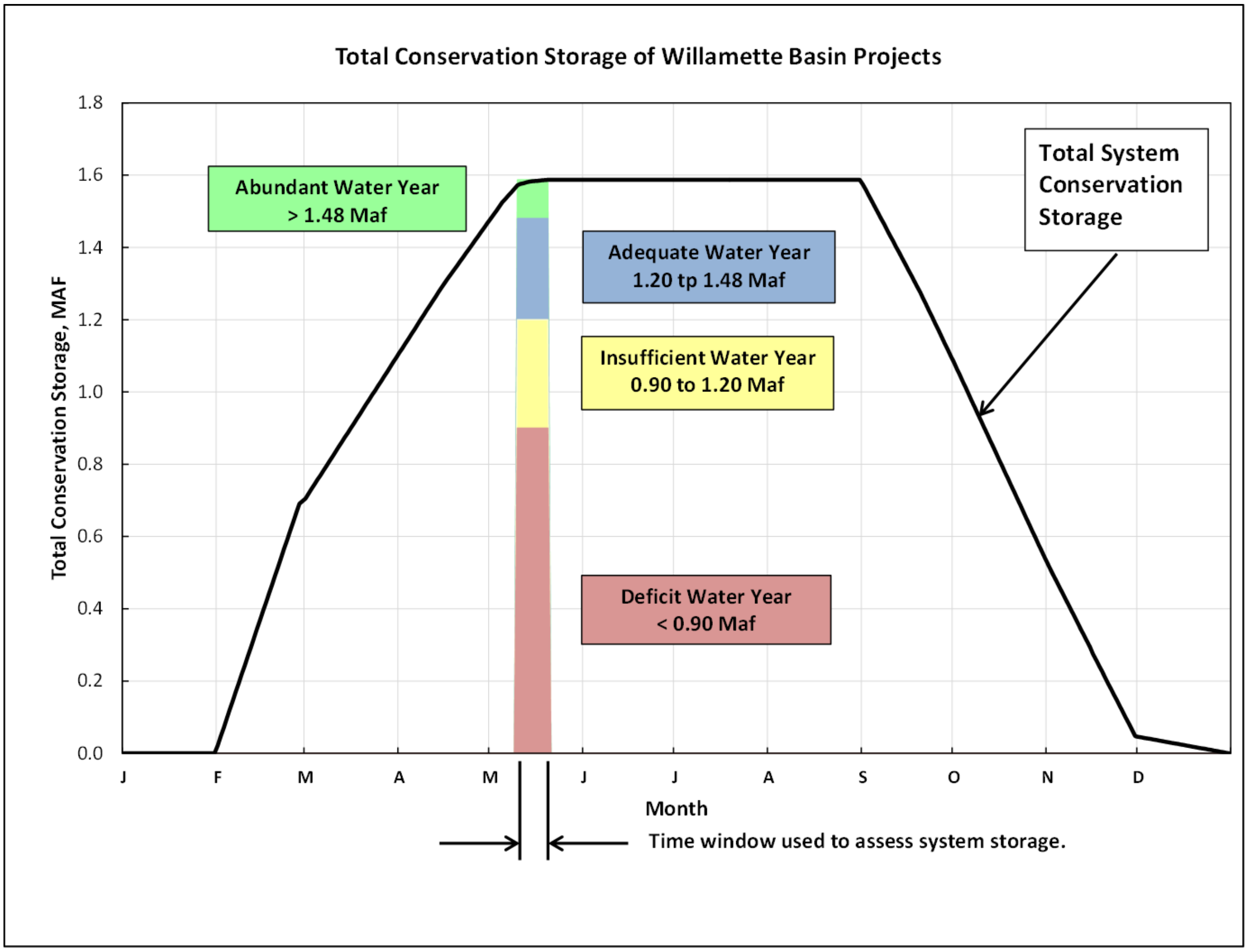


Figure 2.1. Total conservation storage in Willamette Basin USACE projects, by date, and graphical water year type definition.

Table 2.2. Mainstem BiOp Flow Targets for Salem and Albany.

<table>
<tr><th rowspan="2">Time Frame</th><th colspan="3">Albany Targets by Year Type (cfs)</th><th colspan="3">Salem Targets by Year Type (cfs)</th></tr>
<tr><th>Abundant & Adequate</th><th>Insufficient</th><th>Deficit</th><th>Abundant & Adequate</th><th>Insufficient</th><th>Deficit</th></tr>
<tr><td>01 - 30 April</td><td>--</td><td>--</td><td>--</td><td>17,800</td><td rowspan="9">Salem targets are linearly interpolated between Adequate and Deficit targets based on 31 May system storage</td><td>15,000</td></tr>
<tr><td>01 -31 May</td><td>--</td><td>--</td><td>--</td><td>15,000</td><td>15,000</td></tr>
<tr><td>01 - 15 June</td><td>4,500</td><td>4,500</td><td>4,000</td><td>13,000</td><td>11,000</td></tr>
<tr><td>16 - 30 June</td><td>4,500</td><td>4,500</td><td>4,000</td><td>8,700</td><td>5,500</td></tr>
<tr><td>01 - 31 July</td><td>4,500</td><td>4,500</td><td>4,000</td><td>6,000</td><td>5,000</td></tr>
<tr><td>01 - 15 August</td><td>5,000</td><td>4,500</td><td>4,000</td><td>6,000</td><td>5,000</td></tr>
<tr><td>16 - 31 August</td><td>5,000</td><td>4,500</td><td>4,000</td><td>6,500</td><td>5,000</td></tr>
<tr><td>01 - 30 September</td><td>5,000</td><td>4,500</td><td>4,000</td><td>7,000</td><td>5,000</td></tr>
<tr><td>01 - 31 October</td><td>5,000</td><td>4,500</td><td>4,000</td><td>7,000</td><td>5,000</td></tr>
</table>

The important point to note in the lower graph of Figure 2.2, which is the close-up of the minimum flow target window, is that the unregulated system rarely meets the target flow minimum in August and September. This is when even the 95% percentile line, the darkest gray area, is often below the heavy black line. Note also that even the second darkest gray area, the 75% percentile line, drops below the Deficit water year minimum target in those months. This lower graph demonstrates that even Abundant water years have a need for supplemental flows (i.e. additional water at Salem whose purpose is to increase the flow rate to the minimum target) on the mainstem, since the minimum flow targets are higher than the unregulated system in the summer months. (These higher-than-unregulated flows are in the BiOp because the original project authorizations included minimum navigation flows, and water quality issues were also considered.) The supplemental flow is provided by storing some of the spring inflows in the reservoirs and releasing water as needed to meet downstream requirements later in the season. The reservoirs operate to shift flows a bit from earlier in the year to later in the year.

The ResSim rules written in the operation sets for the projects in the Baseline simulation include downstream minimum rules for Salem and Albany, along with other reservoir regulation rules, so that supplemental water on the mainstem is provided by shifting water through the use of storage in the reservoirs. Figure 2.3 is a close-up of the regulated system from the Baseline plotted in the same manner as the lower graph of Figure 2.2. Note that the Salem minimum flow targets are met most of the time in the regulated system.

The calculation of the required water volumes needed to supplement the Salem flow, in other words to go from the lower graph of Figure 2.2 to the graph of Figure 2.3, is the task that is detailed in this report.

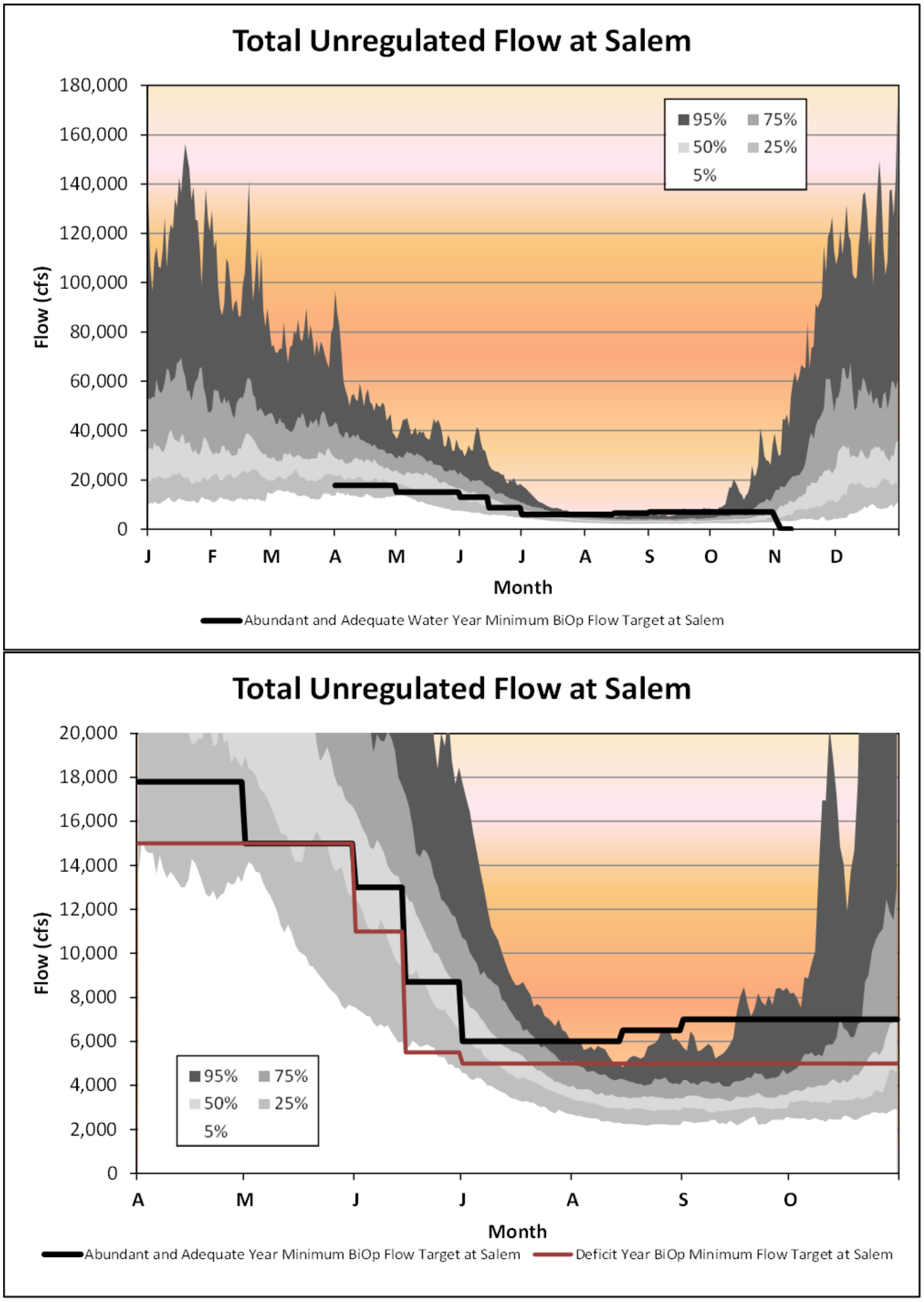


Figure 2.2. Unregulated flow on the Willamette River at Salem, from the record SLM5M in the 2010 Modified Flow dataset. Upper graph is the full year, lower graph is April through October only. Flows are shown as Non-Exceedance percentiles in gray-shaded areas, the solid black line is the minimum flow target for Abundant and Adequate water years, and the solid red line is the minimum flow target in Deficit water years.

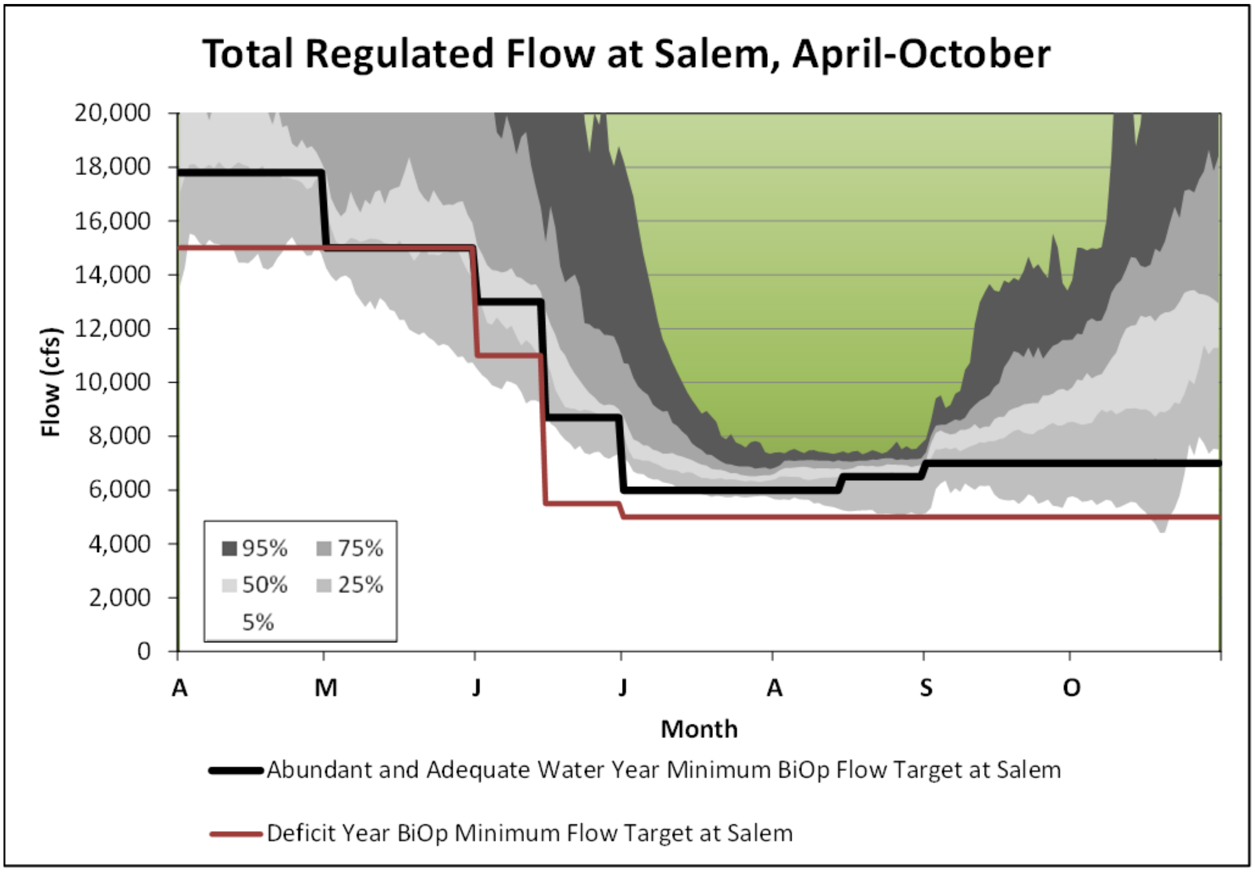


Figure 2.3. Willamette flow at Salem for the regulated system from the Baseline ResSim simulation. Flows are shown as Non-Exceedance percentiles in gray-shaded areas. The solid black line is the minimum flow target for Abundant and Adequate water years, and the solid red line is the minimum flow target in Deficit water years.

3 Water Year Types in Baseline Flow Dataset

The flow dataset used for the Willamette Basin Review Feasibility Study is the 2010 Level Modified Streamflows, for 1928-2008. This dataset was developed by several cooperating federal agencies: the Bonneville Power Administration, the Bureau of Reclamation, and the US Army Corps of Engineers, published in August of 2011. The flow records were obtained from historical data in the whole Columbia Basin, and all flow records were adjusted to represent the current level of irrigation in each region. Evaporative losses have already been adjusted for in the flow dataset as well.

The ResSim analysis runs continuously from 01 October 1928 through 30 September 2008. The mainstem flow targets shown in Table 2.2 start in the spring and continue through October, which is the start of the following water year. For this reason, the water year type is applied to the calendar year. The 1928 flow data is an incomplete calendar year, as is the 2008 flow data. Therefore the years 1929 through 2007 will be used for all calculations of water volume components, which is a total of 79 years.

The calendar years 1929 through 2007 are classified by water year type in Table 3.1 below. The May 10-20 maximum conservation storage value for each year is shown as well. Note that 14% of the years are Deficit years and another 14% are Insufficient years.

Table 3.1. Water Year Types for 1929 – 2007 and Maximum Conservation Storage Value for May 10-20, in Millions of Acre-Feet.

Year	Water Year Type Category	Storage Maf	Year	Water Year Type Category	Storage Maf	Year	Water Year Type Category	Storage Maf
1929	Adequate	1.45	**1956**	Abundant	1.58	**1983**	Abundant	1.53
1930	Deficit	0.68	**1957**	Abundant	1.50	**1984**	Abundant	1.58
1931	Insufficient	1.10	**1958**	Abundant	1.54	**1985**	Adequate	1.36
1932	Abundant	1.58	**1959**	Adequate	1.39	**1986**	Adequate	1.26
1933	Abundant	1.58	**1960**	Abundant	1.59	**1987**	Insufficient	0.91
1934	Deficit	0.62	**1961**	Abundant	1.58	**1988**	Abundant	1.54
1935	Abundant	1.49	**1962**	Abundant	1.57	**1989**	Abundant	1.51
1936	Abundant	1.53	**1963**	Abundant	1.58	**1990**	Adequate	1.41
1937	Abundant	1.58	**1964**	Adequate	1.38	**1991**	Abundant	1.55
1938	Abundant	1.58	**1965**	Insufficient	1.03	**1992**	Deficit	0.84
1939	Insufficient	1.18	**1966**	Adequate	1.37	**1993**	Abundant	1.58
1940	Insufficient	1.17	**1967**	Insufficient	0.99	**1994**	Deficit	0.87
1941	Deficit	0.34	**1968**	Deficit	0.88	**1995**	Abundant	1.55
1942	Deficit	0.62	**1969**	Abundant	1.56	**1996**	Abundant	1.58
1943	Abundant	1.56	**1970**	Adequate	1.27	**1997**	Abundant	1.56
1944	Insufficient	0.91	**1971**	Abundant	1.58	**1998**	Adequate	1.31
1945	Abundant	1.58	**1972**	Abundant	1.58	**1999**	Abundant	1.58
1946	Abundant	1.50	**1973**	Deficit	0.61	**2000**	Abundant	1.57
1947	Adequate	1.36	**1974**	Abundant	1.58	**2001**	Deficit	0.81
1948	Abundant	1.58	**1975**	Abundant	1.57	**2002**	Adequate	1.43
1949	Abundant	1.58	**1976**	Abundant	1.57	**2003**	Abundant	1.56
1950	Abundant	1.58	**1977**	Deficit	0.76	**2004**	Insufficient	1.112
1951	Abundant	1.50	**1978**	Deficit	0.86	**2005**	Insufficient	1.15
1952	Abundant	1.57	**1979**	Abundant	1.57	**2006**	Adequate	1.30
1953	Abundant	1.58	**1980**	Insufficient	1.10	**2007**	Adequate	1.37
1954	Adequate	1.39	**1981**	Insufficient	1.11	14% of years are Insufficient		
1955	Abundant	1.55	**1982**	Abundant	1.54	14% of years are Deficit		

4 ResSim Baseline Operational Rules Used to Meet BiOp Targets

The Baseline ResSim model is fully documented in another report [Reference 2], so this water volume calculation document will not contain all of the model details. However, the specific rules that apply to the BiOp flow targets are discussed here and a methodology explained that uses data values from those rules to calculate each project's BiOp Need share.

A screen shot of the operation set used for Blue River in the Baseline simulation is shown in Figure 4.1. Two rules are shown highlighted in yellow: a downstream minimum flow rule called "*Min Flow – at Salem*" and a downstream minimum flow rule called "*Min Flow – at Albany by Water Year Type*". These two downstream rules contain the flow targets specified in Table 2.2 for all water year types. Both of these rules are used in the Conservation zone of the following projects: Hills Creek, Lookout Point, Fall Creek, Dorena, Cottage Grove, Cougar, and Blue River. Another rule highlighted in yellow in Figure 4.1 is "*Min Flow – at Blue River*" which specifies the minimum tributary flow for the project, and appears in multiple zones in the ResSim model. Each project has its own tributary minimum flow rule.

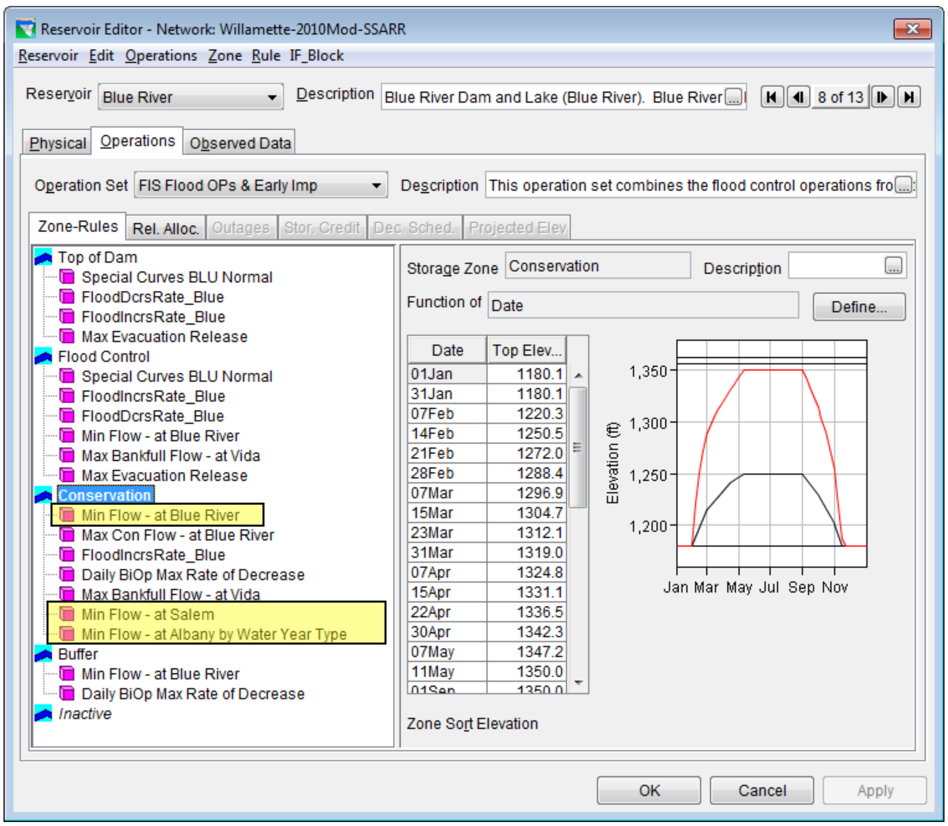


Figure 4.1. Blue River operation set used in ResSim Baseline, with mainstem BiOp flow target rules highlighted.

The Salem and Albany downstream minimum rules are both a specific type of rule in ResSim that allows the program to determine how much additional water should be released from a project (that contains such a rule in its operation set) so the minimum flow is met at the location specified in the rule. This is the rule that determines the share of water that each project should contribute when supplemental flow is needed at either Albany or Salem. A project's share of the flow is determined implicitly in ResSim based on the conservation storage remaining at the project. This means the larger the storage project, the larger that project's share of meeting the minimum flow is.

A rule is only evaluated when the project pool elevation is in the zone where the rule is specified. The Baseline operation sets have the Albany and Salem downstream minimum rules only in Conservation zones of the projects listed above to prevent the reservoirs from draining prematurely. In years where there are low project inflows and supplemental flows are needed frequently, a project's reservoir would drop to the inactive zone early in the year if these rules were also in the Buffer zones. Leaving these two rules out of the Buffer zones is a better mimic of real-time reservoir regulation, where flow management decisions can include many factors not applicable to a ResSim model. (The Buffer zone and all rules are documented in detail for each specific project in the "Willamette Basin Review – ResSim Baseline Model Documentation Report".)

The storage projects on the North and South Santiam River tributaries, Detroit, Green Peter, and Foster Dams, have unique operations that contribute water volume to meet the Salem flow targets differently than the projects mentioned above. (Note the Santiam River confluence with the Willamette is downstream of Albany, so these projects do not assist with meeting the Albany targets.)

The BiOp specifies minimum tributary flows below Foster dam by season to help fish at various stages of development. These minimum flow requirements are listed below in Table 4.1.

Table 4.1. BiOp Minimum Flow Requirements Downstream of Foster Dam.

Date Range	Developmental Stage	Minimum Flow at Foster Dam
01 Jan to 31 Jan	Chinook incubation	1100 cfs
01 Feb to 15 Mar	Chinook rearing	800 cfs
16 Mar to 15 May	Steelhead spawning	1500 cfs
16 May to 30 Jun	Steelhead incubation	1100 cfs
01 Jul to 31 Aug	Steelhead rearing	800 cfs
01 Sep to 15 Oct	Chinook spawning	1500 cfs
16 Oct to 31 Dec	Chinook incubation	1100 cfs

The reservoir operations at Green Peter are aimed at providing enough water to Foster so that Foster Dam outflows meet the tributary minimums listed above. In the process of meeting the Foster outflow minimum rules between April and October, the Green Peter and Foster releases contribute to the flows at Salem, reducing the releases that would otherwise be needed from the dams upstream of Albany.

Figures 4.2 is a screen shot of the operation set used at Foster in the ResSim Baseline simulation. A rule in the Foster operation set, in both the conservation zone and the buffer zone, called "*Foster min better baseline*", specifies the minimum tributary flows from Table 4.1 out of Foster Dam. Foster Dam is only able to meet the minimum flows when supplied with enough water from Green Peter Dam. (Note Foster Dam is a re-regulation dam downstream of Green Peter Dam, with the unregulated South Santiam River providing a significant inflows to Foster reservoir as well.) This rule is highlighted in yellow in Figure 4.2.

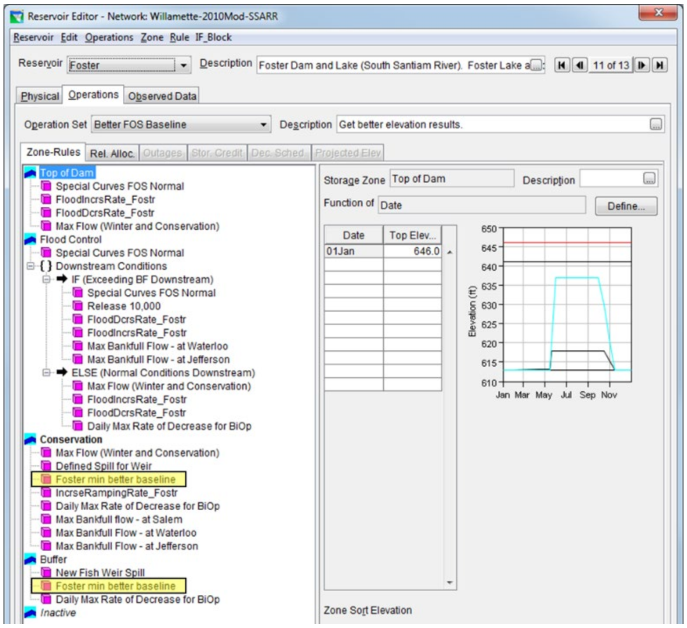


Figure 4.2. Foster Dam operation set used in ResSim Baseline, with BiOp minimum tributary flow rules highlighted. These are local targets set in the BiOp and help meet mainstem targets at Salem as well.

Downstream flow rules at Green Peter Dam are used to help Foster meet the minimum flows, with the Conservation zone rule called "*New Min Con Zone Release*" and the Buffer zone rule called "*New Buffer zone Min rule*". These rules are shown highlighted in yellow in Figure 4.3, which is a screen shot of the operation set for Green Peter in the Baseline ResSim simulation.

Detroit Dam is operated for temperature control beginning in June and continuing into the fall drafting season. During this period, the outflow at Detroit is divided between the spillway and the turbines or between the turbines and the regulating outlets. These three outlet types draw their water from different elevations within the reservoir, and the water at these elevations has different temperatures, with the coldest water being the deepest and the warmest water being the shallowest. The temperature operations at Detroit combine water released from two different pool elevations and use Big Cliff reservoir as a mixing pool, to obtain a more natural river temperature downstream of Big Cliff Dam.

In order to perform the temperature control operations at Detroit beginning in June, the Corps operates the dam so the reservoir level stays high enough through the summer months to be able to spill water from June through the end of August, tapering off during the month of September. These temperature operations are not specified in the BiOp, so the rules associated with this operation are not used for the BiOp Need calculations.

In addition to the temperature operations at Detroit, the project is operated to meet tributary minimum flows downstream of Big Cliff Dam. Since Big Cliff is the re-regulation dam just downstream of Detroit, without significant inflow from other sources, these minimum tributary flows are applied at Detroit in the ResSim model. These minimum tributary flows also help Salem to reach the minimum flow targets specified in the BiOp. The required minimum flows are listed below in Table 4.2.

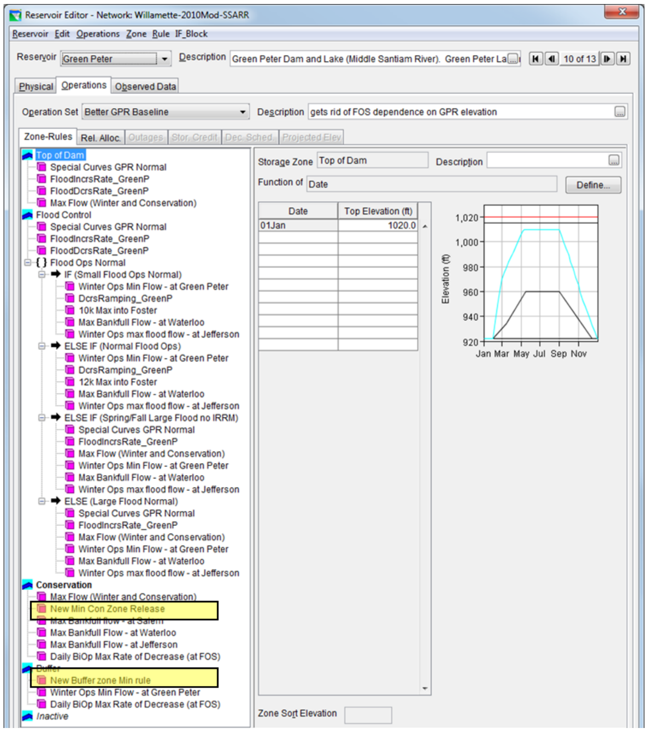


Figure 4.3. Green Peter Dam operation set used in ResSim Baseline, with rules to meet BiOp flow targets at Foster highlighted. These are local targets below Foster Dam set in the BiOp and help meet mainstem targets at Salem.

Table 4.2. BiOp Minimum Flow Requirements Downstream of Detroit Dam.

Date Range	Developmental Stage	Minimum Flow at Foster Dam
01 Jan to 31 Jan	Chinook incubation	1200 cfs
01 Feb to 15 Mar	Chinook rearing	1000 cfs
16 Mar to 31 May	Steelhead spawning	1500 cfs
01 Jun to 15 Jul	Steelhead incubation	1200 cfs
16 Jul to 31 Aug	Steelhead rearing	1000 cfs
01 Sep to 15 Oct	Chinook spawning	1500 cfs
16 Oct to 31 Dec	Chinook incubation	1200 cfs

A screen shot of the Detroit operation set is shown in Figure 4.4 (with the Rereg dam Big Cliff inserted as well), with two rules highlighted in yellow. The rule "*Better DET Min Con zone*" is in the Conservation zone, and the rule "*DET better buffer baseline*" is in the Buffer zone. These rules are used to determine Detroit's BiOp Need share. The Buffer zone rule has a slightly lower September minimum flow than listed in Table 4.2 (1200 cfs rather than 1500 cfs). Both of these ResSim rules are written to include some additional water that Detroit releases to meet irrigation demand downstream, which is documented in the report "Willamette Basin Review – ResSim Baseline Model Documentation Report". This additional water released for irrigation is not included in the calculation of Detroit's BiOp Need share.

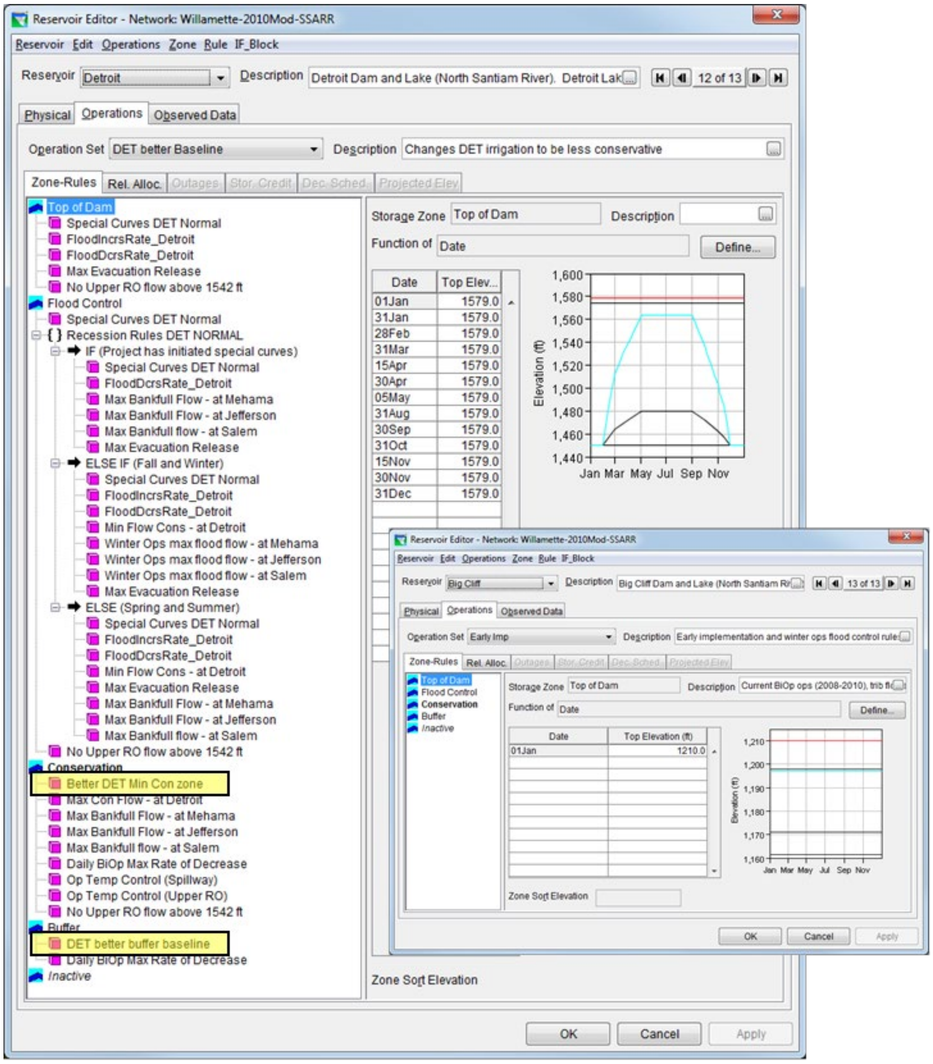


Figure 4.4. Detroit Dam operation set used in ResSim Baseline, with minimum outflow rules highlighted. These flows also help meet mainstem targets at Salem.

Another important component of reservoir operation that is used to meet the minimum tributary flows and mainstem targets is the drafting of each reservoir in the fall. As all of the projects evacuate their conservation storage to prepare for the winter flood season, stored water being released also helps to meet both the Albany and Salem mainstem targets.

The technical details presented in Section 5 include a methodology to estimate how much of the stored water released from each project during fall drafting contribute to their BiOp Need share calculations, and also how much additional stored water is released during drafting that was in addition to the BiOp Need share computed.

5 Basic Methodology– Blue River, 1929

This section details the Basic Methodology for calculating the water volume components for the parsing of the reservoir releases.

The previous section outlined the rules in each project operation set in the Baseline model that are used to help ResSim meet the BiOp minimum flow targets on the mainstem. These rules are used in the calculation of the water volume components that meet the BiOp mainstem targets, but they are not sufficient by themselves to do so. This section provides a detailed look at one project for one year to illustrate the complexities of the full calculation involved to determine the component water volumes contributing to mainstem BiOp minimum flows. The information presented in this section proceeds through the various methods used in a step by step manner, with the full picture of the water volume component computations emerging at the end of the section.

The project used for illustration purposes is Blue River, for model year 1929. Note that year “1929” is not a reproduction of what happened that year – it is the historical flow data from 1929 with the current reservoir regulation operations. The results from this year represent would happen now if this set of project inflows and local flows were to occur today. This year is classified as an Adequate water year, as shown in Table 2.

The general operation of Blue River is to be at minimum conservation pool during the flood season so that space is available to store water during large storm events to reduce downstream flooding, fill the reservoir during the spring, release stored water during the conservation season to supplement the low natural streamflows, and draft remaining water in the fall to prepare for another flood season. Figure 5.1 below is a screen shot from the ResSim Baseline simulation, showing the simulated 1929 year, with the elevation plot in the top portion of the Figure and the project outflow and inflow in the lower portion of the Figure.

The Blue River operation shown in Figure 5.1 for 1929 shows no flood events early in the year that are large enough to store water, and refill occurs slowly. The green elevation line does not reach the conservation zone rule curve until nearly May, when the project stays at or near rule curve for a couple months. Near the end of July, the reservoir drafts below the rule curve in order to provide water according the rules in the operation set. Eventually, near the end of September, the simulation elevation converges with the rule curve, and the project drafts (or evacuates) water according to the rule curve until the minimum conservation zone is reached. There is one large flood event late in the year that requires the reservoir to temporarily store some water to reduce downstream flooding.

The zone boundaries are ResSim specific and covered in detail in Reference [2]. Zones are ResSim tools used for writing rules in operation sets. There is one zone boundary at each project that is called the “Conservation Zone” in the model, and this particular zone at each project is given the shape of the project rule curve and is specified as the Guide Curve for each project. These are ResSim specific concepts covered in Reference [2] – refer to that report for more details.

The specific outflows of this water year are parsed into different components in this section to illustrate which flows contribute to the mainstem minimum targets and how the Blue River project releases that contribute to those flow targets are calculated. The graphs and Figures presented in this section show a step by step process for the parsing of these releases and the reasoning behind calculation decisions.

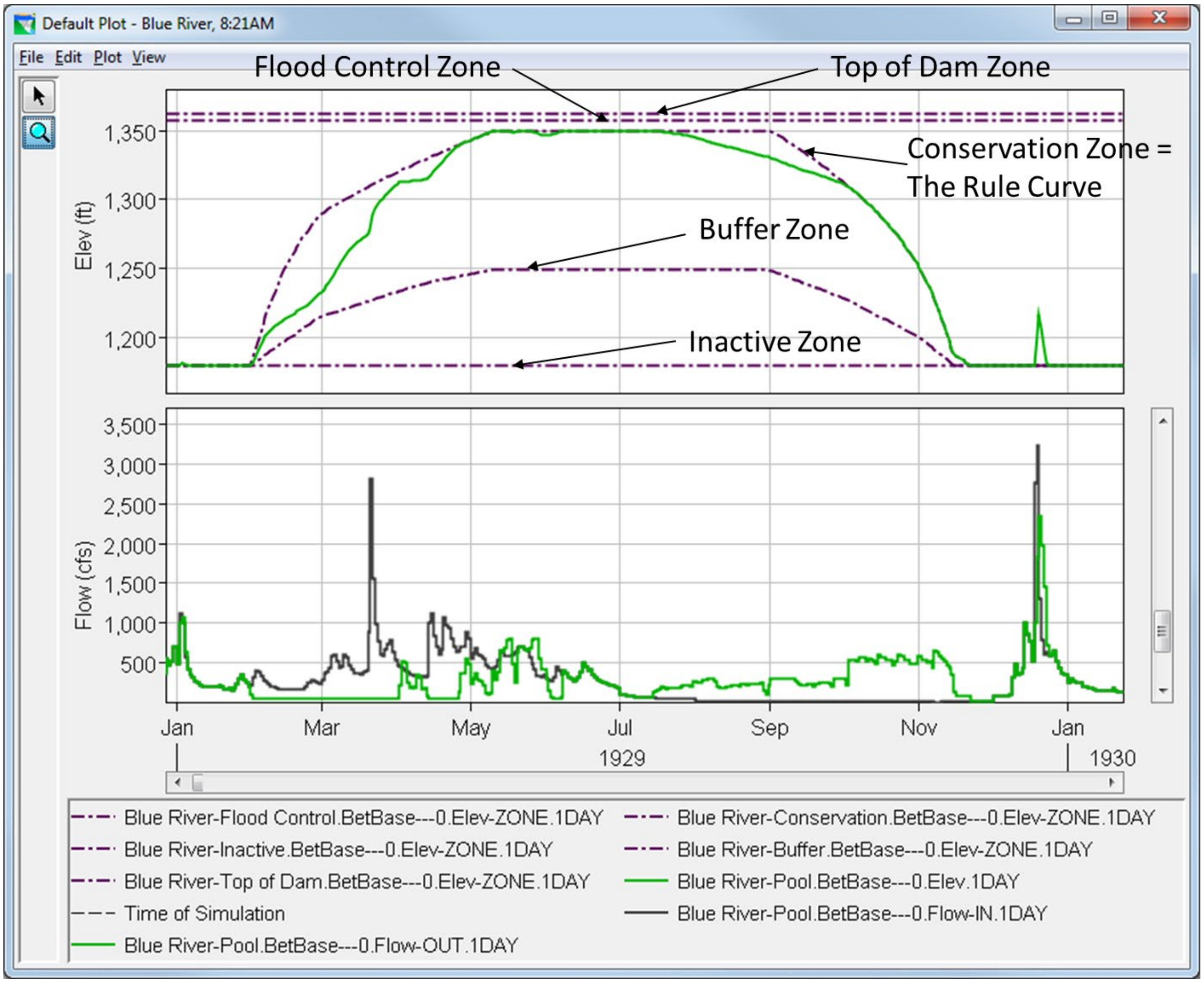


Figure 5.1. Blue River operation for 1929 from the ResSim Baseline. Top portion shows the simulation reservoir elevation (green) compared to the various zone definitions (dotted lines). Bottom portion shows the simulation project outflow (green line) compared to the project inflow (black line). See Reference [2] for more details on zone boundaries.

Figure 5.2 below shows the same flow data as Figure 5.1, but plotted from program simulation data brought into Excel. In the upper graph of Figure 5.2, the blue line is the project inflow and the black line is the regulated outflow as determined by ResSim. The lower graph also shows the blue inflow line and the black regulated outflow line, but areas have been colored into three categories to illustrate what is happening at the project. The area colors mean the following:

Red Areas: Water Being Stored - More water is coming in than is released.
Yellow Areas: Stored Water Being Released - Less water is coming in than is released.

Orange Areas: Inflow that is Passing Through - Water released equal to what is coming in to the reservoir.

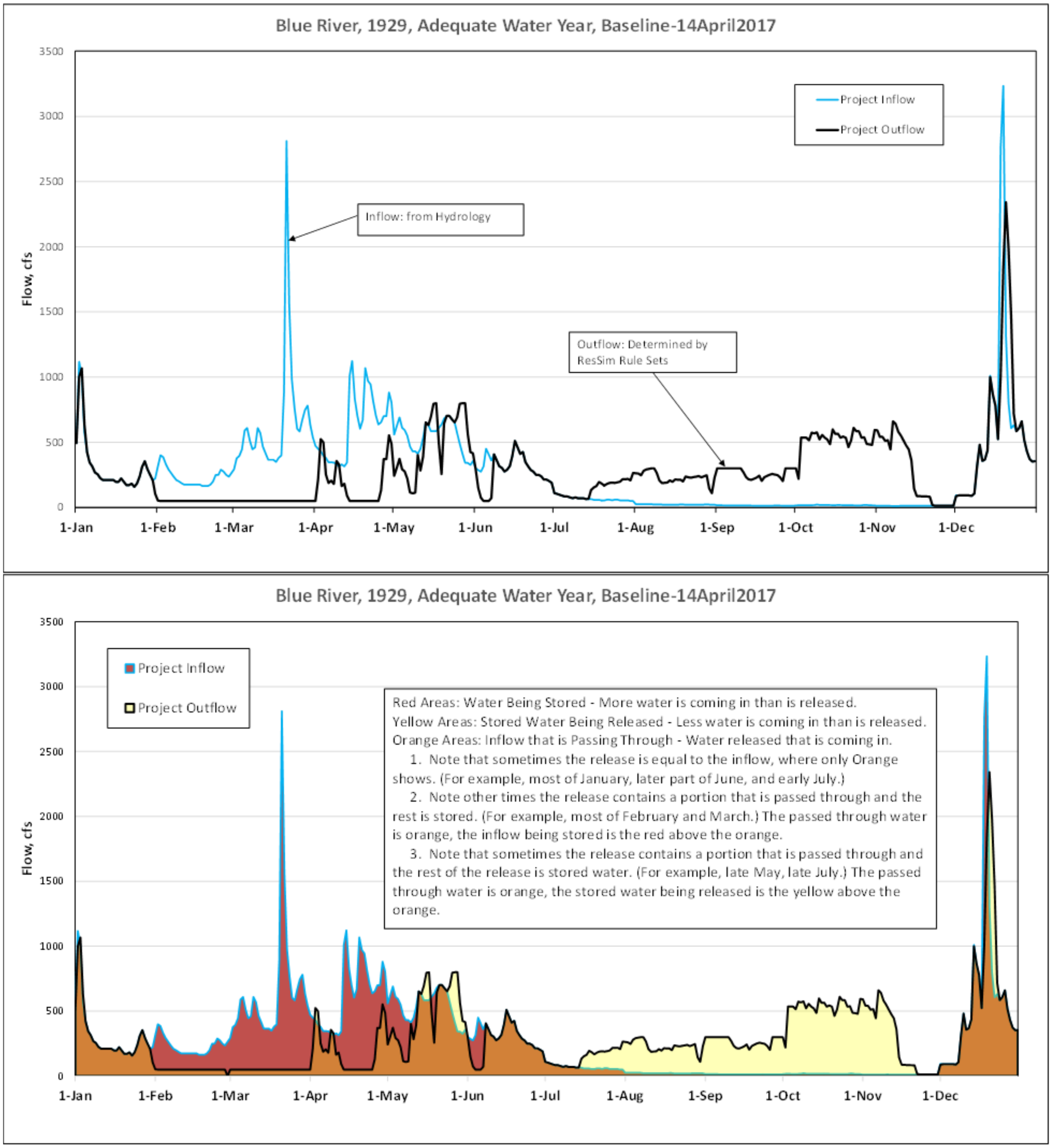


Figure 5.2. Blue River operation for 1929 from the ResSim Baseline from Excel parsing of flows. Top portion shows the simulation reservoir regulated outflow (black) compared to the inflow (blue). The lower graph adds in area coloration for illustration of what is occurring. Red areas represent water being stored in the project, Yellow areas represent stored water that is being released, and Orange areas represent water that is passing through.

Sometimes the release is equal to the inflow, where only Orange shows. (For example, most of January, the later part of June, and early July.) At other times, the release contains a portion that is passed through with the rest being stored, where both orange and yellow areas are present. (For example, see most of February and March.) The passed through water is orange, and the inflow being stored is the red above the orange. The third category is when the release contains a portion that is passed through and the rest of the release is stored water. (For example, late May, late July.) The passed through water is orange, and the stored water being released is the yellow above the orange. Note that the red areas prior to May show the project storing water, as verified by the rising elevation level shown in the plot in Figure 5.1.

The ResSim program records all of the values computed by rule sets that get evaluated (a rule that is not evaluated at a given time step has no entry at that time step), and this information is used in the plot shown in Figure 5.3, which is a detail of April through October of 1929 for Blue River. This time window was chosen because that is the window when Salem has BiOp minimum flow targets (Table 2.1). As in the previous two Figures, the project inflow is the bright blue line and the regulated outflow is the heavy **black** line. The project inflows and outflows were obtained from the *simulation.dss* file records:

//BLUE RIVER-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

(Note that ResSim simulation dss time series records have the six-parting naming convention:
/PART A/PART B/PART C/PART D/PART E/PART F/
Where PART A is controlled by ResSim and is often blank, PART B is from the name of the object in ResSim, PART C is the parameter name in ResSim, PART D is the span of the time series record, PART E is the time step of the record, and PART F is the eight character alternative name with a number indicating the trial, with dashes filling any remaining spots, with this record name controlled by ResSim.)

The rule specifying that Blue River help meet the Salem target is "*Min Flow – at Salem*" and the values computed for that rule are the vertical blue columns in the Figure. Each vertical blue bar represents the ResSim determined flow for that day that Blue River should release to meet its share of the Salem flow target – this is a BiOp Need share for Blue River. The rule specifying that Blue River help meet the Albany flow target is "*Min Flow – at Albany by Water Year Type*", and the values computed for that rule are the vertical red columns in Figure 5.3. Each vertical red bar represents the ResSim determined flow for that day that Blue River should release to help meet its share of the Albany flow target – this is also a BiOp Need share for Blue River. The values for these two rules were obtained from the two *simulation.dss* file records:

//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

The heavy yellow line in Figure 5.3 is the stored water that is released. This value is calculated by subtracting the inflow from outflow, but only retaining the positive values. In other words, when the release on a given day is greater than the flow coming in, the difference is stored water being released (the yellow areas from Figure 5.2). When stored water is being released, the total release is the stored water plus the inflow.

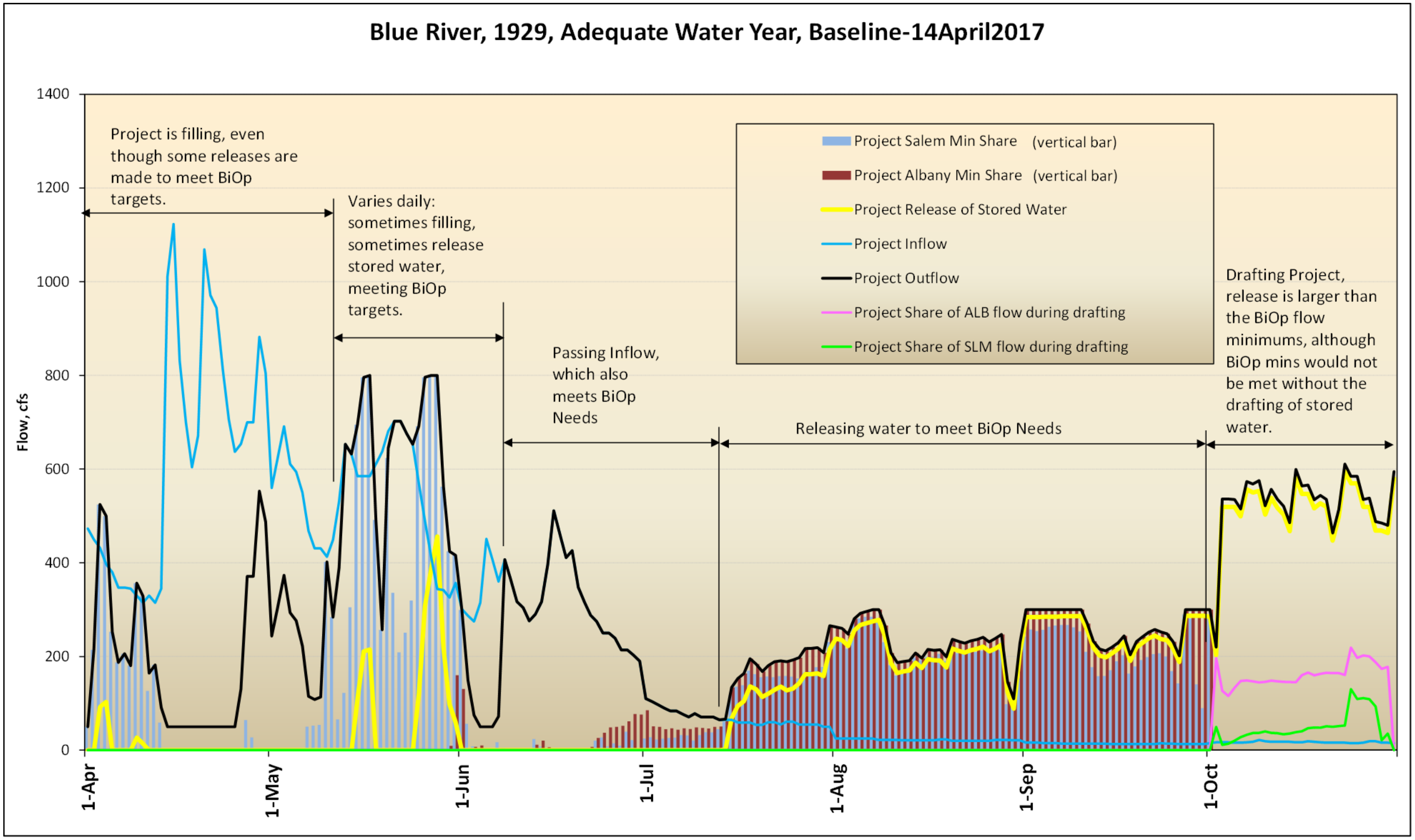


Figure 5.3. Blue River operation for April through October, 1929, from the ResSim Baseline from Excel parsing of flows. Note that "Baseline-14April2017" in the plot title is the full name of the Baseline simulation. (See Table 1.1.)

The rule specifying that Blue River help meet the Salem target is "*Min Flow – at Salem*" and the values computed for that rule are the vertical blue columns in the Figure. Each vertical blue bar represents the ResSim determined flow for that day that Blue River should release to meet its share of the Salem flow target – this is a BiOp Need share for Blue River. The rule specifying that Blue River help meet the Albany flow target is "*Min Flow – at Albany by Water Year Type*", and the values computed for that rule are the vertical red columns in Figure 5.3. Each vertical red bar represents the ResSim determined flow for that day that Blue River should release to help meet its share of the Albany flow target – this is also a BiOp Need share for Blue River. The values for these two rules were obtained from the two *simulation.dss* file records:

//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

The heavy yellow line in Figure 5.3 is the stored water that is released. This value is calculated by subtracting the inflow from outflow, but only retaining the positive values. In other words, when the release on a given day is greater than the flow coming in, the difference is stored water being released (the yellow areas from Figure 5.2). When stored water is being released, the total release is the stored water plus the inflow.

The pink and green lines in October in Figure 5.3 are the project's share of meeting BiOp flow targets during drafting of the reservoir for the flood season – these are BiOp Need shares for Blue River as well. These are shown as lines rather than vertical bars because they include estimated values. Since the project rule curve begins drafting on September first each year, ResSim will calculate the project release based on what is called Guide Curve operation once the pool elevation intersects the rule curve. This means that when the project elevation is either on the rule curve or above it, the program calculates the release for the project elevation to be exactly on the rule curve, and does not use rules in the Conservation zone; therefore, it does not compute the downstream minimum rule values. Note that the graph in the top portion of Figure 5.1 shows the green line, project elevation, intersecting the rule curve, one of the dotted lines, at about the first of October. From that point on, the program is no longer evaluating the downstream minimum rules because it is drafting the project according to Guide Curve operations.

The estimates of the mainstem rule values shown for October in Figure 5.3 were obtained by running another simulation that artificially extends the conservation season to the end of October so that the rules for the Salem and Albany BiOp minimum flows can be evaluated for the full period shown in Table 1. This prevents the program from drafting for the winter flood season during the window of time that rule values are needed to obtain water volumes used for BiOp mainstem target flows. This simulation with the artificial rule curve extension is a tool to obtain an estimate of the project's contribution share to the mainstem targets, and is only used for the window of time when the project is operating to guide curve during drafting. For this particular example, Blue River, 1929, it is used only for mainstem supplemental flow estimates for the month of October, and only when the Baseline run is operating to Guide Curve. (The spreadsheets used for all the water volume computations look for instances when the project zone ID is in the Flood zone rather than the Conservation zone, and during the fall drafting season, this means that ResSim is operating to Guide Curve.)

The graph shown in Figure 5.3 contains the information needed to calculate the BiOp Need share from Blue River and water volume components released by Blue River to contribute the project's share of meeting the BiOp mainstem target flows, but the rule values cannot simply be summed directly. A closer examination of what is happening with the various components shown in Figure 5.3 reveals the reason that a simple summation of these rule values will not provide the correct volume of water required to meet the need. This is detailed in multiple sub-section 5.1 below.

The specific breakdown of the releases from Blue River for this particular water year are described in detail in the following sections. The phrase "BiOp Need" was given a lengthy definition in Section 1, and is repeated here in a brief form for reinforcement of its meaning, since it is used throughout the explanations in the rest of this section and in the project specific sections:

"BiOp Need": the amount of water required to meet minimum flows specified in the BiOp report.

The following concepts and their methods of calculation will be described in later sub-sections. These are water volume components of the release *from each individual project*, with some terms representing a total amount of a component volume at a project and some terms representing a sub-category of a component at a project. The conceptual terms are as follows:

- Stored Water Release (a component total)
  - Stored Water released for BiOp Need (a sub-category component)
  - Amount of Stored Water available at the end of the season (a sub-category component)
- BiOp Need (a component total)
- BiOp Shortage (a component total)
- Passed Inflow (a component total)
  - Passed Inflow that Meets the BiOp Need (a sub-category component)
  - Passed Inflow in excess of BiOp Need (a sub-category component)

The water volume components listed above are calculated independently for each storage project in the Willamette Basin in Sections 6 through 17. Each of those sections will have calculations that use the methodology detailed in Section 5.1 below. The data from the individual project sections are then combined for the whole Willamette Basin in Section 18.

5.1 A Complete Parsing of the Project Releases for Blue River, 1929, April through October

This section will delve into the intricate details of examining all of the releases occurring for 1929 at Blue River during the BiOp window, as depicted in the graph in Figure 5.3. Distinct portions of the graph will be analyzed and discussed so that the theory behind categorizing all flow releases are fully explained. A total of six observational periods from Figure 5.3 are described below, and these periods are illustrated with pink circles in Figure 5.4 below. The water volume components outlined here are specific to Blue River's share. The individual project sections (6 through 17) use this methodology to determine each of their BiOp Need shares and water volume component calculations, and then totals for the basin are summed in Section 18.

Figure 5.4 is a copy of Figure 5.3 with Observation windows circles and labeled. Note that the observation windows are highlighting graph areas that are distinctly different from one another, and these windows are not meant to cover the full time range of the graph. These observation windows were chosen to illustrate some technical concepts that are relevant to water volume component calculations. The observations windows are parsed in the order that is easiest to define the concepts developed in this section, not chronologically. (Each model year analyzed would have a different appearance and a different set of observation windows – there is nothing fixed about the date ranges of any of the observation windows. These observation windows are just a tool to describe some technical computations.)

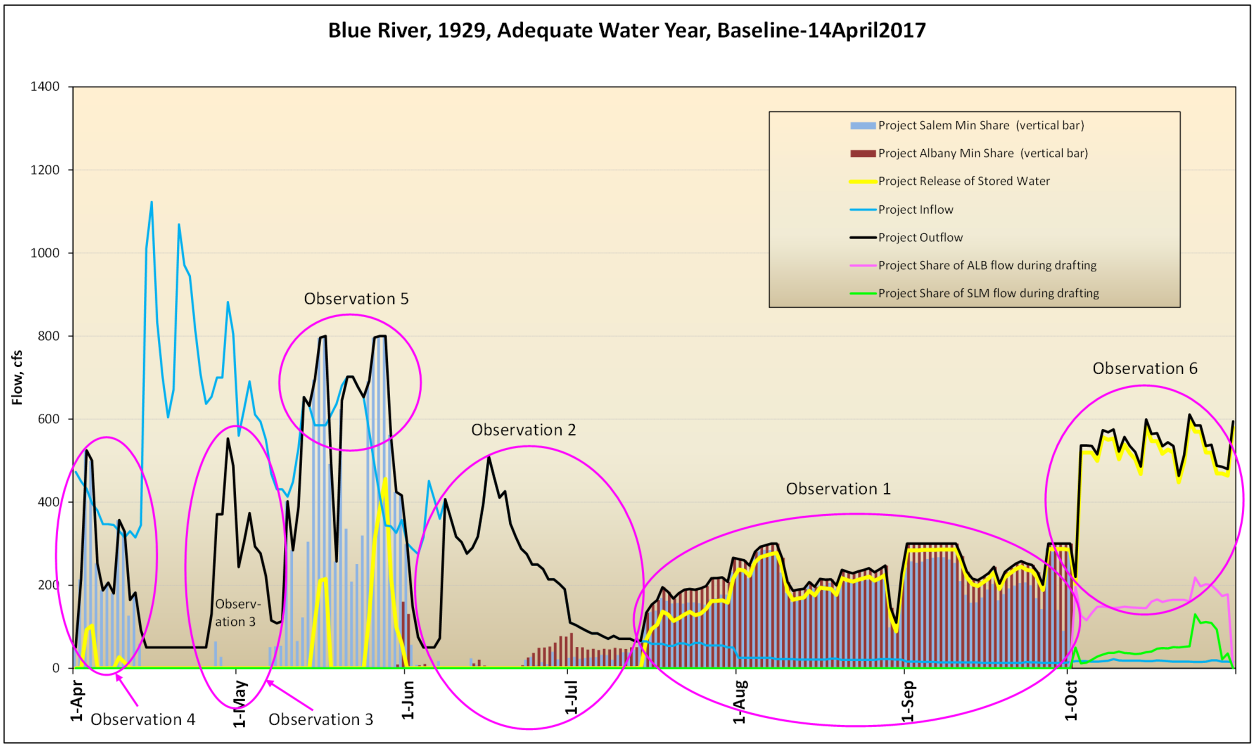


Figure 5.4. Illustration of Observation windows described for the parsing of the project releases for computation of the BiOp Need and water volume component calculations. Observation periods are not labeled chronologically – the order is chosen based on the technical concepts that need to be developed and then used in other observation windows.

Observation Window 1: in the late Conservation Season

First, note that the project release (heavy **black** line) is equal to the greater of the two downstream rule values, not the sum of the Salem and Albany rules (see late July through September). The vertical blue and red bars are computed BiOp Need values for supplemental water that Blue River should release to help Salem and Albany (respectively) meet their BiOp minimum flow targets. Both of these values, in this observation window, are greater than the release required as a minimum flow for the tributary (50 cfs), which is also a BiOp Need. The project outflow, the heavy **black** line, is the greater of the two downstream rule values in this window, and the release value is governed directly by the greatest value of the BiOp Need share. If the rule values were summed individually to obtain the BiOp Need, the calculated need would be too large since the total release is either for Salem or for Albany. (The water released for Albany also travels downstream for Salem, and if the needed water for Salem is greater than that needed for Albany, that water passes through Albany anyway. If the need for Albany is higher than the need for Salem, then Salem gets enough water anyway when the release is made for Albany.) This observation is summarized below:

Use the greater flow value of the Albany downstream rule, the Salem downstream rule, or the minimum tributary flow, not all of them, for any given day when computing the BiOp Need share of the project.

In Figure 5.4, the Stored Water released is the value of the heavy yellow line, and the bright blue line is the project inflow. The project outflow uses all or some of the inflow first, with any additional outflow coming from stored water. (This will be better illustrated in the second observation window.) In all days of Observation window 1, the inflow is very low, so the outflow each day is comprised of all the inflow, which is passed through, and stored water. Passed Inflow is used first to meet the BiOp Need, and then stored water is released to meet the remainder of the BiOp Need.

Observation Window 2: in the early Conservation Season

In the second observation period noted in Figure 5.4, which is for most of June, the regulated outflow is equal to the inflow and there is no stored water released in this window, since the heavy yellow line is zero in this window. (As mentioned above for the first observation window, a released water is first passed inflow and then stored water if needed.) Note that the outflow is greater than the flow calculated for the Salem or Albany minimum rules (vertical blue or red bars), and greater than the minimum tributary flow (50 cfs). This means that some other operation had higher priority in the ResSim analysis than the downstream targets, and the project release was not governed by the BiOp flow requirements. There was still a BiOp Need calculated whenever a red or blue vertical bar appears in this window (and there will always be a tributary minimum flow need), but the release calculated for the project was governed by something else, and more water than the BiOp Need was released. For most of the June period in Figure 5.4, the project release equals the inflow because the project pool elevation is at the maximum conservation elevation, where the governing operation is to stay on the rule curve if that release is enough for downstream needs. This observation is summarized below:

When the project release is equal to the inflow, then it is passing inflow because it is at the maximum conservation pool elevation, and no stored water is released. The BiOp Need is still computed from the maximum downstream rule values or minimum tributary release flow, but the need is met in full by passed inflow instead of stored water. (Passed Inflow is always used first for releases.)

Observation Window 3: near the end of Refill Window

In a third observation window of Figure 5.4, late April and early May, the project outflow, although less than the inflow, is greater than the computed BiOp rule values. This period of time corresponds to the project operating on the rule curve, although the rule curve elevation is still rising and is not yet at the maximum conservation pool elevation. (See Figure 5.1, just before May, when the green elevation line intersects the dotted line.) Since the rule curve defines the target project elevation to be at or below, unless the project needs to store water to reduce downstream flooding, the project release is calculated to be a value that keeps it on the rule curve in the next time step. This is called Guide Curve operation, and shows up as "GC" in the ResSim release decision report for Blue River in this period of time. (The second observation above is also a Guide Curve operation, but the second and third observation are separated here since the inflow/outflow graph looks different.) When the project release is calculated to stay on the rule curve during the refill season, even though the pool elevation has not yet reached the maximum conservation elevation, BiOp Needs are met with some of the passed inflow. This observation is summarized below:

When the project release is governed by Guide Curve operations, BiOp Needs are met by a portion of the passed inflow, while the remainder of the passed inflow volume was released for other reasons.

Note that in the bullet point list right before Section 5.1, there are three passed inflow categories, which were:

- Passed Inflow (a component total)
  - Passed Inflow that Meets the BiOp Need (a sub-category component)
  - Passed Inflow in excess of BiOp Need (a sub-category component)

The component total of the passed inflow is the sum of the inflow passed to meet the BiOp Need and the inflow passed in excess of the BiOp Need. These two sub-categories of passed inflow will be called "Inflow Volume Passed for BiOp Needs" and "Inflow Volume Passed for Other Reasons" in all of the water volume component graphs throughout the rest of this report.

Observation Window 4: Early April Time Window

The fourth observation window of Figure 5.4 is in early April, where there are significant flows calculated as Blue River's share of meeting the BiOp minimum flow targets at Salem, where the vertical blue bars are generally several hundred cfs high. The project outflow, the heavy **black** line, is often equal to the value of the vertical blue bars, the Salem BiOp Need. Referring back to Figure 5.1, the pool elevation is below the project rule curve, so the project is trying to both refill and meet BiOp obligations. The project release is equal to these calculated rule values (BiOp Need). (Except for the last day and third to the last day in the period, as the vertical blue lines do not touch the heavy black line on those two days.) Since inflows are high in this period, there is only a little bit of stored water released in this period – the heavy yellow line is either zero for most of this window, or has a small spike when the heavy **black** line is higher than the inflow bright blue line. This window of time corresponds to the highest Salem minimum flow requirements, as shown in Table 2.2. Since the project is below rule curve during this window, the BiOp flows are met from project inflow that *could have been stored* but had to be released instead to satisfy the Salem target minimum. The BiOp Need is met first by passed inflow, and then if necessary with some stored water, which should be tabulated separately. Note that if there was no BiOp Need, the project *would have* stored the portion of inflow that would have brought the pool level up to the rule curve while still meeting the tributary minimum flow.

Another way to understand the importance of quantifying how much inflow is passed for supplemental mainstem flows during the refill window is this - if there was zero inflow on one of these days, the project would have had to release the full amount of the BiOp Need from stored water in order to meet its share of the downstream BiOp target. The inflow passed for a BiOp Need is an important component of the total amount of water required for the BiOp mainstem flows. The fourth observation is summarized below:

Project inflows passed to meet BiOp Needs should be included in a separate volume computation of the water needs at a project for the BiOp minimum flows. If this inflow had not been available, then stored water of this amount would have been released to meet the BiOp targets at Salem or Albany. Inflow passed during refill specifically for the BiOp Need could have been stored, at least partially, if there had not been a BiOp Need.

Observation Window 5: Most of May

The fifth observation window from Figure 5.4 covers the May period when inflows, project releases, and calculated BiOp flow target rules are all high for model year 1929. This particular window of 1929 occurs just after the project has reached its maximum conservation zone, and so the project has refilled for the year. A variety of different operational issues can be described in this observation window.

- Sometimes the outflow is the same as the Salem BiOp Need (heavy **black** line equals the vertical blue bar). There are two peaks in the outflow graph in this observation window, and in these peaks the outflow is also higher than the inflow (heavy **black** line greater than bright blue inflow line). When the outflow is greater than the inflow, the BiOp Need is met by both passed inflow and stored water.
- Sometimes the outflow equals the inflow, and this value is greater than the BiOp Need. (Here the heavy **black** line equals the bright blue line, but these values are greater than the vertical blue bars.) In these instances, the BiOp Need is all met by inflow passed for the BiOp, with additional inflow passed for other reasons.
- In a few instances, the outflow is less than the inflow, and the BiOp Need for the Salem target is low as well. (Heavy **black** line less than bright blue line, and vertical blue bar less then bright blue line.) This means that some water is being stored, and during this time the BiOp Need is met with inflow passed for that purpose.

Observation Window 6: The month of October

The final observation window of Figure 5.4 is the month of October. As shown in the elevation graph of Figure 5.1, this period coincides with the project elevation intersecting the rule curve during the drafting season, and for this particular year, the outflows are governed by the Guide Curve operations. This results in no rule evaluations for the downstream flow rules, although there is still a need for these flows at Salem and Albany – in other words, there is still a BiOp Need, although no rule is evaluated to obtain this information. The minimum tributary flow required is also not evaluated during the Guide Curve operations. This is an artifact of the way that the ResSim program works, and not a reflection of the BiOp Need.

Suppose that on October 15, the project pool elevation was 1/8th inch below rule curve. The program would calculate that the downstream Salem contribution from the project was X cfs and the downstream Albany contribution was Y cfs. The project would release the greater of X or Y. Now suppose that instead of being just below rule curve on that day, the pool elevation was 1/8th inch above rule curve (so it is slightly in Flood zone). Although the downstream needs at Salem and Albany would still be X and Y cfs from the project, ResSim no longer makes that computation at all and just drafts according to Guide Curve operations – it releases a flow to make the pool elevation equal to Guide Curve. Since the BiOp Need cannot be determined from rule evaluation records once drafting begins and Guide Curve Operation is in effect, it must be estimated in another manner.

The method used to estimate the BiOp Need during fall drafting operations when the project is under Guide Curve operations in ResSim is to run a second simulation with an artificially extended maximum conservation zone rule curve so that fall drafting is delayed. This allows for the downstream rules to be evaluated just to obtain the magnitude of the BiOp Need in October. The BiOp Need obtained from the artificial extension of the rule curve is only used for periods of fall drafting when the project is in the Flood zone. The parameters of this simulation are summarized in Table 5.1.

In this window, the inflow (bright blue line) is very low, the outflow (heavy **black** line) is quite high, and the stored water release, the heavy yellow line, is the difference between these two lines. There are no vertical blue or red lines for Salem and Albany BiOp Needs because of how ResSim is operating, but those locations still have a BiOp Need. The estimated need for Salem is shown as the bright green line and the estimated need for Albany is shown as the bright pink line in this window, with those estimates obtained from the second simulation with the artificial extension of the conservation season. The BiOp Need would then be the greater of the estimated Salem need, the estimated Albany need, or the minimum tributary flow.

To summarize this observation:

When ResSim operates according to Guide Curve operations during the fall drafting season, which is whenever the pool elevation is above the rule curve, that portion of the project release that is a BiOp Need is estimated using a separate simulation and the estimate must be included in the water volume computations.

One final note on project release decisions is that there is a minimum release value to satisfy the minimum tributary flow targets, which the project should release even if there is no Salem or Albany minimum computed. This minimum release should be accounted for even if the mainstem does not need supplemental flow.

Table 5.1. Summary of Artificially Extended Rule Curve Simulation Particulars.

ResSim Version	HEC-ResSim 3.2.0.1197 Dev Build 64-bit		
Watershed	NWP_Willamette		
Network	Willamette-2010Mod-SSARR		
Configuration	Existing		
Alternative	ExtendBase		
Inflow File Name	Final Flows WBR – from 2010 Mod Flows and Hybrids.dss		
Rule Curve File	Willamette_Rule_Curves.dss		
External Variables File	diversion.dss and Water Year Type for 2010 Mod Flows.dss		
Simulation Name	**Extended-Baseline-14April2017***		
Simulation Start	04 Oct 1928 at 2400		
Simulation Lookback	01 Oct 1928 at 2400		
Simulation Ending	30 Sep 2008 at 2400		
Project	**Operation Set Name**	**Lookback Elevation**	**Lookback Flows (cfs)**
Detroit	DET better Baseline	Rule Curve	Power Plant 1500.0, Spillway and ROs 0.0
Big Cliff	Early Imp	1193.0 ft.	Power Plant 1573.0, Spillway 0.0
Green Peter	Better GPR Baseline	Rule Curve	Power Plant 1500.0, Spillway and RO 0.0
Foster	Better FOS Baseline	Rule Curve	Power Plant 1500.0, Spillway 0.0
Cougar	CGR Extended Baseline	Rule Curve	Power Plant 400.0, Spillway and RO 0.0
Blue River	BLU Extended Baseline	Rule Curve	RO 50.0, Spillway 0.0
Hills Creek	HCR Extended Baseline	Rule Curve	Power Plant 400.0, Spillway and ROs 0.0
Lookout Point	LOP Extended Baseline	Rule Curve	Power Plant 1200.0, Spillway and ROs 0.0
Dexter	Early Imp	693.0 ft.	Power Plant 1200.0, Spillway 0.0
Fall Creek	FAL Extended Baseline	Rule Curve	RO 200.0, Spillway 0.0
Cottage Grove	COT Extended Baseline	Rule Curve	RO 50.0, Uncontrolled Spillway 0.0
Dorena	DOR Extended Baseline	Rule Curve	RO 100.0, Uncontrolled Spillway 0.0
Fern Ridge	Improved Baseline	Rule Curve	RO 30.0, Spillway and Sluice Gate 0.0

*Note the date 17April2017 included in the name is the date this simulation was run.

5.2 Example Computations for One Day from Each Observation Period – Blue River, 1929

This section shows exact flow computations for six separate days from Blue River in 1929, one day from each observation window described in Section 5.1, shown in Tables 5.2 through 5.7. These six days will illustrate all of the water volume components described in that section. Note that one of the calculations is for the shortage in BiOp mainstem supplemental flows, which are all zero for Blue River at 1929. This means that in 1929, Blue River could meet all of its share of the BiOp Need. Some water years are drier than 1929, and even though a need is calculated, the project cannot meet the full need. This did not occur in 1929, but occurs frequently in Deficit and Insufficient water years, when the project outflows are less than the calculated need of the BiOp. The shortage in meeting BiOp Needs will be covered in Section 5.3 using model year 1934 as an example.

The calculations show the flow component of the water volume sub-categories that are listed just before Section 5.1. This means that the calculations presented below are in flow (cubic feet per second) since the time series records pulled from the simulation file are flow values, but the flow rates will be converted to water volumes for the graphs. These water volume components will all be color-coded and graphed as indicated below:

- Stored Water Release (a component total) – this component total is not shown separately. It is the sum of the two sub-categories below.
  - Stored Water released for BiOp Need (a sub-category component) – this will be shown as a **black** bar. It will be labeled "Stored Water Released for BiOp Needs".
  - Amount of Stored Water available at the end of the season (a sub-category component) – this will be shown as a **purple** bar. It will be labeled "Volume of Stored Water Released for Other Reasons".
- BiOp Need (a component total) – this will not be graphed, but it is calculated as the sum of the **black** and **white** bars and the BiOp shortage, if any. If there is a shortage, as will be described in Section 5.3, the BiOp Need would also include the shortage volume in its sum.
- BiOp Shortage (a component total) – this will be shown as **red** bars in graphs, although model year 1929 does not have a shortage to show. It will be labeled "Volume Shortage in Meeting BiOp Needs".
- Passed Inflow (a component total) – the component total is not shown separately. It equals the **white** plus **blue** bars.
  - Passed Inflow that Meets the BiOp Need (a sub-category component) – this will be shown as a **white** bar. It will be labeled "Inflow Volume Passed for BiOp Needs".
  - Passed Inflow in excess of BiOp Need (a sub-category component) - this will be shown as a **bright blue** bar. It will be labeled "Inflow Volume Passed for Other Reasons".

Figure 5.5 below shows the water volume component calculations for each day from April through October for 1929 for Blue River. The **black** bars are the stored water released for BiOp Needs, the **white** bars are the inflow passed to meet BiOp Needs, and the **blue** bars are the inflow passed for other reasons. This year does not have any shortages – all BiOp Needs were met. The **purple** bars are the additional stored water released during fall drafting that was not for meeting BiOp Needs. The yellow arrows highlight the six specific days for example calculations from each observation window.

Note that a line tracing the highest point of each day's bar graph in Figure 5.5 would be the same shape as the total outflow graph of Figure 5.4 (the heavy black line).

Figure 5.5 is graphed as daily volume releases in acre-feet, rather than in flow (cfs), in order to be consistent with the project specific Sections 6 through 17 which present total water volume component values for the April through October period of each year. The daily water volume component values of Figure 5.5 would be summed to give one value per year for each component type for 1929.

The six specific day calculations presented below in Tables 5.1 through 5.6 show the simulation file results for each day listed. The dss time series records, which contain Parts A through F, have been slightly abbreviated in the calculations presented to a simpler form by not showing Parts A, D, E, and F:

//PART B/PART C/ = value for specific day example in cfs

The six days of calculated values in the tables below (5.2 through 5.7) use the following shortened names for the time series records:

//BLUE RIVER-POOL/FLOW-IN/ = this the time series record of the inflow to Blue River.
//BLUE RIVER-POOL/FLOW-OUT/ = this the time series record of the ResSim calculated project outflow for Blue River.
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = this is the time series record for the required minimum tributary flow that Blue River should release. It is a BiOp Need that can only be met by Blue River, although the project may or may not be able to release this amount.

//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = this the downstream minimum flow rule for Albany in the Blue River operation set. It is Blue River's share of the supplemental flow needed at Albany. This is a BiOp Need that may or may not be met by the project release calculated by ResSim. When using the second simulation with the artificial extension of the conservation season rule curve, the dss time series record will be denoted as:
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN///EXTENDBASE0

//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = this the downstream minimum flow rule for Salem in the Blue River operation set. It is Blue River's share of the supplemental flow needed at Salem. This is a BiOp Need that may or may not be met by the project release calculated by ResSim. When using the second simulation with the artificial extension of the conservation season rule curve, the dss time series record will be denoted as:
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN///EXTENDBASE0

//BLUE RIVER/ZONEID/ = this is a ResSim generated value for the program to use to specify the zone that the project is in at each time step of the simulation.

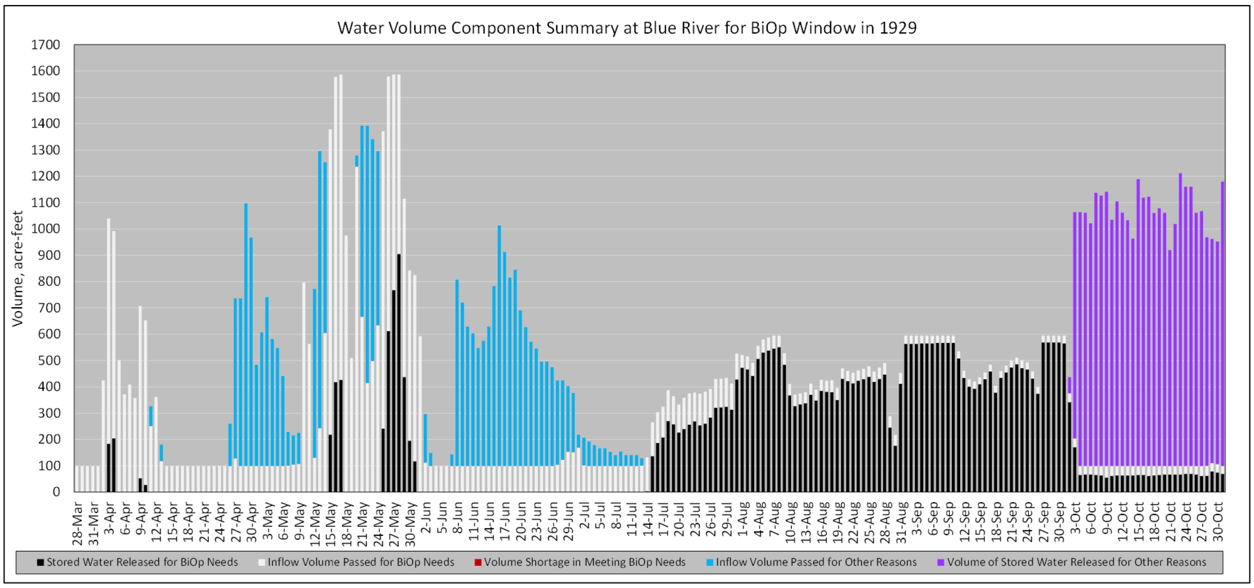


Figure 5.5. Illustration of the component water volume calculations. Black = stored water released for BiOp Needs, white = inflow passed specifically to meet BiOp Needs, and bright blue = inflow passed for other reasons. This year has no shortages. Purple = stored water during fall drafting that was in excess of BiOp Need. Yellow arrows are pointing to specific days for the calculations shown.

Table 5.2 Observation Window 1: Use August 1, 1929 as an example.

Time series record values from the simulation results file for this day:
//BLUE RIVER-POOL/FLOW-IN/ = 25.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 263.0 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = 262.99 cfs (~263.0)
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = 235.10 cfs
//BLUE RIVER/ZONEID/ = 1.00 (Conservation Zone, means project is below Rule Curve)
 	
Calculations using simulation results values on this day:
Stored Water Released this day = 238.00 cfs (FLOW-OUT minus FLOW-IN if positive, 263.0 – 25.00)
BiOp Need for this day = 263.0 cfs (the greater of Albany, Salem, or min trib need, 262.99 or 253.10 or 50.00, since in the Conservation Zone)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 25.00 cfs (FLOW-OUT minus Stored Water Released = 263.0 – 238.00)
Inflow Passed for BiOp Needs = 25.00 cfs (since FLOW-IN < BiOp Need, all inflow goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 238.00 cfs (since Stored water release is < BiOp Need, all stored water goes towards meeting the BiOp need) **(Black bar)**
Inflow Passed for Other Reasons = 0 cfs (all inflow went to BiOp needs) **(Blue bar)**

Table 5.3 Observation Window 2: Use July 1, 1929 as an example.

Time series record values from the simulation results file for this day:
//BLUE RIVER-POOL/FLOW-IN/ = 110.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 110.00 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = 85.22 cfs
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = 24.99 cfs
//BLUE RIVER/ZONEID/ = 1.00 (Conservation Zone, means project is below Rule Curve)
 	
Calculations using simulation results values on this day:
Stored Water Released this day = 0 cfs (FLOW-OUT minus FLOW-IN if positive, otherwise zero, 110.00 – 110.00)
BiOp mainstem Need this day = 85.22 cfs (the greater of Albany, Salem or min trib need, 85.22 or 24.99 or 50.00, since in the Conservation Zone)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 110.00 cfs (FLOW-OUT minus Stored Water Released = 110.00 – 0)
Inflow Passed for BiOp Needs = 85.22 cfs (since FLOW-IN > BiOp Need, some inflow goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 0 cfs (all BiOp Need is met with inflow) **(Black bar)**
Inflow Passed for Other Reasons = 24.78 cfs (110.00 – 85.22) **(Blue bar)**

Table 5.4 Observation Window 3: Use April 27, 1929 as an example.

Time series record values from the simulation results file for this day:

//BLUE RIVER-POOL/FLOW-IN/ = 700.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 371.0 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = 0 cfs
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = 64.53 cfs
//BLUE RIVER/ZONEID/ = 1.00 (Conservation Zone, means project is below Rule Curve)

Calculations using simulation results values on this day:

Stored Water Released this day = 0 cfs (FLOW-OUT minus FLOW-IN if positive, otherwise zero, 371.0 – 700.00 < 0)
BiOp mainstem Need this day = 64.53 cfs (the greater of Albany, Salem, or min trib need, 0 or 64.53 or 50.00, since in the Conservation Zone)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 371.0 cfs (FLOW-OUT minus Stored Water Released = 371.0 – 0)
Inflow Passed for BiOp Needs = 64.53 cfs (since FLOW-IN > BiOp Need, some inflow goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 0 cfs (all BiOp Need is met with inflow) **(Black bar)**
Inflow Passed for Other Reasons = 329.0 cfs (700.00 – 371.0) **(Blue bar)**

Table 5.5 Observation Window 4: Use April 4, 1929 as an example.

Time series record values from the simulation results file for this day:

//BLUE RIVER-POOL/FLOW-IN/ = 397.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 499.9 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = 0 cfs
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = 499.91 cfs
//BLUE RIVER/ZONEID/ = 1.00 (Conservation Zone, means project is below Rule Curve)

Calculations using simulation results values on this day:

Stored Water Released this day = 102.9 cfs (FLOW-OUT minus FLOW-IN if positive, otherwise zero, 499.9 – 397.00)
BiOp mainstem Need this day = 499.91 cfs (the greater of Albany, Salem, or min trib need, 0 or 499.91 or 50.00, since in the Conservation Zone)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 397.00 cfs (FLOW-OUT minus Stored Water Released = 499.9 – 102.9)
Inflow Passed for BiOp Needs = 397.00 cfs (since FLOW-IN < BiOp Need, all inflow goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 102.9 cfs (all stored water released is for the BiOp Need) **(Black bar)**
Inflow Passed for Other Reasons = 0 cfs (all used to meet BiOp Need since Need > FLOW-IN) **(Blue bar)**

Table 5.6 Observation Window 5: Use May 21, 1929 as an example.

Time series record values from the simulation results file for this day:

//BLUE RIVER-POOL/FLOW-IN/ = 702.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 702.00 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = 0 cfs
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = 335.83 cfs
//BLUE RIVER/ZONEID/ = 1.00 (Conservation Zone, means project is below Rule Curve)

Calculations using simulation results values on this day:

Stored Water Released this day = 0 cfs (FLOW-OUT minus FLOW-IN if positive, otherwise zero, 702.00 – 702.00)
BiOp mainstem Need this day = 335.83 cfs (the greater of Albany, Salem, or min trib need, 0 or 335.83 or 50.00, since in the Conservation Zone)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 702.00 cfs (FLOW-OUT minus Stored Water Released = 702.00 – 0)
Inflow Passed for BiOp Needs = 335.83 cfs (since FLOW-IN >BiOp Need, only amount equal to need goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 0 cfs (no stored water released) **(Black bar)**
Inflow Passed for Other Reasons = 366.17 cfs (702.00 – 335.83) **(Blue bar)**

Table 5.7 Observation Window 6: Use October 10, 1929 as an example.

Time series record values from the simulation results file for this day:

//BLUE RIVER-POOL/FLOW-IN/ = 19.00 cfs
//BLUE RIVER-POOL/FLOW-OUT/ = 521.9 cfs
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/ = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/ = N/A cfs (rule not evaluated since in Flood zone)
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/ = N/A cfs (rule not evaluated since in flood zone)
//BLUE RIVER/ZONEID/ = 2.00 (Flood Control Zone, means project is above Rule Curve when evaluated)
Since on this day the pool elevation is just above the rule curve, use the rule values from the simulation with the artificial extension of the maximum conservation pool through October:
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN///EXTENDBASE0 = 50.00 cfs
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN///EXTENDBASE0 = 0.0 cfs

Calculations using simulation results values on this day:

Stored Water Released this day = 502.9 cfs (FLOW-OUT minus FLOW-IN if positive, otherwise zero, 521.9 – 19.00)
BiOp mainstem Need this day = 50.00 cfs (the greater of Albany, Salem, or min trib need, 50.00 or 0 or 50.00, since in the Conservation Zone in the Extended Conservation zone simulation)
BiOp Shortage from this Project = 0 (there would be a shortage if FLOW-OUT were < BiOp Need)
Passed Inflow = 19.00 cfs (FLOW-OUT minus Stored Water Released = 521.9 – 502.9)
Inflow Passed for BiOp Needs = 19.00 cfs (since FLOW-IN < BiOp Need, all inflow goes to BiOp) **(White bar)**
Stored Water Released for BiOp Needs = 31.00 cfs (BiOp Need minus the Passed inflow to meet BiOp, 50.00 – 19.00) **(Black bar)**
Inflow Passed for Other Reasons = 0 cfs (since passed inflow < BiOp Need) **(Blue bar)**
Stored Water Released for Other Reasons = 471.9 cfs (Stored Water Released minus the Stored Water Released for BiOp Needs, 502.9 – 31.00) (**Purple bar**)

5.3 Side Note Discussion on BiOp Shortages and Estimated Needs – Blue River, 1934

The year chosen for the detailed parsing of flows in Section 5.2 was 1929, which was an Adequate water year, and one for which Blue River Reservoir was always able to meet its calculated share of the BiOp Need. This is not always the case, especially in Deficit or Insufficient water years. For example, the year

1934 was a Deficit water year, and Blue River releases could not always meet the project share of the BiOp Needs. Figure 5.6 below shows the ResSim simulation plot for 1934. The top portion of the graph has dotted lines tracing the zone boundaries, and for 1934, much of May through October shows the pool elevation following the Buffer zone line or dipping below it. Recall that the Conservation zone includes the Salem and Albany minimum rules and the Buffer zone does not, although the Buffer zone does contain the project minimum tributary flow rule for 50 cfs.

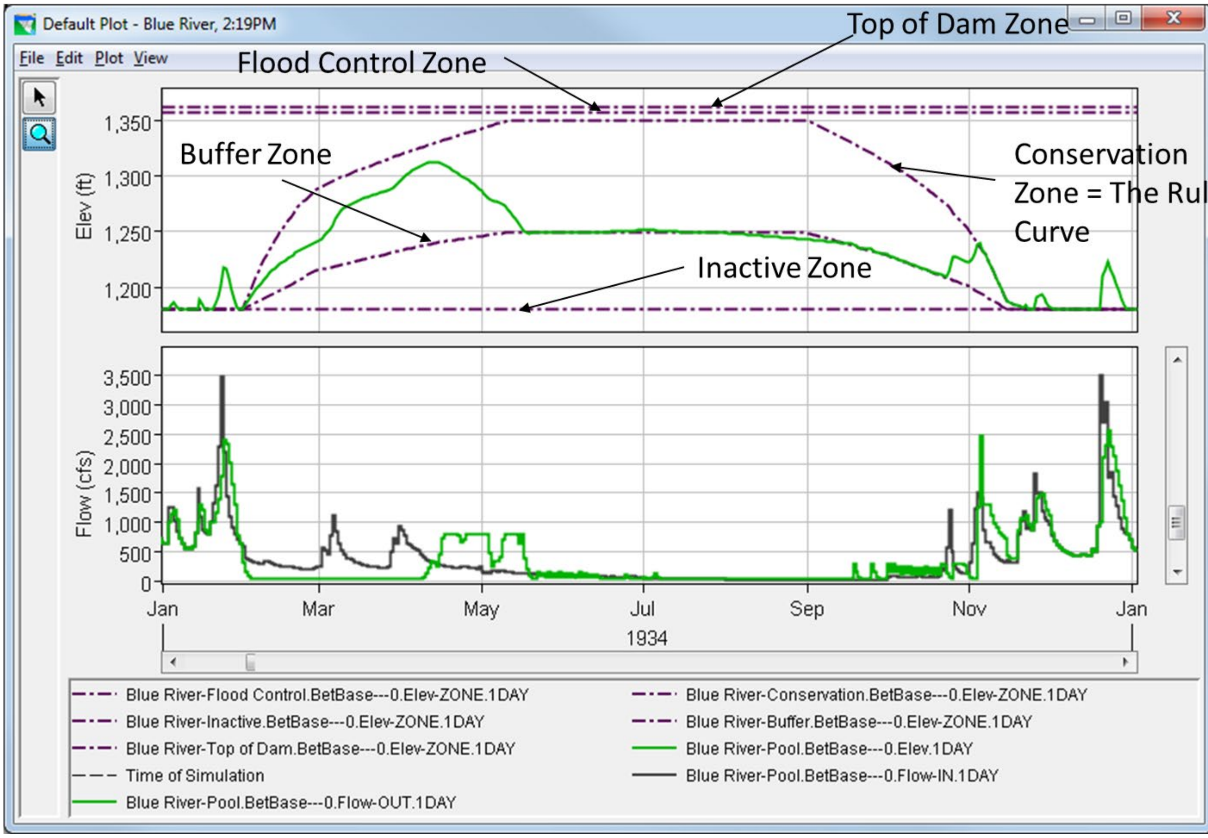


Figure 5.6. Blue River operation for 1934 from the ResSim Baseline. Top portion shows the simulation reservoir elevation (green) compared to the various zone definitions (dotted lines). Note that the project elevation hugs the Buffer zone line and sometimes dips below it for much of the conservation season. Bottom portion shows the simulation project outflow (green line) compared to the project inflow (black line).

There are two important notes about this example year of 1934:

1) When the project is in the Buffer zone in ResSim, there are no downstream flow rules for Albany or Salem to evaluate, but there can still be a need for supplemental flows on the mainstem.
2) The project outflow may be less than the Salem or Albany minimum rule calculates. In this case, the project cannot meet all of its BiOp Need share.

The graph in Figure 5.7 shows the parsing of the ResSim results, the same as was done for 1929 in Figure 5.3. Note that the heavy **black** line (project outflows) are often less than the red or blue vertical bars (Salem and Albany flow supplements needed from Blue River). Also, note that a window from mid-July through mid-September (which is circled in pink to highlight it) does not show any red or blue bars – not because there isn't a need for more water at Salem and Albany, but because this is when the pool elevation is in the Buffer zone, which does not contain those downstream minimum rules. The project is able to evaluate and meet its minimum tributary flow in this window (50 cfs), since this rule is in the Buffer zone.

The challenge of the Deficit water years is to be able to determine the project share of the supplemental mainstem BiOp Need when these rules are not evaluated due to the pool level dropping into the Buffer zone. (The purpose of having the Buffer zone in the ResSim model is to try to mimic some level of real-time reservoir regulation in low water periods – when pool levels are low during the Conservation season, less water is released to preserve some of the storage for the late summer supplemental flow needs. If the Salem and Albany rules were added to the Buffer zone, the projects would drain to minimum conservation pool early in the summer, leaving little water for the rest of the season.)

When the pool elevation drops into the Buffer zone and the project share of the supplemental mainstem flows cannot be evaluated, this BiOp Need must be estimated.

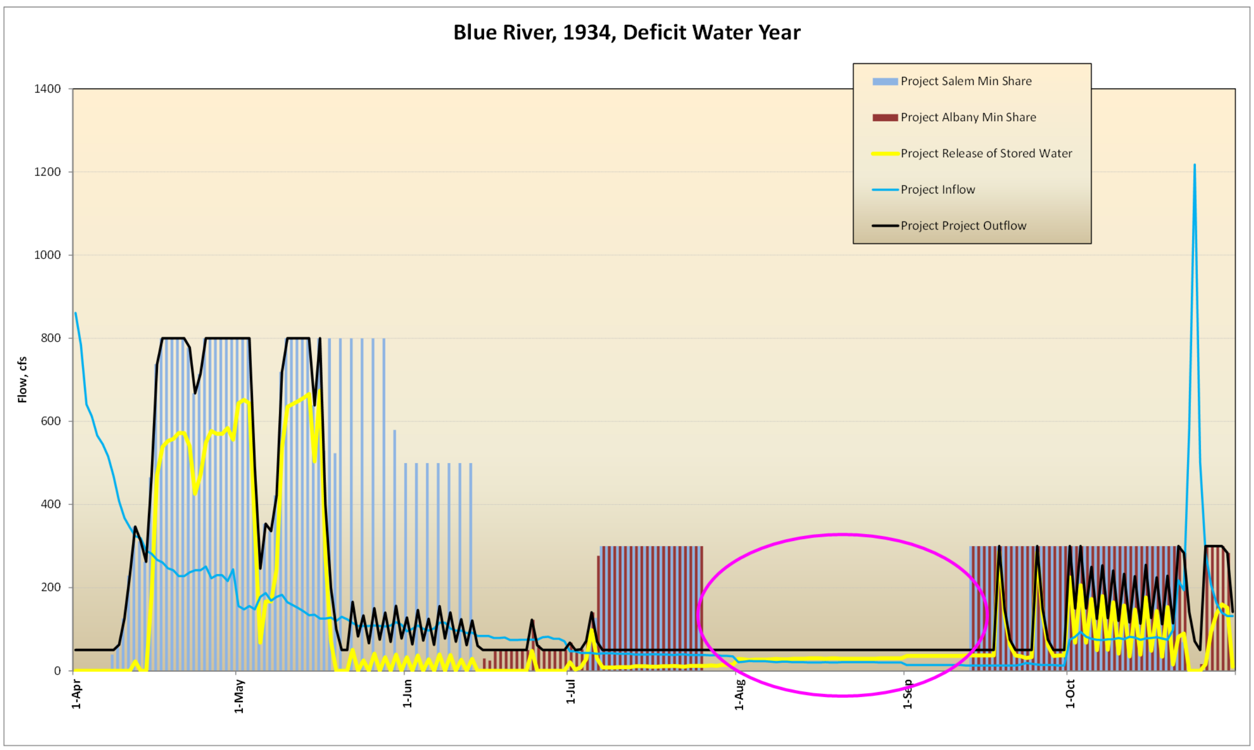


Figure 5.7. Blue River operation for April through October, 1934 – a Deficit year, from the ResSim Baseline from Excel parsing of flows. There is still a need for supplemental flows on the mainstem in the pink oval window, but the program does not evaluate this need because the pool level is in a zone that does not contain the mainstem flow rules.

The BiOp Need for periods when the project drops into the Buffer zone are estimated at 300 cfs for Blue River. This estimate is obtained by inspection of the simulation results for Blue River. Since the oval pink window in Figure 5.7 is bounded by downstream flow rules of 300 cfs, this flow value is chosen as the estimated share when Blue River is in the Buffer zone. This estimated value is used everywhere in April through October when the pool level is in the Buffer zone, rather than using a different estimated value at different times of the year.

The water volume component calculations are done for every day this year, just as has been described for 1929, and the daily volume components are shown below in Figure 5.8 for 1834. Note the large number of days with shortages (**red** bars), and almost no inflow passed for other reasons (**bright blue** bars). The color coding is the same as in Figure 5.5.

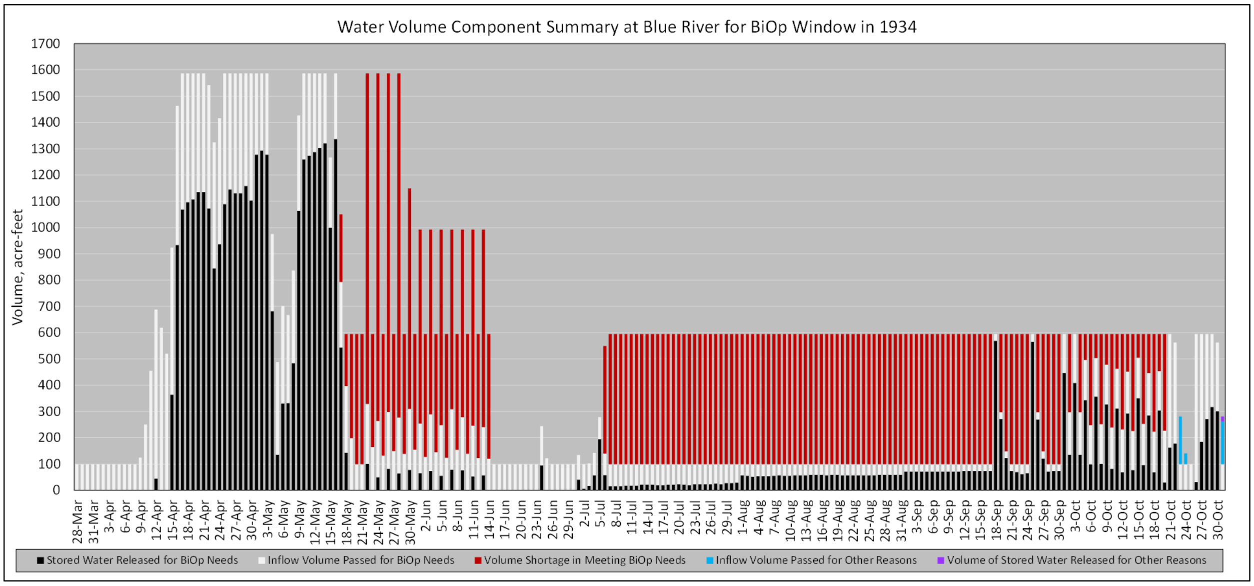


Figure 5.8. Illustration of the component water volume calculations for a Deficit water year, 1934, the same year as shown in Figure 5.7, and the same style of graph as Figure 5.5. Note this Deficit year has many days of shortages in meeting BiOp flows, with inflow passed for other reasons (bright blue) just for a few days late in October, and one day of stored water released that was not for meeting BiOp minimums, which is 31 October 1934.

The total decision process to calculate the BiOp Need is shown as a flow chart for Blue River in Figure 5.9. The flow chart is color coded – all IF block decisions are in yellow, estimates are shown in green, and exact values from the simulation files are in blue. The other Willamette projects that use Salem and Albany minimum rules follow the same process as outlined in the flow chart of Figure 5.9, except that the project estimated share when the pool level is in the Buffer zone will vary by project. Each project's minimum tributary flow rule is also different.

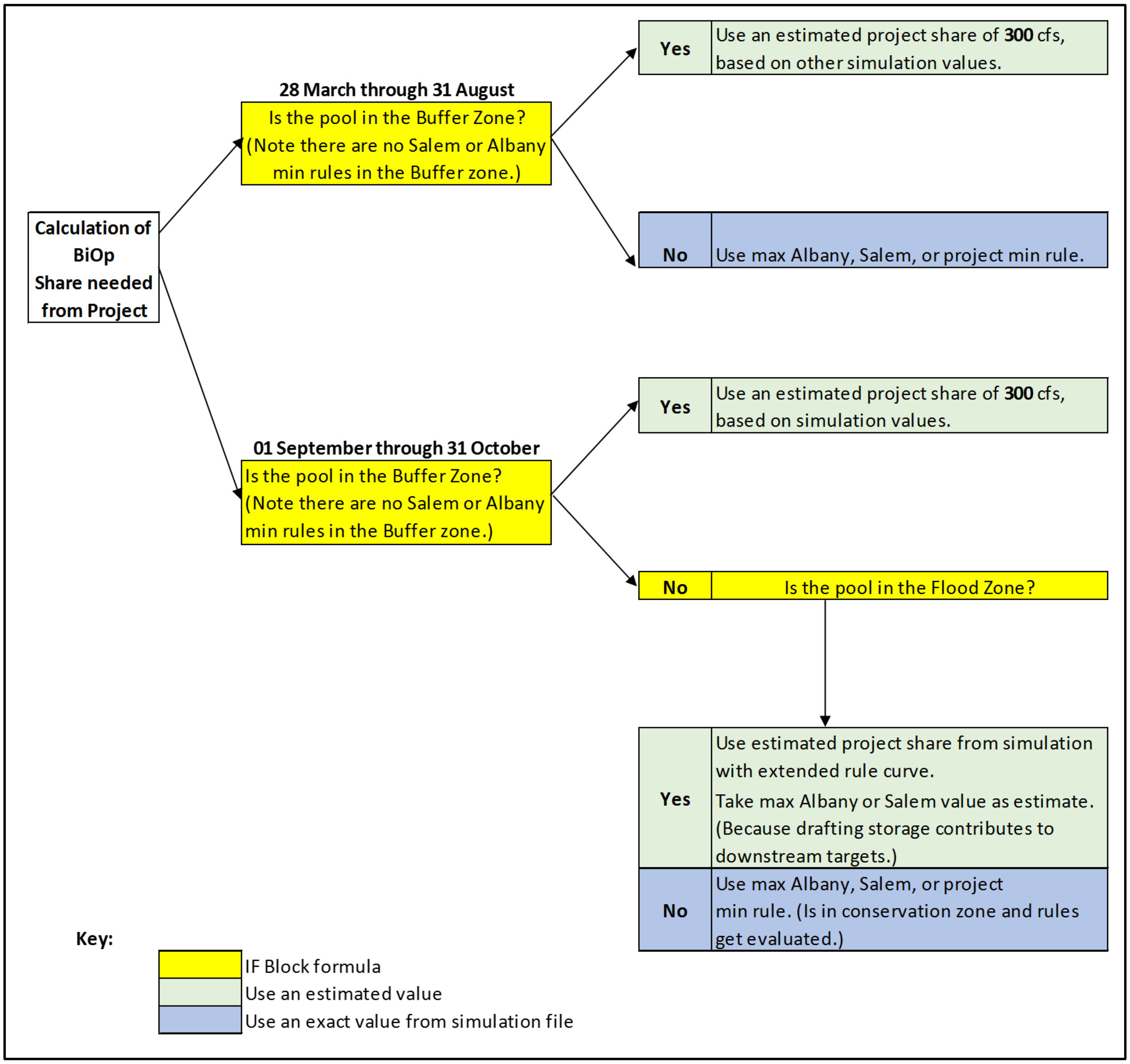


Figure 5.9. Blue River flow chart to calculate BiOp Need share. Note that the estimated values for the Buffer zone needs will be project dependent.

5.4 Storage Summary for Blue River, 1929

The calendar year of 1929 is summarized in this section for Blue River, with emphasis on several concepts related to water volume computations described in previous sections. This Blue River storage summary graph is shown in Figure 5.9 below. The dotted line is the rule curve for the project, in project storage (ac-ft) rather than pool elevation. The storage values in ResSim are total storage, which includes the water in the reservoir below the minimum conservation pool, so the reservoir storage below this level must be subtracted from the ResSim storage value reported from Res-Sim whenever conservation pool storage values are needed.

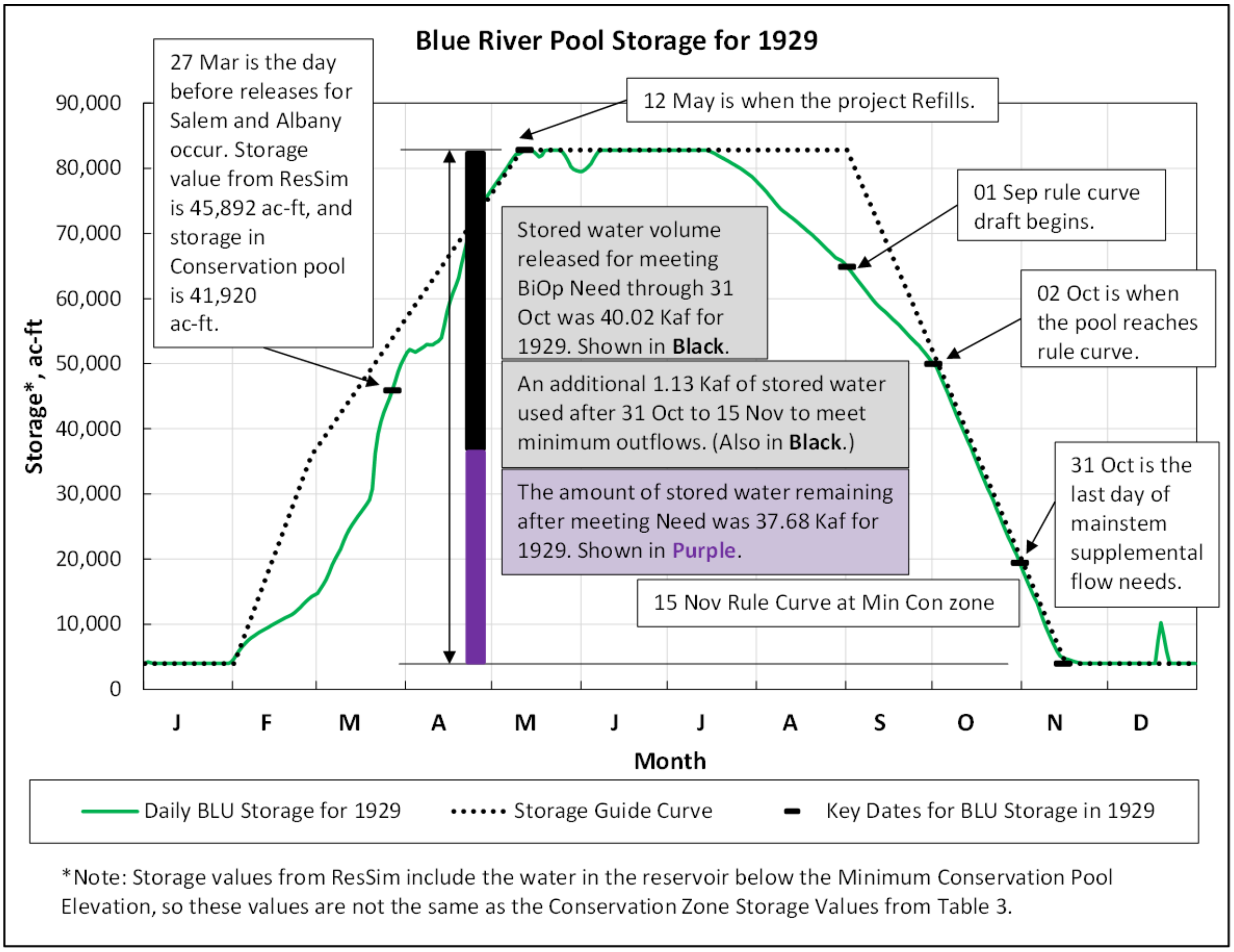


Figure 5.9. Storage volume summary information for Blue River example in 1929.

The green line in Figure 5.9 is the daily storage value from the Baseline simulation. Some specific dates are highlighted with horizontal bars. These important milestone dates are:

March 27: Blue River storage on the last day before releases may be needed to supplement mainstem flows at Salem and Albany. Releases on 28 March would arrive at Salem on April 1. The storage on the date marked, 27 March, is a measure of how much stored water the project gets to start with to help supplement flows for the mainstem. This date will be the same for Blue River for all years in the Baseline simulation, since the travel times do not vary by year.

May 12: Blue River has refilled, meaning it reaches the maximum conservation pool on this date, for this year specifically. The date will vary every year, and some years will not refill at all.

September 1: This is the date that the rule curve decreases, indicating the start of the fall season drafting. For this particular year, the reservoir elevation is below the rule curve, so in this year, the project is not drafting for fall yet. Releases are controlled by the minimum tributary flow and mainstem supplemental flows needed. (The decreasing storage of Blue River in 1929 after 01 Sept is for meeting BiOp Needs, both mainstem flow targets and minimum tributary flows.)

October 2: On this day in 1929, the project pool level has intersected the rule curve and begins to draft its storage to reach the minimum conservation pool for winter flood control needs, in addition to meeting its obligations for minimum tributary flows and mainstem supplemental flows. If the required outflows to meet the BiOp Need were greater than those needed for drafting along the rule curve, the outflows would increase to meet the Need. If the project outflow following the drafting rule curve are sufficient to satisfy the BiOp Need, some flow is still meeting the Need even if it would have been released to follow the pool draft anyway.

October 31: This is the last day for BiOp mainstem minimum flow targets, and marks the end of the BiOp window used in this report. Note that the project rule curve is not yet at the minimum conservation zone for Blue River at this day, and the pool level for 1929 is still drafting along the rule curve.

November 15: This is the day that the reservoir rule curve reaches the minimum conservation zone. Between 31 October and 15 November the project should still meet the minimum outflow requirements, and stored water may be needed to meet this.

The total conservation storage that was in the reservoir for 1929 can be broken into two components: 1) the amount of stored water released to satisfy the BiOp Need, including any stored water used to meet minimum tributary flows between 31 October and the date the rule curve reaches the minimum conservation zone, and 2) the rest of the stored water released at the end of the season.

For 1929, the total amount of stored water released to meet BiOp Needs from March 28 – October 31 was 40.02 Kaf. An additional 1.13 kaf of stored water met the minimum outflow targets after October 31 until the rule curve reaches the minimum conservation zone. Blue River did not have a BiOp shortage for 1929 – all project shares of flow targets were met, so the shortage was 0 Kaf. The project filled, so the maximum storage in the conservation pool for 1929 was 78.83 Kaf. Therefore, 78.83 Kaf – 40.02 Kaf – 1.13 Kaf = 37.68 Kaf of stored water was released from the project for reasons other than meeting BiOp Need. This 37.68 Kaf can be thought of as remaining storage that *could have been* released at other times during the season, with Blue River still having enough stored water available to meet its share of BiOp obligations.

Figure 5.9 shows these two stored water components as two columns in **black** and **purple** which sum to the total conservation storage maximum for the year. The volume of stored water released to meet BiOp Need is illustrated by the **black** vertical bar. The remaining storage that was not used for meeting BiOp Need is illustrated by the vertical **purple** bar. This remaining storage volume was released because the project had to draft, it was not released for BiOp Needs. This means that for 1929, there was 37,680 acre-feet of stored water that *could have been* used for other purposes without reducing the water volume that was needed for the BiOp flows.

If the year 1929 had had a non-zero BiOp shortage volume, then the amount of remaining stored water not used for meeting BiOp Need would have been reduced by the volume of the shortage. This reduction in remaining stored water by the shortage amount would approximate the additional storage released in real-time reservoir regulation decisions that would have been made to meet BiOp Need based on forecasts, snow levels in the basin, and other factors that cannot be modeled in Res-Sim.

5.5 Example Summary of Total Volume Calculations – Blue River, 1929

Two previous sections described in a written format how computation would occur (Section 5.1) for BiOp Needs (mainstem flow supplements), and specific dates for different observation windows were calculated as examples (Section 5.2). The total water volume calculations for Blue River in 1929 are presented here.

- The total calculated BiOp Need that was Blue River's share was 75,500 acre-feet for 1929. (This includes the estimated need in fall drafting season.)
- There was no shortage in meeting BiOp Needs from Blue River in 1929.
- The total volume of Inflow Passed through Blue River during the BiOp mainstem target period was 60,680 acre-feet. This is all outflows that were not stored water, regardless of why the inflow was passed. Note that the window begins on 28 Mar to include the travel time of released flows to Salem.
- The total volume of Inflow passed specifically to meet BiOp targets (mainstem and tributary minimum) was 35,480 acre-feet in 1929. This water volume is critical to include in meeting the mainstem minimums, since if this inflow was not available to pass, the need would have been met with stored water. At least some of the passed inflow could have been stored in the project if there was no BiOp Need, since the project was below rule curve during the refill season, but that inflow had to pass through to meet the BiOp mainstem targets instead. This water is represented by the white bars in Figure 5.5.
- The total volume of stored water released from Blue River specifically to meet the BiOp targets through 31 October was 40,020 acre-feet in 1929. This water is represented by the **black** bars in Figure 5.5. There is an additional 1.13 Kaf of stored water needed to meet the minimum outflows until the rule curve reaches the minimum conservation zone.
- The total volume of Inflow passed during the BiOp mainstem target window for reasons other than meeting BiOp flows was 25,200 acre-feet. These are inflows passed so that the project does not go above rule curve. This water is represented by the **bright blue** bars in Figure 5.5.
- The remaining amount of stored water in the Blue River conservation zone that was released at the end of drafting for reasons other than meeting BiOp Need was 37,680 acre-feet.

The yearly total volumes for the three total water volume component calculations (stored water released to meet BiOp Needs, inflow passed to meet BiOp Needs, and inflow passed for other reasons) for Blue River, 1929, are graphed in Figure 5.10 using the same color coding that has already been developed. In this figure, stored water released for the BiOp mainstem flow supplements is shown in **black** (40.502 Kaf), Inflow passed for the BiOp flows as white (35.48 Kaf), and Inflow passed for all other reasons is **bright blue** (25.20 Kaf). These volumes are shown as stacked column values.

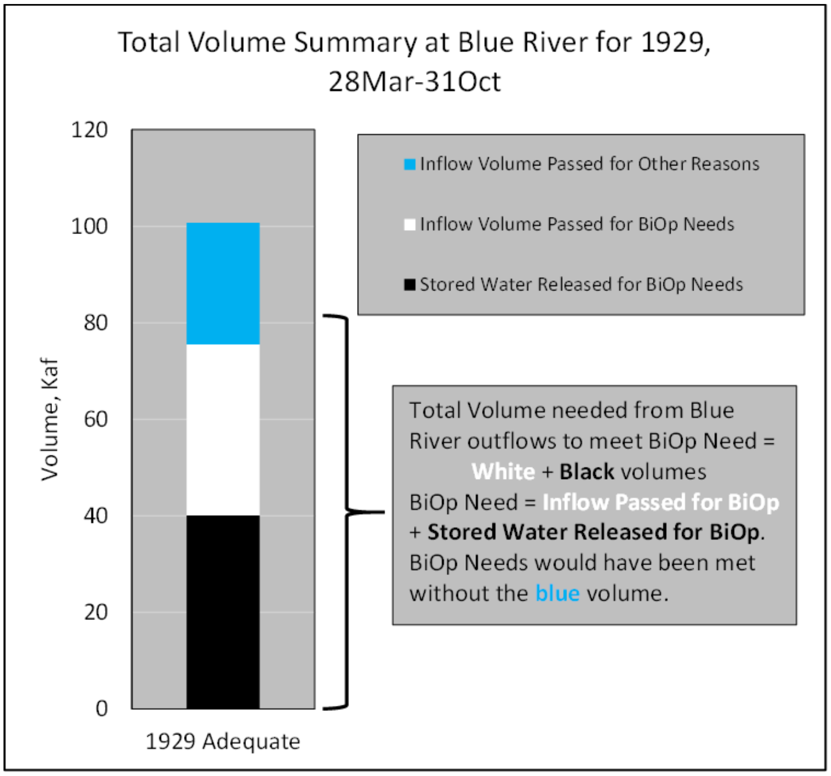


Figure 5.10. Volume totals summary for Blue River example in 1929.

5.6 Project Specific Yearly Water Volume Computations in Sections 6-17.

The project specific computations are detailed in Sections 6 through 17 for the full Period of Record 1929-2007. Section 5 highlighted the specific calculation methods that apply to Blue River, and many of these methods can applied directly to other projects. However, some projects have differences that must be explained individually, so the project specific computations are broken out separately for the following reasons:

- The project specific water volume components are needed for the Feasibility study. Alternatives analyzed in the Feasibility report will have a project by project comparison to the Baseline results in addition to a total basin comparison to the Baseline.
- The unique operations at some of the projects need to be clearly outlined and documented, since these operations affect how the water volume components are calculated.
- Each project needs to have its own section written in a stand-alone format for easier reference when alternatives are evaluated in the Feasibility report. Then the effects of modelled changes in an alternative can be referred back to a project specific detailed section, where differences between the alternative and the Baseline can be more readily identified.

As mentioned at the end of the Introduction to this report, the flow of the report is to lead the reader into a phased understanding of the concepts and the calculation methodology. In light of this phased approach, the projects with water volume component calculation methodologies most similar to Blue River will be presented first. Thus Cougar, Dorena, Cottage Grove, and Fall Creek will be presented after the full Blue River computations, since these projects are computed in ways most similar to that of Blue River. Blue River results are in Section 6, Cougar results in Section 7, Dorena results in Section 8, Cottage Grove results in Section 9, and Fall Creek results in Section 10.

Hills Creek and Lookout Point water volume components are presented in *three* sections following the projects listed above. This is because of the way that ResSim computes the values of the downstream minimum flow rules when reservoirs are in series – *since Lookout Point reservoir is in series with Hills Creek, the Albany and Salem rule evaluation at Lookout Point include the Hills Creek share of the flow release*. The two projects need their individual water volume component breakdowns in separate sections and their combined water volume components need to be identified as well. Hills Creek is presented first, in Section 11, which contains the project specific results for Hills Creek computed in much the same way as Blue River. The combined total for the two projects in series is presented next, in Section 12, which contains the Lookout Point plus Hills Creek flow components. The Lookout Point project specific results are then presented in Section 13, which must be estimated from the results of the previous two sections. The three sections covering Hills Creek and Lookout Point are presented in the order chosen so that the details presented build on the concept of the phased approach of describing the full methodology.

Fern Ridge project specific results are presented in Section 14. Fern Ridge is modelled without the Albany or Salem downstream minimum rule, but its operation still provides supplemental flow to the mainstem. These details are fully outlined in the section.

Green Peter and Foster project specific results are presented in Sections 15 and 16, respectively. Although Foster Dam is in series with Green Peter, the water volume component calculations are not similar to those of Lookout Point. This is because Green Peter and Foster are modelled to meet the mainstem flow at Salem differently than with a downstream Salem rule. The full details are of these differences are presented in these two sections.

The final project specific results, for Detroit Dam, are presented in Section 16. Detroit is modelled to meet its share of the Salem supplemental flows through high minimum tributary flows instead of a downstream minimum flow rule on the mainstem. These specific details are presented in Section 16.

Dexter and Big Cliff dams do not have results presented in this report, since they are re-regulation dams that just pass inflow in the ResSim model. These two dams are modeled to just pass inflow since they do not contain any stored water volume that is used for supplemental flows, as there is no Rule Curve associated with their operation.

The methodology to obtain the basin wide totals and those results are then presented in Section 17.

6 Blue River Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Blue River. The results are both tabulated and graphed. The time series records used for the calculations are from two simulation.dss files, from the Baseline and the extended rule curve variation (see the details in Section 5 for this variation).

The time series records used from the Baseline are:

//BLUE RIVER-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-DAM-MIN FLOW - AT BLUE RIVER/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

The time series records used from the variation with the extended rule curves are:

//BLUE RIVER-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//BLUE RIVER-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/

Table 6.1 (split into Table 6.1a for 1929 through 1970 and Table 6.1b for 1971 through 2007) shows the water volumes calculated for each of the categories described in Section 5.5. Results are presented in Kaf, or thousands of acre-feet. Note that all years have a BiOp Need, but not all years have a shortage in meeting those needs. The BiOp Need is the project share of the need, and the shortage is the volume of BiOp Need share that the project could not meet. Note that the first six columns of data are for the specific time window 28 March to 31 October, the window in which supplemental storage may be released to help meet mainstem flow targets.

The column in Table 6.1 labeled “Inflow Passed for BiOp” is the water volume that the project had to pass, whether or not any portion of it could have been stored, in order for Blue River outflows to meet the project’s share of BiOp mainstem minimum flows. If these inflows were not available, then all BiOp Needs from Blue River would have to have been taken from stored water, which would not have always been available.

The column labeled “Stored Water for BiOp” is the total volume of stored water released from Blue River to meet its share of the BiOp Need for each of the water years for 28 Mar – 31 Oct. The amount of storage space available in the Blue River reservoir between the minimum conservation pool and the maximum conservation pool is about 79 kaf. This is the amount of stored water in the project when it reaches refill. However, the project does not always refill, and so the full 79 Kaf is not always available. This column of data, “Stored Water for BiOp”, should be looked at in combination with all other columns, in particular the BiOp Need column and the BiOp Shortage column. The need is greatest when flows are lowest, which is when the project is not likely to refill.

The column labeled "Inflow Passed Other Reasons" represents the volume of water that Blue River released without ever storing and that was not used to supplement the mainstem flows. This volume of inflow could not have been stored - it was passed because the project was on the rule curve. If these inflows were not available, it would not have affected the Blue River BiOp Need calculation or the Inflow Passed for the BiOp or Stored Water released for the BiOp.

The maximum conservation zone storage (which does not include the storage below the minimum conservation pool) is shown in the column labeled "Maximum Conservation Storage for this Year". Since there is some additional conservation storage under the rule curve after 31 October (Blue River rule curve reaches the minimum conservation zone on 15 November), the stored water released in this small window to meet the minimum project outflows is shown in the second-to-last column of the table.

Some years Blue River had stored water released during fall drafting that was not released for meeting BiOp Need. This remaining release of stored water is shown in the last data column of the table and is calculated by subtracting the volume of stored water released to meet BiOp Need, the shortage in volume for meeting BiOp Need, and the small amount of stored water needed after 31 October from the maximum conservation storage for that year. This column of data is labeled "Remaining Storage". Note that a negative value of remaining storage shows a lack of conservation storage. This remaining storage value is of interest to the Willamette Basin Review feasibility study because it represents stored water that may be available for other purposes. The lowest value of the remaining storage is negative (indicating pool levels below the minimum conservation zone), showing that this project does not have any firm yield.

A ***year*** can have both remaining storage released shown in this last column and a shortage in meeting the share of the BiOp Need at the project because of the timing of flows. The values in Table 6.1 are summed from daily computations – a ***day*** can only have a shortage or an additional storage release, but the daily values summed over the period can have both. Similarly, a ***year*** can have inflow passed for other reasons and a shortage in meeting BiOp Needs, while a ***day*** cannot have both.

Figure 6.1 is side-by-side bar graphs of the water volume component results for all years. The graph on the left presents years in chronological order, while those on the right have the data sorted by the total BiOp Need calculated for the project. The **black** bars are the volume of stored water released to meet the BiOp mainstem minimums, the **white** bars are inflow volume passed to meet BiOp Needs, and the **red** bars are the shortage in volume – the amount of the BiOp Need from Blue River that was not met. The **bright blue** bars are the inflow volumes passed for other reasons. (Remember that a year can have both a volume shortage in meeting BiOp Needs and inflow passed for other reasons because the timing of flows into the reservoir factors into the calculation – the bars represent the sum of all the daily calculations.)

Figure 6.2 is another set of side-by-side graphs, showing the total volume shortage in releases to meet the BiOp Needs and the remaining stored water released that was not for BiOp Need. The volume shortage is shown in **red** in the graph on the left side of the Figure, and these values are the same as the "BiOp Shortage" values in the second data column of Table 6.1. The graph on the right is the remaining storage let out during the drafting phase that was not released for meeting BiOp needs, and these are **purple** bars. These values are the same as in the last column of Table 6.1.

The data in the graphs of Figure 6.2 have been sorted twice: the first sorting was based on the BiOp Need (as the right-hand graph of Figure 6.1 was), and then additionally sorted from low shortage to high shortage volumes. The right-hand graph is the data for the same sorting of years.

Figure 6.3 summarizes the Blue River release components by average values of monthly totals. The color coding of the bars is the same as in Figure 6.1 – **black** is stored water released to meet BiOp Need, **white** is inflow passed to meet BiOp Need, **red** is the shortage in meeting the BiOp Need, and **bright blue** is the inflow that was passed for other reasons (when the project was already on the rule curve or above it). The total BiOp Need at Blue River is the sum of the black, white, and red bars.

Note that the average monthly total BiOp Need varies by month for two reasons – the flow targets on the mainstem change throughout the season and less supplemental flow is required on the mainstem when local flows downstream of the dams are higher. Although April flow minimums at Salem are higher than those in May, the local inflows are higher in April. Blue River's minimum tributary flow is constant throughout the year, so this does not have an effect on the changing total need each month.

Figure 6.4 shows the daily non-exceedance percentiles for the Blue River storage in the reservoir. These values are computed separately for each day of the year – none of the lines shown represent any specific year. For example, 01 July has a 5% line (purple) of about 20 Kaf. This means that on July 1, the project storage was 20 Kaf *or less* 5% of the time. On that same day, the green line (25%) is about 42 Kaf. This mean July 1 has a pool storage of 42 Kaf *or less* 25% of the time.

The non-exceedance storage graph shown in Figure 6.4 gives a graphical representation of the storage percentiles of the project for the period of record analysis, but does not convey the amount of stored water used to meet BiOp flow targets or the amount of stored water not used for meeting BiOp Needs at the end of the season.

The following sections for Cougar, Dorena, Cottage Grove, Fall Creek, and Hills Creek, Sections 6 through 11, have tables and graphs in the same format as those presented here for Blue River, and the water volume calculations for those projects follow the same procedures as outlined in the Basic Methodology, presented in Section 5. Sections 6-11 will not contain the full discussions of the tables and figures as this Blue River section.

The sections for Lookout Point, Fern Ridge, Foster, Green Peter, and Detroit will follow a similar format for tables and graphs, but will include some additional details that are unique to those projects.

Table 6.1a. Water Volume Calculations for 28 March through 31 October, Blue River, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	75.50	0.00	60.68	35.48	40.02	25.20	78.83	1.13	37.68
1930	96.89	14.00	36.86	35.86	47.04	1.00	41.77	0.00	-19.26
1931	141.95	48.11	44.33	32.42	61.41	11.91	63.34	0.00	-46.18
1932	56.08	0.05	96.87	22.77	33.26	74.10	78.83	0.00	45.52
1933	47.77	0.12	139.27	32.13	15.52	107.13	78.83	0.00	63.19
1934	144.26	64.40	34.38	34.00	45.86	0.39	47.60	0.00	-62.66
1935	83.12	0.16	63.85	40.20	42.77	23.66	78.83	0.21	35.69
1936	66.22	0.00	67.37	29.98	36.24	37.39	78.83	0.83	41.76
1937	43.18	0.29	168.48	22.89	20.00	145.58	78.83	0.00	58.54
1938	65.46	0.19	92.55	31.96	33.31	60.59	78.83	0.00	45.33
1939	118.98	3.32	66.68	60.65	55.01	6.04	58.32	0.33	-0.34
1940	152.92	60.76	41.03	30.27	61.89	10.76	60.96	0.00	-61.68
1941	121.48	41.81	45.96	45.75	33.92	0.21	19.98	0.00	-55.76
1942	86.47	1.20	38.03	37.35	47.92	0.67	41.13	0.00	-7.98
1943	46.83	0.00	104.26	27.24	19.60	77.02	78.83	0.00	59.23
1944	91.62	0.00	38.56	37.97	53.65	0.59	60.01	0.00	6.36
1945	65.97	0.21	93.60	21.76	44.00	71.84	78.83	0.00	34.61
1946	97.77	0.13	75.01	55.74	41.89	19.27	78.83	0.00	36.80
1947	72.12	0.00	90.76	32.62	39.50	58.14	66.88	0.00	27.37
1948	43.14	0.10	109.67	23.05	19.99	86.62	78.83	0.00	58.74
1949	65.58	0.00	113.42	36.39	29.20	77.03	78.83	0.07	49.56
1950	44.21	0.00	178.98	25.18	19.02	153.80	78.83	0.00	59.80
1951	87.18	0.00	90.94	42.54	44.64	48.40	78.83	0.00	34.19
1952	64.62	0.20	91.49	34.19	30.23	57.30	78.83	0.51	47.89
1953	54.44	0.00	92.09	33.41	21.03	58.68	78.83	0.02	57.78
1954	76.74	0.00	62.18	42.77	33.97	19.41	68.69	0.00	34.72
1955	47.29	0.00	145.10	25.51	21.79	119.59	78.83	0.00	57.04
1956	41.25	0.00	135.41	22.59	18.66	112.82	78.83	0.00	60.17
1957	71.55	0.00	51.85	30.64	40.91	21.21	77.76	0.30	36.55
1958	81.63	0.02	49.95	40.33	41.28	9.62	74.36	0.02	33.03
1959	91.30	0.00	73.96	42.40	48.89	31.56	62.73	0.00	13.83
1960	57.17	0.25	120.11	21.38	35.54	98.73	78.83	0.00	43.04
1961	73.83	0.00	67.84	39.19	34.65	28.65	78.83	0.00	44.18
1962	56.79	0.00	100.88	29.12	27.67	71.76	78.83	0.00	51.16
1963	62.79	0.00	81.48	30.44	32.34	51.04	78.83	0.00	46.48
1964	93.76	0.00	93.12	61.06	32.70	32.06	78.83	0.01	46.13
1965	98.06	0.00	44.54	43.40	54.66	1.14	45.96	0.11	-8.81
1966	135.85	16.83	96.62	51.24	67.78	45.38	64.54	0.01	-20.08
1967	102.56	0.00	59.10	51.31	51.25	7.79	56.51	0.00	5.26
1968	87.49	0.00	54.21	39.87	47.62	14.34	55.83	0.00	8.21
1969	63.79	0.00	115.81	39.94	23.85	75.86	78.83	0.15	54.83
1970	108.11	10.47	34.61	33.30	65.38	1.31	58.72	0.00	-17.13

Table 6.1b. Water Volume Calculations for 28 March through 31 October, Blue River, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	39.16	0.00	124.30	23.80	15.36	100.50	78.83	0.00	63.47
1972	38.65	0.01	87.69	18.66	19.99	69.03	78.83	0.12	58.71
1973	138.08	48.89	41.33	40.93	48.46	0.40	43.60	0.00	-53.75
1974	46.81	0.17	118.10	21.67	24.97	96.44	78.83	1.22	52.47
1975	75.49	0.19	79.45	44.39	30.91	35.06	78.83	0.00	47.72
1976	61.39	0.29	62.55	26.15	34.95	36.39	78.83	0.76	42.83
1977	105.25	0.00	56.63	55.39	49.86	1.24	44.52	0.00	-5.34
1978	77.00	0.06	39.03	38.84	38.10	0.20	50.60	0.87	11.57
1979	88.15	0.00	64.52	26.27	61.89	38.26	78.83	0.24	16.70
1980	103.92	0.00	49.09	38.14	65.78	10.95	68.30	0.20	2.32
1981	85.08	0.00	49.06	34.04	51.04	15.02	76.32	0.50	24.78
1982	66.05	0.20	74.93	33.75	32.10	41.18	78.83	0.00	46.53
1983	65.27	0.03	54.98	29.29	35.95	25.69	78.83	0.11	42.74
1984	32.75	0.00	112.82	19.98	12.77	92.84	78.83	0.00	66.06
1985	88.50	0.00	77.87	44.58	43.92	33.29	71.71	0.00	27.79
1986	93.72	0.00	37.64	34.98	58.74	2.65	54.25	0.04	-4.53
1987	157.10	72.08	29.60	29.26	56.61	0.34	57.34	0.99	-72.35
1988	70.91	0.00	72.65	24.71	46.20	47.94	78.83	0.07	32.56
1989	81.94	0.00	70.37	35.61	46.33	34.76	74.16	0.61	27.22
1990	126.28	0.00	59.10	52.94	73.34	6.17	70.99	0.10	-2.45
1991	74.54	0.00	53.21	31.78	42.76	21.43	78.83	0.52	35.55
1992	163.66	80.52	20.57	20.17	65.88	0.40	53.79	0.00	-92.61
1993	45.36	0.26	112.72	17.68	27.43	95.03	78.83	1.17	49.98
1994	140.76	40.88	45.42	34.92	66.53	10.49	64.43	0.00	-42.98
1995	96.98	0.00	63.41	40.26	56.71	23.15	78.83	0.00	22.11
1996	56.01	0.09	91.12	23.98	32.00	67.14	78.83	0.05	46.69
1997	48.07	0.00	81.82	26.90	21.17	54.93	78.83	0.03	57.63
1998	77.15	0.09	38.94	37.34	39.71	1.60	66.75	0.03	26.91
1999	61.05	0.15	95.82	36.14	24.85	59.68	78.83	0.29	53.54
2000	62.28	0.08	50.70	30.29	31.92	20.41	78.83	0.83	46.01
2001	124.63	33.52	44.44	42.96	48.14	1.47	42.08	0.07	-39.65
2002	111.40	0.00	79.56	46.79	64.61	32.77	69.38	0.19	4.59
2003	103.03	0.44	47.95	27.06	75.53	20.89	78.83	0.94	1.92
2004	98.15	1.70	55.26	48.27	48.19	7.00	50.19	0.24	0.07
2005	96.52	0.00	36.77	35.53	60.99	1.24	72.15	0.00	11.16
2006	88.65	0.00	42.05	35.65	53.00	6.41	68.15	0.00	15.15
2007	121.16	18.90	44.30	43.10	59.16	1.20	64.31	0.11	-13.86

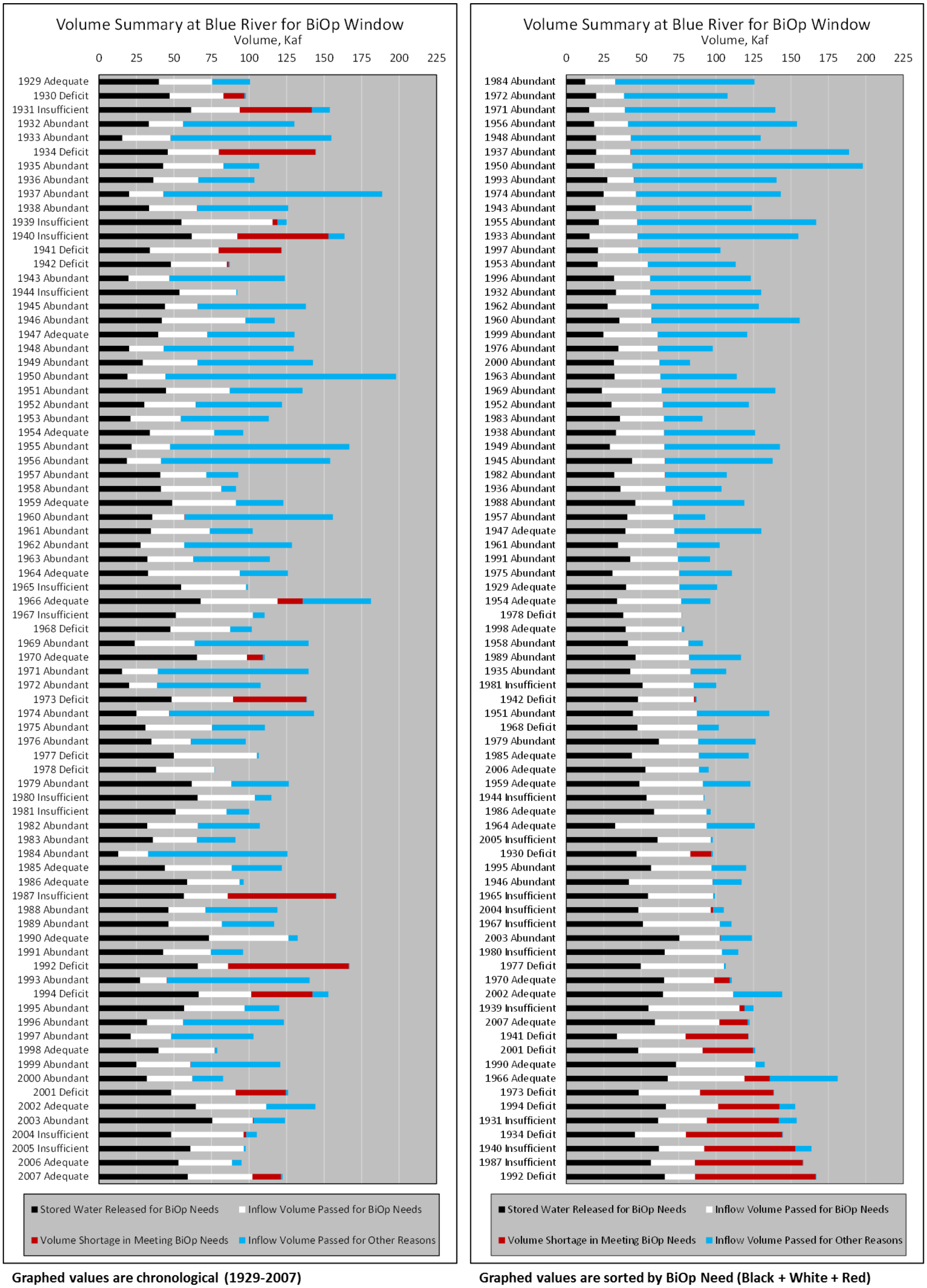


Figure 6.1. Water volume totals for Blue River 1929-2007, in chronological order (on left), and sorted by BiOp Need (on right), which is the Black + White + Red value.

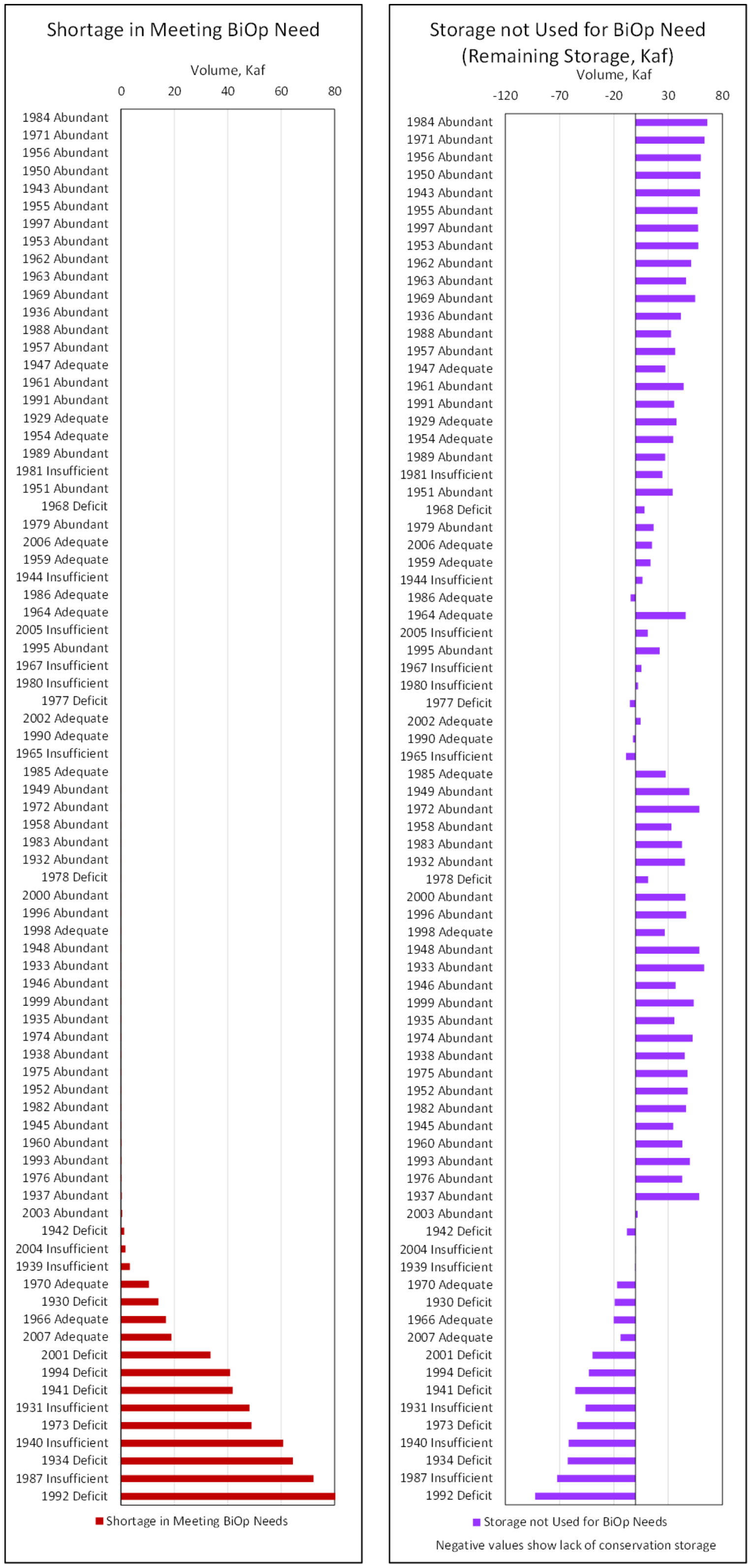
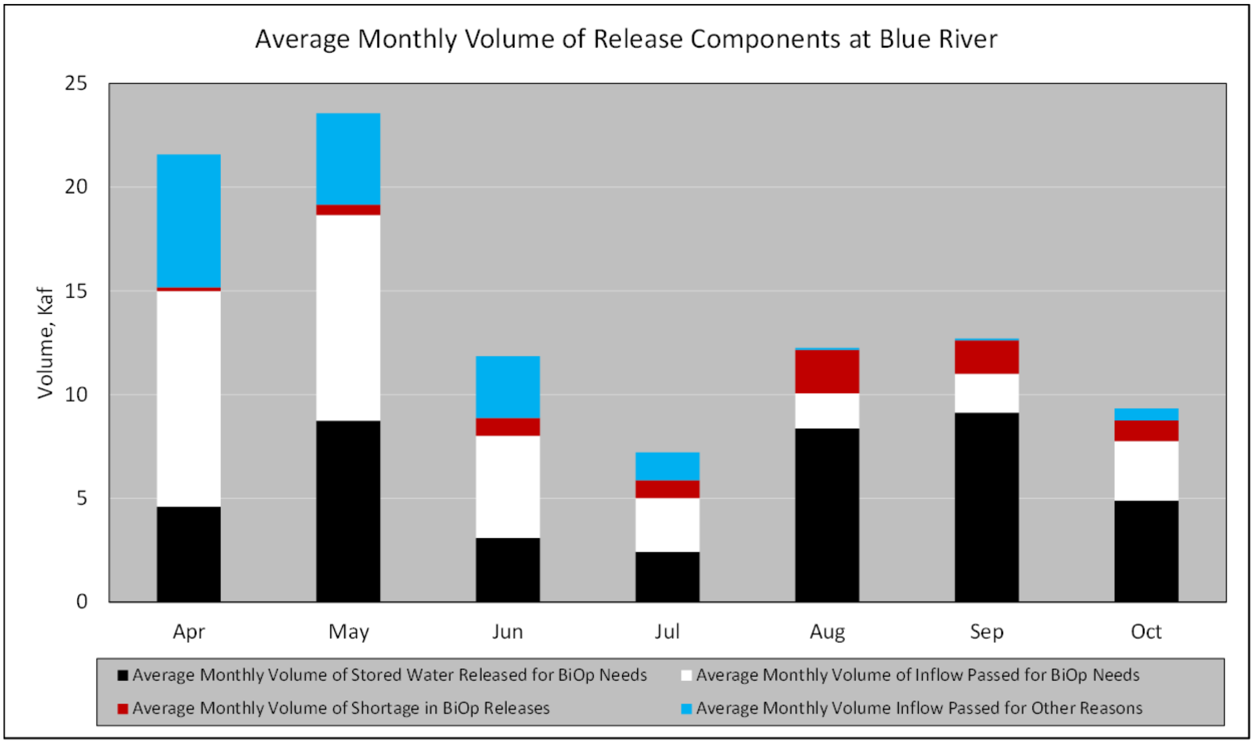


Figure 6.2. Water Volume totals for Blue River 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need Share of Project	0.91	15.18	19.15	8.87	5.85	12.12	12.62	8.77
Stored Water Released for BiOp Need	0.24	4.61	8.75	3.10	2.43	8.38	9.13	4.89
Inflow Passed for BiOp Need	0.67	10.39	9.91	4.92	2.58	1.69	1.88	2.88
Shortage in meeting BiOp Need	0.00	0.18	0.49	0.86	0.86	2.10	1.62	1.00
Inflow Passed Other Reasons	0.54	6.41	4.42	2.98	1.35	0.10	0.08	0.58

Figure 6.3. Water volume average monthly totals for release components for Blue River 1929-2007. Black is the stored water released for the BiOp Need, white is the inflow passed to meet the BiOp Need, red is the shortage in meeting BiOp Need, and blue is the inflow passed for other reasons.

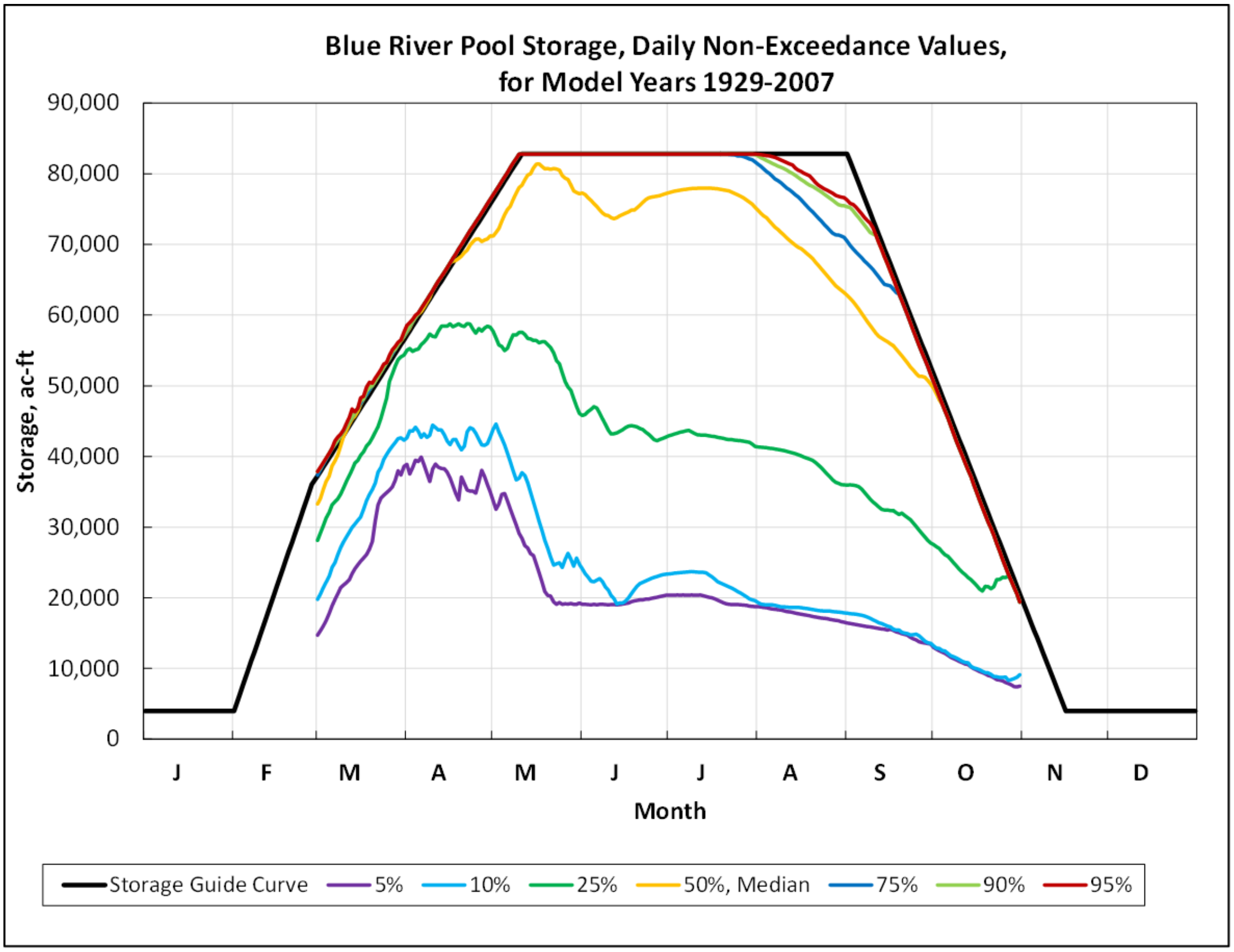


Figure 6.4. Non-exceedance storage values for Blue River 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

7 Cougar Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Cougar. The results are both tabulated and graphed in the same manner that was described for Blue River in Section 6. The time series records used for the Cougar calculations are:

//COUGAR-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-MINCONSERVFLOW_COUGAR/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COUGAR-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//COUGAR-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/ EXTENDBASE 0/

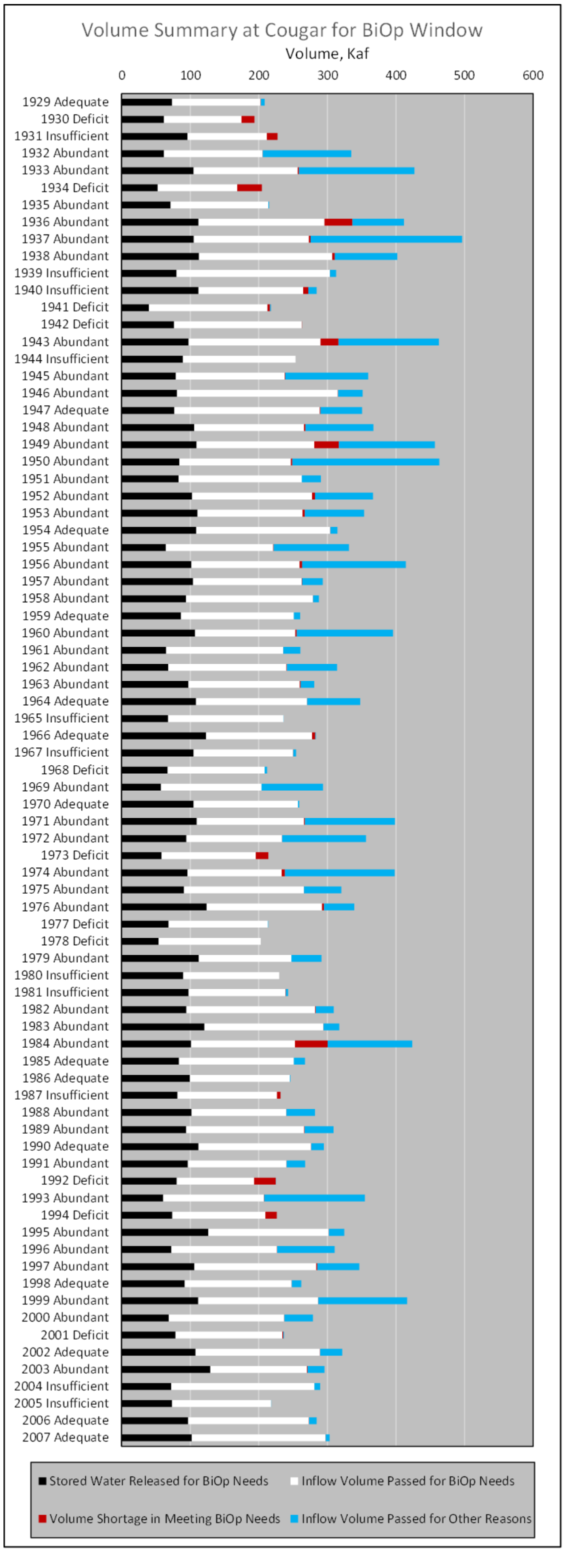
Water volume component calculations for Cougar are tabulated in Table 7.1 (split into Table 7.1a for 1929 through 1970 and Table 7.1b for 1971 through 2007) and graphed in Figure 7.1. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 7.2, and the average monthly total volumes are shown in Figure 7.3. The Cougar storage non-exceedance graph is shown in Figure 7.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Table 7.1a. Water Volume Calculations for 28 March through 31 October, Cougar, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

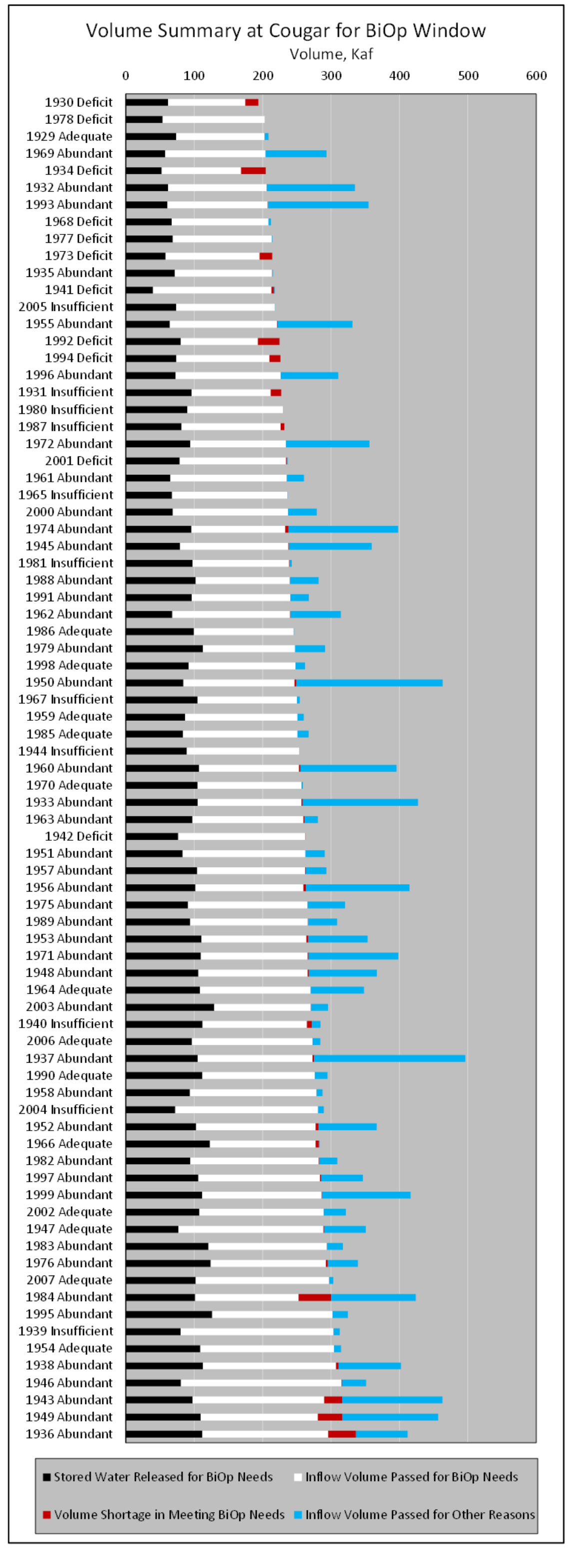
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	203.12	0.39	134.69	129.21	73.52	5.48	136.80	13.05	49.84
1930	193.61	18.93	112.94	112.94	61.74	0.00	59.36	1.05	-22.35
1931	227.26	15.42	115.71	115.71	96.13	0.00	94.95	0.20	-16.80
1932	205.99	0.28	272.91	144.12	61.60	128.80	136.90	0.00	75.02
1933	258.69	1.95	319.98	151.67	105.06	168.31	137.08	5.40	24.66
1934	204.42	35.91	116.02	116.02	52.49	0.00	51.41	0.00	-36.99
1935	214.10	0.15	143.33	142.46	71.50	0.87	136.80	1.75	63.41
1936	336.48	40.69	259.11	183.73	112.06	75.38	136.80	9.74	-25.69
1937	275.32	2.34	388.85	167.71	105.27	221.14	136.90	0.17	29.12
1938	310.71	3.54	285.91	194.49	112.68	91.42	136.90	0.00	20.68
1939	303.69	0.04	232.69	223.69	79.95	8.99	100.61	7.92	12.69
1940	272.18	7.48	164.84	152.58	112.12	12.26	105.94	0.07	-13.73
1941	216.36	3.60	174.49	173.04	39.71	1.45	32.94	0.00	-10.37
1942	262.69	0.41	185.88	185.88	76.40	0.00	106.44	0.00	29.64
1943	316.14	26.14	338.93	192.36	97.64	146.57	136.90	0.00	13.12
1944	253.40	0.00	164.15	164.15	89.26	0.00	101.12	3.71	8.15
1945	238.69	1.01	279.47	158.60	79.08	120.87	136.90	0.19	56.63
1946	315.81	0.59	270.21	234.70	80.52	35.50	136.80	0.00	55.69
1947	290.06	1.19	272.83	212.17	76.70	60.66	127.17	0.00	49.28
1948	268.11	2.19	258.89	160.03	105.89	98.87	136.90	0.35	28.46
1949	316.81	35.98	311.34	171.46	109.36	139.88	136.90	6.02	-14.46
1950	248.96	2.25	376.88	162.67	84.05	214.21	136.99	0.00	50.70
1951	262.72	0.00	207.66	179.70	83.01	27.96	135.49	0.05	52.43
1952	281.93	4.31	259.56	174.80	102.82	84.76	136.90	7.79	21.98
1953	267.03	3.18	239.70	153.24	110.61	86.46	136.90	2.70	20.41
1954	304.35	0.00	205.81	195.48	108.88	10.33	136.80	2.27	25.65
1955	221.75	0.75	266.31	156.64	64.36	109.67	137.07	0.00	71.96
1956	263.30	3.79	309.18	157.90	101.60	151.28	136.90	0.04	31.46
1957	263.17	0.75	188.23	158.16	104.25	30.07	132.82	3.98	23.83
1958	279.16	0.19	193.45	185.09	93.89	8.36	136.80	0.79	41.93
1959	250.97	0.00	173.64	164.49	86.48	9.15	116.40	1.34	28.57
1960	255.33	2.24	286.39	145.92	107.16	140.47	136.90	1.17	26.32
1961	235.59	0.10	195.42	170.49	65.00	24.93	136.87	0.29	71.48
1962	241.04	0.78	245.54	172.43	67.83	73.12	136.90	1.17	67.11
1963	260.96	1.26	182.22	162.41	97.29	19.81	136.80	0.32	37.93
1964	270.57	0.00	239.61	162.16	108.42	77.45	136.90	4.49	24.00
1965	236.16	0.00	168.74	168.54	67.62	0.20	86.54	3.24	15.69
1966	282.49	4.89	155.27	154.52	123.07	0.75	114.90	0.09	-13.15
1967	250.11	0.02	149.41	145.18	104.91	4.23	115.66	3.75	6.98
1968	208.56	0.00	144.97	141.48	67.08	3.49	85.26	0.19	17.99
1969	204.06	0.00	236.07	146.63	57.43	89.44	136.90	6.58	72.89
1970	256.92	0.00	154.08	152.06	104.86	2.02	106.43	0.16	1.42

Table 7.1b. Water Volume Calculations for 28 March through 31 October, Cougar, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	267.26	1.42	287.42	156.15	109.69	131.27	136.90	0.00	25.78
1972	234.09	0.11	261.71	139.50	94.47	122.21	136.90	3.60	38.71
1973	213.97	18.35	137.41	137.41	58.21	0.00	56.42	0.00	-20.14
1974	237.99	4.90	297.36	137.11	95.97	160.25	137.93	8.04	29.01
1975	265.88	0.20	229.29	174.74	90.95	54.56	136.90	0.00	45.75
1976	295.28	3.02	212.27	168.27	123.99	44.00	136.90	10.37	-0.49
1977	213.37	0.00	145.61	144.86	68.50	0.75	78.49	0.02	9.97
1978	202.78	0.00	149.06	149.06	53.71	0.00	81.12	12.33	15.09
1979	247.45	0.00	178.65	134.84	112.61	43.81	136.80	2.83	21.36
1980	229.66	0.00	139.75	139.75	89.91	0.00	99.94	5.41	4.62
1981	239.51	0.69	144.26	141.15	97.67	3.12	120.31	4.42	17.53
1982	283.05	0.94	213.87	187.74	94.37	26.13	136.81	0.13	41.36
1983	294.32	0.33	196.23	173.21	120.78	23.02	136.80	0.86	14.83
1984	300.26	47.67	274.83	151.31	101.28	123.52	138.32	0.00	-10.63
1985	251.11	0.00	183.63	167.58	83.53	16.05	136.80	1.43	51.84
1986	245.50	0.00	146.63	145.91	99.59	0.72	110.50	0.00	10.91
1987	231.68	5.37	144.96	144.96	81.36	0.00	79.52	0.38	-7.59
1988	240.22	0.20	179.62	137.94	102.08	41.68	136.90	0.63	33.99
1989	266.67	0.57	214.30	172.02	94.08	42.28	131.89	2.85	34.38
1990	276.49	0.26	182.52	164.17	112.06	18.35	132.29	0.03	19.95
1991	240.58	0.11	170.90	143.95	96.52	26.95	136.80	1.86	38.31
1992	224.61	31.55	112.77	112.70	80.36	0.06	71.79	0.60	-40.72
1993	208.08	0.53	293.58	146.86	60.69	146.72	136.90	11.20	64.48
1994	226.15	16.41	135.97	135.97	73.77	0.00	69.02	0.20	-21.36
1995	302.15	0.10	198.24	175.82	126.23	22.42	136.84	0.97	9.54
1996	226.64	0.08	237.79	153.97	72.59	83.82	136.90	0.00	64.23
1997	285.48	1.77	238.79	177.80	105.92	60.99	136.81	0.84	28.29
1998	248.01	0.03	170.00	156.00	91.98	13.99	128.94	1.36	35.57
1999	286.88	0.51	304.12	174.77	111.60	129.35	136.90	0.69	24.09
2000	237.26	0.16	210.15	168.40	68.70	41.74	136.90	6.25	61.79
2001	235.58	1.33	156.78	155.73	78.52	1.05	82.19	1.69	0.65
2002	289.38	0.05	213.80	181.62	107.71	32.18	133.59	7.37	18.45
2003	271.11	0.76	165.74	141.16	129.19	24.58	135.54	5.11	0.47
2004	281.08	0.00	217.12	208.87	72.21	8.25	120.24	0.85	47.18
2005	218.03	0.00	144.55	144.50	73.53	0.05	112.21	0.00	38.68
2006	273.24	0.28	187.21	176.13	96.83	11.08	136.36	0.50	38.75
2007	297.47	0.22	200.71	194.99	102.25	5.71	114.53	1.64	10.41



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 7.1. Water volume totals for Cougar 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

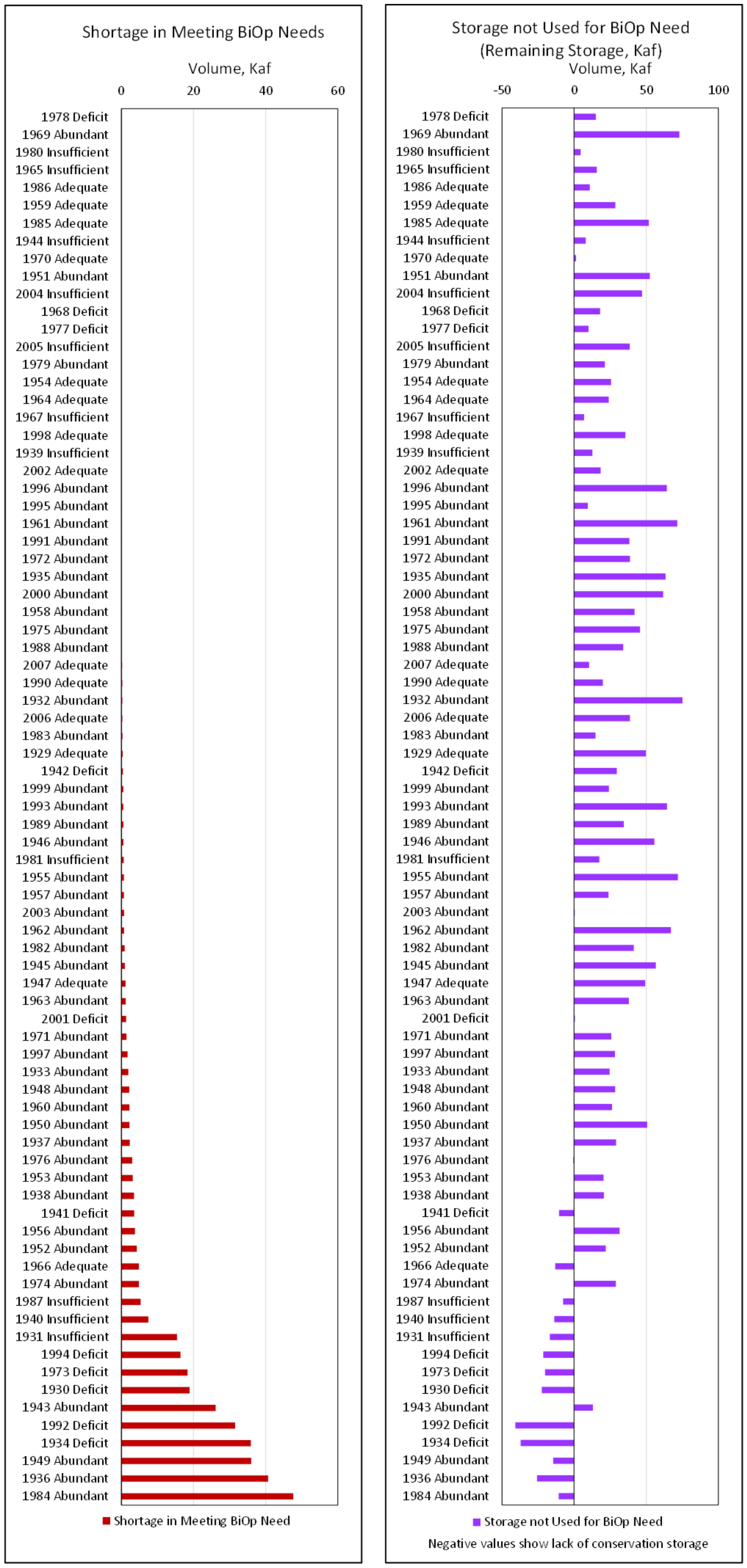
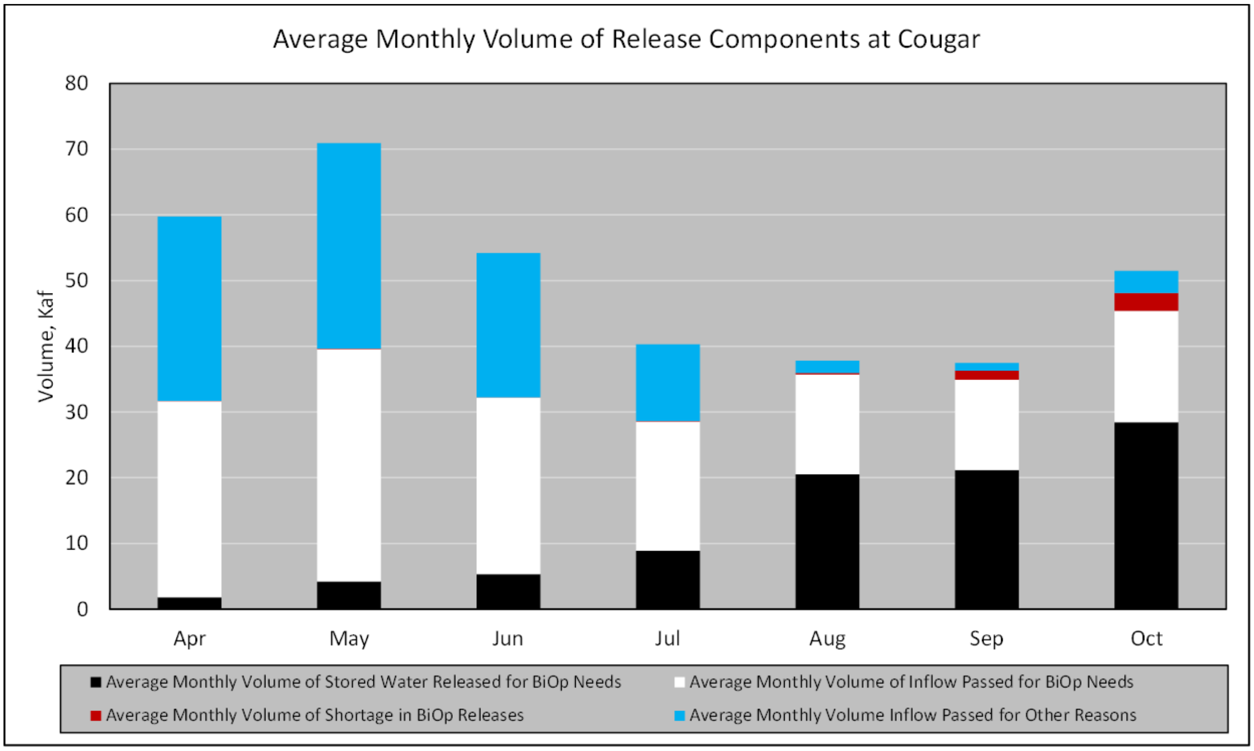


Figure 7.2. Water Volume totals for Cougar 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	3.33	31.69	39.66	32.23	28.63	35.96	36.28	48.13
Stored Water Released for BiOp Needs	0.06	1.80	4.23	5.33	8.90	20.50	21.14	28.45
Inflow Passed for BiOp Needs	3.27	29.85	35.35	26.88	19.68	15.24	13.76	16.91
Shortage in meeting BiOp Needs	0.00	0.04	0.09	0.02	0.06	0.22	1.38	2.76
Inflow Passed Other Reasons	3.20	28.05	31.25	21.95	11.67	1.86	1.18	3.35

Figure 7.3. Water volume average monthly totals for release components for Cougar 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

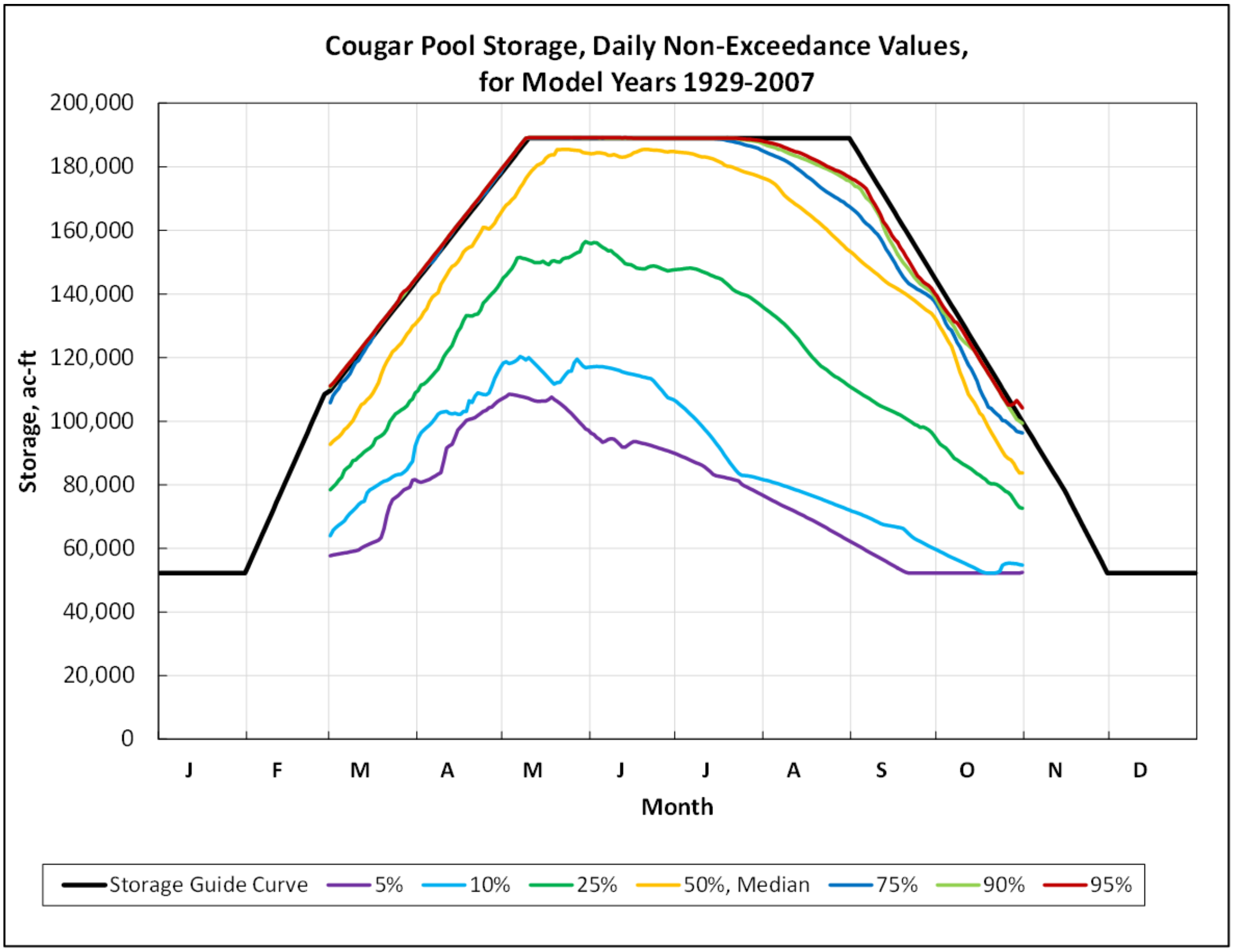


Figure 7.4. Non-exceedance storage values for Cougar 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

8 Dorena Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Dorena. The results are both tabulated and graphed in the same manner that was described for Blue River in Section 6. The time series records used for the Dorena calculations are:

//DORENA-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-DAM-MIN FLOW FROM DORENA/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DORENA-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//DORENA-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/ EXTENDBASE /

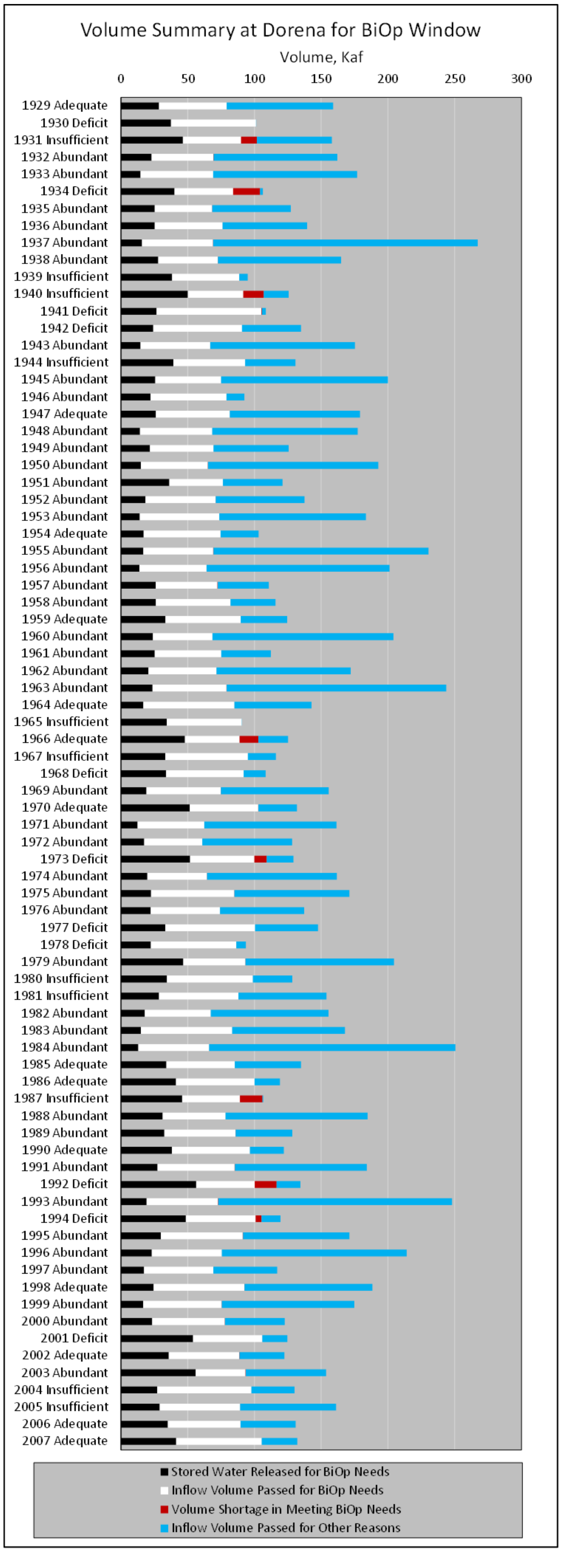
Water volume component calculations for Dorena are tabulated in Table 8.1 (split into Table 8.1a for 1929 through 1970 and Table 8.1b for 1971 through 2007) and graphed in Figure 8.1. Table 8.1 does not need the column labeled "Stored Water Used After 10/31 for Min" since the project rule curve reaches minimum conservation zone on 31 October. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 8.2, and the average monthly total volumes are shown in Figure 8.3. The Dorena storage non-exceedance graph is shown in Figure 8.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Table 8.1a. Volume Calculations for 28 March through 31 October, Dorena, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage. Negative value in last column shows lack of conservation storage. Note 10/31 last day of conservation storage for DOR.)

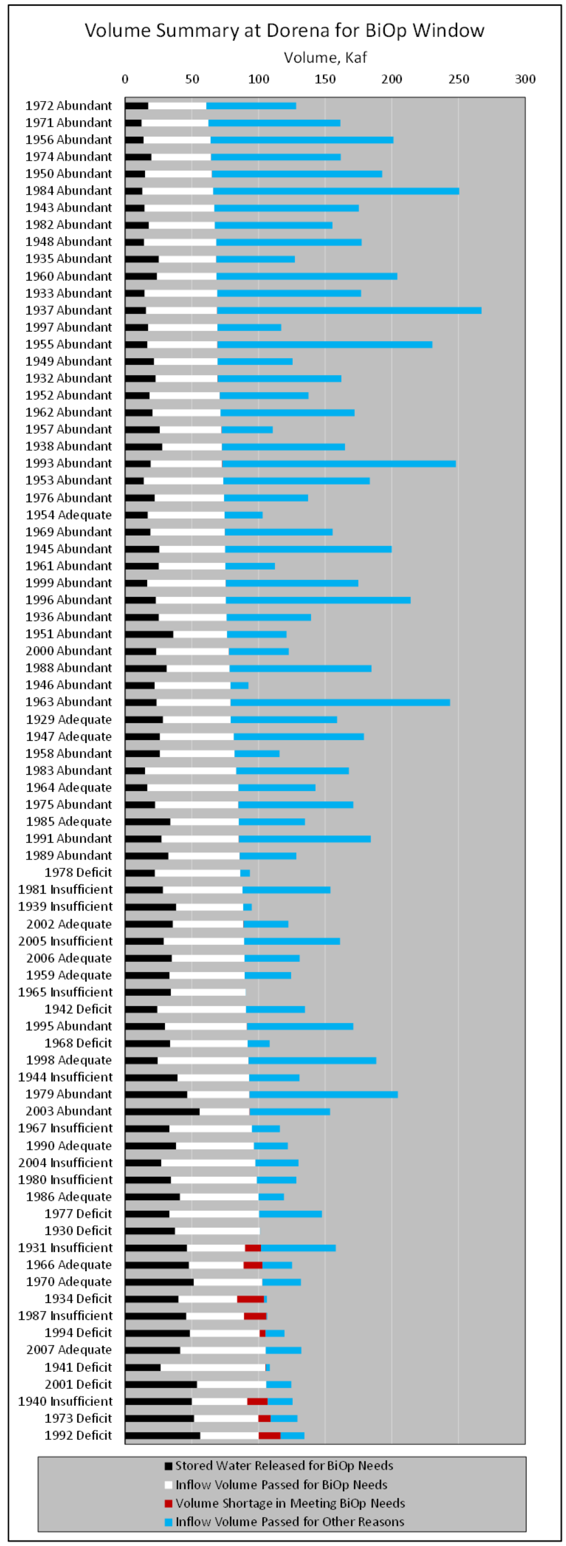
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF	
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Remaining Storage (if<0 below Min Con)
1929	79.21	0.00	130.48	50.74	28.47	79.74	65.01	36.54
1930	101.18	0.00	63.92	63.76	37.42	0.16	52.95	15.53
1931	101.82	11.90	99.60	43.48	46.44	56.12	45.96	-12.38
1932	69.42	0.17	138.99	46.29	22.95	92.70	65.01	41.88
1933	69.03	0.00	162.22	54.36	14.67	107.86	65.01	50.33
1934	104.23	20.19	45.99	43.98	40.06	2.00	39.69	-20.56
1935	68.38	0.00	102.04	43.18	25.20	58.86	63.72	38.52
1936	76.17	0.00	114.13	50.93	25.23	63.20	65.01	39.77
1937	69.05	0.11	251.41	53.23	15.71	198.17	76.53	60.71
1938	72.62	0.12	136.91	44.63	27.87	92.28	65.01	37.02
1939	88.54	0.00	56.66	50.33	38.21	6.33	41.56	3.35
1940	106.88	15.21	60.27	41.54	50.12	18.73	46.22	-19.12
1941	105.63	0.52	81.34	78.51	26.60	2.82	45.19	18.07
1942	90.58	0.00	110.65	66.39	24.19	44.26	65.01	40.82
1943	66.87	0.00	160.71	52.29	14.58	108.42	65.01	50.43
1944	92.92	0.00	91.45	53.65	39.27	37.80	55.95	16.68
1945	74.96	0.00	174.28	49.33	25.63	124.95	65.01	39.38
1946	79.03	0.00	70.46	57.01	22.02	13.46	61.99	39.97
1947	81.45	0.00	153.02	55.34	26.11	97.68	51.85	25.74
1948	68.32	0.00	163.19	54.15	14.17	109.04	65.01	50.84
1949	69.36	0.00	103.86	47.63	21.73	56.22	65.01	43.28
1950	65.16	0.08	177.85	50.16	14.92	127.69	65.01	50.00
1951	76.39	0.00	84.96	40.27	36.11	44.69	65.01	28.89
1952	71.06	0.12	118.99	52.54	18.40	66.45	65.01	46.49
1953	73.67	0.00	169.36	59.55	14.12	109.81	65.01	50.89
1954	74.62	0.00	86.08	57.65	16.97	28.43	57.84	40.87
1955	69.30	0.19	213.58	52.48	16.63	161.10	65.01	48.19
1956	64.16	0.00	187.54	50.42	13.74	137.11	65.01	51.27
1957	72.46	0.16	84.60	46.41	25.90	38.19	61.55	35.50
1958	82.01	0.00	89.76	55.98	26.03	33.78	65.01	38.98
1959	89.66	0.00	91.24	56.39	33.27	34.85	57.70	24.43
1960	68.48	0.00	180.21	44.57	23.90	135.64	65.01	41.10
1961	75.18	0.00	87.05	49.93	25.26	37.12	65.01	39.75
1962	71.60	0.00	151.60	51.09	20.50	100.50	65.01	44.50
1963	79.05	0.17	219.89	55.34	23.65	164.55	65.01	41.19
1964	84.94	0.00	126.04	68.30	16.64	57.74	65.01	48.36
1965	90.51	0.00	56.28	56.25	34.26	0.02	43.18	8.92
1966	102.76	14.08	63.16	40.82	47.98	22.34	45.98	-16.08
1967	95.08	0.00	82.85	61.91	33.17	20.94	65.01	31.84
1968	91.85	0.00	74.60	58.18	33.67	16.42	41.84	8.17
1969	74.88	0.20	136.42	55.65	19.04	80.77	65.01	45.77
1970	102.94	0.20	80.15	51.26	51.49	28.89	64.41	12.72

Table 8.2b. Volume Calculations for 28 March through 31 October, Dorena, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage. Negative value in last column shows lack of conservation storage. Note 10/31 last day of conservation storage for DOR.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF	
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Remaining Storage (if<0 below Min Con)
1971	62.48	0.00	149.00	50.13	12.34	98.87	65.01	52.66
1972	60.94	0.00	110.83	43.57	17.37	67.27	65.01	47.63
1973	109.11	9.31	68.13	48.09	51.80	20.04	51.89	-9.22
1974	64.58	0.02	141.84	44.79	19.76	97.05	65.01	45.22
1975	85.03	0.01	148.69	62.59	22.43	86.11	65.01	42.56
1976	74.19	0.00	114.98	52.02	22.17	62.96	64.78	42.61
1977	100.45	0.00	114.47	67.31	33.13	47.16	65.01	31.87
1978	86.29	0.00	71.23	63.99	22.31	7.24	61.49	39.18
1979	93.33	0.07	157.82	46.58	46.68	111.23	64.91	18.17
1980	98.81	0.00	94.02	64.44	34.37	29.59	65.01	30.63
1981	88.03	0.00	125.48	59.53	28.50	65.94	65.01	36.51
1982	67.29	0.00	137.58	49.46	17.83	88.13	61.65	43.82
1983	83.25	0.00	152.77	68.30	14.94	84.47	65.01	50.06
1984	66.03	0.00	237.66	53.14	12.89	184.52	66.57	53.67
1985	85.22	0.00	100.91	51.28	33.94	49.63	65.01	31.07
1986	100.08	0.00	77.94	58.88	41.20	19.06	64.30	23.10
1987	105.25	16.88	43.82	43.29	45.85	0.53	38.67	-24.07
1988	78.29	0.00	153.51	47.07	31.21	106.44	65.01	33.79
1989	86.00	0.16	95.75	53.40	32.43	42.35	65.01	32.41
1990	96.64	0.00	83.93	58.56	38.08	25.37	65.01	26.93
1991	85.34	0.20	156.65	57.75	27.39	98.90	65.01	37.41
1992	116.01	16.36	61.69	43.81	56.40	17.88	51.09	-21.67
1993	72.90	0.20	228.60	53.49	19.21	175.12	65.01	45.59
1994	105.25	4.36	66.54	52.29	48.60	14.24	46.75	-6.21
1995	91.41	0.20	141.04	61.37	29.85	79.67	65.01	34.96
1996	75.61	0.00	190.99	52.59	23.02	138.40	65.01	41.99
1997	69.19	0.00	99.82	51.99	17.19	47.83	64.39	47.20
1998	92.56	0.09	163.88	68.02	24.45	95.86	65.01	40.46
1999	75.51	0.10	158.16	58.81	16.60	99.35	65.01	48.31
2000	77.94	0.19	99.27	54.47	23.29	44.80	65.01	41.53
2001	105.88	0.00	70.59	51.83	54.06	18.76	65.01	10.95
2002	88.78	0.17	86.43	52.84	35.77	33.60	52.32	16.38
2003	93.52	0.20	97.63	37.43	55.89	60.20	62.28	6.20
2004	97.62	0.00	102.98	70.56	27.07	32.43	65.01	37.94
2005	89.32	0.00	132.16	60.35	28.97	71.81	65.01	36.04
2006	89.59	0.00	95.76	54.55	35.05	41.21	65.01	29.96
2007	105.48	0.00	90.74	64.18	41.30	26.56	55.48	14.17



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 8.1. Water volume totals for Dorena 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

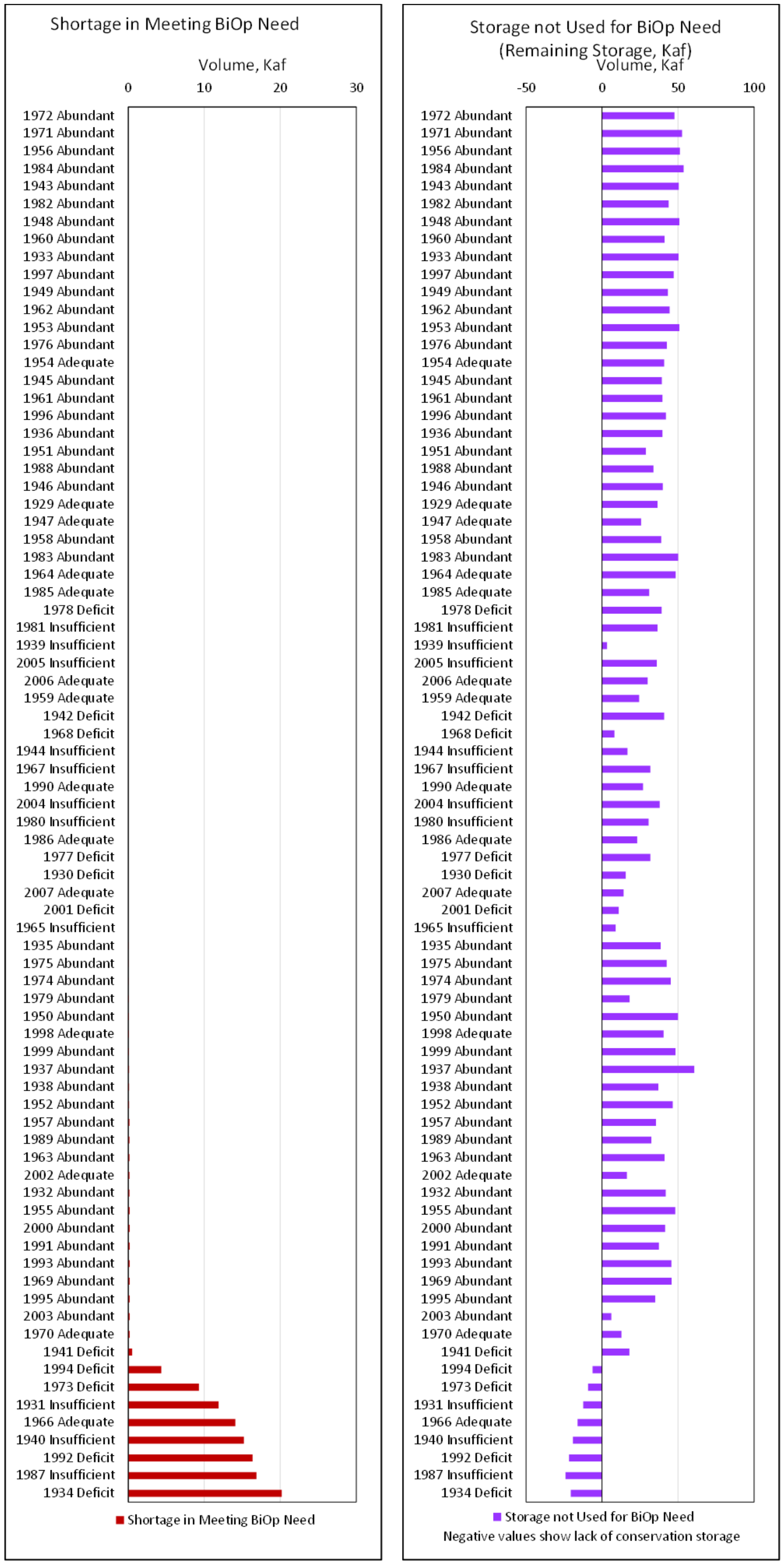
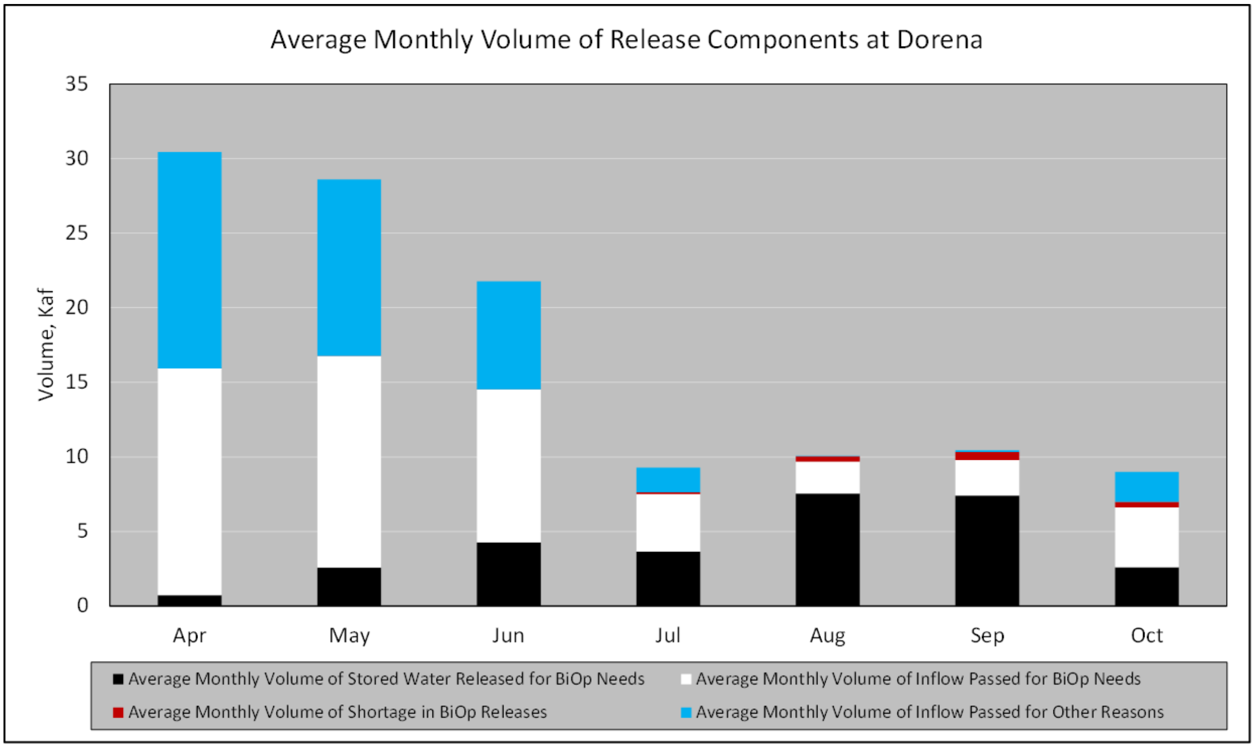


Figure 8.2. Water Volume totals for Dorena 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	1.82	15.94	16.77	14.51	7.61	10.04	10.32	6.98
Stored Water Released for BiOp Needs	0.13	0.72	2.56	4.25	3.63	7.53	7.40	2.59
Inflow Passed for BiOp Needs	1.68	15.22	14.21	10.27	3.86	2.15	2.37	4.02
Shortage in meeting BiOp Needs	0.00	0.00	0.00	0.00	0.12	0.37	0.56	0.37
Inflow Passed Other Reasons	1.57	14.50	11.84	7.27	1.66	0.03	0.12	2.00

Figure 8.3. Water volume average monthly totals for release components for Dorena 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

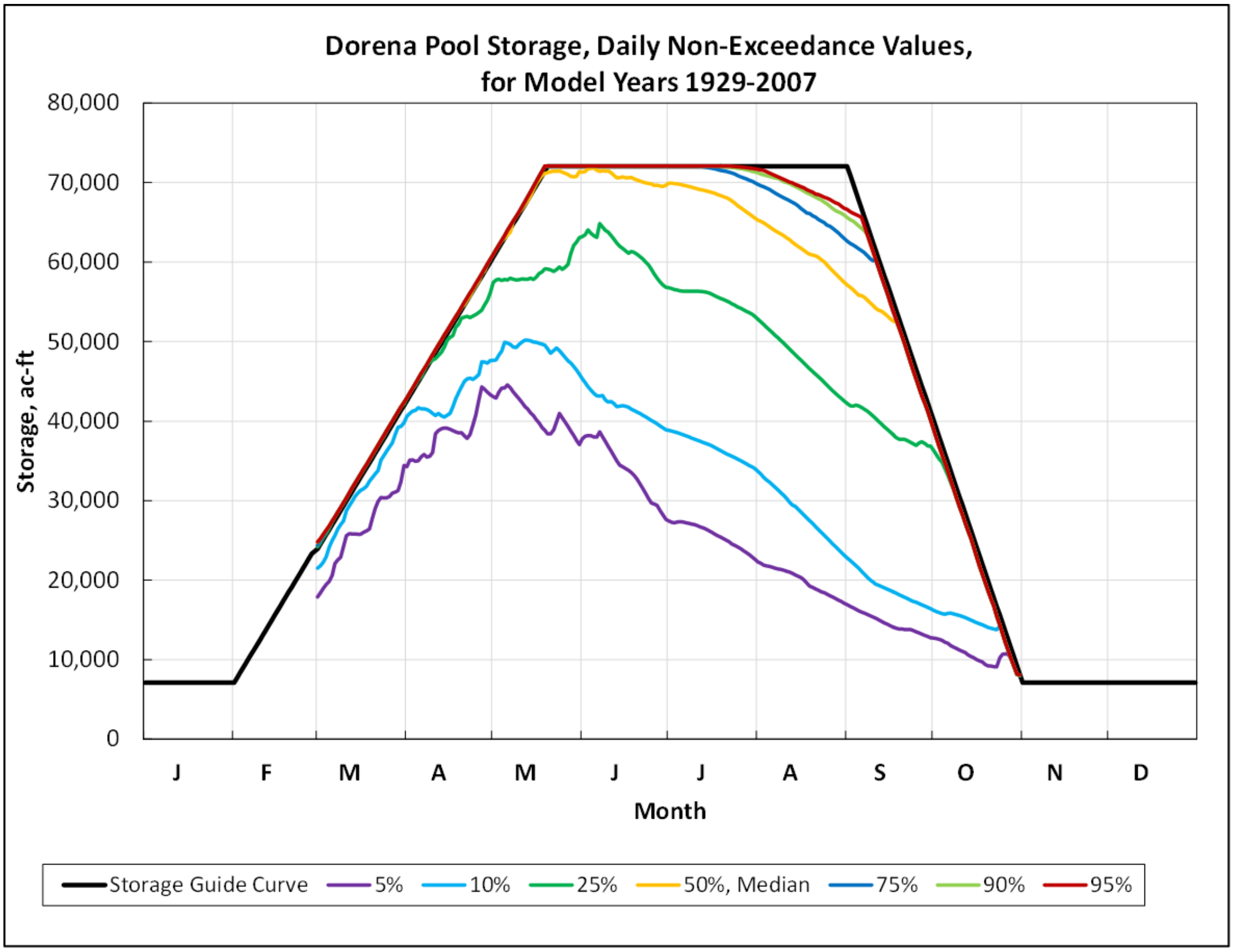


Figure 8.4. Non-exceedance storage values for Dorena 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

9 Cottage Grove Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Cottage Grove. The results are both tabulated and graphed in the same manner that was described for Blue River in Section 6. The time series records used for the Cottage Grove calculations are:

//COTTAGE GROVE-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-DAM-MIN FLOW FROM COTTAGE GROVE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//COTTAGE GROVE-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//COTTAGE GROVE-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/ EXTENDBASE0/

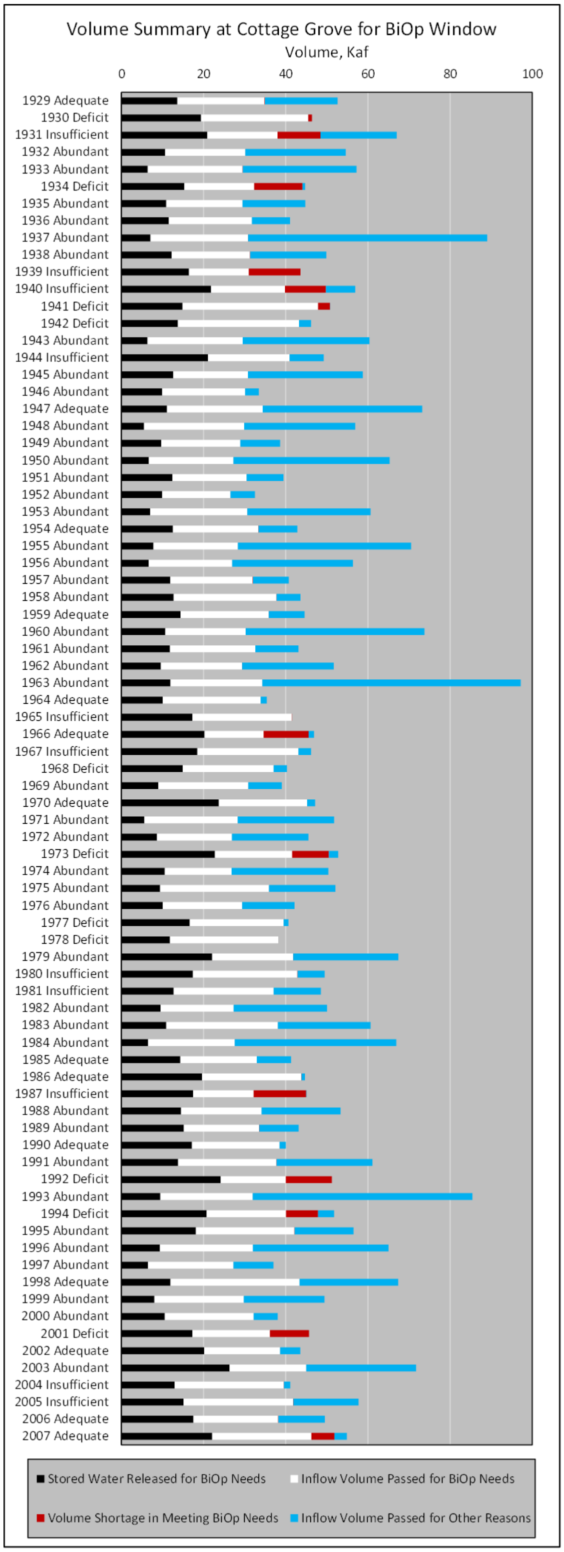
Water volume component calculations for Cottage Grove are tabulated in Table 9.1 (split into Table 9.1a for 1929 through 1970 and Table 9.1b for 1971 through 2007) and graphed in Figure 9.1. Table 9.1 does not need the column labeled "Stored Water Used After 10/31 for Min" since the project rule curve reaches minimum conservation zone on 31 October. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 9.2, and the average monthly total volumes are shown in Figure 9.3. The Cottage Grove storage non-exceedance graph is shown in Figure 9.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

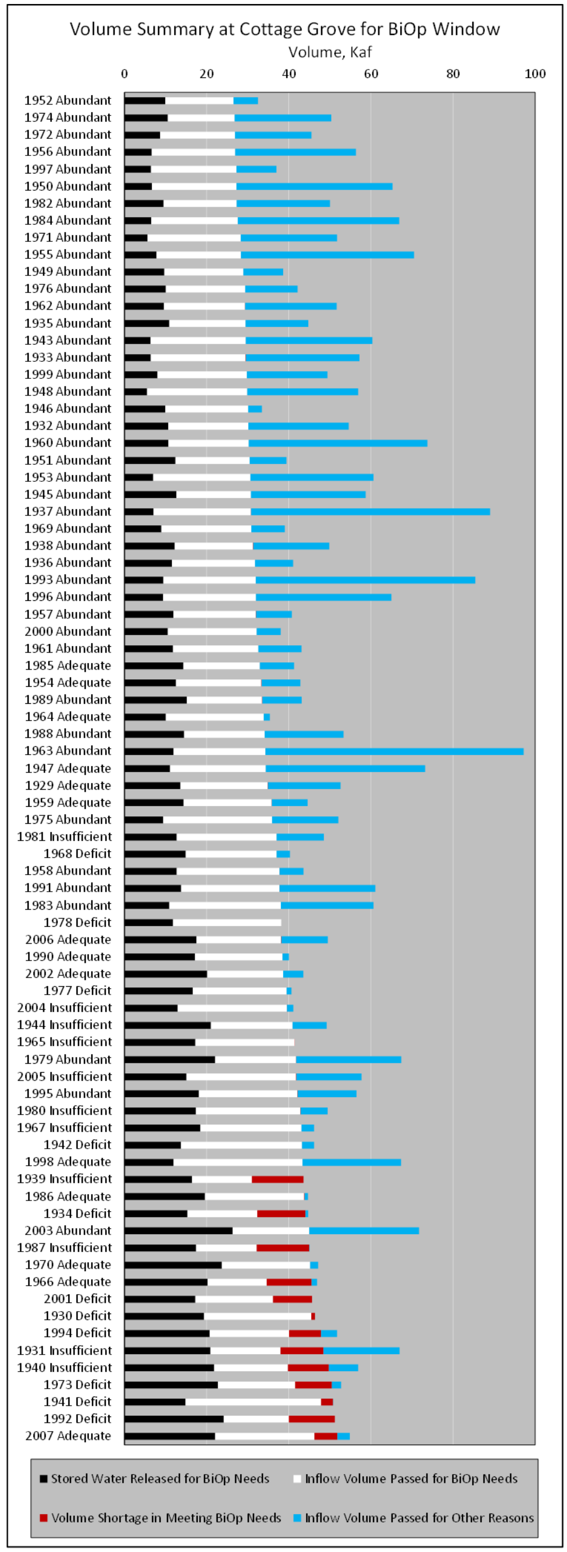
Table 9.1a. Volume Calculations for 28 March through 31 October, Cottage Grove, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage. Negative value in last column shows lack of conservation storage. Note 10/31 last day of conservation storage for COT.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF	
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Remaining Storage (if<0 below Min Con)
1929	34.95	0.10	38.94	21.27	13.58	17.66	28.66	14.98
1930	46.39	0.89	26.11	26.11	19.39	0.00	14.75	-5.53
1931	48.47	10.46	35.65	17.12	20.90	18.54	20.28	-11.07
1932	30.16	0.00	43.96	19.52	10.65	24.44	28.66	18.02
1933	29.56	0.10	50.71	23.06	6.40	27.65	28.66	22.16
1934	44.06	11.75	17.67	16.99	15.32	0.67	14.82	-12.25
1935	29.47	0.00	33.83	18.56	10.91	15.27	26.93	16.02
1936	31.79	0.00	29.53	20.27	11.52	9.26	28.66	17.14
1937	30.82	0.03	81.94	23.73	7.07	58.21	28.66	21.57
1938	31.38	0.10	37.53	19.07	12.21	18.46	28.58	16.27
1939	43.57	12.54	14.58	14.58	16.45	0.00	16.21	-12.78
1940	49.76	9.94	25.14	17.99	21.83	7.15	19.41	-12.35
1941	50.74	2.85	33.02	33.01	14.88	0.00	8.72	-9.01
1942	43.23	0.00	32.40	29.48	13.74	2.92	28.66	14.92
1943	29.53	0.00	54.02	23.20	6.33	30.82	28.66	22.33
1944	40.94	0.00	28.17	19.88	21.06	8.30	24.34	3.28
1945	30.76	0.00	46.13	18.15	12.61	27.98	28.66	16.05
1946	30.12	0.00	23.56	20.23	9.89	3.32	21.02	11.13
1947	34.38	0.00	62.13	23.29	11.09	38.84	21.77	10.68
1948	29.88	0.00	51.38	24.37	5.51	27.00	28.66	23.15
1949	28.96	0.00	28.97	19.29	9.66	9.68	28.35	18.68
1950	27.26	0.00	58.59	20.58	6.68	38.01	28.66	21.98
1951	30.45	0.00	27.09	18.08	12.37	9.01	24.52	12.16
1952	26.56	0.00	22.57	16.64	9.92	5.94	27.23	17.31
1953	30.67	0.00	53.66	23.70	6.97	29.96	28.66	21.69
1954	33.39	0.10	30.21	20.76	12.53	9.45	21.85	9.23
1955	28.33	0.00	62.75	20.56	7.77	42.20	28.66	20.89
1956	26.95	0.00	49.73	20.34	6.60	29.39	28.66	22.06
1957	32.03	0.08	28.80	20.07	11.88	8.73	27.32	15.36
1958	37.79	0.02	30.86	25.07	12.70	5.79	28.66	15.94
1959	35.89	0.06	30.17	21.46	14.37	8.71	22.16	7.74
1960	30.25	0.00	63.06	19.57	10.68	43.50	28.66	17.98
1961	32.60	0.00	31.30	20.81	11.79	10.49	28.66	16.87
1962	29.37	0.01	42.07	19.79	9.57	22.28	28.66	19.08
1963	34.29	0.00	85.27	22.34	11.95	62.93	28.66	16.71
1964	33.89	0.00	25.35	23.87	10.02	1.48	22.88	12.86
1965	41.49	0.01	24.22	24.22	17.26	0.00	16.95	-0.32
1966	45.47	10.93	15.71	14.41	20.22	1.30	19.74	-11.41
1967	43.08	0.00	27.66	24.59	18.49	3.07	25.08	6.59
1968	37.05	0.00	25.37	22.14	14.91	3.22	17.22	2.31
1969	30.85	0.00	30.11	21.91	8.95	8.20	28.66	19.71
1970	45.20	0.00	23.42	21.49	23.71	1.94	23.47	-0.24

Table 9.1b. Volume Calculations for 28 March through 31 October, Cottage Grove, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage. Negative value in last column shows lack of conservation storage. Note 10/31 last day of conservation storage for COT.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF	
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Remaining Storage (if<0 below Min Con)
1971	28.29	0.00	46.19	22.72	5.58	23.48	28.66	23.08
1972	26.90	0.00	36.90	18.26	8.63	18.64	28.66	20.03
1973	50.39	8.92	21.10	18.82	22.74	2.27	21.75	-9.92
1974	26.80	0.00	39.79	16.25	10.55	23.54	27.55	17.01
1975	35.94	0.00	42.66	26.55	9.39	16.11	28.66	19.27
1976	29.36	0.00	32.10	19.32	10.05	12.79	26.18	16.13
1977	39.50	0.00	24.06	22.88	16.62	1.18	15.43	-1.19
1978	38.16	0.00	26.37	26.37	11.79	0.00	19.42	7.62
1979	41.83	0.03	45.29	19.74	22.06	25.55	28.56	6.47
1980	42.91	0.10	31.93	25.40	17.41	6.52	22.60	5.09
1981	37.05	0.00	35.88	24.36	12.69	11.51	24.32	11.64
1982	27.32	0.00	40.54	17.83	9.48	22.70	25.00	15.52
1983	38.10	0.00	49.77	27.21	10.88	22.55	28.66	17.78
1984	27.56	0.00	60.42	21.09	6.48	39.33	28.66	22.19
1985	32.93	0.00	26.96	18.62	14.31	8.35	23.54	9.22
1986	43.84	0.07	25.04	24.18	19.59	0.85	27.62	7.97
1987	44.98	12.80	14.83	14.73	17.45	0.11	16.12	-14.13
1988	34.11	0.00	38.81	19.61	14.50	19.20	28.66	14.16
1989	33.60	0.10	27.88	18.33	15.16	9.54	24.34	9.08
1990	38.51	0.00	22.84	21.33	17.18	1.51	20.38	3.21
1991	37.79	0.07	47.24	23.93	13.79	23.30	28.66	14.80
1992	50.98	11.20	15.84	15.84	24.17	0.00	20.90	-14.48
1993	31.96	0.00	75.96	22.49	9.48	53.47	28.66	19.18
1994	47.87	7.79	23.25	19.38	20.71	3.87	20.41	-8.09
1995	42.18	0.10	38.28	23.98	18.10	14.30	28.66	10.46
1996	32.00	0.00	55.66	22.63	9.37	33.03	28.66	19.29
1997	27.25	0.00	30.55	20.81	6.44	9.74	26.77	20.33
1998	43.35	0.00	55.41	31.41	11.94	24.00	28.66	16.72
1999	29.78	0.00	41.36	21.75	8.03	19.60	28.66	20.63
2000	32.18	0.00	27.52	21.64	10.53	5.87	28.66	18.13
2001	45.67	9.52	18.90	18.90	17.24	0.00	14.49	-12.27
2002	38.63	0.00	23.38	18.46	20.16	4.91	23.07	2.91
2003	44.97	0.00	45.42	18.65	26.31	26.77	27.92	1.60
2004	39.57	0.02	28.15	26.63	12.92	1.52	17.52	4.58
2005	41.88	0.09	42.50	26.70	15.09	15.80	28.66	13.48
2006	38.22	0.08	31.91	20.62	17.52	11.29	25.68	8.09
2007	51.84	5.60	27.15	24.15	22.09	3.00	23.18	-4.51





Graphed values are chronological (1929-2007)

Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 9.1. Water volume totals for Cottage Grove 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

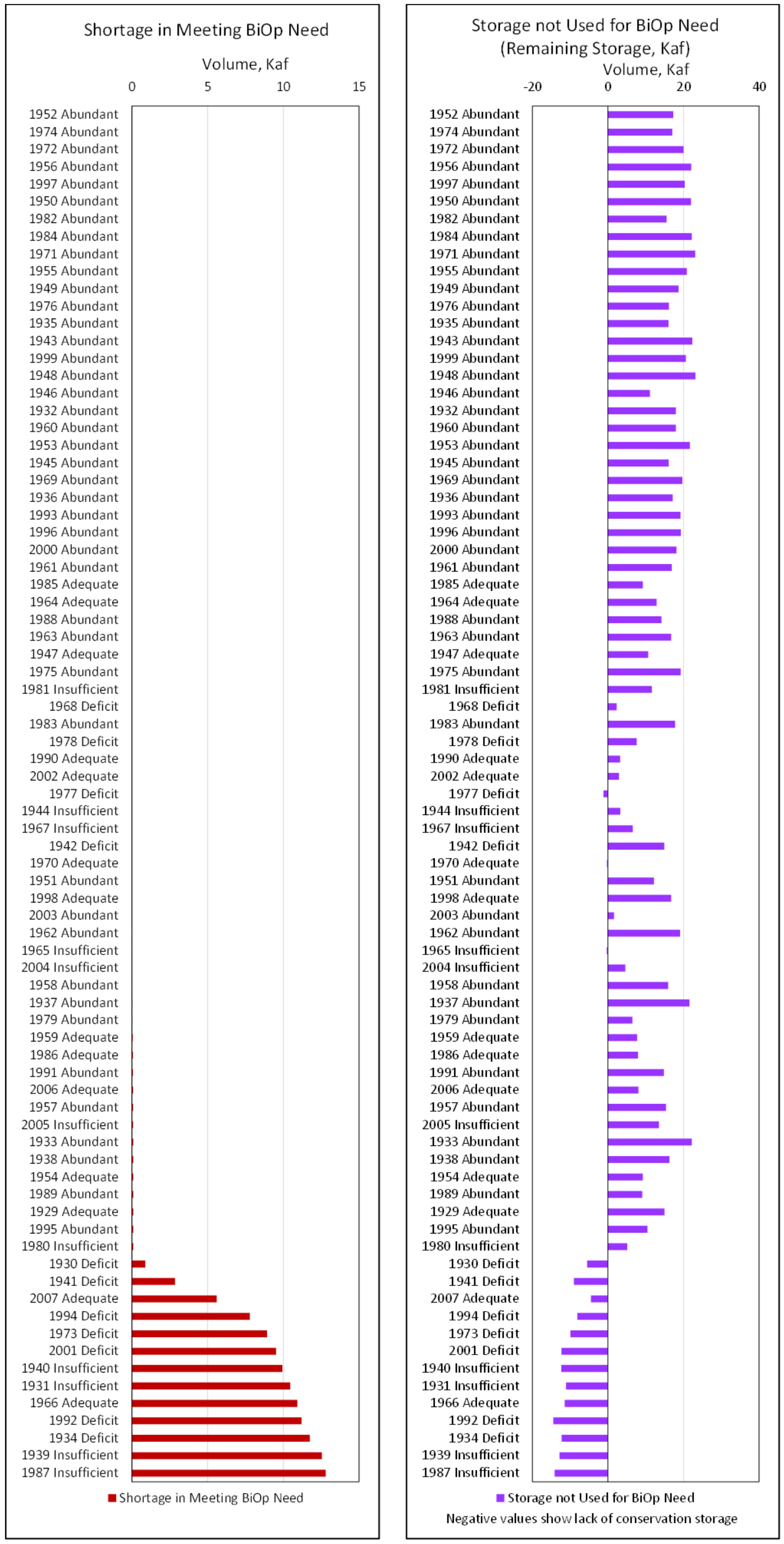
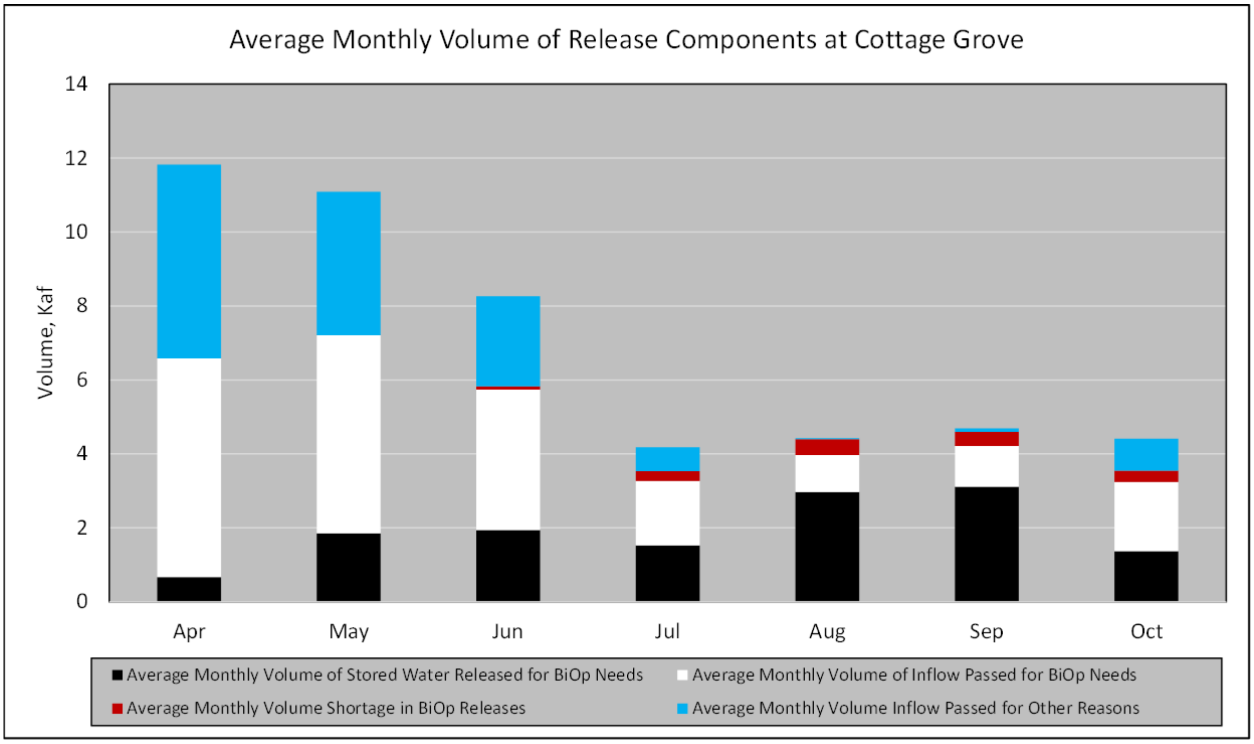


Figure 9.2. Water Volume totals for Cottage Grove 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	0.73	6.58	7.21	5.83	3.53	4.39	4.59	3.54
Stored Water Released for BiOp Needs	0.07	0.67	1.85	1.94	1.53	2.97	3.11	1.37
Inflow Passed for BiOp Needs	0.66	5.91	5.35	3.80	1.74	1.00	1.10	1.87
Shortage in meeting BiOp Needs	0.00	0.00	0.01	0.09	0.27	0.43	0.38	0.30
Inflow Passed Other Reasons	0.60	5.25	3.88	2.43	0.64	0.02	0.10	0.86

Figure 9.3. Water volume average monthly totals for release components for Cottage Grove 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

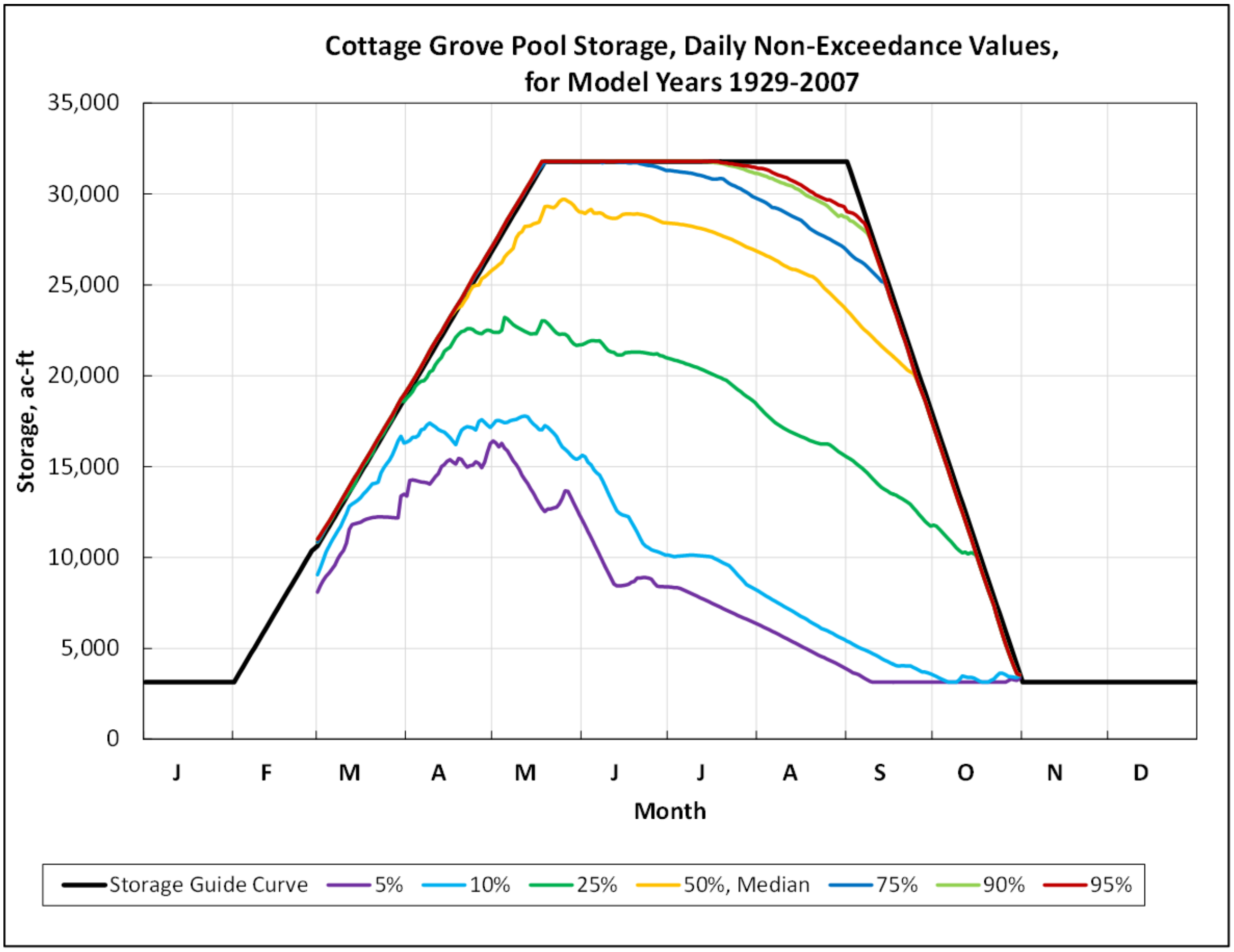


Figure 9.4. Non-exceedance storage values for Cottage Grove 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

10 Fall Creek Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Fall Creek. The results are both tabulated and graphed in the same manner that was described for Blue River in Section 6. The time series records used for the Fall Creek calculations are:

//FALL CREEK-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-MIN CONSERV FLOW@FALLCRK/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FALL CREEK-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//FALL CREEK-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/

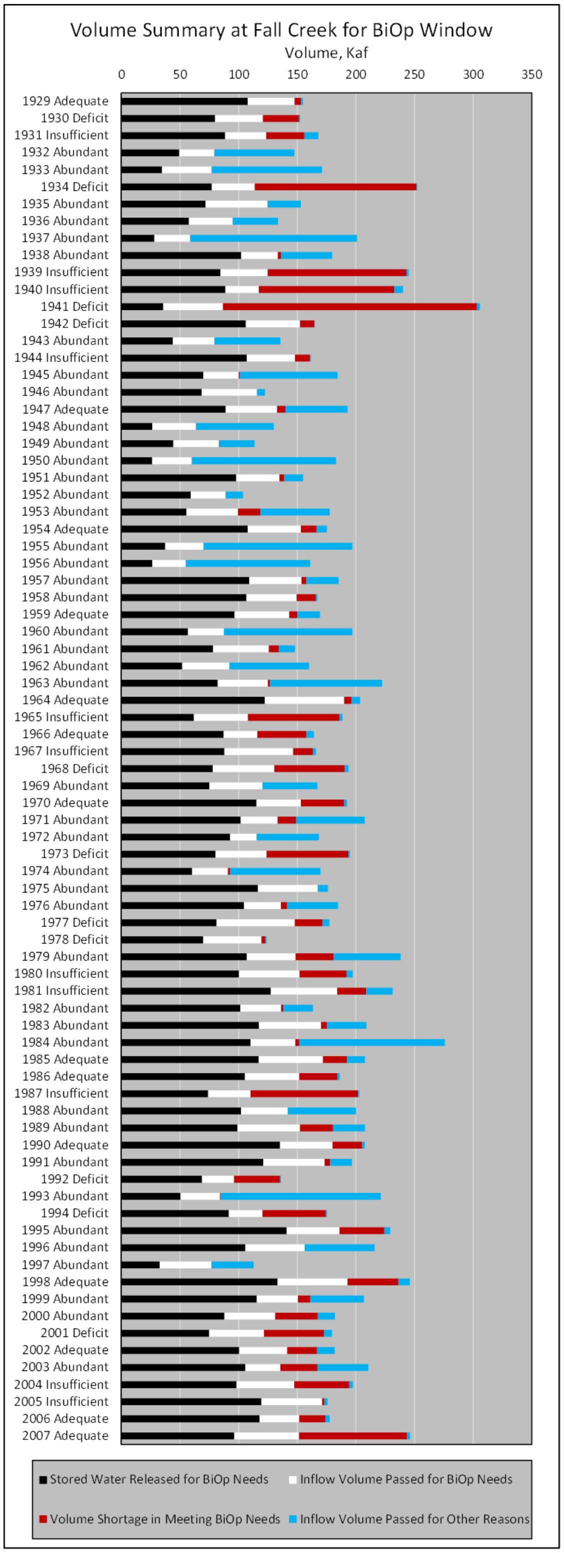
Water volume component calculations for Fall Creek are tabulated in Table 10.1 (split into Table 10.1a for 1929 through 1970 and Table 10.1b for 1971 through 2007) and graphed in Figure 10.1. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 10.2, and the average monthly total volumes are shown in Figure 10.3. The Fall Creek storage non-exceedance graph is shown in Figure 10.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Table 10.1a. Volume Calculations for 28 March through 31 October, Fall Creek, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

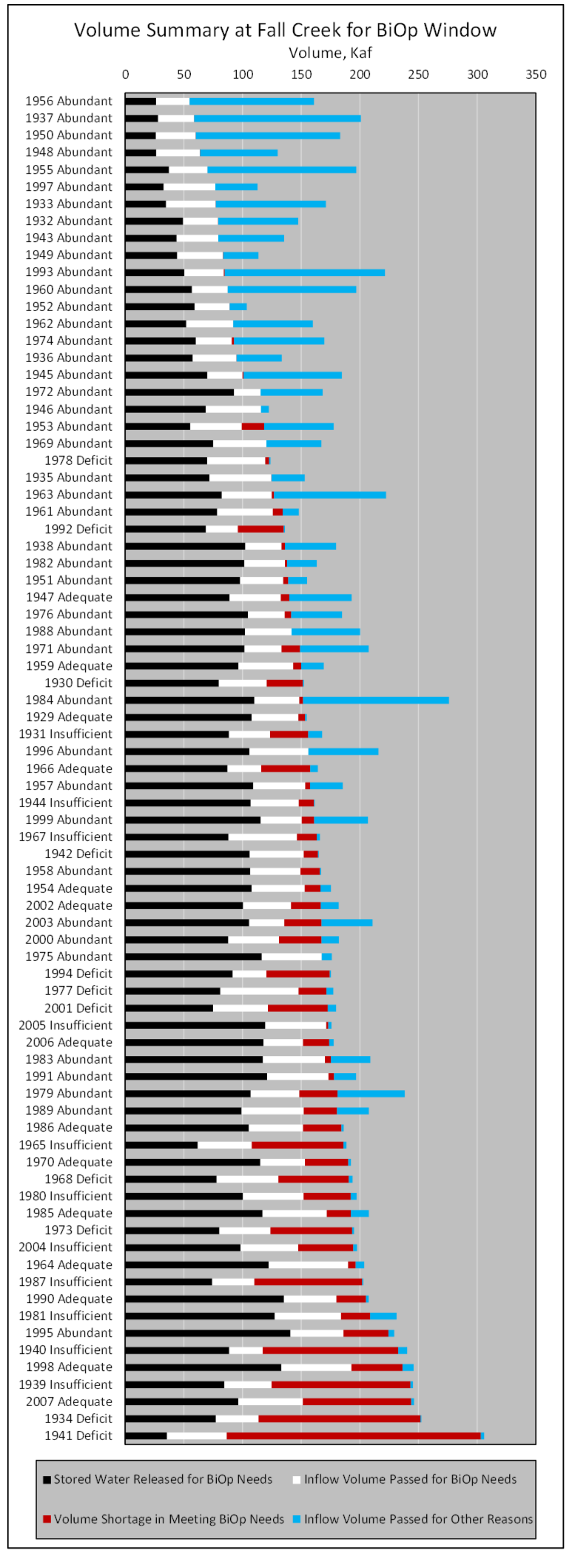
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	153.28	5.61	41.47	39.95	107.72	1.53	88.52	1.49	-26.29
1930	151.51	30.81	41.83	40.91	79.79	0.92	59.15	0.30	-51.75
1931	156.05	32.48	46.89	35.01	88.56	11.88	85.71	0.40	-35.73
1932	79.37	0.12	97.96	29.88	49.37	68.08	106.34	1.49	55.37
1933	77.22	0.10	136.16	42.35	34.77	93.81	106.34	1.49	69.98
1934	251.72	137.99	37.18	36.49	77.23	0.69	69.23	0.99	-146.98
1935	124.81	0.20	81.07	52.86	71.75	28.21	106.34	1.49	32.90
1936	94.95	0.01	75.91	37.32	57.63	38.59	106.34	1.49	47.22
1937	58.90	0.16	172.73	30.72	28.01	142.01	106.34	1.49	76.68
1938	136.13	2.85	74.53	30.97	102.30	43.55	106.34	1.09	0.09
1939	243.18	118.38	42.15	40.20	84.60	1.94	76.17	0.64	-127.44
1940	232.75	115.57	35.99	28.48	88.69	7.51	82.34	0.60	-122.52
1941	303.08	216.42	53.92	51.08	35.58	2.84	26.62	0.69	-226.08
1942	164.36	12.14	46.65	46.05	106.17	0.60	72.60	1.39	-47.10
1943	79.39	0.00	91.63	35.53	43.86	56.10	106.34	1.49	60.99
1944	160.87	12.87	41.76	41.06	106.95	0.70	77.95	0.57	-42.44
1945	100.92	0.88	113.69	30.09	69.95	83.60	106.34	1.49	34.02
1946	115.72	0.00	53.92	47.17	68.55	6.75	73.83	1.49	3.79
1947	139.88	7.21	96.77	43.65	89.02	53.12	89.87	1.49	-7.85
1948	63.81	0.29	103.35	37.10	26.42	66.25	106.34	1.49	78.14
1949	83.55	0.34	68.90	38.90	44.31	30.00	106.34	1.49	60.20
1950	60.27	0.20	156.79	33.94	26.13	122.85	106.34	1.49	78.52
1951	138.94	4.23	52.83	36.76	97.95	16.07	85.34	1.49	-18.33
1952	89.04	0.10	44.46	29.79	59.16	14.67	106.34	1.49	45.60
1953	118.48	19.03	103.09	43.91	55.54	59.17	106.34	1.49	30.28
1954	166.46	13.43	54.13	45.33	107.71	8.80	89.43	0.40	-32.10
1955	70.12	0.00	159.52	32.69	37.43	126.83	106.34	1.49	67.42
1956	54.87	0.00	134.66	28.58	26.30	106.08	106.34	1.49	78.55
1957	157.61	4.07	72.16	44.44	109.10	27.72	88.21	0.12	-25.08
1958	165.90	16.47	43.95	42.79	106.63	1.16	74.88	0.90	-49.13
1959	150.10	6.90	65.78	46.59	96.61	19.20	78.95	1.49	-26.05
1960	87.37	0.00	140.08	30.49	56.88	109.59	106.34	1.49	47.97
1961	134.21	8.37	61.28	47.52	78.32	13.76	100.47	1.49	12.29
1962	92.13	0.00	108.06	40.17	51.96	67.89	106.34	1.49	52.90
1963	126.84	1.91	138.16	42.65	82.28	95.51	106.34	1.39	20.76
1964	196.36	6.41	74.94	67.66	122.29	7.27	77.80	0.40	-51.30
1965	186.00	78.05	48.70	46.13	61.82	2.57	38.34	0.56	-102.09
1966	156.63	41.76	35.13	28.70	87.27	6.44	84.98	0.50	-44.55
1967	163.21	16.75	61.20	58.49	87.98	2.70	74.23	1.39	-31.89
1968	190.23	59.98	55.86	52.64	77.91	3.22	69.48	1.29	-69.71
1969	120.37	0.00	92.08	45.27	75.10	46.81	106.34	1.49	29.75
1970	189.59	36.93	40.26	37.92	115.22	2.34	62.38	0.69	-90.46

Table 10.1b. Volume Calculations for 28 March through 31 October, Fall Creek, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	149.03	15.78	89.97	31.52	101.73	58.45	106.34	0.89	-12.06
1972	115.42	0.00	75.71	22.70	92.71	53.00	106.34	1.09	12.54
1973	193.34	69.55	45.15	43.64	80.25	1.51	60.49	0.99	-90.31
1974	92.65	1.92	107.54	30.55	60.27	76.99	106.34	1.49	42.66
1975	167.49	0.00	59.72	51.08	116.42	8.64	80.28	1.49	-37.62
1976	141.25	5.45	74.70	31.39	104.61	43.31	106.34	0.94	-4.67
1977	171.36	23.72	72.53	66.69	81.15	5.84	47.99	1.09	-57.96
1978	122.73	3.26	50.84	49.65	69.81	1.19	36.52	1.45	-38.01
1979	180.08	32.52	98.73	41.57	106.95	57.16	106.34	0.89	-34.02
1980	192.06	40.09	56.74	51.66	100.37	5.07	71.19	0.64	-69.92
1981	208.82	24.77	79.03	56.56	127.48	22.47	92.00	0.53	-60.79
1982	138.01	1.87	59.94	34.60	101.53	25.33	102.82	1.49	-2.07
1983	175.06	5.04	86.56	52.85	117.38	33.71	92.80	0.60	-30.22
1984	151.65	3.29	162.51	38.29	110.10	124.22	106.34	1.29	-8.35
1985	192.30	20.43	70.21	54.81	117.08	15.40	84.00	0.89	-54.40
1986	184.34	32.71	48.10	46.20	105.43	1.90	62.90	1.29	-76.53
1987	201.49	91.78	37.02	36.02	74.08	1.01	66.80	1.05	-100.11
1988	141.87	0.00	98.06	39.78	102.09	58.29	106.34	1.49	2.76
1989	180.44	28.30	80.20	53.09	99.17	27.12	89.16	0.52	-38.82
1990	205.32	25.25	46.94	44.75	135.32	2.19	60.60	1.29	-101.25
1991	177.94	4.72	70.96	52.20	121.01	18.76	106.34	1.49	-20.88
1992	134.44	39.09	28.24	27.38	68.75	0.86	49.77	0.50	-58.57
1993	84.80	0.71	170.10	33.59	50.50	136.51	106.34	1.49	53.64
1994	171.22	53.88	29.72	28.75	91.68	0.97	82.70	0.69	-63.56
1995	224.23	38.29	50.05	45.10	140.91	4.95	106.34	0.60	-73.45
1996	156.26	0.00	110.11	50.46	105.80	59.65	106.34	1.19	-0.65
1997	76.88	0.00	80.10	44.17	32.71	35.93	106.34	1.49	72.15
1998	236.12	43.42	69.16	59.65	133.23	9.51	72.16	0.60	-105.07
1999	161.05	10.51	80.81	34.99	115.55	45.82	106.34	0.42	-20.14
2000	167.37	36.23	57.95	43.26	87.88	14.70	106.34	1.49	-19.26
2001	172.65	51.01	53.76	46.77	74.88	7.00	62.02	0.44	-64.30
2002	166.74	25.34	56.04	40.90	100.50	15.14	91.70	0.20	-34.34
2003	167.34	31.72	73.36	29.97	105.65	43.40	106.34	0.08	-31.12
2004	194.39	46.96	52.28	49.21	98.23	3.07	60.63	1.49	-86.04
2005	173.10	1.82	54.55	51.87	119.41	2.68	81.52	1.39	-41.09
2006	173.90	22.27	37.52	33.75	117.88	3.77	91.87	0.79	-49.07
2007	243.70	92.21	57.61	55.19	96.30	2.42	72.40	0.79	-116.90



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 10.1. Water volume totals for Fall Creek 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

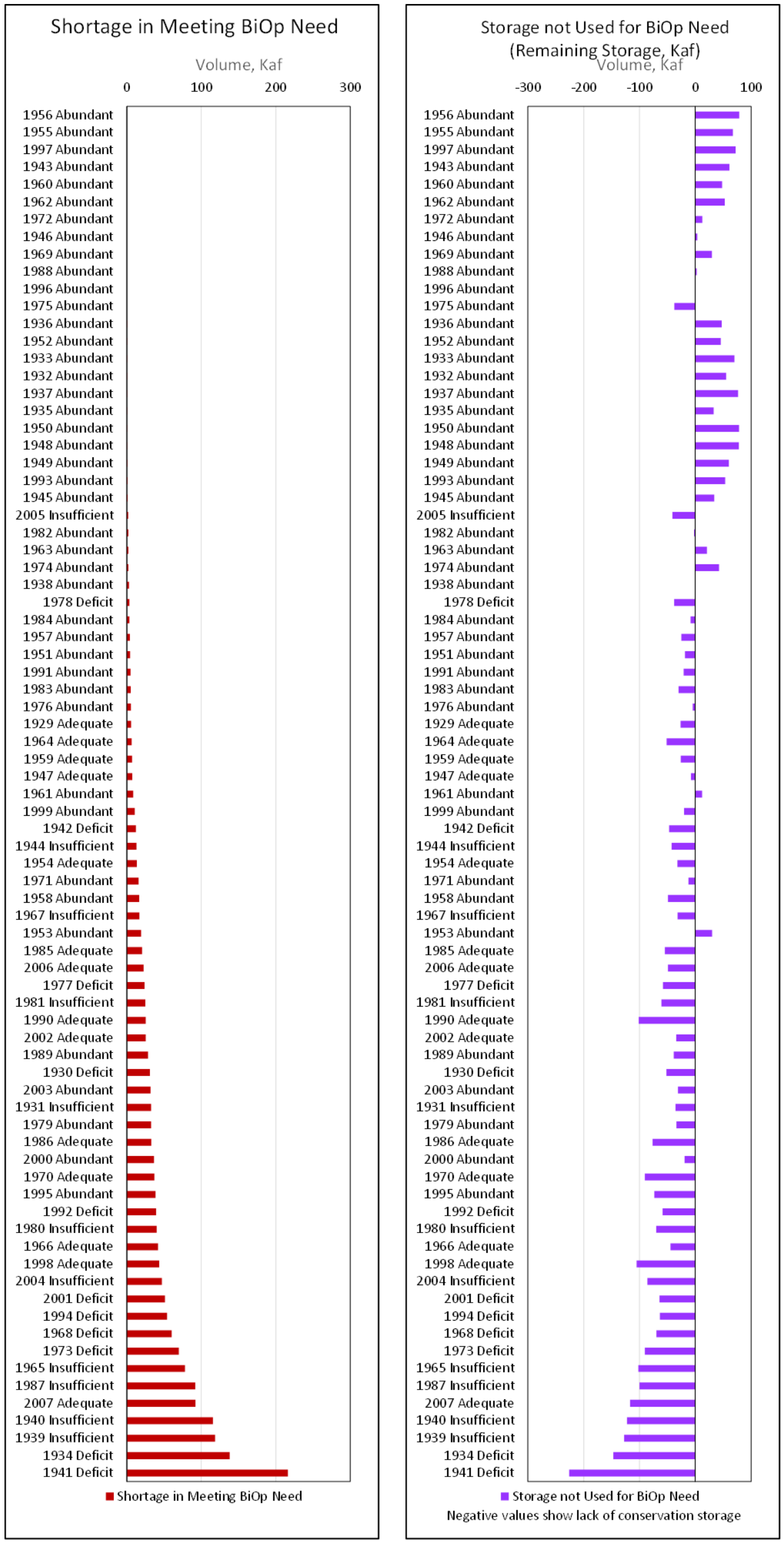
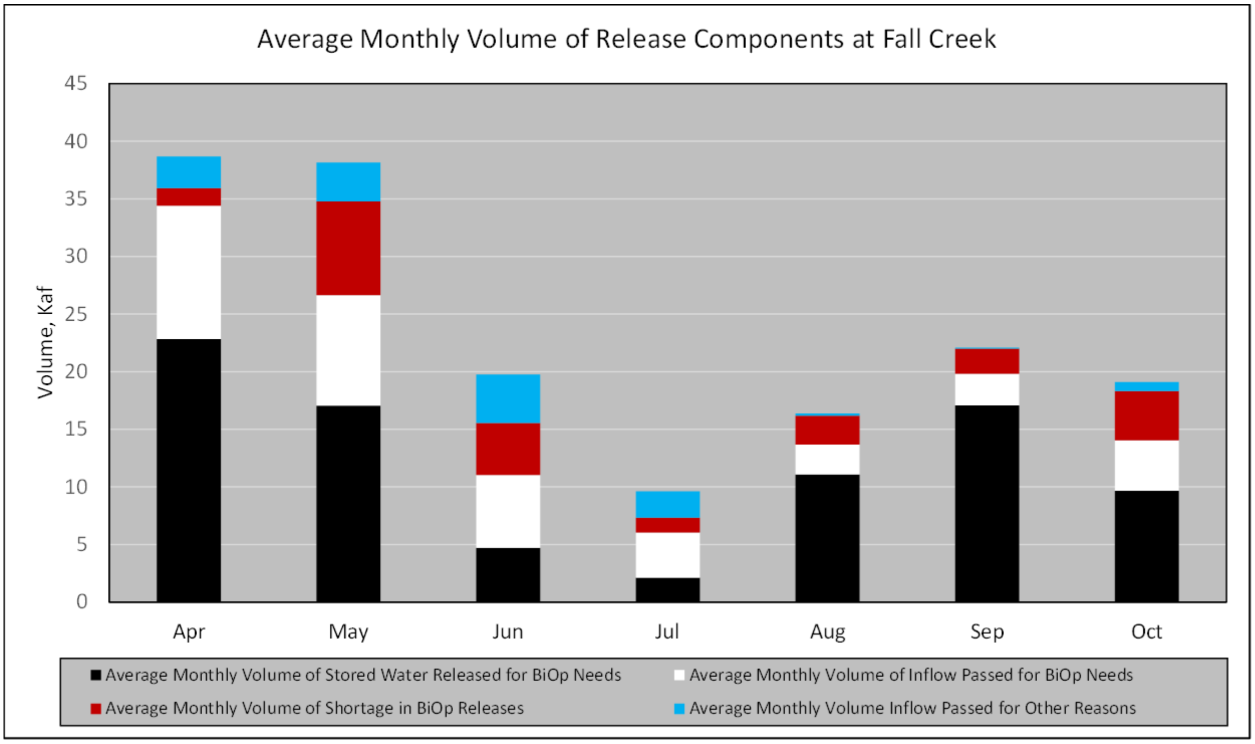


Figure 10.2. Water Volume totals for Fall Creek 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	1.61	35.92	34.77	15.56	7.32	16.13	21.98	18.27
Stored Water Released for BiOp Needs	0.90	22.83	17.04	4.70	2.11	11.07	17.08	9.65
Inflow Passed for BiOp Needs	0.71	11.58	9.58	6.31	3.91	2.60	2.72	4.39
Shortage in meeting BiOp Needs	0.01	1.52	8.14	4.54	1.30	2.51	2.18	4.27
Inflow Passed Other Reasons	0.44	2.75	3.38	4.19	2.29	0.20	0.10	0.78

Figure 10.3. Water volume average monthly totals for release components for Fall Creek 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

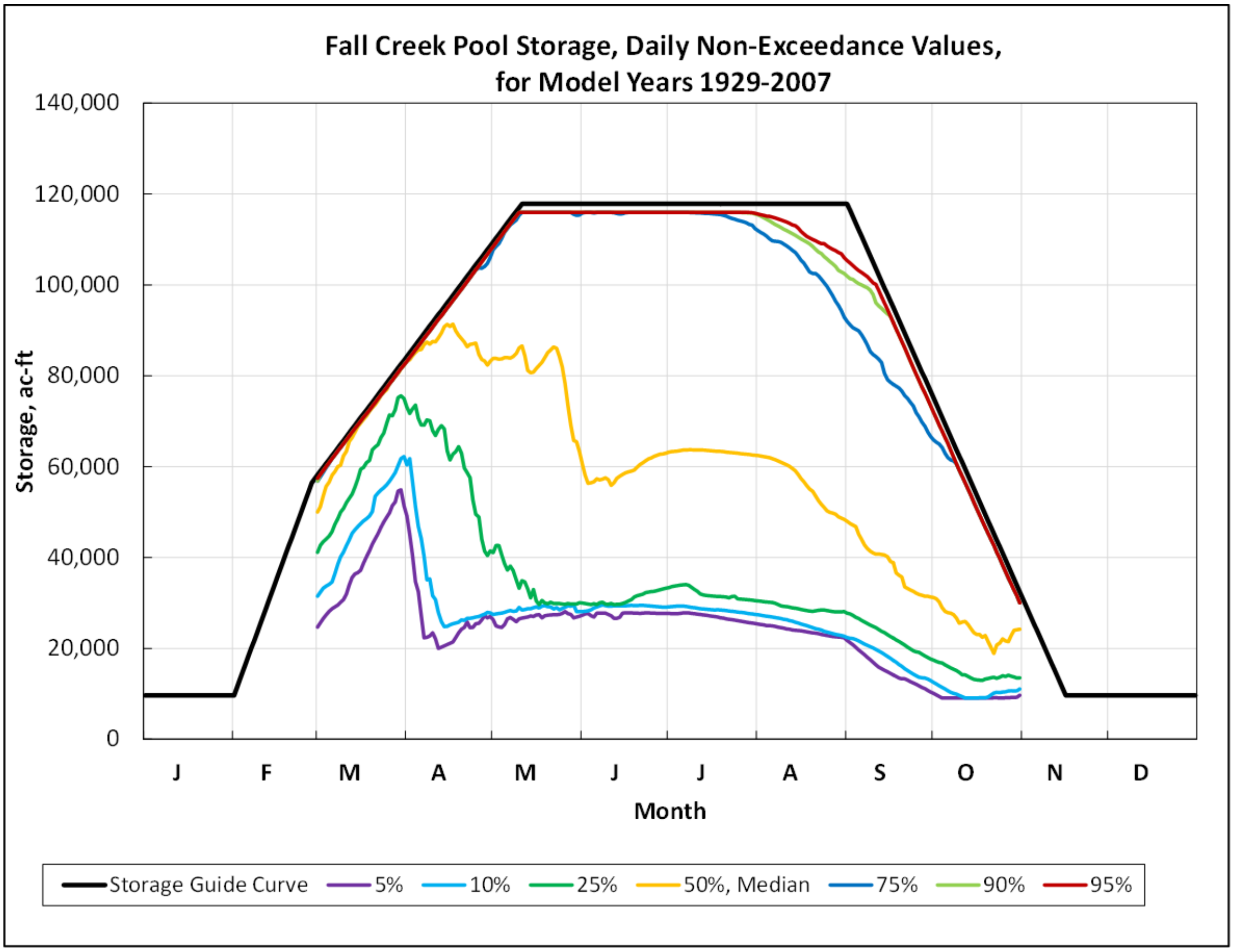


Figure 10.4. Non-exceedance storage values for Fall Creek 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

11 Hills Creek Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Hills Creek. The results are both tabulated and graphed in the same manner that was described for Blue River in Section 6. The time series records used for the Hills Creek calculations are:

//HILLS CREEK-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-DAM-MIN FLOW - HILLS CREEK/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//HILLS CREEK-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//HILLS CREEK-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/

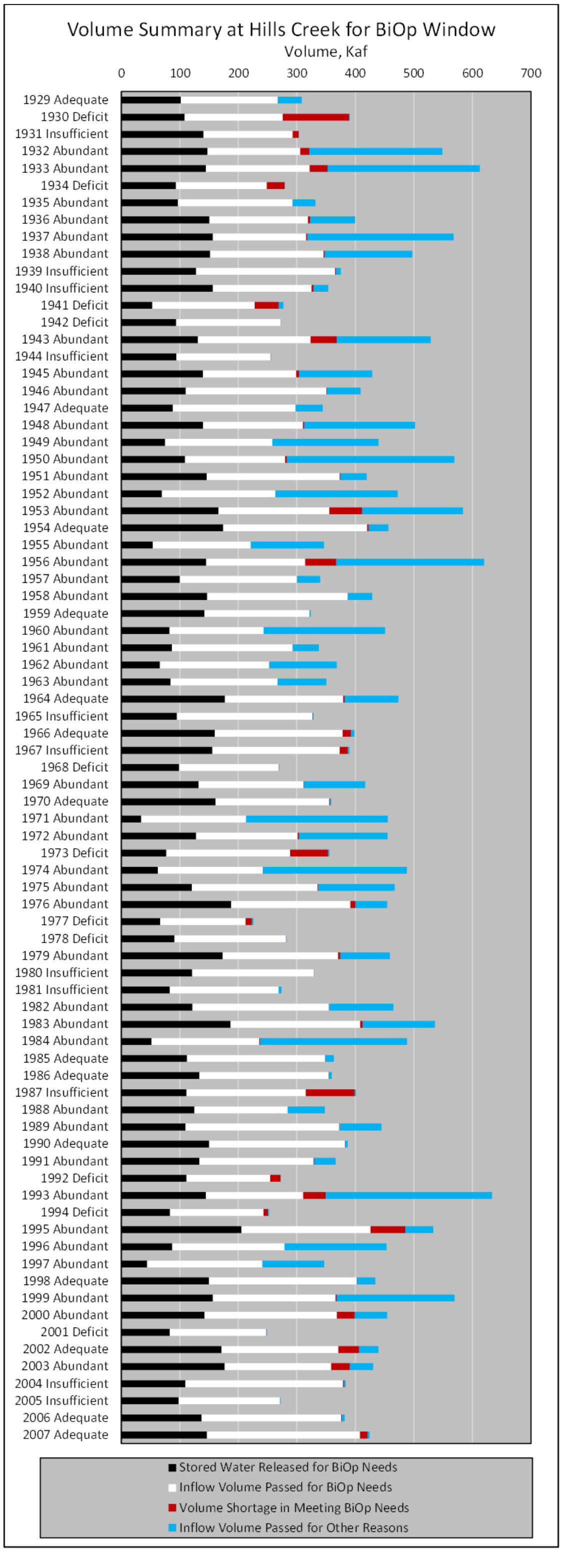
Water volume component calculations for Hills Creek are tabulated in Table 11.1 (split into Table 11.1a for 1929 through 1970 and Table 11.1b for 1971 through 2007) and graphed in Figure 11.1. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 11.2, and the average monthly total volumes are shown in Figure 11.3. The Hills Creek storage non-exceedance graph is shown in Figure 11.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Table 11.1a. Volume Calculations for 28 March through 31 October, Hills Creek, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

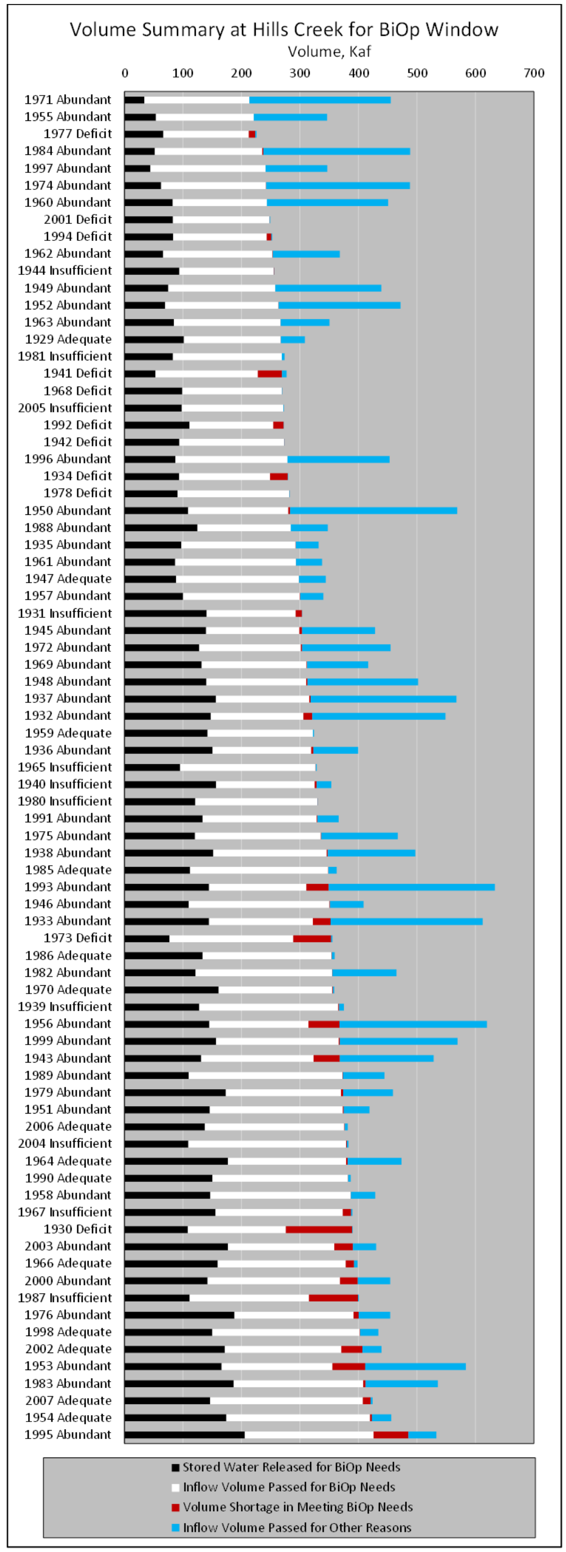
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	267.57	0.03	206.53	165.74	101.80	40.79	194.63	11.38	81.42
1930	389.31	113.33	168.69	167.59	108.39	1.10	99.99	4.22	-125.95
1931	303.38	10.51	152.48	152.19	140.67	0.29	139.16	1.80	-13.81
1932	321.25	15.32	386.01	158.52	147.41	227.49	195.30	0.24	32.34
1933	352.51	30.40	437.41	177.37	144.74	260.03	201.85	3.83	22.88
1934	279.27	30.48	155.75	155.22	93.57	0.53	95.10	0.00	-28.95
1935	293.07	0.24	234.57	195.84	96.99	38.73	194.63	3.18	94.22
1936	322.94	3.64	245.07	168.67	150.64	76.40	194.83	10.79	29.78
1937	318.33	2.33	408.88	159.48	156.51	249.40	195.41	1.15	35.42
1938	347.57	1.83	343.66	193.93	151.81	149.73	195.32	0.20	41.48
1939	366.80	1.55	245.57	237.36	127.89	8.21	145.55	9.31	6.80
1940	328.62	3.33	193.67	168.57	156.71	25.10	151.79	0.01	-8.27
1941	269.36	41.34	182.83	175.04	52.98	7.79	48.02	0.10	-46.39
1942	272.96	0.01	179.29	179.10	93.85	0.18	125.57	0.35	31.36
1943	368.24	44.78	352.80	192.41	131.06	160.39	194.83	0.00	19.00
1944	255.68	0.37	161.72	161.29	94.02	0.42	122.76	3.11	25.26
1945	303.67	4.66	284.32	159.43	139.58	124.89	195.45	0.97	50.24
1946	351.48	0.98	297.71	240.38	110.12	57.33	194.65	0.00	83.55
1947	298.29	0.12	255.69	209.90	88.26	45.79	164.15	0.00	75.76
1948	312.78	2.06	360.08	170.80	139.92	189.28	195.37	0.00	53.40
1949	258.12	0.00	364.31	183.10	75.02	181.21	194.83	3.24	116.57
1950	283.21	3.07	457.04	171.25	108.90	285.79	195.96	0.00	84.00
1951	374.74	1.56	271.57	227.19	145.99	44.38	194.73	0.00	47.18
1952	263.59	0.32	402.23	193.69	69.58	208.54	195.79	3.46	122.43
1953	411.64	56.14	361.49	189.28	166.22	172.21	195.19	0.73	-27.91
1954	422.94	2.90	279.23	245.86	174.18	33.37	194.63	1.75	15.80
1955	221.22	0.00	292.77	167.56	53.66	125.21	195.56	0.00	141.90
1956	367.53	53.15	421.50	169.21	145.16	252.29	195.92	0.00	-2.40
1957	300.65	0.55	239.16	199.85	100.25	39.31	194.63	2.07	91.75
1958	387.16	0.48	281.57	239.91	146.78	41.66	195.21	0.57	47.38
1959	322.07	0.14	181.51	179.68	142.25	1.83	153.31	4.17	6.74
1960	243.51	0.00	368.20	160.95	82.56	207.25	196.06	2.51	110.99
1961	293.43	0.52	250.66	206.24	86.66	44.41	194.79	0.69	106.92
1962	253.49	0.50	301.68	186.94	66.05	114.74	194.65	0.17	127.93
1963	267.16	0.03	266.03	182.78	84.35	83.24	194.99	0.18	110.44
1964	381.57	2.58	293.84	201.95	177.04	91.89	195.43	0.88	14.94
1965	327.29	0.55	233.06	231.66	95.08	1.40	114.25	0.79	17.84
1966	392.63	14.28	224.42	218.72	159.63	5.70	157.22	1.86	-18.55
1967	387.49	14.21	219.88	217.64	155.63	2.24	164.50	2.14	-7.48
1968	269.71	0.26	171.16	170.63	98.82	0.52	127.11	0.00	28.03
1969	312.31	0.84	283.68	179.32	132.14	104.35	194.87	0.59	61.30
1970	356.53	1.39	196.41	194.17	160.97	2.24	139.78	0.39	-22.96

Table 11.1b. Volume Calculations for 28 March through 31 October, Hills Creek, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	213.41	0.00	421.34	179.41	34.01	241.93	195.23	0.00	161.22
1972	303.94	2.51	324.62	173.58	127.85	151.04	195.04	0.36	64.32
1973	353.45	64.93	213.51	211.56	76.96	1.94	88.27	0.00	-53.62
1974	242.37	0.48	425.09	179.37	62.53	245.72	195.74	0.16	132.58
1975	336.69	1.11	345.46	214.82	120.76	130.64	195.51	0.00	73.63
1976	400.23	8.81	257.69	203.59	187.83	54.10	194.83	4.29	-6.10
1977	223.49	10.97	148.39	146.07	66.45	2.32	87.79	0.00	10.37
1978	282.02	0.04	191.80	191.15	90.83	0.65	114.67	6.70	17.10
1979	374.01	3.86	281.67	196.73	173.41	84.94	194.64	0.00	17.36
1980	329.60	0.06	208.58	208.39	121.15	0.19	138.52	0.35	16.97
1981	268.99	0.00	190.97	186.30	82.69	4.67	166.88	0.28	83.91
1982	355.49	0.50	342.85	233.37	121.61	109.48	195.02	0.00	72.91
1983	412.45	4.33	344.71	221.29	186.82	123.42	195.21	0.00	4.05
1984	237.54	1.78	434.81	183.88	51.88	250.93	195.35	0.00	141.69
1985	348.65	0.32	250.28	236.00	112.34	14.28	188.48	0.00	75.82
1986	354.71	0.62	225.24	220.46	133.62	4.78	149.16	0.00	14.91
1987	398.96	83.51	205.69	203.87	111.58	1.82	114.22	3.81	-84.68
1988	284.52	0.00	222.81	159.57	124.95	63.25	194.96	0.16	69.85
1989	373.44	0.94	333.59	262.52	109.99	71.08	183.55	0.00	72.62
1990	382.32	0.36	236.05	231.69	150.26	4.36	177.72	0.00	27.09
1991	330.04	1.44	231.30	195.05	133.54	36.25	194.83	0.00	59.85
1992	272.13	17.57	143.49	143.17	111.39	0.32	89.41	0.00	-39.56
1993	349.19	38.25	450.49	166.30	144.64	284.19	196.41	7.14	6.37
1994	251.04	7.91	161.49	159.87	83.26	1.63	80.90	0.05	-10.32
1995	485.53	59.63	267.97	220.28	205.62	47.69	194.69	1.46	-72.02
1996	278.99	0.00	366.34	191.92	87.07	174.42	196.24	0.00	109.17
1997	241.32	0.00	302.30	197.00	44.32	105.30	194.63	0.00	150.31
1998	402.96	0.75	283.30	252.17	150.04	31.14	194.63	0.00	43.83
1999	368.10	1.81	410.91	209.61	156.69	201.30	195.52	0.00	37.02
2000	398.91	30.55	281.51	226.02	142.34	55.49	194.83	0.00	21.94
2001	248.28	0.50	165.78	164.96	82.83	0.82	72.38	0.37	-11.32
2002	406.69	35.85	232.19	199.33	171.51	32.87	168.02	2.71	-42.05
2003	390.43	31.79	221.59	181.70	176.94	39.89	192.50	3.96	-20.18
2004	380.28	1.45	272.14	269.32	109.50	2.81	155.06	0.04	44.07
2005	271.62	0.00	174.64	173.78	97.84	0.85	168.35	0.00	70.51
2006	376.84	1.12	243.20	238.41	137.30	4.79	194.63	0.05	56.15
2007	420.94	13.20	264.42	261.10	146.63	3.32	157.17	0.13	-2.79



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 11.1. Water volume totals for Hills Creek 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

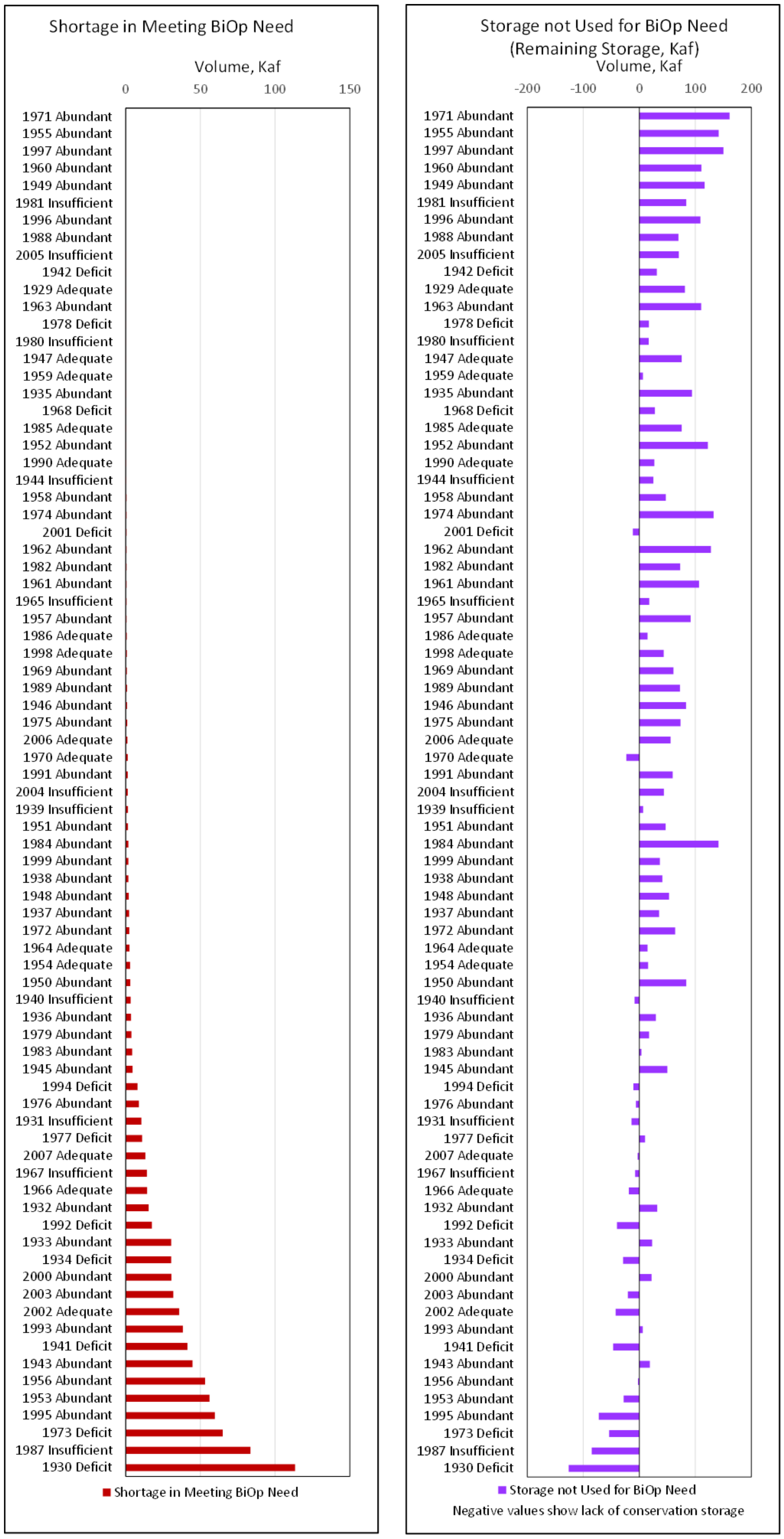
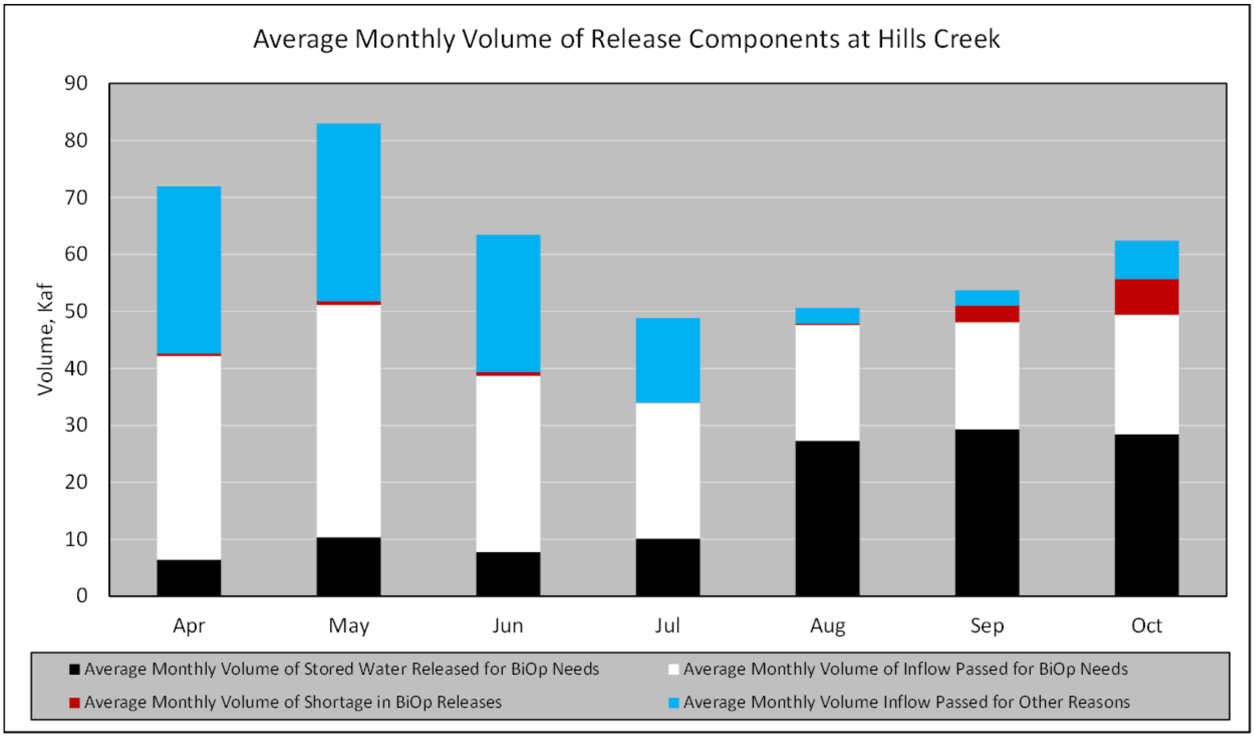


Figure 11.2. Water Volume totals for Hills Creek 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	3.89	42.61	51.80	39.31	33.98	47.87	51.07	55.68
Stored Water Released for BiOp Needs	0.34	6.41	10.35	7.75	10.16	27.28	29.32	28.44
Inflow Passed for BiOp Needs	3.55	35.77	40.81	30.97	23.82	20.31	18.76	20.95
Shortage in meeting BiOp Needs	0.00	0.43	0.63	0.59	0.00	0.29	3.00	6.30
Inflow Passed Other Reasons	3.24	29.37	31.19	24.12	14.85	2.75	2.62	6.74

Figure 11.3. Water volume average monthly totals for release components for Hills Creek 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

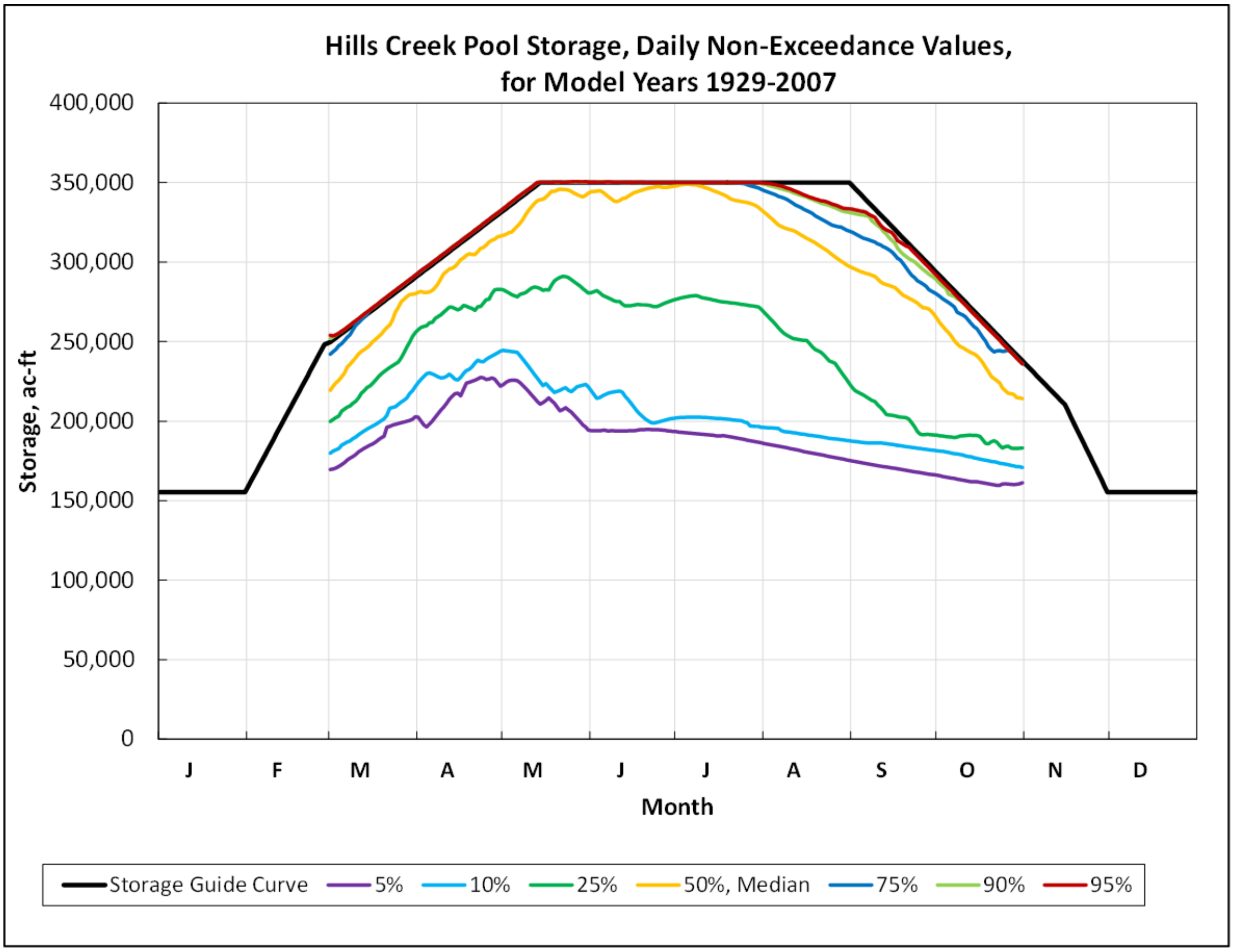


Figure 11.4. Non-exceedance storage values for Hills Creek 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

12 Lookout Point Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Lookout Point, although some additional computations for Lookout Point need to be made since the project is in series with Hills Creek. The Basic Methodology results are tabulated and graphed in the same manner that was described for Blue River (Table 12, Figures 12.1 to 12.4), with additional data presented in Tables 12.2 and 12.3 and Figures 12.5 to 12.7 to take the two-reservoir series into consideration.

The time series records used for the Lookout Point Basic Methodology calculations are:

//LOOKOUT POINT-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-MIN FLOW - AT LOP/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//LOOKOUT POINT-MIN FLOW - AT ALBANY BY WATER YEAR TYPE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/
//LOOKOUT POINT-MIN FLOW - AT SALEM/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/EXTENDBASE0/

The time series records used in addition to the Basic Methodology calculations are:

/HYBRID-LOCAL/LOP-LOCAL/FLOW-LOCAL/01JAN1928 - 01JAN2008/1DAY/2010-LEVEL/
//HILLS CREEK-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

Water volume component calculations for Lookout Point are tabulated in Table 12.1 (split into Table 12.1a for 1929 through 1970 and Table 12.1b for 1971 through 2007) and graphed in Figure 12.1. The yearly project shortages in meeting BiOp Needs and the stored water not used for meeting BiOp Needs are graphed in Figure 12.2, and the average monthly total volumes are shown in Figure 12.3. The Lookout Point storage non-exceedance graph is shown in Figure 12.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Note that Table 12.1 contains the comment "*Data includes the Hills Creek water volume release components*" in the table name, and that Figures 12.1 through 12.3 also indicate that Hills Creek data is included. This is because Lookout Point and Hills Creek are in series – all water released from Hills Creek enters the Lookout Point reservoir. There is also a significant amount of local inflow to the Lookout Point reservoir. The total volume inflows for these two components (local inflows to LOP and HCR releases entering the LOP reservoir) for the BiOp window are graphed in Figure 12.5 for model years 1929-2007. The **green** bars in the figure are the local inflow volumes and the **light yellow** bars are the inflow volumes that were released from Hills Creek. The Hills Creek release volumes are generally higher than the local inflow volumes.

The data presented in Table 12 and Figures 12.1 through 12.3 have not been differentiated by the type of inflow volume. This differentiation of inflow source is presented a little later in this section.

The entries in Table 12.1 need to be interpreted slightly differently for Lookout Point since it is in series with and downstream of Hills Creek. These table entries for the BiOp window 28Mar-31Oct mean the following:

BiOp Need: *this is the total BiOp Need for the combined reservoirs of Hills Creek and Lookout Point. For example, when no supplemental flow is needed on the mainstem at Albany or Salem, both reservoirs must still release their minimum tributary flows, 400 cfs for Hills Creek and 1200 cfs for Lookout Point. This 1200 cfs is the total flow needed for the BiOp tributary minimum downstream of Lookout Point, but Lookout Point's share of this flow would be 800 cfs (with the 400 cfs from Hills Creek released as well). If Hills Creek releases less than 400 cfs, Lookout Point needs to make up the difference. If Hills Creek releases more than 400 cfs, Lookout Point may release a smaller share than 800 cfs to still meet the total need. Table 12 does not make this distinction – it represents the total need downstream of both projects. If the 1200 cfs were considered to be Lookout Point's BiOp Need in addition to the Hills Creek 400 cfs, then the 400 cfs would be counted twice. The BiOp Need is calculated from the Lookout Point minimum tributary flows and the Lookout Point Albany and Salem downstream minimum rule values.*

BiOp Shortage: *this is the total shortage in meeting BiOp Need for the combined reservoirs of Hills Creek and Lookout Point.*

Inflow Passed: *this is the total inflow to Lookout Point that is passed without being stored in Lookout Point reservoir. It may be from either local inflows to Lookout Point or inflows that arrived from Hills Creek releases. No distinction is made for the source of the inflow in this table entry.*

Inflow Passed for BiOp: *this is the portion of the Inflow Passed that met the total downstream BiOp Need. No distinction is made between local inflows and Hills Creek releases in this table entry.*

Stored Water for BiOp: *this is the Lookout Point stored water released to meet the total downstream BiOp Need. Lookout Point may have stored water from either local inflows or Hills Creek releases. No distinction is made between water stored from local inflows or Hills Creek releases in this table entry.*

Inflow Passed Other Reasons: *this is the portion of inflow passed that was not for meeting the total downstream BiOp Need.*

The last four columns in Table 12, for 01 Sep – 31 Oct, apply only to Lookout Point. These columns are stored water from Lookout Point released for the total downstream BiOp Need in this window, the total project outflows and inflows in this window (with no distinction made as to the source of the inflows), and additional storage released from Lookout Point in this window for other reasons.

Table 12.2 (split into Table 12.2a for 1929 through 1970 and Table 12.2b for 1971 through 2007) takes the BiOp Need shown in Table 12.1 for Lookout Point with Hills Creek included and the BiOp Need shown in Table 11.1 for Hills Creek and estimates the Need attributed to Lookout Point only. This is necessary because the BiOp Need volumes reported in Table 12.1 include the BiOp Need at Hills Creek, but a project specific set of water volume computations is needed as well. The BiOp Need share for LOP is found by subtracting the Hills Creek BiOp Need from the Lookout Point Total BiOp Need. The results are listed in the third data column of Table 12.2. The table also shows that the Lookout Point only share of the shortage in meeting the BiOp Need is obtained by subtracting the shortage at Hills Creek from that of the Lookout Point total values from Table 12.1. There are a few cases where the shortage at Hills Creek was made up for by Lookout Point (see 1930, last column of data).

In order to show that the BiOp mainstem minimum flow rules for Albany and Salem that are evaluated at Lookout Point contain the amounts computed for Hills Creek, a single year simulation for 1929 was made in ResSim that included two alternatives – an alternative called “NewBase” and an alternative called “LOP-NET”. The details of this simulation with both alternatives are shown in Table 12.3 below.

This one year simulation using the “NewBase” alternative has the same rules as the Baseline, while the “LOP-NET” alternative removes Hills Creek. In “LOP-NET”, Hills Creek has no operations, and the Lookout Point inflow is specified as the net inflow to Lookout Point from the “NewBase” simulation. The rule set at Lookout Point is the same as in the Baseline. This makes the daily net inflow to Lookout Point in “LOP-NET” identical to that of “NewBase” and acts like Hills Creek isn’t there. Since the operation set at Lookout Point still includes the Albany and Salem downstream minimum flow rules, these rules still get evaluated at LOP. Figure 12.6 shows the ResSim plot of the LOP pool elevations and outflows for both alternatives, with the initial months of the two results tracking nearly identically. This shows that the “LOP-NET” alternative mimics the operation of the Baseline alternative “NewBase” very well when the two pool elevation lines coincide.

Figure 12.7 shows the values determined for LOP Salem and Albany downstream minimum rules for both alternatives in this short simulation. The top graph of the figure is the Salem rule values, and the bottom graph is the Albany rule values. In both graphs, the blue line is the rule value from the alternative “NewBase” and the red line is from the alternative “LOP-NET”. The rules are evaluated almost identically for the spring of 1929, when the pool elevations of the two alternatives are the same, although they begin to diverge somewhat as the summer progresses.

The two graphs in Figure 12.7 allow for an important conclusion to be made. Since the Salem downstream rule in April is basically unchanged at LOP when HCR does not get evaluated (the “NewBase” HCR rule varies between 400 and 500 cfs in this period), the rule evaluation at Lookout Point contains the total BiOp Need for the projects in series.

The water volume components shown in Table 12.1 and Figure 12.1 can be broken into their sub-components based on where the water came from. This is shown in Table 12.4 and Figure 12.8. The first two data columns of Table 12.4 show the volume components for the inflow passed to meet the BiOp Need and the inflow passed for other reasons from Table 12.1. The inflow volumes in the BiOp window for the releases made by Hills Creek and the local inflows to Lookout Point are shown in the third and sixth data columns of Table 12.4, respectively. These inflow volume component titles are color-coded the same as the bars in the graph of Figure 12.5 (light yellow for HCR releases flowing into LOP and green for local inflows to LOP). These inflow components were then assumed to be divided into various sub-components by the following method, which are color-coded by reason for the inflow being passed and where the inflow came from:

Step 1: When the volume of water from HCR is larger than the total volume of water passed at LOP for reasons other than meeting BiOp Need, the whole water volume for other reasons is assigned to be from a portion of the HCR releases. This value is in the fourth column of data in Table 12.4.

> Example for 1929: 114.05 Kaf Inflow passed for other reasons is < 320.77 Kaf from HCR releases, so 114.05 Kaf of HCR releases is assigned as the "Inflow Passed for Other Reasons".

Step 2: When the volume of water from HCR is less than the total volume of water passed at LOP for reasons other than meeting the BiOp Need, the whole volume from HCR is assigned as being passed for other reasons. This value is in the fourth column of data in Table 12.4.

> Example for 1932: 627.94 Kaf Inflow passed for other reasons is > 501.60 Kaf from HCR releases, so the whole 501.60 Kaf of HCR releases is assigned to contribute to "Inflow Passed for Other Reasons".

Step 3: The remainder of the inflow from HCR releases is assigned to be a portion of the total **Inflow Passed for BiOp Needs**. This will be zero when the conditions of Step 2 apply. This value is in the fifth column of data in Table 12.4.

> Example for 1929: 320.77 Kaf from HCR releases, with 114.05 Kaf of HCR releases assigned as the "Inflow Passed for Other Reasons" and (320.77-114.05) = 206.71 Kaf remainder of HCR releases as Inflow Passed for BiOp Need.

> Example for 1932: 501.60 Kaf from HCR releases, all applied to "Inflow Passed for Other Reasons", so the inflow passed for BiOp Needs does not contain a portion from HCR releases.

Step 4: The remainder of the inflow passed for BiOp Needs comes from the local inflows to Lookout Point. This value is calculated by taking the total volume of inflow passed for the BiOp Need minus the portion that came from the HCR releases. This value is in the seventh data column of Table 12.4.

> Example for 1929: 527.03 Kaf Inflow passed for BiOp Need minus 206.71 Kaf from HCR releases, so the remaining 320.32 Kaf comes from local inflows to LOP to be passed for BiOp Need.

> Example for 1932: 558.67 Kaf Inflow passed for BiOp Need minus 0 Kaf from HCR releases, so the full 558.67 Kaf comes from local inflows to LOP to be passed for BiOp Need.

Step 5: Sometimes a local inflow to Lookout Point contributes to inflow passed for other reasons. This only occurs when the conditions of Step 2 apply, when the total inflow passed for other reasons is greater than the HCR releases. The difference between is the local inflow passed for other reasons. This value is in the eighth column of data in Table 12.4, although this value is very often zero.

> Example for 1932: 627.94 Kaf total Inflow passed for other reasons with 501.60 Kaf from HCR releases, so the (627.94 - 501.60) = 126.34 Kaf of local inflow to LOP is assigned the remaining "Inflow Passed for Other Reasons" needed.

Step 6: Any remaining local inflow to Lookout Point goes into storage at Lookout Point. The stored water is calculated as the total volume of local inflow minus the portion that is passed for BiOp Need minus the portion passed for other reasons. This value is in the ninth column of data in Table 12.4. The stored water calculated here is not the same as the stored water released to meet BiOp Needs, since that released storage *comes from* the quantity calculated here.

> Example for 1932: 759.57 Kaf total local inflow to LOP, 558.67 Kaf passed to meet BiOp Need, 126.34 Kaf passed for other reasons, so (759.57 – 558.67 –126.34) = 74.56 Kaf of local inflow to LOP is stored during the BiOp window.

Figure 12.8 illustrates how the water volume components at Lookout Point have been sub-divided according to their inflow source. This figure is a set of side-by-side graphs, both presented chronologically by year, with the graph on the left the same as that of Figure 12.1. In the left hand graph, the inflow passed to meet BiOp Need is a **white** bar and the inflow passed for other reasons is a bright blue bar. In the graph on the right of Figure 12.8, the white and bright blue bars have been sub-divided into the portions that come from the Hills Creek releases and the portions that come from local inflows to Lookout Point. The color coding is light yellow for inflows to LOP from HCR releases and green for local inflows to LOP, with the portions for inflow passed for other reasons these same colors but with the bars outlined in bright blue.

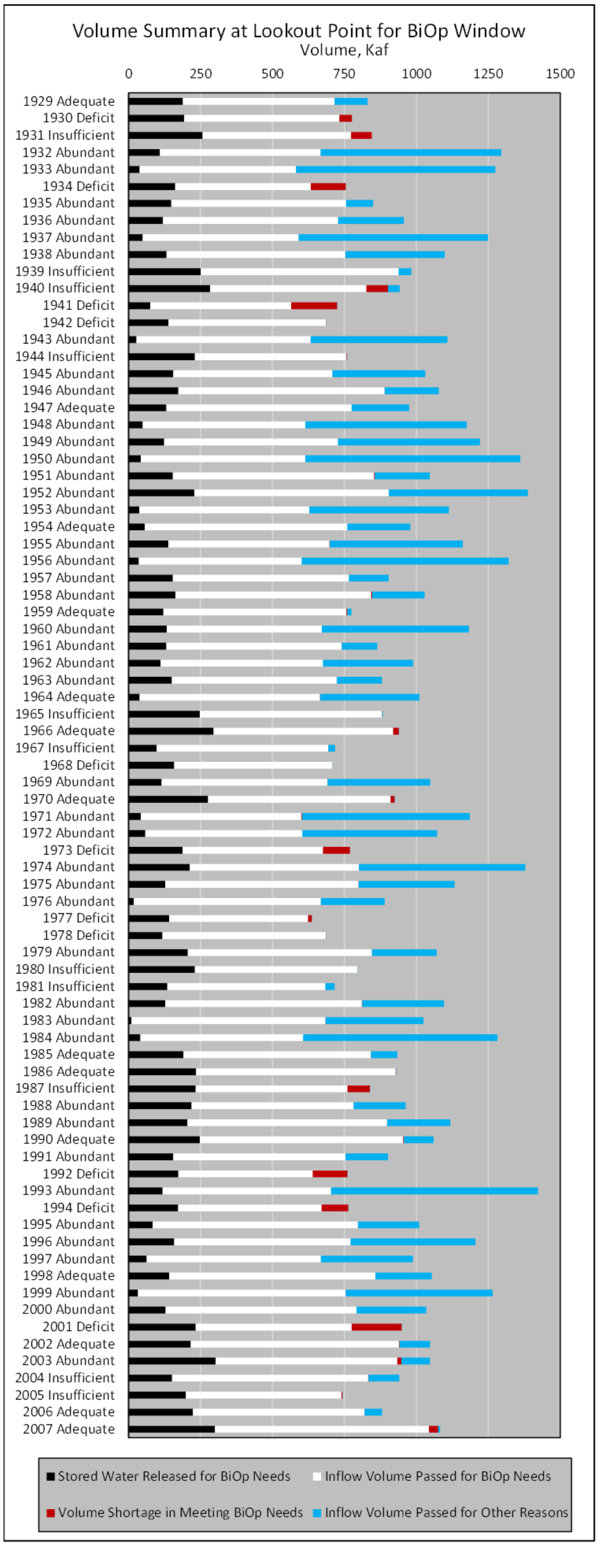
The average monthly volume for each water volume component shown in Figure 12.3 for Lookout Point (without distinction by inflow source) is shown in Figure 12.9 with the break-out of inflow source estimated. Using the assumptions outlined in the steps above, the HCR releases are applied first to the calculated inflow passed for other reasons, with any remainder applied to the inflow passed for BiOp Need. The stored water releases and shortages remain the same. The local inflows to LOP are assigned any remainder so that the average monthly totals remain the same. All remaining local inflow volumes would go to storage in LOP, which is not plotted on the graph.

Table 12.1a. Volume Calculations for 28 March through 31 October, Lookout Point, 1929 through 1970. (Data includes the Hills Creek water volume release components.) (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

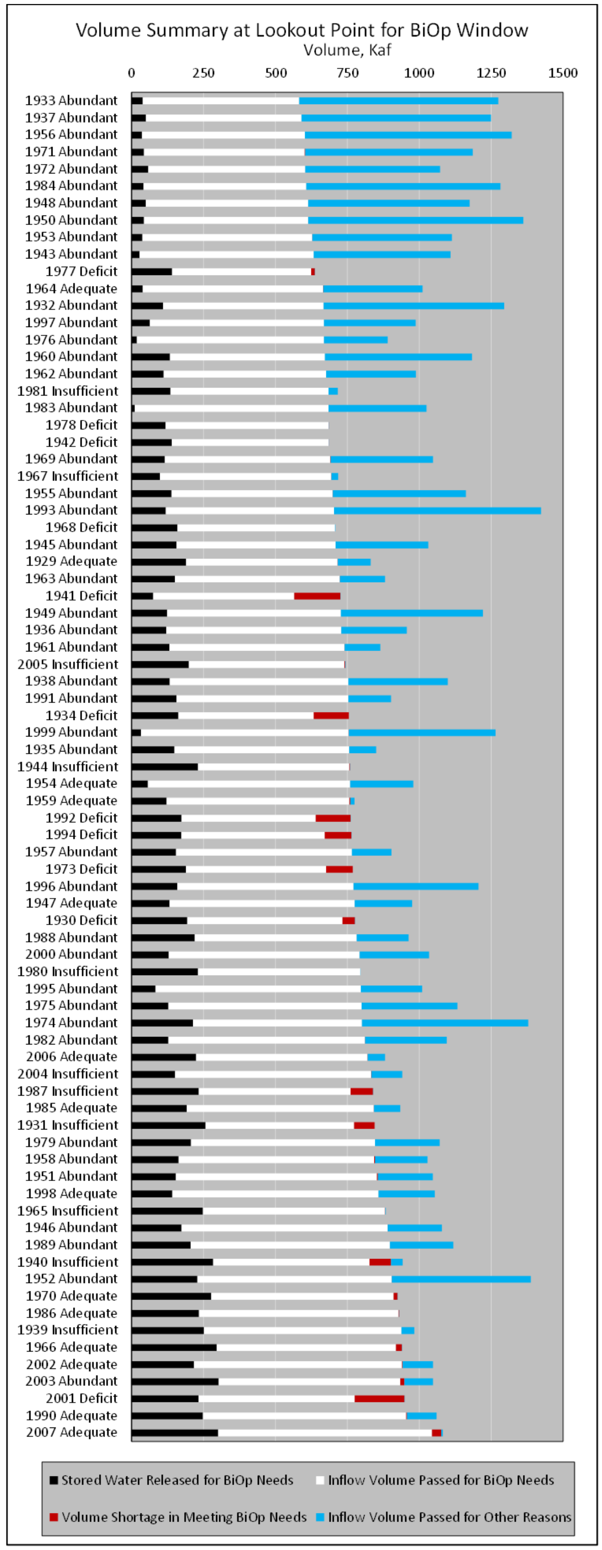
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	716.71	0.34	641.09	527.03	189.34	114.05	319.42	0.00	129.74
1930	776.15	43.22	539.85	539.43	193.49	0.42	198.01	12.46	-51.16
1931	844.71	71.33	516.12	516.12	257.26	0.00	261.83	7.04	-73.81
1932	667.61	0.00	1186.61	558.67	108.94	627.94	319.42	1.26	209.22
1933	582.53	0.00	1236.09	543.74	38.80	692.35	320.88	4.21	277.87
1934	754.72	121.32	470.69	470.69	162.72	0.00	155.36	0.22	-128.90
1935	756.24	0.00	701.32	607.48	148.76	93.84	319.42	0.00	170.66
1936	728.76	0.00	836.06	608.43	120.33	227.63	319.42	14.49	184.59
1937	591.05	0.00	1200.00	541.54	49.52	658.46	320.22	2.53	268.17
1938	753.72	0.00	966.40	621.18	132.54	345.22	319.42	0.75	186.13
1939	938.49	0.00	731.13	687.15	251.34	43.98	319.42	14.56	53.52
1940	901.70	74.94	583.98	543.28	283.49	40.70	277.98	0.66	-81.09
1941	725.52	160.31	490.03	489.84	75.37	0.18	66.79	0.35	-169.23
1942	686.80	0.16	547.21	547.20	139.43	0.01	239.51	0.22	99.70
1943	633.09	0.00	1080.67	605.38	27.71	475.29	320.22	0.00	292.51
1944	758.72	1.72	527.22	526.33	230.68	0.90	241.74	7.50	1.85
1945	708.79	0.00	875.15	552.98	155.82	322.17	319.42	2.94	160.66
1946	890.52	0.20	904.53	716.76	173.55	187.77	319.42	0.00	145.66
1947	775.23	0.00	843.01	643.36	131.87	199.65	319.42	0.00	187.55
1948	614.23	0.00	1125.72	564.87	49.36	560.85	319.42	0.37	269.69
1949	727.78	0.00	1097.48	603.95	123.82	493.53	319.42	0.00	195.59
1950	614.34	0.00	1318.67	571.67	42.67	746.99	320.22	0.00	277.55
1951	855.89	2.84	889.86	699.05	154.01	190.82	319.42	0.00	162.57
1952	904.63	0.05	1158.31	675.50	229.09	482.81	319.42	0.00	90.28
1953	628.37	0.00	1076.01	590.96	37.41	485.05	320.22	6.73	276.08
1954	760.03	0.00	922.57	703.53	56.50	219.04	319.42	5.79	257.13
1955	699.19	0.50	1022.50	560.05	138.64	462.45	320.21	0.00	181.07
1956	602.46	0.00	1285.38	566.64	35.82	718.74	320.05	0.00	284.23
1957	765.54	0.00	749.19	611.04	154.50	138.16	319.42	0.00	164.91
1958	846.13	3.11	862.70	679.98	163.04	182.73	319.42	0.43	152.83
1959	760.12	3.10	650.15	635.57	121.45	14.58	289.92	0.51	164.85
1960	671.91	0.00	1050.24	539.04	132.87	511.20	320.22	0.00	187.35
1961	740.80	0.17	732.70	609.28	131.34	123.42	319.42	0.00	187.90
1962	676.16	0.00	876.91	564.58	111.57	312.33	319.42	0.00	207.84
1963	724.12	0.02	730.10	573.51	150.59	156.60	319.42	0.00	168.81
1964	666.58	0.97	971.81	626.97	38.63	344.84	320.22	4.96	275.65
1965	881.15	0.40	634.76	632.69	248.07	2.07	271.04	1.62	20.95
1966	939.41	20.15	623.56	623.54	295.73	0.02	316.91	6.88	-5.85
1967	694.51	0.48	619.12	595.84	98.20	23.28	319.42	2.39	218.35
1968	708.01	0.00	549.65	548.73	159.27	0.92	225.19	0.00	65.92
1969	692.04	1.20	931.39	575.49	115.34	355.90	320.20	1.26	202.40
1970	924.64	13.60	634.49	634.40	276.64	0.09	296.19	2.04	3.91

Table 12.1b. Volume Calculations for 28 March through 31 October, Lookout Point, 1971 through 2007. (Data includes the Hills Creek water volume release components.) (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	603.50	1.68	1141.08	559.00	42.82	582.08	319.75	0.00	275.25
1972	604.05	0.00	1014.18	545.81	58.24	468.37	319.42	0.55	260.63
1973	768.93	92.78	487.51	487.51	188.64	0.00	182.43	0.00	-98.99
1974	800.89	0.00	1165.06	587.55	213.33	577.51	320.22	0.00	106.88
1975	799.69	0.16	1004.98	671.97	127.56	333.01	319.42	0.00	191.70
1976	668.91	0.00	872.34	650.88	18.03	221.47	319.42	11.94	289.45
1977	637.17	12.85	483.62	483.37	140.94	0.25	170.11	0.22	16.09
1978	686.68	0.62	568.34	568.07	118.00	0.27	194.41	9.42	66.37
1979	846.05	0.00	864.45	639.74	206.31	224.71	319.42	2.23	110.88
1980	795.08	0.00	565.01	564.09	230.99	0.92	278.97	4.44	43.55
1981	684.47	0.00	581.18	549.12	135.35	32.06	319.42	0.00	184.07
1982	811.94	1.11	967.30	683.42	127.41	283.88	319.42	0.00	190.89
1983	684.78	0.05	1014.54	674.20	10.53	340.34	319.42	0.32	308.52
1984	606.94	0.00	1240.52	565.48	41.46	675.04	320.19	0.00	278.74
1985	842.38	0.01	742.83	651.35	191.01	91.48	319.42	0.00	128.39
1986	929.90	1.74	694.54	693.52	234.64	1.02	319.36	0.00	82.98
1987	839.01	77.98	527.77	527.32	233.71	0.45	224.43	0.21	-87.47
1988	782.40	0.00	743.34	563.00	219.40	180.35	319.42	0.54	99.48
1989	898.06	0.00	912.93	693.08	204.98	219.85	319.42	0.00	114.44
1990	957.46	2.75	809.12	706.48	248.22	102.64	319.42	0.00	68.45
1991	753.74	0.00	745.93	598.00	155.74	147.93	319.42	0.00	163.67
1992	760.98	120.76	467.47	466.58	173.64	0.89	167.31	0.45	-127.54
1993	703.94	0.00	1304.79	585.40	118.54	719.39	320.21	8.79	192.88
1994	763.53	91.94	499.31	498.79	172.80	0.52	162.79	0.52	-102.46
1995	796.89	0.00	926.27	713.41	83.48	212.86	319.42	0.96	234.98
1996	771.55	0.00	1046.79	612.75	158.80	434.04	320.22	0.00	161.41
1997	668.70	0.00	924.65	605.57	63.13	319.08	319.42	0.00	256.29
1998	857.97	0.00	912.76	716.80	141.17	195.96	319.42	1.32	176.92
1999	754.92	0.01	1232.36	721.94	32.97	510.43	320.22	0.01	287.23
2000	792.24	0.00	905.29	663.32	128.93	241.98	319.42	5.56	184.93
2001	948.72	173.35	542.62	542.13	233.24	0.48	251.67	10.76	-165.68
2002	942.38	2.26	828.65	723.35	216.77	105.30	319.42	5.52	94.86
2003	948.41	14.12	730.86	631.54	302.74	99.32	319.42	6.03	-3.47
2004	833.83	1.27	788.16	681.31	151.25	106.84	319.42	0.00	166.91
2005	742.83	3.21	541.60	540.45	199.17	1.15	300.71	0.51	97.81
2006	820.64	0.88	655.49	595.50	224.26	59.99	319.42	0.41	93.87
2007	1076.44	32.09	749.18	743.54	300.81	5.64	319.42	4.97	-18.45



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 12.1. Water volume totals for Lookout Point 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value. (Includes Hills Creek.)

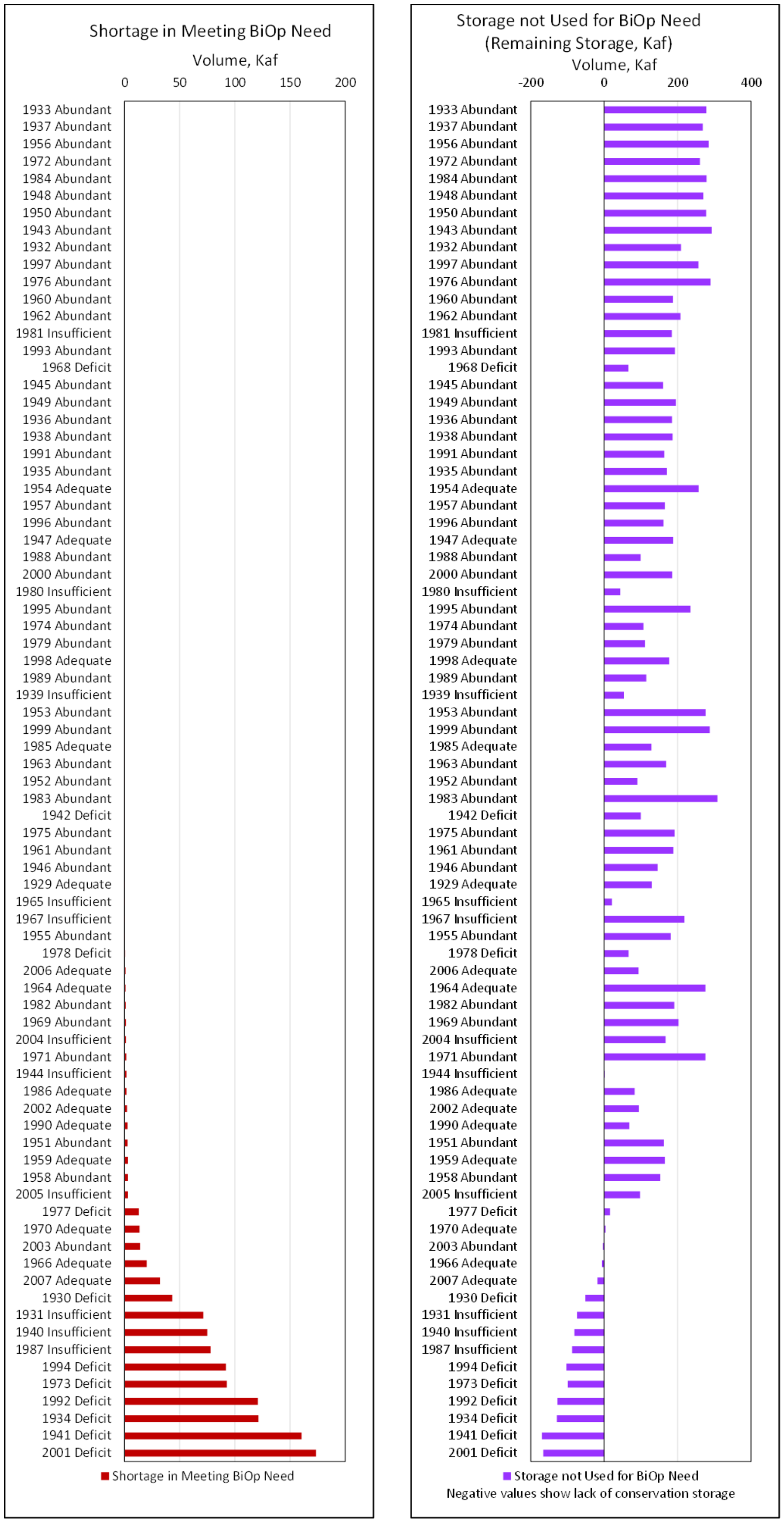
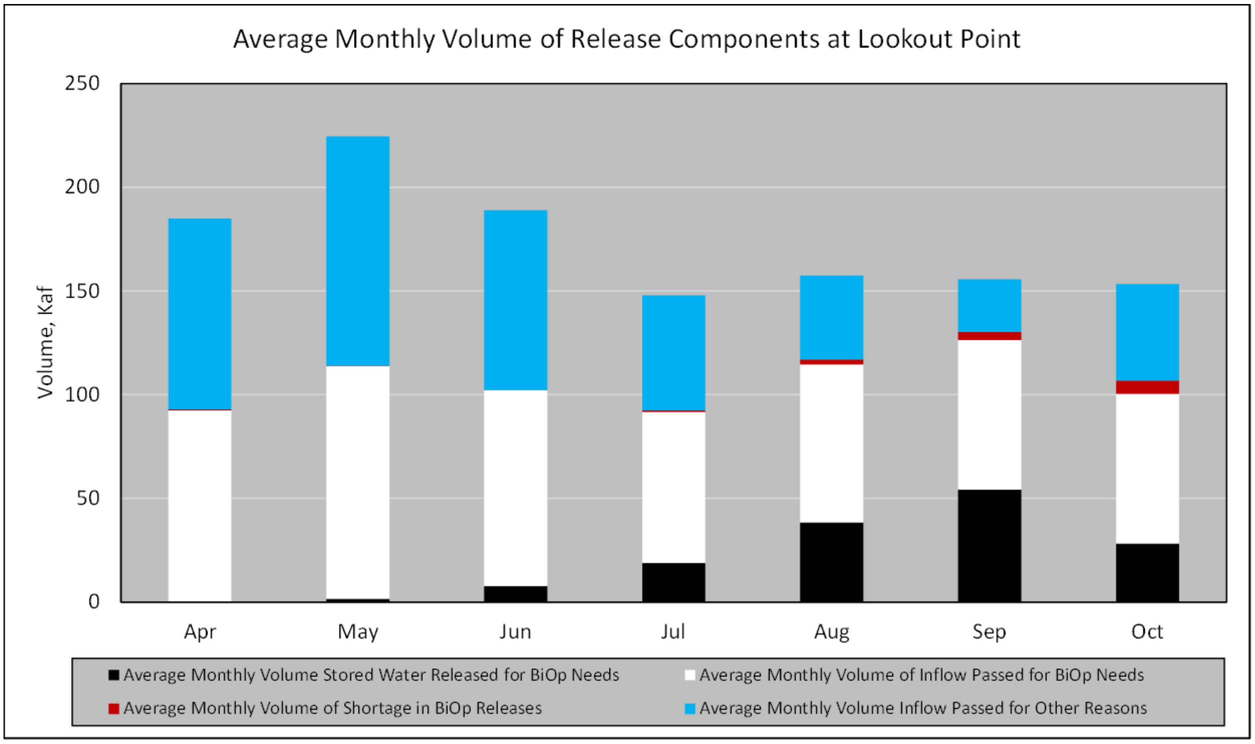


Figure 12.2. Water Volume totals (with Hills Creek) for Lookout Point 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	9.86	92.94	113.96	102.19	92.44	116.98	130.29	106.84
Stored Water Released for BiOp Needs	0.01	0.21	1.58	7.78	18.86	38.32	54.15	28.26
Inflow Passed for BiOp Needs	9.71	92.19	112.19	94.27	72.86	76.30	72.14	72.10
Shortage in meeting BiOp Needs	0.15	0.54	0.20	0.14	0.73	2.36	3.99	6.48
Inflow Passed Other Reasons	9.70	91.98	110.61	86.76	55.44	40.48	25.37	46.41

Figure 12.3. Water volume average monthly totals for release components for Lookout Point 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons. These monthly totals include the water volume release components from Hills Creek.

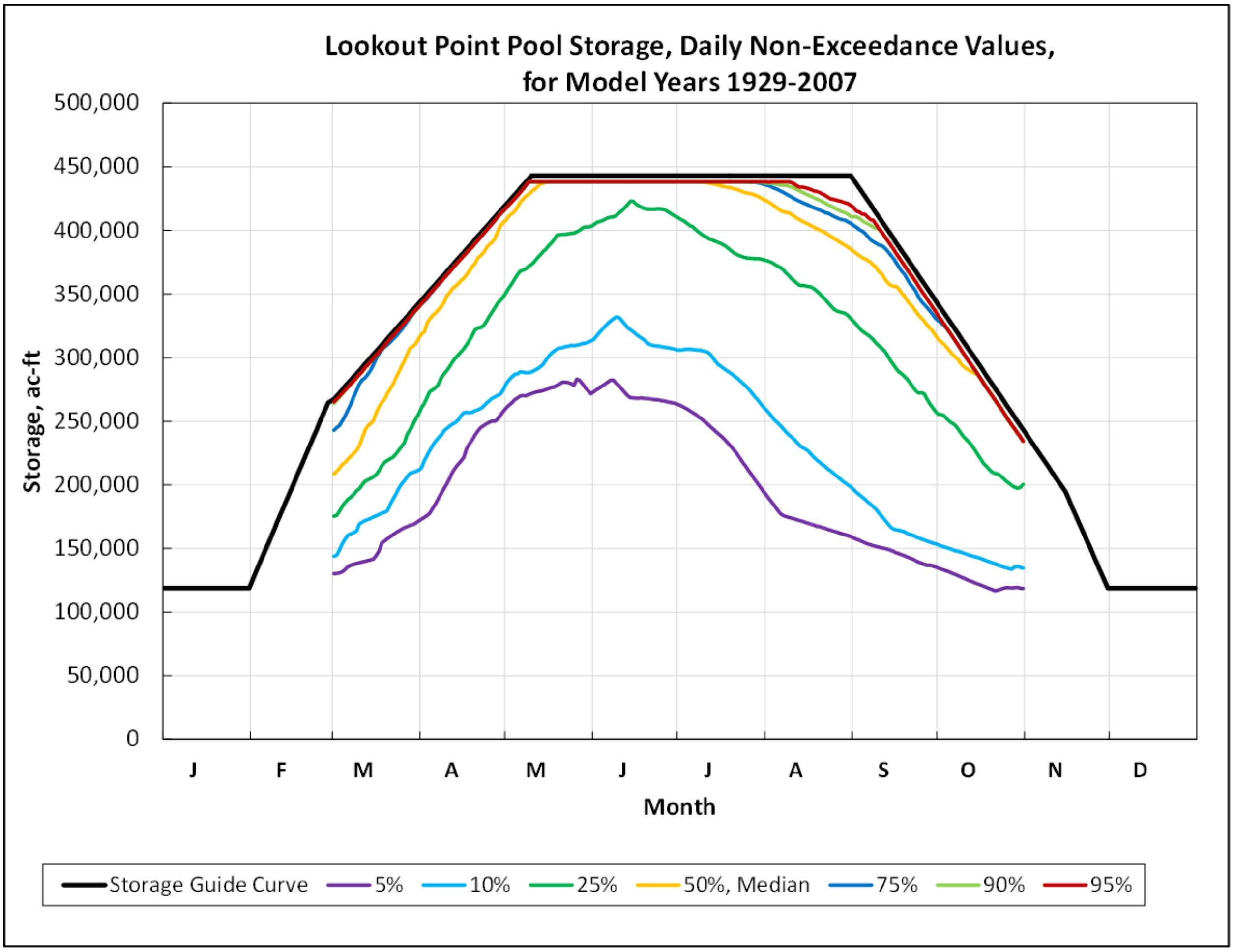


Figure 12.4. Non-exceedance storage values for Lookout Point 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

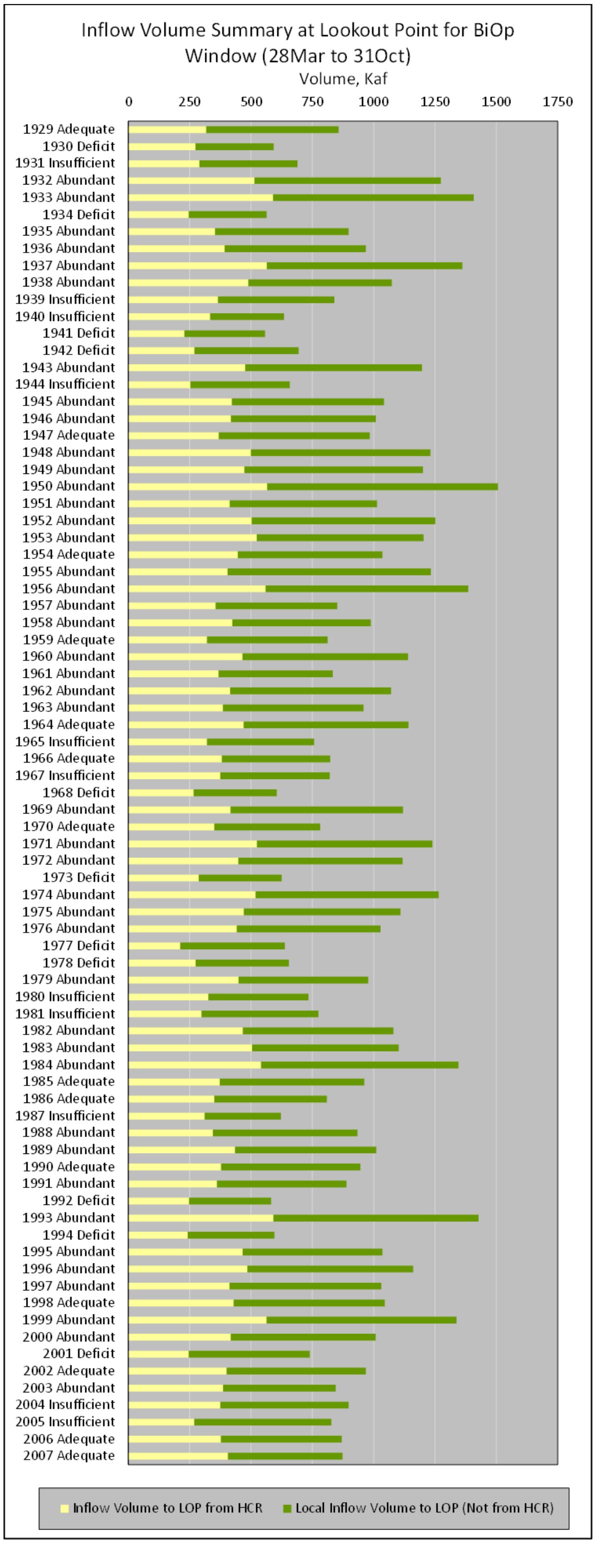


Figure 12.5. Inflow volume totals to Lookout Point reservoir for 28 March through 31 October, the BiOp window, for 1929-2007 model years. Green bars are local inflows to the reservoir and light yellow bars are inflows to the reservoir that were released from Hills Creek. Total inflow to Lookout Point is the green plus light yellow bars.

Table 12.2a. Estimated Lookout Point Only Volume Calculations for 28 March through 31 October, 1929 through 1970. (Data subtracts the HCR volume from LOP totals.)

Year	Volumes Computed for 28 March through 31 October, KAF						
	LOP + HCR BiOp Need	HCR Only BiOp Need	LOP Only BiOp Need	LOP + HCR BiOp Shortage	HCR Only BiOp Shortage	LOP Only BiOp Shortage	HCR Shortage Met by LOP
1929	716.71	267.57	449.14	0.34	0.03	0.32	0.00
1930	776.15	389.31	386.84	43.22	113.33	43.22	70.11
1931	844.71	303.38	541.34	71.33	10.51	60.83	0.00
1932	667.61	321.25	346.36	0.00	15.32	0.00	15.32
1933	582.53	352.51	230.02	0.00	30.40	0.00	30.40
1934	754.72	279.27	475.45	121.32	30.48	90.83	0.00
1935	756.24	293.07	463.17	0.00	0.24	0.00	0.24
1936	728.76	322.94	405.82	0.00	3.64	0.00	3.64
1937	591.05	318.33	272.72	0.00	2.33	0.00	2.33
1938	753.72	347.57	406.15	0.00	1.83	0.00	1.83
1939	938.49	366.80	571.69	0.00	1.55	0.00	1.55
1940	901.70	328.62	573.08	74.94	3.33	71.60	0.00
1941	725.52	269.36	456.16	160.31	41.34	118.97	0.00
1942	686.80	272.96	413.84	0.16	0.01	0.16	0.00
1943	633.09	368.24	264.85	0.00	44.78	0.00	44.78
1944	758.72	255.68	503.04	1.72	0.37	1.35	0.00
1945	708.79	303.67	405.12	0.00	4.66	0.00	4.66
1946	890.52	351.48	539.04	0.20	0.98	0.20	0.78
1947	775.23	298.29	476.94	0.00	0.12	0.00	0.12
1948	614.23	312.78	301.46	0.00	2.06	0.00	2.06
1949	727.78	258.12	469.65	0.00	0.00	0.00	0.00
1950	614.34	283.21	331.13	0.00	3.07	0.00	3.07
1951	855.89	374.74	481.15	2.84	1.56	1.28	0.00
1952	904.63	263.59	641.05	0.05	0.32	0.05	0.28
1953	628.37	411.64	216.73	0.00	56.14	0.00	56.14
1954	760.03	422.94	337.09	0.00	2.90	0.00	2.90
1955	699.19	221.22	477.97	0.50	0.00	0.50	0.00
1956	602.46	367.53	234.94	0.00	53.15	0.00	53.15
1957	765.54	300.65	464.89	0.00	0.55	0.00	0.55
1958	846.13	387.16	458.97	3.11	0.48	2.63	0.00
1959	760.12	322.07	438.05	3.10	0.14	2.96	0.00
1960	671.91	243.51	428.40	0.00	0.00	0.00	0.00
1961	740.80	293.43	447.37	0.17	0.52	0.17	0.35
1962	676.16	253.49	422.67	0.00	0.50	0.00	0.50
1963	724.12	267.16	456.96	0.02	0.03	0.02	0.01
1964	666.58	381.57	285.01	0.97	2.58	0.97	1.60
1965	881.15	327.29	553.86	0.40	0.55	0.40	0.16
1966	939.41	392.63	546.79	20.15	14.28	5.87	0.00
1967	694.51	387.49	307.02	0.48	14.21	0.48	13.74
1968	708.01	269.71	438.29	0.00	0.26	0.00	0.26
1969	692.04	312.31	379.73	1.20	0.84	0.36	0.00
1970	924.64	356.53	568.11	13.60	1.39	12.21	0.00

Table 12.2b. Estimated Lookout Point Only Volume Calculations for 28 March through 31 October, 1971 through 2007. (Data subtracts the HCR volume from LOP totals.)

Year	Volumes Computed for 28 March through 31 October, KAF						
	LOP + HCR BiOp Need	HCR Only BiOp Need	LOP Only BiOp Need	LOP + HCR BiOp Shortage	HCR Only BiOp Shortage	LOP Only BiOp Shortage	HCR Shortage Met by LOP
1971	603.50	213.41	390.09	1.68	0.00	1.68	0.00
1972	604.05	303.94	300.12	0.00	2.51	0.00	2.51
1973	768.93	353.45	415.48	92.78	64.93	27.85	0.00
1974	800.89	242.37	558.51	0.00	0.48	0.00	0.48
1975	799.69	336.69	463.00	0.16	1.11	0.16	0.94
1976	668.91	400.23	268.68	0.00	8.81	0.00	8.81
1977	637.17	223.49	413.68	12.85	10.97	1.89	0.00
1978	686.68	282.02	404.66	0.62	0.04	0.57	0.00
1979	846.05	374.01	472.04	0.00	3.86	0.00	3.86
1980	795.08	329.60	465.49	0.00	0.06	0.00	0.06
1981	684.47	268.99	415.48	0.00	0.00	0.00	0.00
1982	811.94	355.49	456.45	1.11	0.50	0.61	0.00
1983	684.78	412.45	272.33	0.05	4.33	0.05	4.28
1984	606.94	237.54	369.40	0.00	1.78	0.00	1.78
1985	842.38	348.65	493.72	0.01	0.32	0.01	0.30
1986	929.90	354.71	575.20	1.74	0.62	1.12	0.00
1987	839.01	398.96	440.05	77.98	83.51	77.98	5.53
1988	782.40	284.52	497.88	0.00	0.00	0.00	0.00
1989	898.06	373.44	524.62	0.00	0.94	0.00	0.94
1990	957.46	382.32	575.14	2.75	0.36	2.39	0.00
1991	753.74	330.04	423.71	0.00	1.44	0.00	1.44
1992	760.98	272.13	488.85	120.76	17.57	103.18	0.00
1993	703.94	349.19	354.75	0.00	38.25	0.00	38.25
1994	763.53	251.04	512.48	91.94	7.91	84.03	0.00
1995	796.89	485.53	311.35	0.00	59.63	0.00	59.63
1996	771.55	278.99	492.57	0.00	0.00	0.00	0.00
1997	668.70	241.32	427.38	0.00	0.00	0.00	0.00
1998	857.97	402.96	455.01	0.00	0.75	0.00	0.75
1999	754.92	368.10	386.81	0.01	1.81	0.01	1.80
2000	792.24	398.91	393.34	0.00	30.55	0.00	30.55
2001	948.72	248.28	700.43	173.35	0.50	172.85	0.00
2002	942.38	406.69	535.69	2.26	35.85	2.26	33.58
2003	948.41	390.43	557.98	14.12	31.79	14.12	17.66
2004	833.83	380.28	453.55	1.27	1.45	1.27	0.18
2005	742.83	271.62	471.21	3.21	0.00	3.21	0.00
2006	820.64	376.84	443.80	0.88	1.12	0.88	0.24
2007	1076.44	420.94	655.50	32.09	13.20	18.88	0.00

Table 12.3. Summary of Lookout Point Test Simulation Particulars.

ResSim Version	HEC-ResSim 3.2.0.1197 Dev Build 64-bit
Watershed	NWP_Willamette
Network	Willamette-2010Mod-SSARR
Configuration	Existing
Alternative	NewBase and LOP-NET (both alternatives in same simulation)
Inflow File Name	Final Flows WBR – from 2010 Mod Flows and Hybrids.dss for all projects in “NewBase” and all projects except HCR and LOP in “LOP-NET”, where that alternative uses: *HCR inflow is zero, using “Zero Flow record.dss”.* *LOP inflow is from “HCR Baseline Outflows.dss”.*
Rule Curve File	Willamette_Rule_Curves.dss
External Variables File	diversion.dss and Water Year Type for 2010 Mod Flows.dss
Simulation Name	**LOP-use-net-inflow-1929***
Simulation Start	04 Oct 1928 at 2400
Simulation Lookback	01 Oct 1928 at 2400
Simulation Ending	05 Jan 1930 at 2400

Project	**Operation Set Name**	**Lookback Elevation**	**Lookback Flows (cfs)**
DET	Revised Temp Ops DET	Rule Curve	Power Plant 1500.0, Spillway and ROs 0.0
BCL	Early Imp	1193.0 ft.	Power Plant 1573.0, Spillway 0.0
GPR	GPR new FOS rules	Rule Curve	Power Plant 1500.0, Spillway and RO 0.0
FOS	Revised FOS	Rule Curve	Power Plant 1500.0, Spillway 0.0
CGR	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 400.0, Spillway and RO 0.0
BLU	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Spillway 0.0
HCR ***NewBase*** ***LOP-NET***	 *FIS Flood OPs & Early Imp* *HCR Pass Inflow*	Rule Curve For both alternatives	 *Power Plant 400.0, Spillway and RO 0.0* *All 0.0*
LOP	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 1200.0, Spillway and ROs 0.0
DEX	Early Imp	693.0 ft.	Power Plant 1200.0, Spillway 0.0
FAL	FIS and Early Imp 728	Rule Curve	RO 200.0, Spillway 0.0
COT	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Uncontrolled Spillway 0.0
DOR	FIS Flood OPs & Early Imp	Rule Curve	RO 100.0, Uncontrolled Spillway 0.0
FRN	FIS Flood OPs & Early Imp	Rule Curve	RO 30.0, Spillway and Sluice Gate 0.0

*Note on simulation: The LOP inflow is the net inflow from the NewBase run, which includes both the local flow component and the releases from HCR as modeled in the Baseline simulation. HCR has no operations in LOP-NET, it just passes zero inflow. This simulation includes the alternative “NewBase” as well so that both simulations can be plotted at the same time.

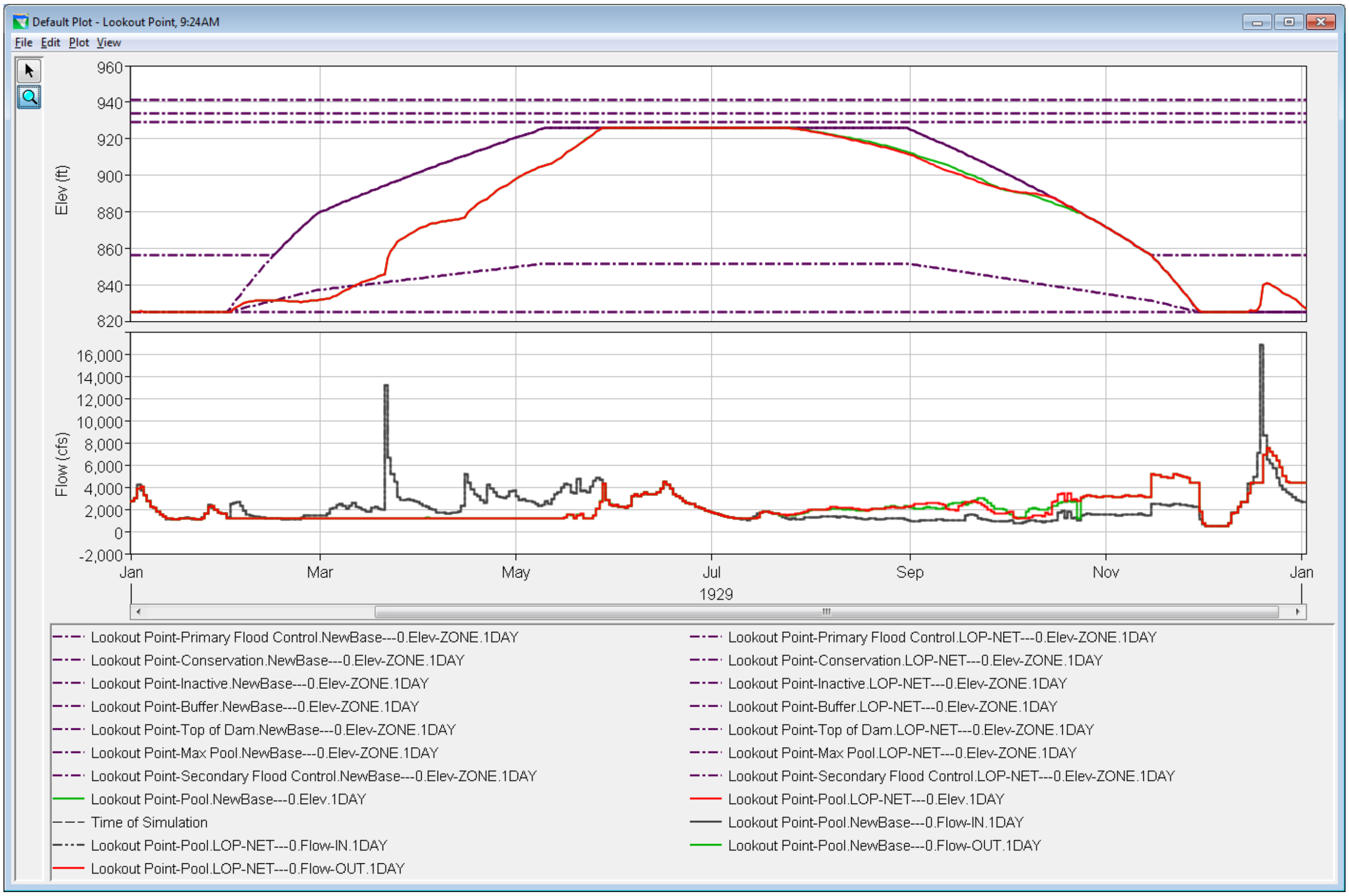
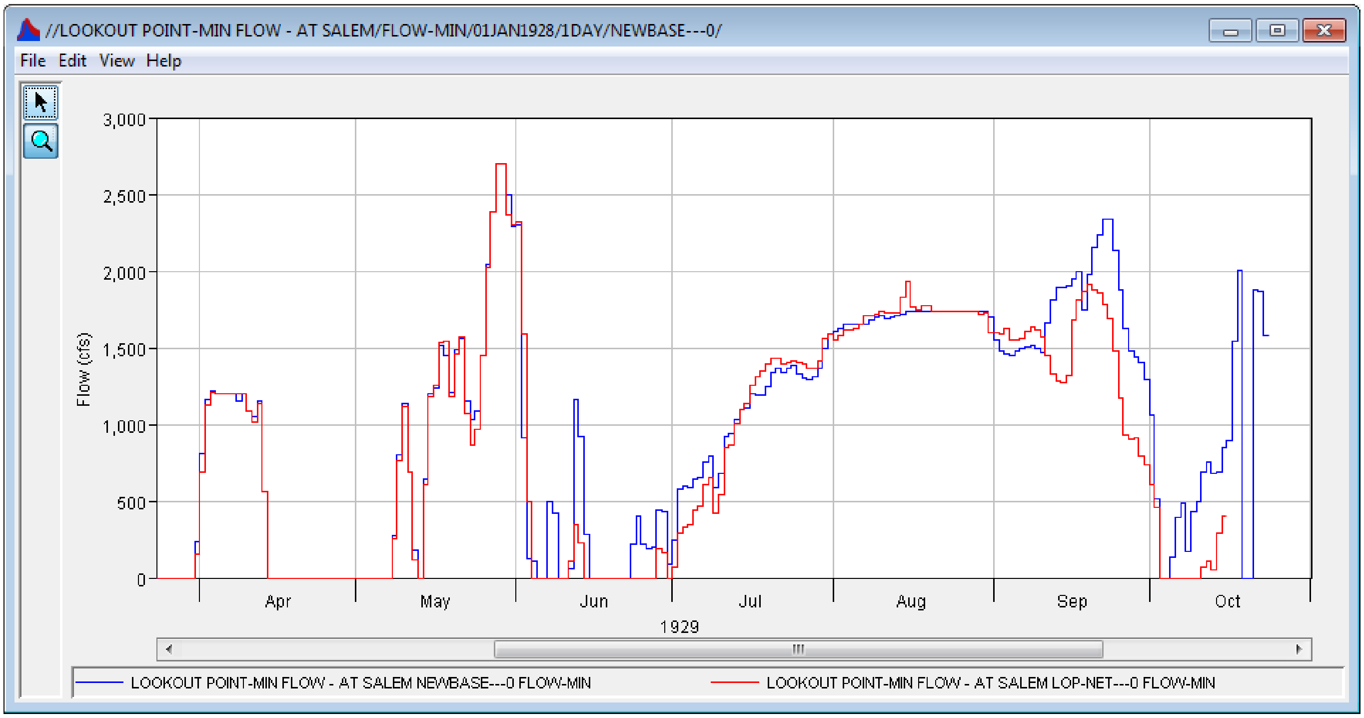


Figure 12.6. Screen shot of ResSim plot of 1929 for the "NewBase" alternative (green) and the "LOP-NET" alternative (red). "NewBase" operations are the same as the Baseline. "LOP-NET" operations at Lookout Point are the same as the Baseline, with no inflow to or operations at Hills Creek, and with Lookout Point inflow set to the net inflow from "NewBase". Note pool elevation is nearly identical for the two alternatives.



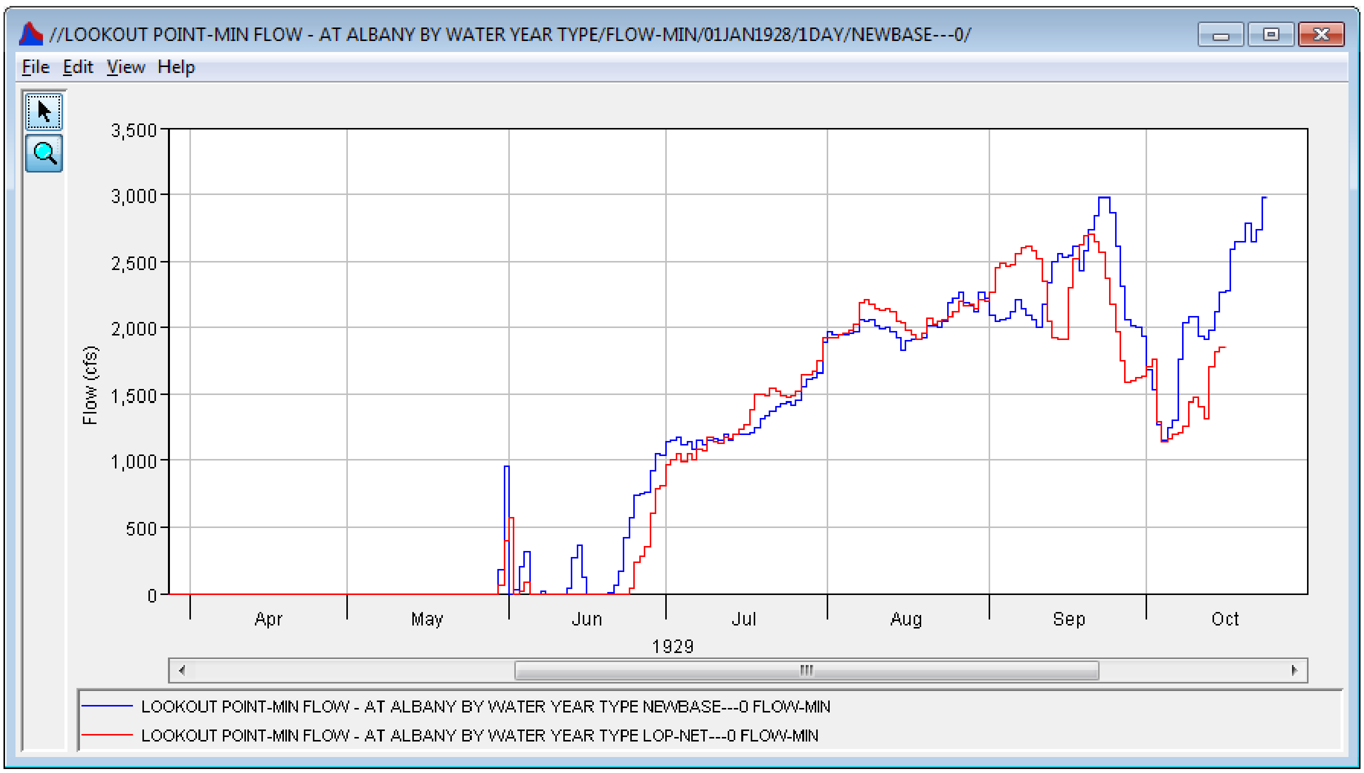


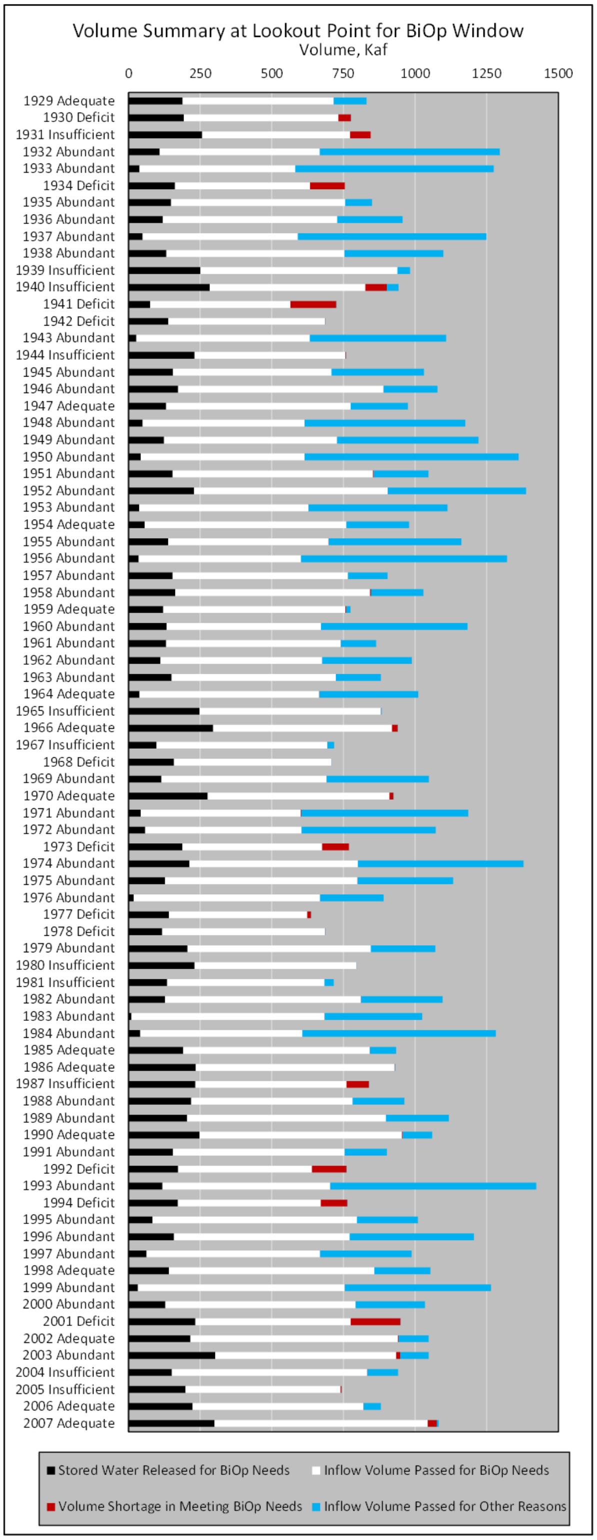
Figure 12.7. The values of the Salem downstream rule (top) and the Albany downstream rule (bottom) as evaluated at LOP for both the alternative "NewBase" (blue) and the alternative "LOP-NET" (red).

Table 12.4a. Inflow volume to Lookout Point for 28 March through 31 October, 1929 through 1970, with LOP local Inflow and HCR releases to LOP divided into water volume components.

Year	LOP Total Inflow, Kaf (from Table 12.1a)		LOP Inflow from HCR Releases, Kaf			LOP Local Inflow, Kaf			
	Passed For BiOp Need	Passed for Other Reasons	HCR Total Volume To LOP	Portion of HCR Inflow To LOP Passed for Other Reasons	Portion of HCR Inflow To LOP Passed to Meet LOP Total BiOp	Local Inflow Volume To LOP	Portion of LOP Local Inflow Passed to Meet LOP Total BiOp	Portion of LOP Local Inflow Passed for Other Reasons	Portion Of LOP Local Inflow Stored In LOP
1929	527.03	114.05	320.77	114.05	206.71	539.55	320.32	0.00	219.23
1930	539.43	0.42	277.71	0.42	277.29	318.45	262.14	0.00	56.31
1931	516.12	0.00	287.71	0.00	287.71	399.77	228.41	0.00	171.36
1932	558.67	627.94	501.60	501.60	0.00	759.57	558.67	126.34	74.57
1933	543.74	692.35	591.16	591.16	0.00	818.36	543.74	101.19	173.44
1934	470.69	0.00	249.39	0.00	249.39	317.08	221.29	0.00	95.79
1935	607.48	93.84	356.70	93.84	262.86	544.56	344.62	0.00	199.94
1936	608.43	227.63	360.82	227.63	133.19	575.17	475.24	0.00	99.93
1937	541.54	658.46	567.11	567.11	0.00	796.91	541.54	91.35	164.03
1938	621.18	345.22	503.17	345.22	157.95	584.89	463.23	0.00	121.66
1939	687.15	43.98	380.16	43.98	336.18	474.03	350.97	0.00	123.06
1940	543.28	40.70	350.93	40.70	310.23	300.99	233.05	0.00	67.94
1941	489.84	0.18	233.65	0.18	233.46	329.12	256.38	0.00	72.74
1942	547.20	0.01	271.26	0.01	271.25	424.17	275.96	0.00	148.21
1943	605.38	475.29	489.18	475.29	13.90	720.61	591.48	0.00	129.13
1944	526.33	0.90	258.62	0.90	257.73	405.68	268.60	0.00	137.08
1945	552.98	322.17	402.60	322.17	80.43	620.41	472.55	0.00	147.86
1946	716.76	187.77	423.70	187.77	235.93	591.17	480.83	0.00	110.34
1947	643.36	199.65	371.83	199.65	172.18	615.46	471.18	0.00	144.28
1948	564.87	560.85	502.52	502.52	0.00	731.37	564.87	58.33	108.16
1949	603.95	493.53	478.67	478.67	0.00	727.68	603.95	14.86	108.87
1950	571.67	746.99	573.54	573.54	0.00	940.26	571.67	173.46	195.13
1951	699.05	190.82	420.24	190.82	229.42	599.49	469.63	0.00	129.86
1952	675.50	482.81	561.56	482.81	78.75	748.28	596.75	0.00	151.52
1953	590.96	485.05	525.23	485.05	40.18	679.51	550.77	0.00	128.74
1954	703.53	219.04	455.29	219.04	236.25	589.61	467.28	0.00	122.33
1955	560.05	462.45	408.31	408.31	0.00	828.12	560.05	54.14	213.94
1956	566.64	718.74	551.38	551.38	0.00	826.27	566.64	167.36	92.27
1957	611.04	138.16	366.25	138.16	228.09	495.34	382.94	0.00	112.40
1958	679.98	182.73	422.18	182.73	239.46	563.82	440.52	0.00	123.30
1959	635.57	14.58	322.66	14.58	308.08	491.84	327.49	0.00	164.35
1960	539.04	511.20	484.72	484.72	0.00	674.82	539.04	26.48	109.30
1961	609.28	123.42	376.15	123.42	252.73	465.64	356.56	0.00	109.08
1962	564.58	312.33	418.56	312.33	106.24	655.32	458.35	0.00	196.97
1963	573.51	156.60	388.45	156.60	231.85	573.23	341.66	0.00	231.57
1964	626.97	344.84	464.63	344.84	119.79	672.33	507.18	0.00	165.15
1965	632.69	2.07	332.65	2.07	330.58	437.03	302.11	0.00	134.93
1966	623.54	0.02	384.36	0.02	384.34	441.52	239.20	0.00	202.32
1967	595.84	23.28	364.38	23.28	341.09	446.76	254.74	0.00	192.02
1968	548.73	0.92	272.25	0.92	271.33	337.92	277.41	0.00	60.52
1969	575.49	355.90	419.90	355.90	64.00	702.77	511.49	0.00	191.27
1970	634.40	0.09	358.95	0.09	358.86	431.73	275.54	0.00	156.19

Table 12.4b. Inflow volume to Lookout Point for 28 March through 31 October, 1971 through 2007, with LOP local Inflow and HCR releases to LOP divided into water volume components.

Year	LOP Total Inflow, Kaf (from Table 12.1b)		LOP Inflow from HCR Releases, Kaf			LOP Local Inflow, Kaf			
	Passed For BiOp Need	Passed for Other Reasons	HCR Total Volume To LOP	Portion of HCR Inflow To LOP Passed for Other Reasons	Portion of HCR Inflow To LOP Passed to Meet LOP Total BiOp	Local Inflow Volume To LOP	Portion of LOP Local Inflow Passed to Meet LOP Total BiOp	Portion of LOP Local Inflow Passed for Other Reasons	Portion Of LOP Local Inflow Stored In LOP
1971	559.00	582.08	538.14	538.14	0.00	714.65	559.00	43.94	111.71
1972	545.81	468.37	439.85	439.85	0.00	669.62	545.81	28.52	95.28
1973	487.51	0.00	290.39	0.00	290.39	338.01	197.12	0.00	140.89
1974	587.55	577.51	542.05	542.05	0.00	745.69	587.55	35.46	122.68
1975	671.97	333.01	475.32	333.01	142.32	638.33	529.65	0.00	108.67
1976	650.88	221.47	445.91	221.47	224.44	585.43	426.43	0.00	159.00
1977	483.37	0.25	214.72	0.25	214.47	426.01	268.90	0.00	157.11
1978	568.07	0.27	280.88	0.27	280.60	379.18	287.47	0.00	91.71
1979	639.74	224.71	455.93	224.71	231.22	528.34	408.52	0.00	119.82
1980	564.09	0.92	328.66	0.92	327.74	407.25	236.35	0.00	170.90
1981	549.12	32.06	302.02	32.06	269.96	476.50	279.16	0.00	197.35
1982	683.42	283.88	470.32	283.88	186.44	613.80	496.97	0.00	116.83
1983	674.20	340.34	530.54	340.34	190.20	597.72	484.00	0.00	113.72
1984	565.48	675.04	553.57	553.57	0.00	804.77	565.48	121.48	117.82
1985	651.35	91.48	375.74	91.48	284.25	589.03	367.10	0.00	221.93
1986	693.52	1.02	359.04	1.02	358.02	458.25	335.50	0.00	122.75
1987	527.32	0.45	317.56	0.45	317.11	310.92	210.21	0.00	100.71
1988	563.00	180.35	346.24	180.35	165.89	588.96	397.11	0.00	191.85
1989	693.08	219.85	452.79	219.85	232.94	575.20	460.14	0.00	115.06
1990	706.48	102.64	379.88	102.64	277.24	567.28	429.25	0.00	138.03
1991	598.00	147.93	370.61	147.93	222.68	527.41	375.32	0.00	152.10
1992	466.58	0.89	255.27	0.89	254.38	334.37	212.19	0.00	122.18
1993	585.40	719.39	569.59	569.59	0.00	835.59	585.40	149.80	100.39
1994	498.79	0.52	244.98	0.52	244.46	353.45	254.33	0.00	99.12
1995	713.41	212.86	473.42	212.86	260.55	569.98	452.85	0.00	117.13
1996	612.75	434.04	489.08	434.04	55.04	676.15	557.71	0.00	118.44
1997	605.57	319.08	418.47	319.08	99.39	618.48	506.18	0.00	112.30
1998	716.80	195.96	441.40	195.96	245.44	616.18	471.36	0.00	144.82
1999	721.94	510.43	569.61	510.43	59.18	773.75	662.76	0.00	110.99
2000	663.32	241.98	425.55	241.98	183.57	590.11	479.75	0.00	110.36
2001	542.13	0.48	248.16	0.48	247.67	493.91	294.46	0.00	199.45
2002	723.35	105.30	403.52	105.30	298.22	567.25	425.13	0.00	142.12
2003	631.54	99.32	398.54	99.32	299.22	458.97	332.32	0.00	126.65
2004	681.31	106.84	393.59	106.84	286.75	522.66	394.57	0.00	128.09
2005	540.45	1.15	271.26	1.15	270.12	558.18	270.33	0.00	287.84
2006	595.50	59.99	384.94	59.99	324.95	492.09	270.55	0.00	221.54
2007	743.54	5.64	412.28	5.64	406.64	467.27	336.90	0.00	130.37



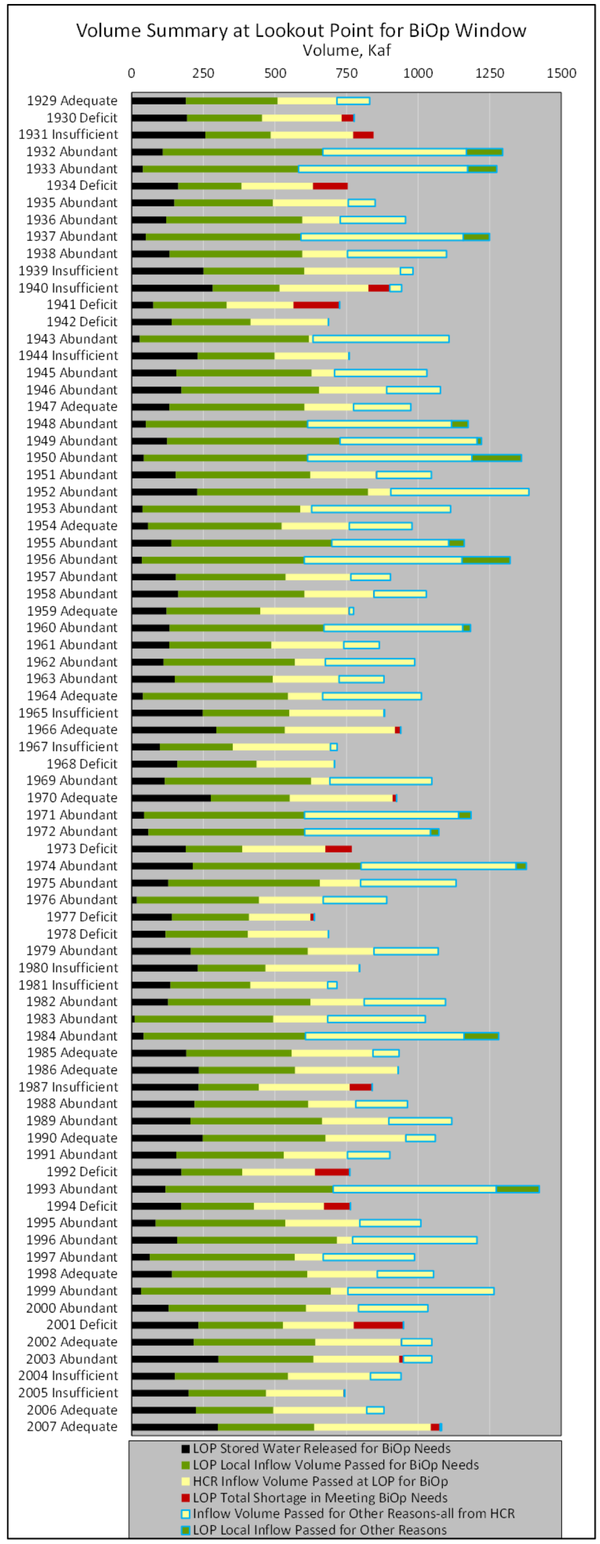
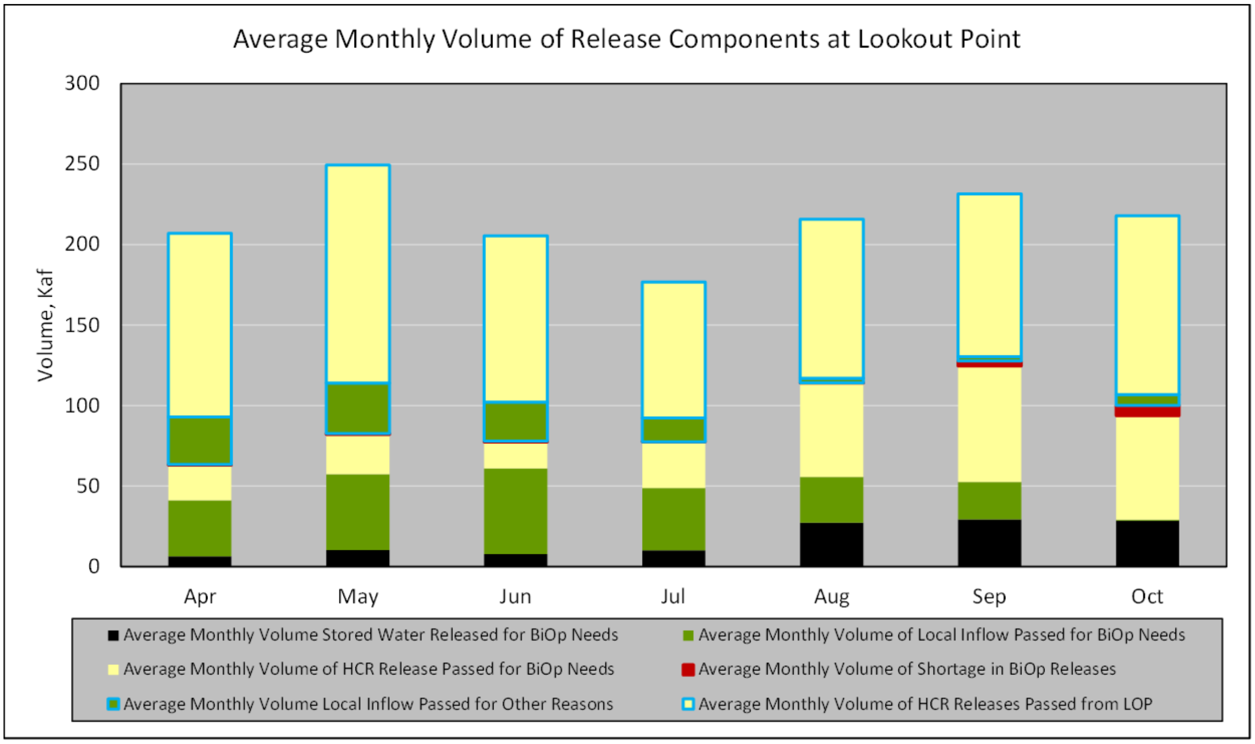


Figure 12.8. Water volume totals for Lookout Point, BiOp window, 1929-2007. Left side is the same as Figure 12.1, right side has white and bright blue bars divided by inflow source (LOP locals or HCR releases). White bars are green + yellow, blue bars are yellow + green with bright blue outlines.



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Stored Water Released for BiOp Needs	0.34	6.41	10.35	7.75	10.16	27.28	29.32	28.44
Local Inflow Passed for BiOp Needs	5.06	34.68	47.02	53.32	38.55	28.36	23.21	0.77
HCR Releases Passed for BiOp Needs	1.22	22.07	24.77	16.42	28.88	58.31	72.14	64.60
Shortage in meeting BiOp Needs	0.00	0.43	0.63	0.59	0.00	0.29	3.00	6.30
Local Inflow Passed Other Reasons	3.24	29.37	31.19	24.12	14.85	2.75	2.62	6.74
HCR Inflow Passed Other Reasons	9.70	91.98	110.61	86.76	55.44	40.48	25.37	46.41
Volume of HCR Releases (not plotted)	10.92	114.05	135.37	103.18	84.32	98.79	101.08	111.01

Figure 12.9. Water volume average monthly totals for release components for Lookout Point 1929-2007, with estimates of the inflow source divided by local flows into LOP and HCR releases. Black is the stored water released for the mainstem BiOp target minimums, green is the local inflow passed to meet the mainstem BiOp target minimums, light yellow is HCR releases passed to meet BiOp Need, red is the shortage in releases for the mainstem supplemental flows, and light yellow outlined in bright blue is the HCR releases passed through LOP for other reasons. The local inflows to LOP passed for other reasons are green outlined in bright blue.

13 Fern Ridge Water Volume Summary, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Fern Ridge, although it should be noted that Fern Ridge is modeled without the rules for the mainstem minimum flow targets at Albany and Salem, with the need determined by the minimum project releases. The Basic Methodology results are tabulated and graphed in the same manner that was described for Blue River.

The time series records used for the Fern Ridge calculations are:

//FERN RIDGE-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FERN RIDGE-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FERN RIDGE-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FERN RIDGE-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FERN RIDGE/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FERN RIDGE-NEW MIN WITH 2007 IRRIGATION/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

Water volume component calculations for Fern Ridge are tabulated in Table 13.1 (split into Table 13.1a for 1929 through 1970 and Table 13.1b for 1971 through 2007) and graphed in Figure 13.1. Note that the BiOp Need is a constant value, since the need is calculated by the project minimum releases which does not vary during the BiOp window, and there are no shortages. The remaining stored water released during drafting that is not for BiOp Need is graphed in Figure 13.2, and the average monthly water volume components are shown in Figure 13.3. The Fern Ridge storage non-exceedance graph is shown in Figure 13.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

The mainstem downstream minimum flow rules are not used in the ResSim operation set at Fern Ridge because it does not produce a well modeled system at Fern Ridge. Part of the reason is that the inflows to Fern Ridge reservoir are much lower for the storage reservoir size than other projects. (The downstream rules use daily storage levels at each reservoir, rather than inflow amounts, to compute a project's proportional share of downstream supplemental flow.) Another reason is the summer inflows to the reservoir are often less than the amount of water evaporating from the reservoir, producing a net negative inflow to the project. (See the note below Table 13.1 for the reference.) Using supplemental mainstem minimum flow rules at Fern Ridge in the ResSim operation set drains the reservoir every year, because its storage size is disproportionate to its inflow volume, when compared to the other projects in the Willamette Basin. Note that the inflow passed for other reasons, shown in bright blue in Figures 13.1 and 13.3, occur mostly in April and May when the project is at rule curve.

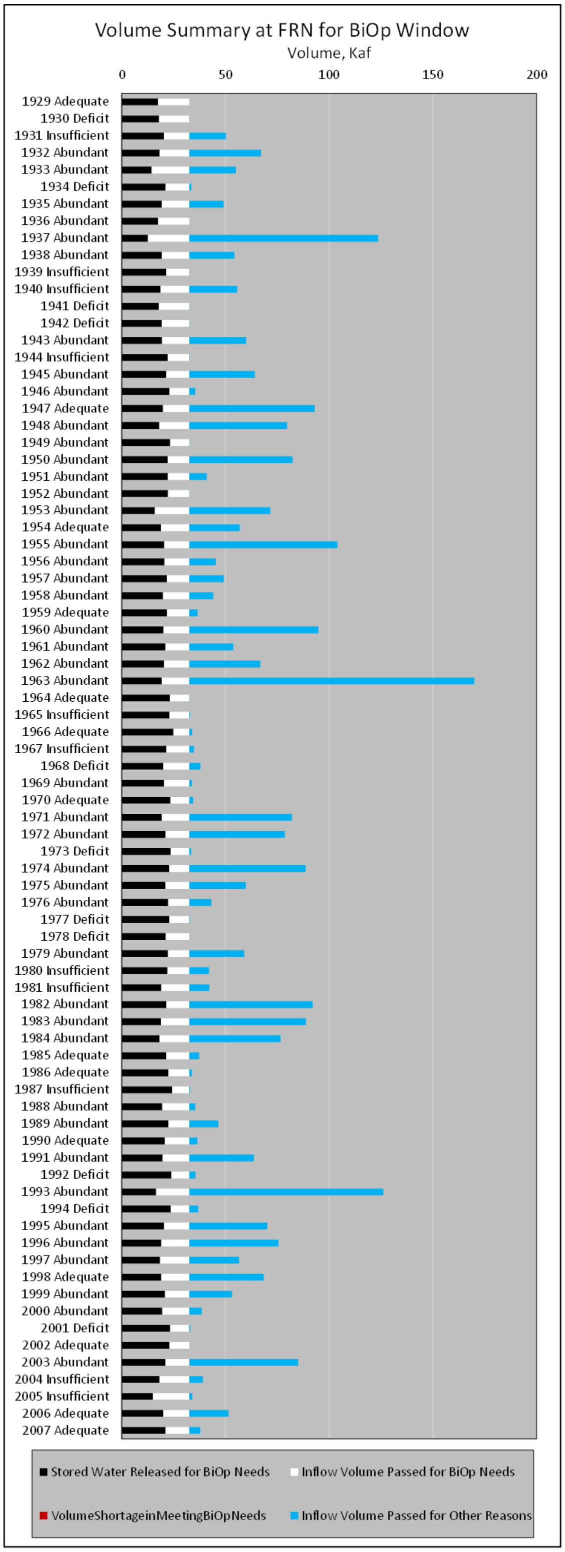
Special Note: The minimum releases from Fern Ridge include irrigation releases for May through September (see the "Willamette Basin Review, ResSim Baseline Model Documentation Report"), which are included in the BiOp Need calculations in this section. Only one other project (Detroit) has specific irrigation releases specified, and those releases are also included in the Detroit BiOp Need calculations in Section 16. Section 17, which totals the results for all storage projects in the basin, will then have a calculation that removes irrigation releases from both the BiOp Need total calculations and the stored water used for BiOp total calculations. Refer to Section 17 for more details.

Table 13.1a. Volume Calculations for 28 March through 31 October, Fern Ridge, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/14 last day of conservation storage.)

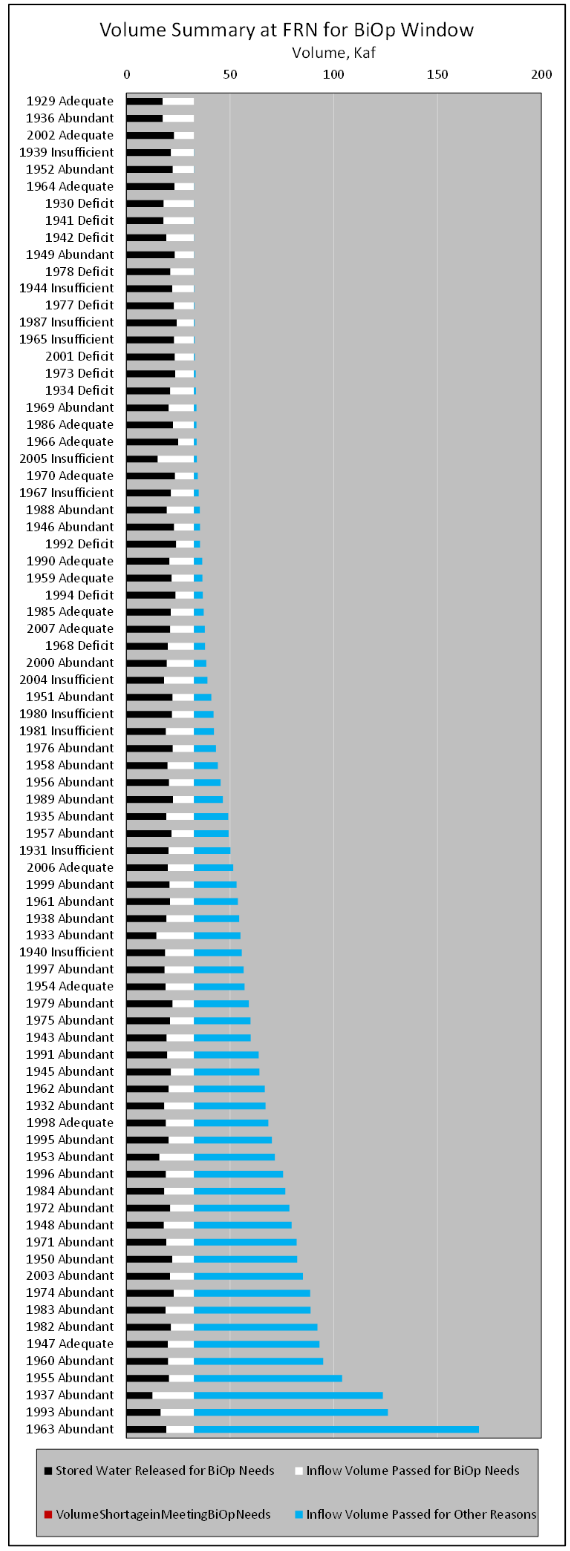
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	32.56	0.00	15.07	15.07	17.48	0.00	90.54	0.20	72.86
1930	32.56	0.00	14.61	14.53	18.03	0.08	75.42	0.14	57.26
1931	32.56	0.00	29.83	12.23	20.33	17.60	94.50	0.01	74.16
1932	32.56	0.00	48.81	14.30	18.26	34.51	94.50	0.04	76.21
1933	32.56	0.00	40.52	18.08	14.48	22.44	94.50	0.00	80.02
1934	32.56	0.00	12.38	11.40	21.16	0.98	53.92	0.00	32.76
1935	32.56	0.00	29.88	13.32	19.23	16.56	94.50	0.09	75.18
1936	32.56	0.00	14.98	14.98	17.58	0.00	89.56	0.36	71.63
1937	32.56	0.00	110.99	19.90	12.66	91.09	94.50	0.00	81.84
1938	32.56	0.00	34.98	13.19	19.36	21.78	94.50	0.00	75.14
1939	32.56	0.00	11.14	11.10	21.45	0.04	76.65	0.30	54.90
1940	32.56	0.00	36.94	13.85	18.70	23.08	94.50	0.00	75.80
1941	32.56	0.00	14.72	14.63	17.93	0.09	62.40	0.00	44.47
1942	32.56	0.00	13.39	13.27	19.29	0.12	65.17	0.00	45.89
1943	32.56	0.00	40.49	13.14	19.41	27.35	94.50	0.00	75.08
1944	32.56	0.00	10.68	10.45	22.11	0.23	74.90	0.04	52.75
1945	32.56	0.00	42.68	11.10	21.45	31.58	94.50	0.29	72.76
1946	32.56	0.00	12.44	9.52	23.04	2.92	93.00	0.00	69.96
1947	32.56	0.00	73.14	12.63	19.92	60.50	94.50	0.00	74.58
1948	32.56	0.00	61.63	14.47	18.09	47.16	94.56	0.00	76.47
1949	32.56	0.00	9.36	9.22	23.34	0.14	94.40	0.12	70.94
1950	32.56	0.00	60.24	10.41	22.14	49.82	94.50	0.06	72.30
1951	32.56	0.00	18.70	10.30	22.26	8.40	88.41	0.00	66.15
1952	32.56	0.00	10.27	10.23	22.33	0.05	85.91	0.33	63.24
1953	32.56	0.00	55.63	16.64	15.91	38.99	94.50	0.08	78.51
1954	32.56	0.00	38.08	13.69	18.87	24.39	94.50	0.18	75.45
1955	32.56	0.00	83.43	12.01	20.55	71.42	94.50	0.00	73.95
1956	32.56	0.00	24.80	11.93	20.62	12.86	94.50	0.08	73.79
1957	32.56	0.00	27.52	10.81	21.74	16.70	94.50	0.56	72.20
1958	32.56	0.00	24.25	12.69	19.87	11.56	94.50	0.00	74.63
1959	32.56	0.04	14.78	10.74	21.82	4.04	94.54	0.62	72.05
1960	32.56	0.00	74.71	12.41	20.15	62.30	94.50	0.45	73.90
1961	32.56	0.00	32.71	11.50	21.05	21.21	94.50	0.65	72.79
1962	32.56	0.00	46.28	12.11	20.44	34.17	94.50	0.09	73.97
1963	32.56	0.00	150.74	13.28	19.27	137.46	94.50	0.04	75.18
1964	32.56	0.00	9.43	9.35	23.21	0.08	84.13	0.01	60.92
1965	32.56	0.00	9.92	9.56	23.00	0.37	53.82	0.09	30.74
1966	32.56	0.00	9.01	7.62	24.94	1.39	87.22	0.12	62.16
1967	32.56	0.00	13.36	11.06	21.50	2.30	94.50	0.42	72.58
1968	32.56	0.00	17.95	12.56	20.00	5.39	79.43	0.00	59.43
1969	32.56	0.00	13.41	12.14	20.41	1.26	84.46	0.41	63.64
1970	32.56	0.00	10.99	9.07	23.49	1.92	83.54	0.36	59.70

Table 13.1b. Volume Calculations for 28 March through 31 October, Fern Ridge, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/14 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	32.56	0.00	62.79	13.27	19.28	49.52	94.50	0.38	74.84
1972	32.56	0.00	57.48	11.44	21.12	46.04	94.50	0.42	72.96
1973	32.56	0.00	9.89	9.01	23.55	0.88	73.22	0.00	49.67
1974	32.56	0.00	65.78	9.73	22.83	56.05	94.50	0.48	71.19
1975	32.56	0.00	38.78	11.54	21.01	27.24	94.50	0.11	73.38
1976	32.56	0.00	20.83	10.18	22.38	10.65	94.50	0.74	71.38
1977	32.56	0.00	9.93	9.65	22.91	0.29	37.62	0.27	14.44
1978	32.56	0.00	11.49	11.35	21.21	0.14	84.06	0.76	62.10
1979	32.56	0.00	36.72	10.25	22.31	26.48	94.50	0.23	71.96
1980	32.56	0.00	20.05	10.55	22.01	9.50	94.50	0.36	72.14
1981	32.56	0.00	23.16	13.47	19.09	9.69	94.50	0.31	75.10
1982	32.56	0.00	70.61	11.10	21.46	59.51	94.50	0.73	72.32
1983	32.56	0.00	69.94	13.65	18.91	56.29	94.50	0.00	75.59
1984	32.56	0.00	58.39	14.33	18.23	44.06	94.50	0.00	76.27
1985	32.56	0.00	15.94	11.17	21.38	4.76	88.42	0.04	66.99
1986	32.56	0.00	11.39	10.09	22.47	1.30	93.38	0.46	70.46
1987	32.56	0.00	8.67	8.31	24.25	0.36	76.27	0.16	51.86
1988	32.56	0.00	15.92	13.07	19.49	2.86	94.50	0.00	75.01
1989	32.56	0.00	24.00	10.05	22.50	13.94	94.50	0.54	71.45
1990	32.56	0.00	15.80	11.81	20.75	3.99	74.66	0.16	53.75
1991	32.56	0.00	44.06	12.87	19.68	31.19	94.50	0.06	74.76
1992	32.56	0.00	11.55	8.61	23.95	2.94	84.28	0.27	60.06
1993	32.56	0.00	109.54	16.01	16.55	93.53	94.50	0.33	77.62
1994	32.56	0.00	13.18	8.88	23.68	4.30	86.82	0.06	63.08
1995	32.56	0.00	49.67	12.12	20.43	37.55	94.50	0.32	73.75
1996	32.56	0.00	56.50	13.46	19.09	43.04	94.50	0.14	75.26
1997	32.56	0.00	38.14	14.13	18.42	24.01	94.50	0.03	76.05
1998	32.56	0.00	49.31	13.45	19.10	35.86	94.50	0.41	74.99
1999	32.56	0.00	32.28	11.67	20.89	20.61	94.50	0.12	73.49
2000	32.56	0.00	19.03	13.01	19.55	6.02	94.50	0.03	74.93
2001	32.56	0.00	9.60	9.16	23.40	0.44	32.96	0.08	9.49
2002	32.56	0.00	9.56	9.56	23.00	0.00	94.37	0.06	71.31
2003	32.56	0.10	63.93	11.49	21.07	52.44	94.54	0.03	73.34
2004	32.56	0.00	20.93	14.35	18.21	6.58	88.96	0.00	70.76
2005	32.56	0.00	18.89	17.46	15.10	1.43	90.57	0.00	75.48
2006	32.56	0.03	31.49	12.59	19.96	18.90	94.55	0.00	74.56
2007	32.56	0.00	16.67	11.40	21.15	5.27	88.14	0.03	66.95



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 13.1. Water volume totals for Fern Ridge 1929-2007, in chronological order on the left and sorted by inflow volume passed for other reasons. No years have a shortage (no red bars).

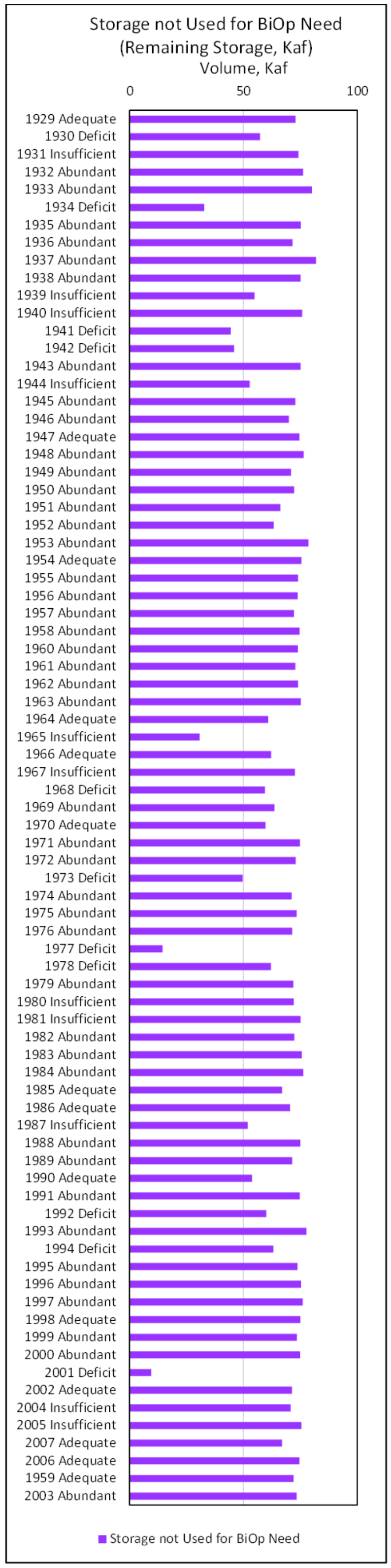
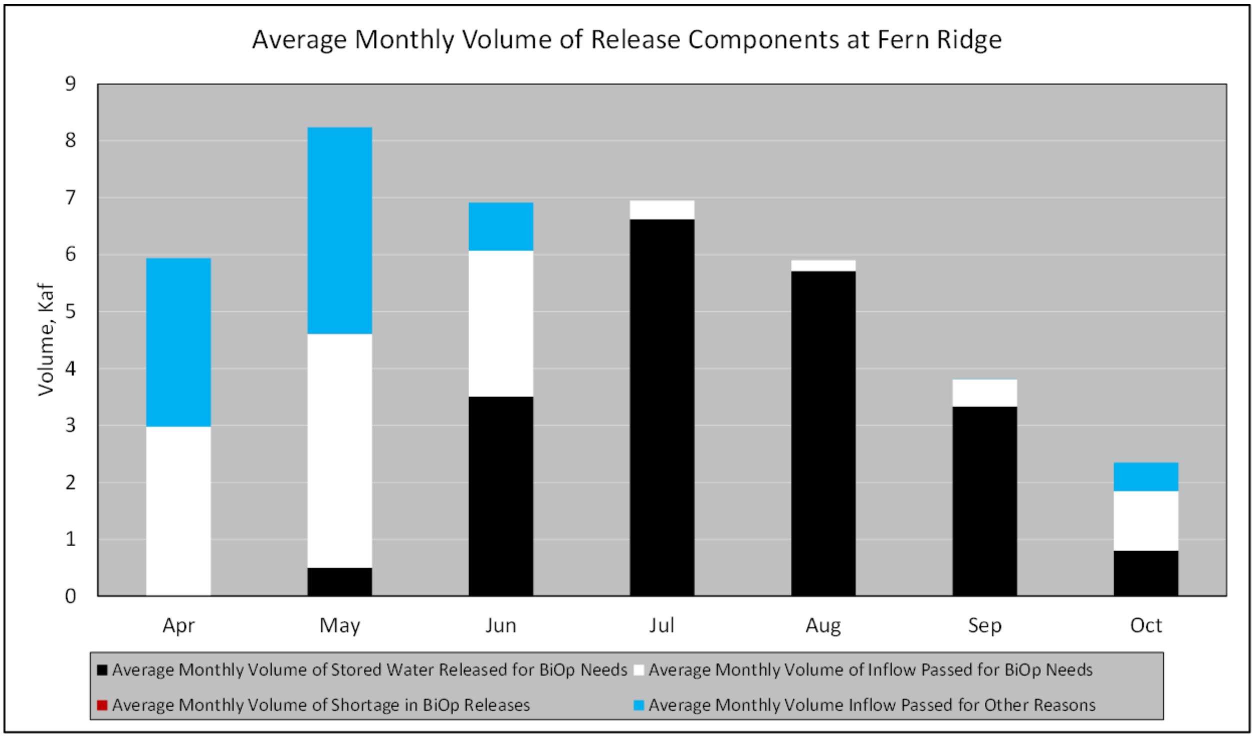


Figure 13.2. Volume of remaining storage volume released not for BiOp Needs for Fern Ridge 1929-2007, sorted (purple) high to low. Note that there are no negative values in the graph.



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	0.40	2.98	4.61	6.07	6.95	5.90	3.81	1.84
Stored Water Released for BiOp Needs	0.00	0.01	0.49	3.50	6.62	5.71	3.33	0.80
Inflow Passed for BiOp Needs	0.40	2.97	4.12	2.57	0.33	0.19	0.47	1.04
Shortage in meeting BiOp Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inflow Passed Other Reasons	0.40	2.96	3.62	0.84	0.00	0.00	0.00	0.50

Figure 13.3. Water volume average monthly totals for release components for Fern Ridge 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in meeting required releases (none at FRN), and blue is the inflow passed for other reasons.

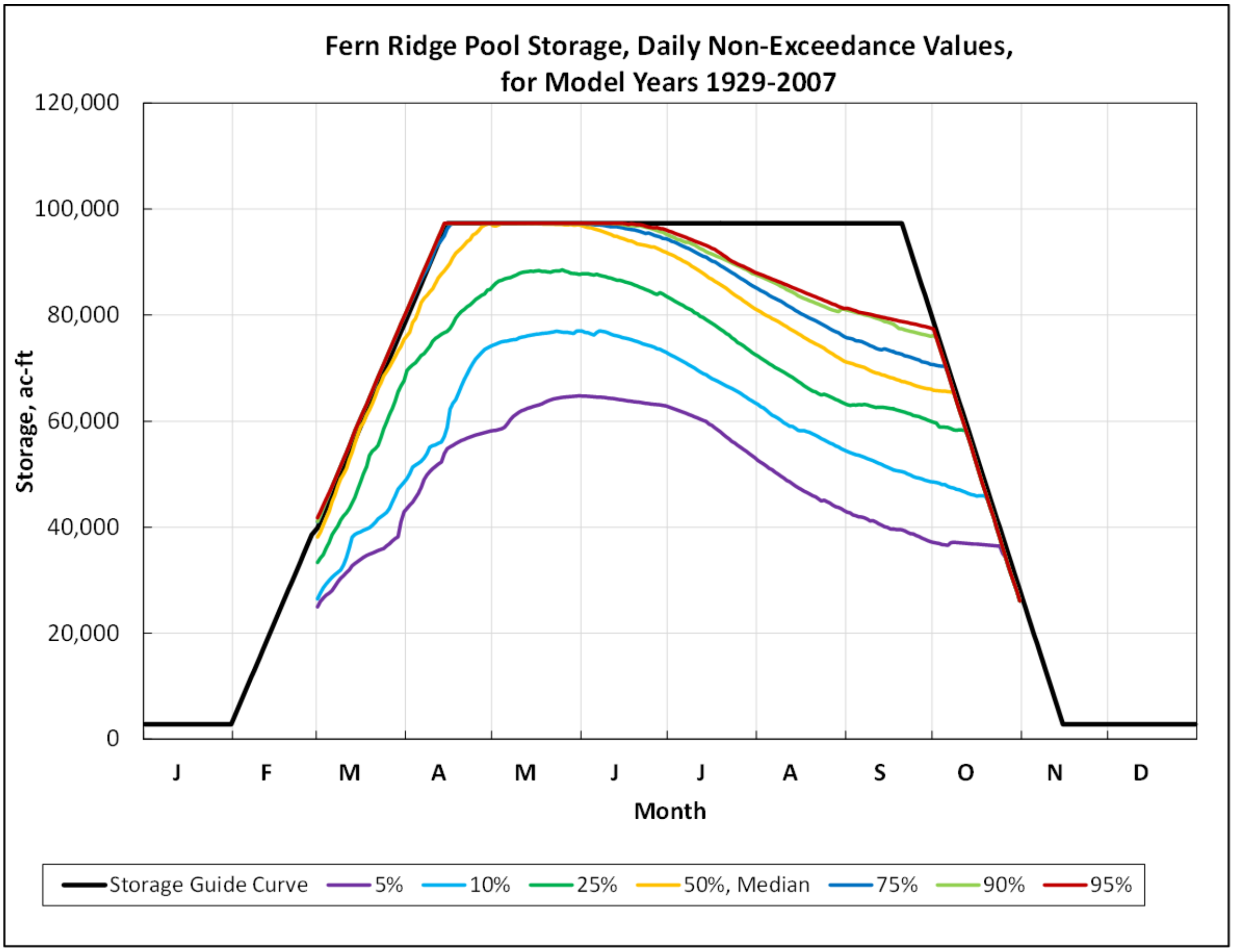


Figure 13.4. Non-exceedance storage values for Fern Ridge 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

14 Green Peter Water Volume Summary, 28Mar-31Oct, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Green Peter, where the ResSim operation set for the project uses minimum flow targets at Foster without a rule for the mainstem minimum flow targets at Salem. Downstream of Green Peter Dam, the BiOp specifies flow targets below Foster dam by season to help fish at various stages of development. These minimum flow requirements are:

01 Jan to 31 Jan: Chinook incubation, 1100 cfs minimum flow,
01 Feb to 15 Mar: Chinook rearing, 800 cfs minimum flow,
16 Mar to 15 May: Steelhead spawning, 1500 cfs minimum flow,
16 May to 30 Jun: Steelhead incubation, 1100 cfs minimum flow,
01 Jul to 31 Aug: Steelhead rearing, 800 cfs minimum flow,
01 Sep to 15 Oct: Chinook spawning, 1500 cfs minimum flow,
16 Oct to 31 Dec: Chinook incubation, 1100 cfs minimum flow.

These flow targets below Foster dam are met nearly in full by releases from Green Peter, and the rules used in the Green Peter operation set to meet these targets are described in Section 4 and shown in Figure 4.3. These flows take a significant amount of water from Green Peter, and using the Salem minimum flow rule would drain Green Peter rapidly, without leaving enough water to meet the targets below Foster. Therefore, the BiOp Need is determined by the minimum project releases at Foster. The Basic Methodology results are tabulated and graphed in the same manner that was described for Blue River.

The time series records used for the Green Peter calculations are:

//GREEN PETER-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER-NEW MIN CON ZONE RELEASE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//GREEN PETER-NEW BUFFER ZONE MIN RULE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

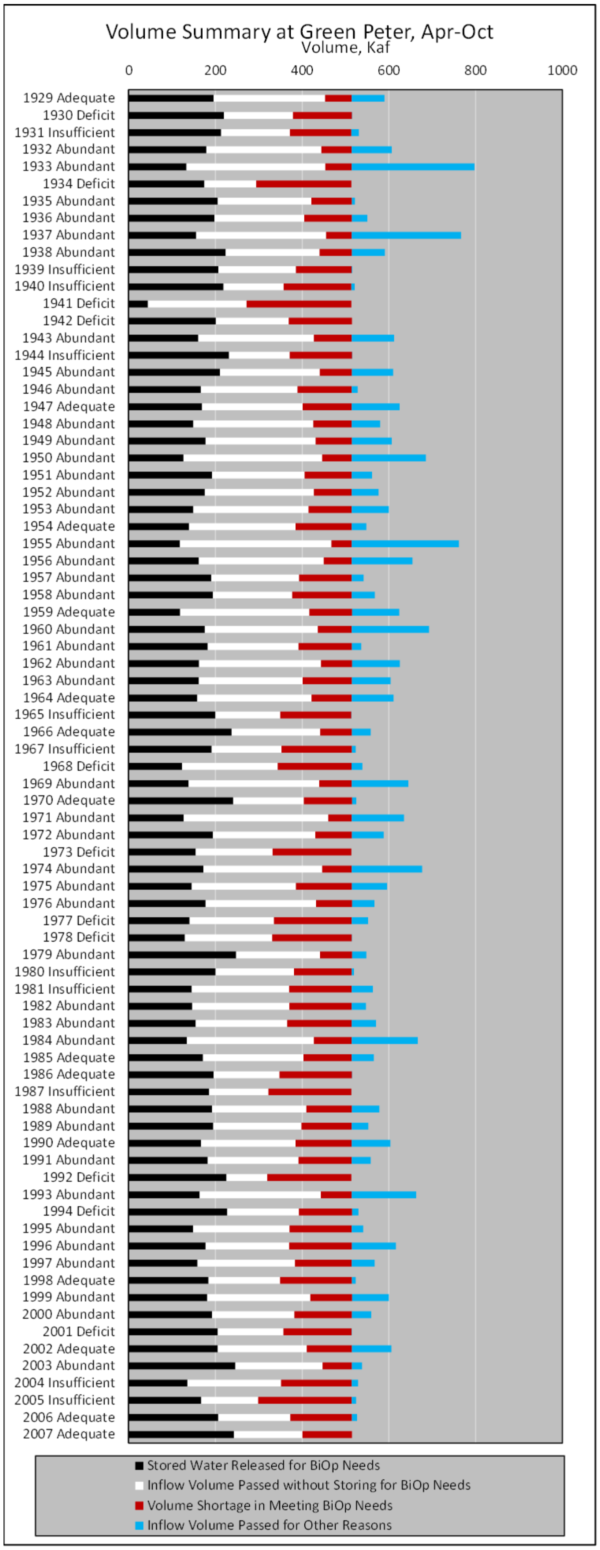
Water volume component calculations for Green Peter are tabulated in Table 14.1 (split into Table 14.1a for 1929 through 1970 and Table 14.1b for 1971 through 2007) and graphed in Figure 14.1. Note that the BiOp Need is a constant value, like Fern Ridge was, since the need is calculated by the Green Peter rule values (the amount of flow that ResSim computes Green Peter should release so that Foster releases are at the target flow) rather than the flow target itself. The project shortages in meeting BiOp Need and the additional stored water released during drafting that is not for BiOp Need is graphed side-by-side in Figure 13.2. Note that there are very few years showing additional storage releases. The average monthly water volume components are shown in Figure 14.3. The Green Peter storage non-exceedance graph is shown in Figure 14.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

Table 14.1a. Volume Calculations for 28 March through 31 October, Green Peter, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 12/31 last day of conservation storage.)

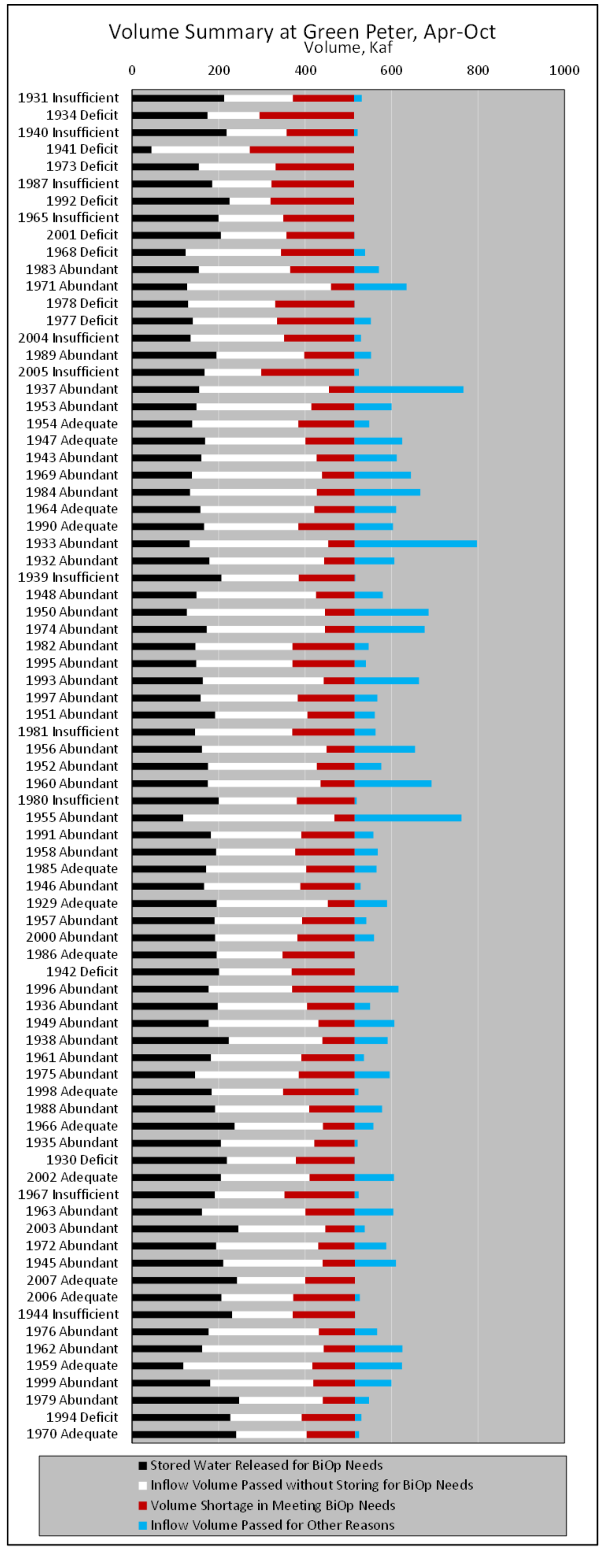
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	514.58	61.53	332.20	256.96	196.09	75.25	249.94	54.27	-7.68
1930	514.67	135.92	159.41	159.06	219.70	0.36	202.57	16.10	-153.05
1931	513.32	141.33	176.27	158.64	213.35	17.63	215.26	12.42	-139.42
1932	514.50	70.19	357.12	265.17	179.14	91.96	249.94	8.43	0.61
1933	514.49	60.85	603.34	320.46	133.18	282.88	250.67	35.01	56.63
1934	513.32	218.94	119.89	119.89	174.49	0.00	171.45	0.54	-221.98
1935	514.62	93.33	222.85	215.91	205.38	6.94	249.94	37.34	-48.77
1936	514.60	109.93	242.17	206.68	197.98	35.49	249.94	58.08	-57.98
1937	514.43	59.20	551.57	299.75	155.48	251.82	250.35	10.33	35.67
1938	514.60	74.55	292.69	216.35	223.70	76.34	249.94	18.38	-48.31
1939	514.52	129.09	180.05	178.63	206.80	1.42	235.51	47.23	-100.38
1940	513.32	156.07	146.57	138.56	218.69	8.01	213.91	12.56	-160.85
1941	513.32	241.24	227.40	227.40	44.68	0.00	20.84	6.94	-265.09
1942	514.59	145.34	168.08	168.08	201.17	0.00	198.99	0.00	-147.51
1943	514.46	87.55	364.12	266.39	160.52	97.74	249.94	41.68	1.87
1944	515.09	143.75	140.09	139.91	231.43	0.18	231.28	12.28	-143.90
1945	514.97	74.26	325.06	229.99	210.72	95.07	250.75	3.95	-34.23
1946	514.57	125.21	236.33	222.77	166.60	13.57	249.94	7.11	-41.86
1947	514.45	113.46	342.41	231.95	169.04	110.46	224.91	0.91	-57.59
1948	514.52	88.75	341.83	276.68	149.09	65.15	249.94	9.62	12.10
1949	514.60	83.60	345.67	253.82	177.18	91.86	249.94	18.56	-10.84
1950	514.52	68.32	490.64	319.64	126.56	171.00	249.94	0.00	55.06
1951	514.54	109.06	259.55	213.05	192.43	46.50	249.94	8.29	-51.55
1952	514.55	87.35	313.25	251.54	175.66	61.71	249.94	57.86	-13.07
1953	514.44	99.74	351.08	265.51	149.19	85.58	249.94	19.00	1.01
1954	514.44	129.65	279.34	245.60	139.20	33.74	249.94	23.26	-18.90
1955	514.56	46.90	596.36	349.48	118.18	246.88	250.65	0.00	85.57
1956	514.55	64.98	427.62	287.86	161.71	139.76	249.94	16.48	23.25
1957	514.58	121.48	229.23	202.39	190.71	26.84	239.76	19.69	-72.43
1958	514.57	137.42	235.98	182.78	194.37	53.20	244.98	3.19	-86.81
1959	515.21	98.41	407.25	298.34	118.46	108.91	249.94	21.97	33.07
1960	514.55	78.46	438.61	260.58	175.51	178.03	250.74	6.17	-3.23
1961	514.61	123.01	230.76	209.41	182.19	21.35	249.94	10.41	-55.26
1962	515.16	71.80	391.27	281.19	162.16	110.07	249.94	13.77	15.98
1963	514.72	113.69	328.56	239.12	161.91	89.44	249.94	5.04	-25.66
1964	514.49	92.82	359.63	263.35	158.33	96.28	249.94	22.26	-1.20
1965	513.39	163.73	149.95	149.60	200.06	0.35	189.14	20.90	-174.64
1966	514.62	73.04	247.28	204.10	237.49	43.19	249.94	20.58	-60.58
1967	514.71	162.16	169.95	161.07	191.48	8.89	236.37	12.37	-117.27
1968	513.92	169.93	245.40	220.55	123.44	24.85	196.55	0.00	-96.81
1969	514.46	75.24	431.18	300.90	138.32	130.28	249.94	33.12	36.38
1970	515.38	111.65	172.17	162.93	240.80	9.24	249.94	8.30	-102.51

Table 14.1b. Volume Calculations for 28 March through 31 October, Green Peter, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 12/31 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	514.31	54.13	453.55	333.11	127.08	120.44	249.94	0.77	68.74
1972	514.75	84.42	309.26	235.97	194.36	73.29	250.28	31.56	-28.49
1973	513.32	181.52	177.22	177.22	154.59	0.00	153.35	0.00	-182.75
1974	514.54	68.33	435.76	273.67	172.54	162.10	250.34	18.43	9.47
1975	514.61	129.01	321.09	240.13	145.47	80.96	249.94	0.00	-24.54
1976	515.16	83.23	306.07	254.75	177.18	51.32	249.94	68.31	-10.46
1977	514.36	179.33	232.38	194.68	140.34	37.70	249.94	0.40	-69.73
1978	514.35	183.29	201.78	201.38	129.68	0.40	187.82	19.57	-125.16
1979	515.35	74.28	226.07	193.44	247.63	32.62	249.94	9.54	-71.96
1980	514.55	133.55	185.46	180.63	200.37	4.83	232.37	10.58	-101.55
1981	514.55	144.17	273.07	224.74	145.63	48.32	250.74	9.00	-39.07
1982	514.54	143.75	256.73	224.19	146.60	32.54	249.94	3.77	-40.41
1983	514.24	148.80	267.22	210.96	154.49	56.26	249.94	3.39	-53.34
1984	514.48	87.26	445.51	293.23	133.99	152.28	251.06	1.16	29.81
1985	514.57	111.77	282.08	231.37	171.43	50.71	250.34	5.57	-32.86
1986	514.59	166.70	152.09	152.05	195.84	0.04	249.94	4.68	-112.60
1987	513.32	191.10	136.86	136.86	185.37	0.00	190.75	4.73	-185.72
1988	514.62	105.04	280.52	217.29	192.29	63.24	249.94	4.02	-47.39
1989	514.39	116.01	241.27	203.12	195.27	38.16	243.78	19.79	-67.50
1990	514.49	129.84	306.94	217.97	166.68	88.97	249.94	1.13	-46.58
1991	514.56	123.09	252.46	209.00	182.47	43.46	249.94	5.41	-55.62
1992	513.32	193.47	94.32	94.32	225.53	0.00	207.79	2.83	-211.21
1993	514.54	71.41	428.31	279.58	163.55	148.73	249.94	58.37	14.98
1994	515.37	123.12	179.54	164.97	227.28	14.57	214.25	0.00	-136.15
1995	514.54	143.51	248.52	222.28	148.75	26.24	249.94	6.13	-42.32
1996	514.59	144.30	294.44	192.88	177.41	101.57	250.35	5.14	-71.37
1997	514.54	131.12	277.24	224.73	158.69	52.51	249.94	22.80	-39.87
1998	514.61	165.28	173.86	165.25	184.09	8.61	249.94	6.45	-99.42
1999	515.25	96.21	322.73	238.04	181.00	84.69	250.34	9.98	-26.86
2000	514.58	132.45	234.39	189.77	192.36	44.62	250.34	34.68	-74.48
2001	513.71	156.82	151.29	151.23	205.65	0.06	205.36	9.99	-157.12
2002	514.71	104.22	295.97	205.08	205.42	90.90	249.94	35.92	-59.69
2003	514.74	67.75	224.25	201.14	245.85	23.10	249.94	3.20	-63.66
2004	514.39	162.79	230.65	216.00	135.60	14.65	249.94	23.56	-48.44
2005	514.41	215.67	141.19	131.19	167.54	10.00	249.94	6.02	-133.27
2006	514.99	142.04	178.03	166.32	206.64	11.71	249.94	2.30	-98.74
2007	514.98	114.24	158.07	158.07	242.67	0.00	239.29	17.58	-117.62



Graphed values are chronological (1929-2007)



Graphed values are sorted by BiOp Need (Black + White + Red)

Figure 14.1. Water volume totals for Green Peter 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value (always constant).

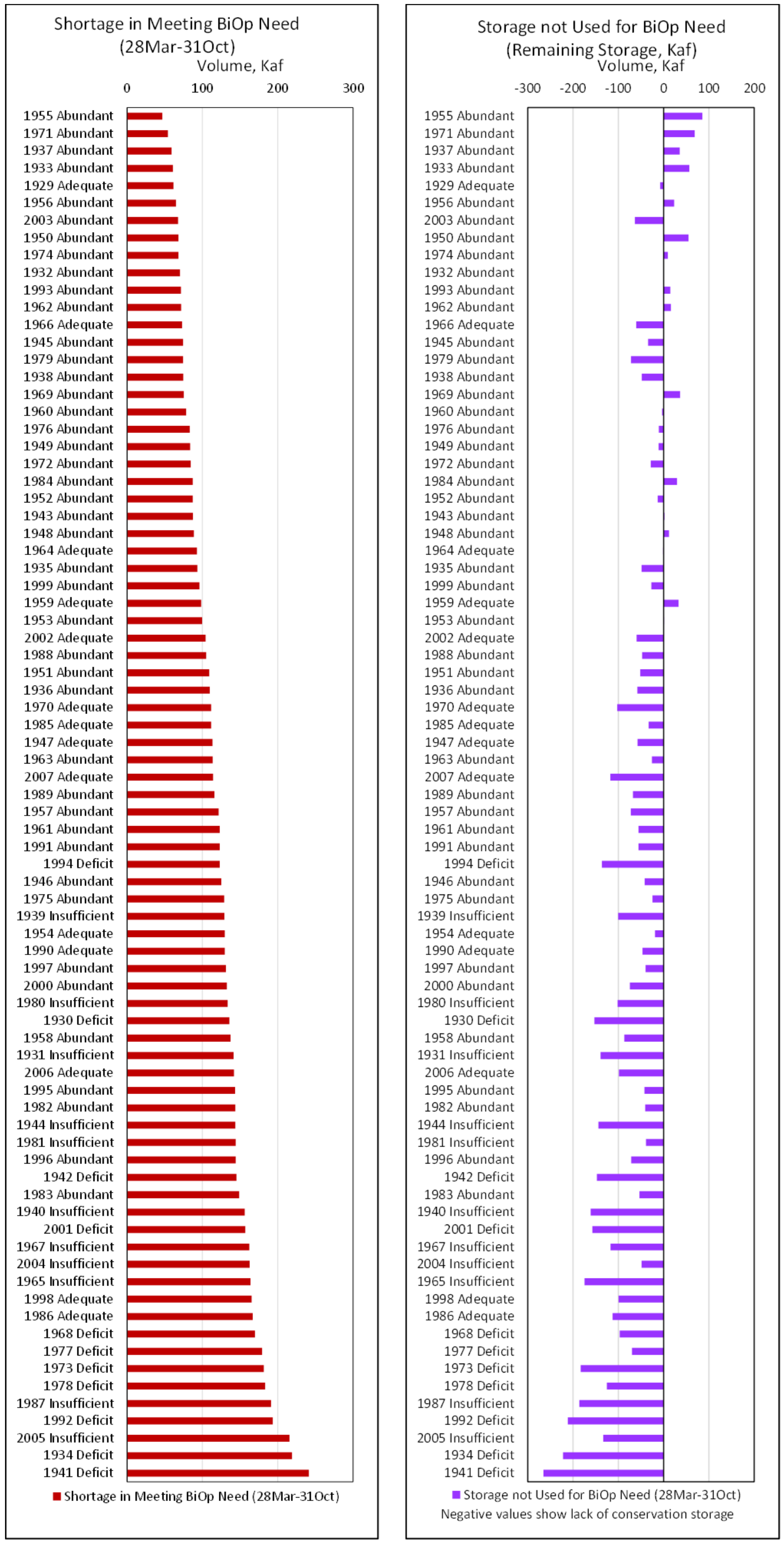
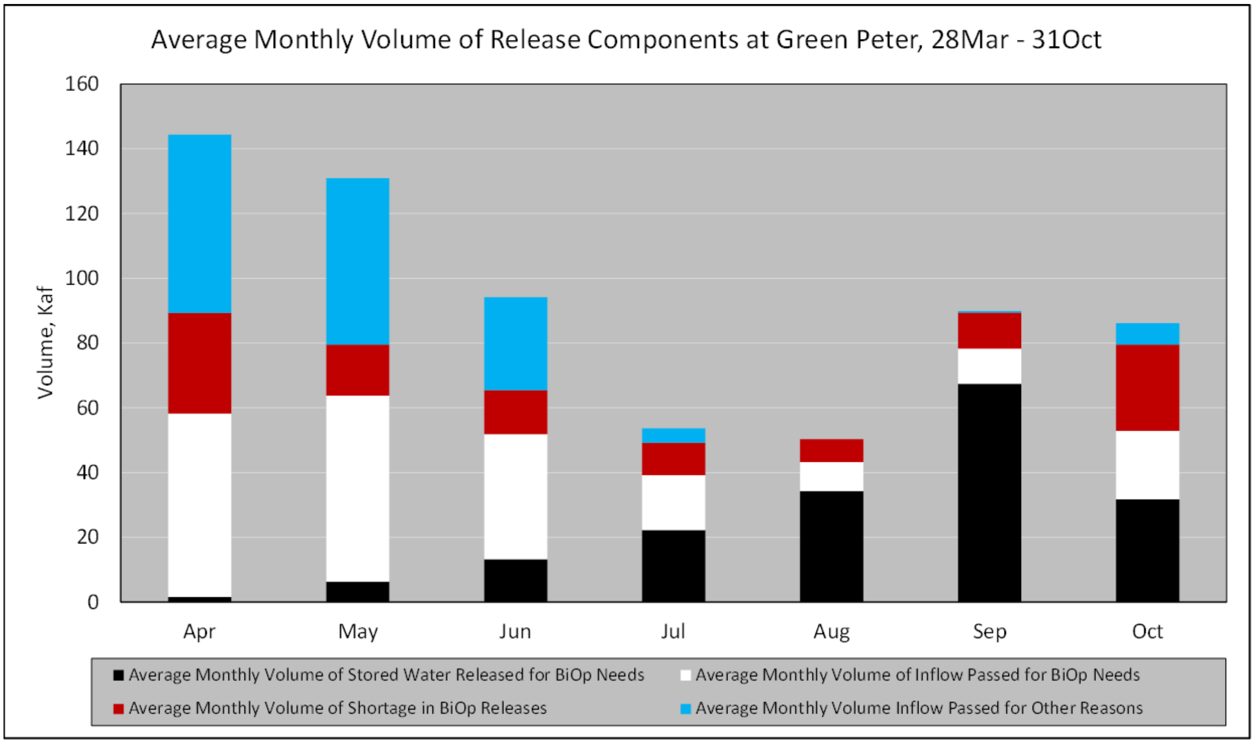


Figure 14.2. Water Volume totals for Green Peter 1929-2007 sorted by BiOp Need and then by shortage, with shortage volume to meet BiOp Need on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	11.90	89.26	79.54	65.45	49.19	50.25	89.34	79.55
Stored Water Released for BiOp Needs	0.33	1.60	6.31	13.30	22.24	34.30	67.38	31.77
Inflow Passed for BiOp Needs	7.35	56.66	57.43	38.62	16.99	8.94	10.93	21.17
Shortage in meeting BiOp Needs	4.22	31.00	15.80	13.53	9.97	7.02	11.04	26.61
Inflow Passed Other Reasons	7.14	55.06	51.36	28.71	4.45	0.12	0.50	6.59

Figure 14.3. Water volume average monthly totals for release components for Green Peter 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

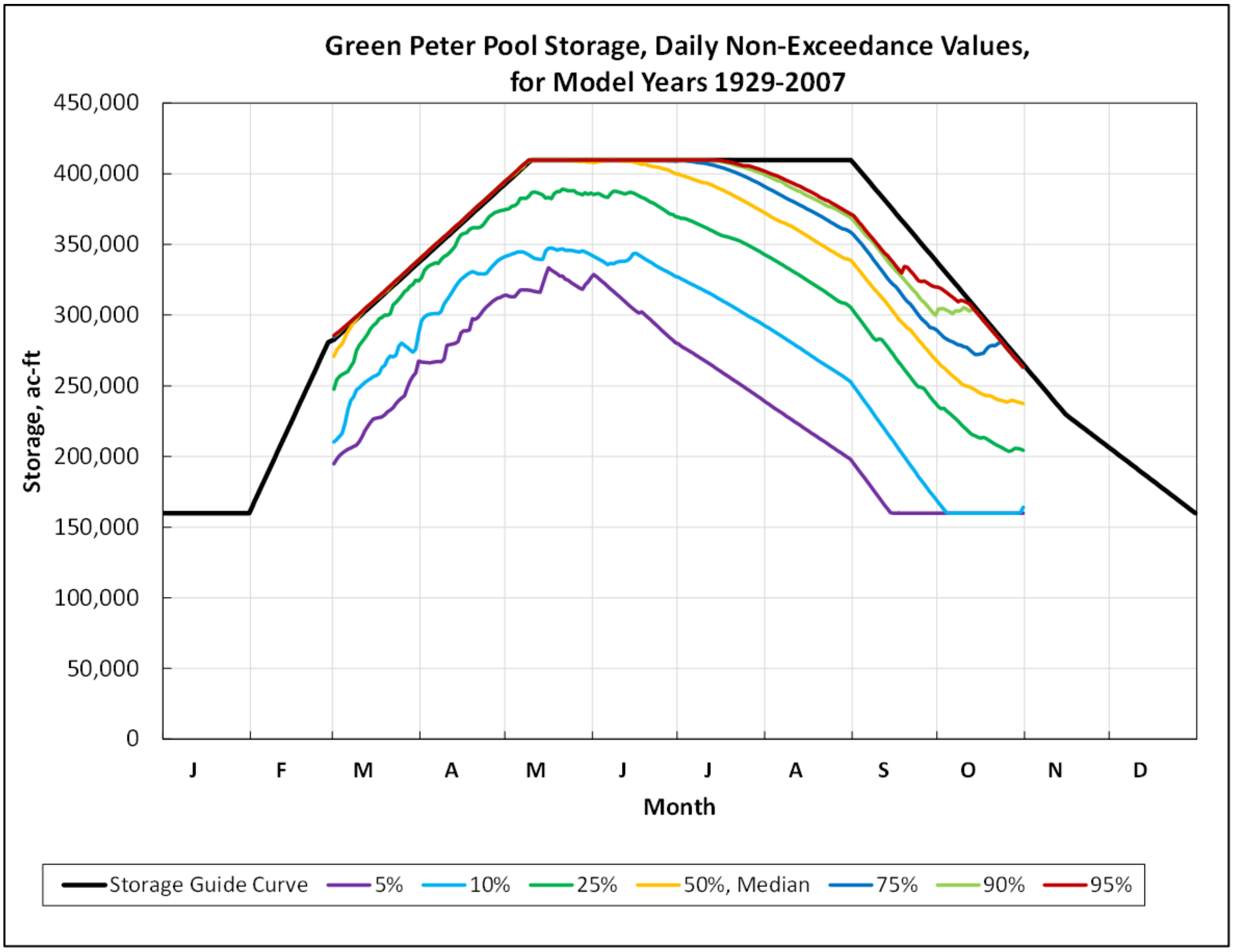


Figure 14.4. Non-exceedance storage values for Green Peter 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

15 Foster Water Volume Summary, 28Mar-31Oct, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Foster, where the ResSim operation set for the project uses minimum flow targets at Foster without a rule for the mainstem minimum flow targets at Salem, similar to Green Peter operations. The BiOp specifies flow targets below Foster dam by season to help fish at various stages of development. These minimum flow requirements are:

01 Jan to 31 Jan: Chinook incubation, 1100 cfs minimum flow,
01 Feb to 15 Mar: Chinook rearing, 800 cfs minimum flow,
16 Mar to 15 May: Steelhead spawning, 1500 cfs minimum flow,
16 May to 30 Jun: Steelhead incubation, 1100 cfs minimum flow,
01 Jul to 31 Aug: Steelhead rearing, 800 cfs minimum flow,
01 Sep to 15 Oct: Chinook spawning, 1500 cfs minimum flow,
16 Oct to 31 Dec: Chinook incubation, 1100 cfs minimum flow.

These flow targets below Foster dam are met in large part by releases from Green Peter (see Section 14), but additional water is available to meet these targets from the unregulated South Santiam which flows into Foster reservoir several miles downstream of Green Peter Dam.

The rule used in the Foster operation set to meet these targets is described in Section 4 and shown in Figure 4.2. This is a rule specific to Foster dam – it is not the same rule that was used at Green Peter. (The rule at Green Peter is downstream minimum flow rule, while the rule at Foster is a minimum release rule at the dam. This is different than Hills Creek and Lookout Point, since both of those reservoirs used the same downstream minimum flow rule in their operation sets.)

The time series records used for the Foster calculations are:

//FOSTER-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FOSTER-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FOSTER-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FOSTER-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FOSTER/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//FOSTER-FOSTER MIN BETTER BASELINE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

Water volume component calculations for Foster are tabulated in Table 15.1 (split into Table 15.1a for 1929 through 1970 and Table 15.1b for 1971 through 2007). Note that the BiOp Need is not listed in Table 15.1 since it is a constant value. Table 15.1 also shows the amount of inflow to Foster that comes from Green Peter releases in the BiOp window, and the table name includes the phrase “Foster with Green Peter” because the Green Peter contributions to the various components has not been separated out in the table entries. (Recall that Lookout Point data, Section 12, was initially presented without Hills Creek inflows separated from local inflows.) These water volume components are graphed in Figure 15.1, chronologically by year on the left in the figure and sorted by Foster stored water released for BiOp Need on the right.

The project shortages in meeting BiOp Need and the additional stored water released during drafting that is not for BiOp Need is graphed side-by-side in Figure 15.2. The average monthly water volume components are shown in Figure 15.3. The inflows graphed in white and blue have not been parsed into inflow source (from Green Peter releases or local inflows), so the graph is noted as containing Green Peter flows.

The Foster storage non-exceedance graph is shown in Figure 15.4. Note that the Foster operations are modeled to include the current fish weir operations, which have a delayed refill from the standard rule curve.

The Foster only data, with Green Peter releases accounted for separately, is shown in Table 15.2 for all model years. This data is presented as the stored water released from Foster for the BiOp Needs (the same as in Table 15.1, but presented again for clarity), the local inflow from the South Santiam River that was passed for BiOp Needs in the second column, the shortage at Foster only in meeting the BiOp flow minimums, and the South Santiam inflow that was passed for other reasons.

The further parsing of the Foster inflow passed to meet the BiOp outflow targets at Foster is illustrated in Figure 15.5. This Figure has side-by-side graphs, with the one on the left for Green Peter and the one on the right for Foster. The left-hand graph was shown in Figure 14.1 (on the right in that case), and that Green Peter data is shown here again with a dashed vertical line that represents the total 513 Kaf of water needed for Foster outflows for 28Mar-31Oct to meet the release minimum requirements. The graph on the right side of Figure 15.5 is the data from Foster (right side of Figure 15.1), but with two changes. The first change is that the sorting is for the same order as the Green Peter data on the left-hand graph, and the other is that the white bars of Figure 15.1 have been divided into their two components:

- olive green with yellow outline - the volume of water from Green Peter (stored water and passed inflow) that was released specifically to meet Foster minimum flows
- light orange - the volume of water from the unregulated South Santiam River that Foster passes without storing in order to meet its minimum outflow requirements.

In Figure 15.6, the average monthly volume components from Figure 15.3 are sub-divided to show the Green Peter contributions to the Foster releases. Foster stored water released to meet its minimum targets is black, the Foster share of the shortage is red and the Green Peter share of the shortage is orange. The white bars from 15.3 have been parsed into their Green Peter and South Santiam River components, with light green the water volume from Green Peter that was released to meet the Foster minimum flows, and yellow the inflow from the South Santiam that was passed to meet the release targets. The light green plus the yellow bars in 15.6 equals the white in 15.3.

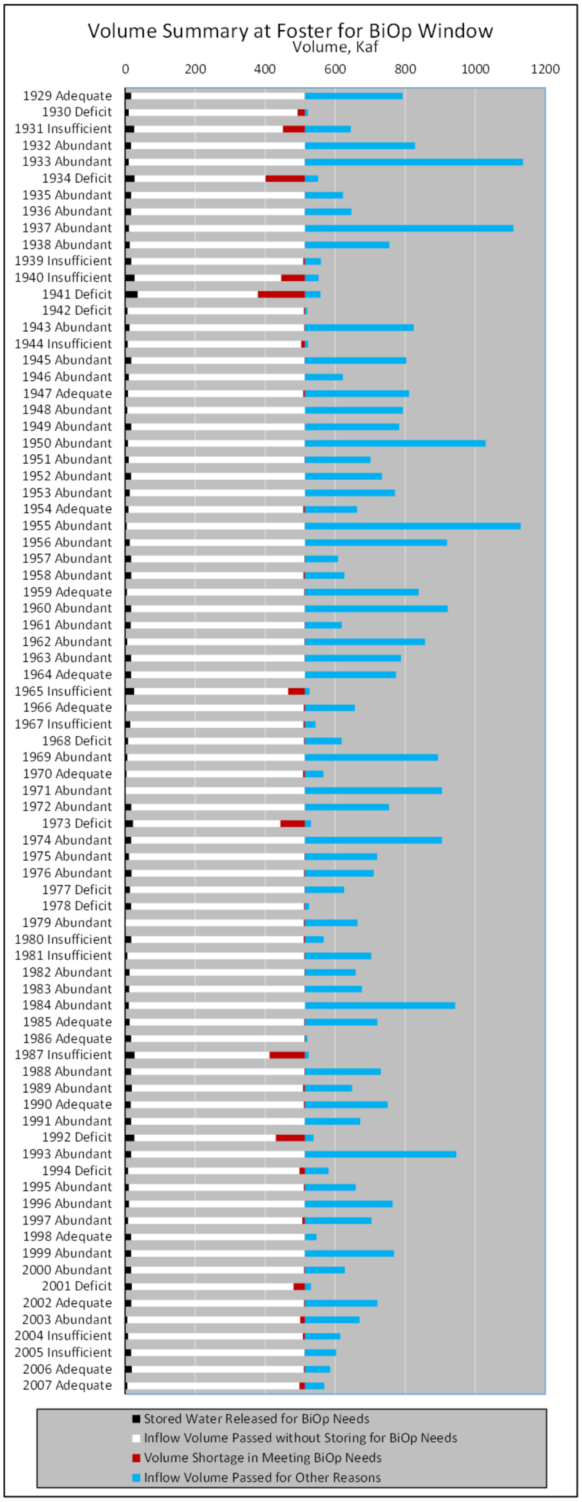
The bright blue bars from 15.3 have been parsed into their Green Peter and South Santiam River components as well. The water volume from Green Peter that was passed for other reasons is shown as dark green, and the inflow from the South Santiam River that was passed for other reasons is shown in brown. The dark green plus the brown bars in 15.6 equals the bright blue bars in 15.3.

Table 15.1a. Volume Calculations for 28 March through 31 October, Foster with Green Peter, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

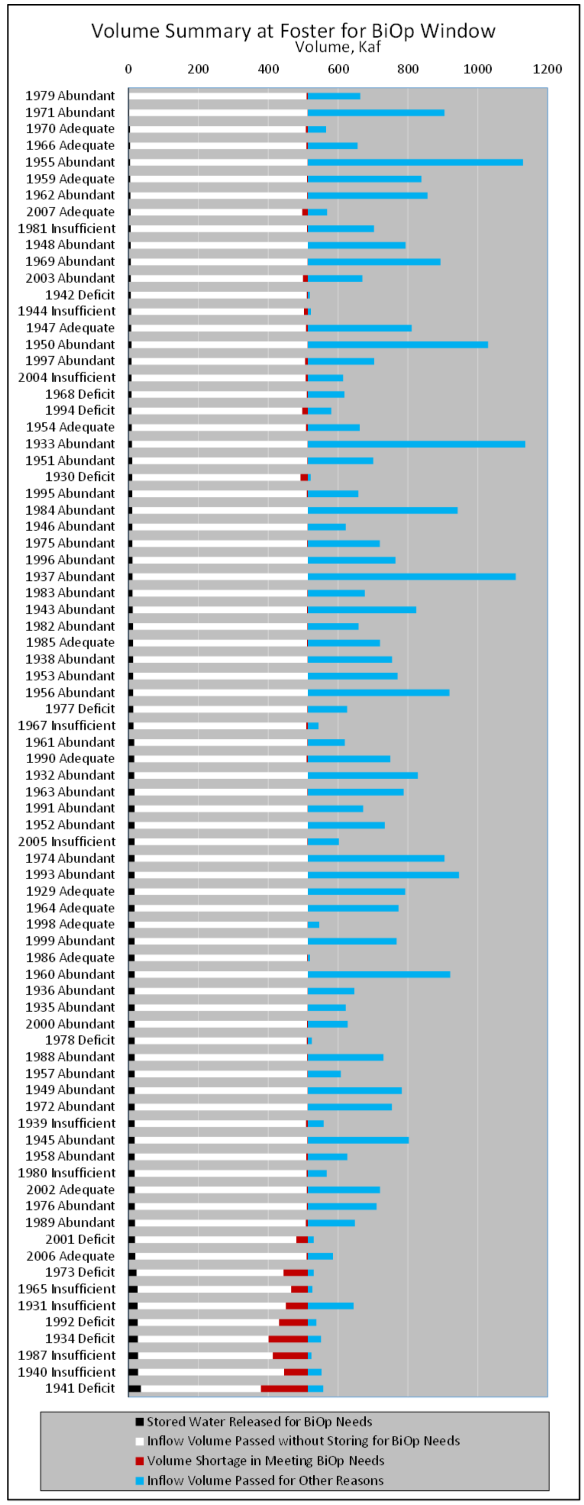
Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Shortage	Total Inflow Passed	Inflow From GPR Releases	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	0.13	774.96	531.29	495.84	17.36	279.12	26.00	7.43	1.09
1930	20.81	490.35	329.13	481.95	10.56	8.40	24.83	7.93	-14.47
1931	62.75	555.82	429.93	424.53	26.05	131.29	24.83	2.16	-66.12
1932	0.00	811.08	549.08	496.31	17.01	314.77	26.00	0.80	8.19
1933	0.47	1125.56	745.47	502.52	10.33	623.04	35.15	0.00	24.34
1934	112.27	411.96	285.49	373.96	27.09	38.00	24.83	0.51	-115.03
1935	0.52	603.77	422.72	495.19	17.61	108.58	24.83	6.80	-0.10
1936	0.52	628.20	442.07	495.20	17.60	133.00	24.83	7.43	-0.71
1937	0.00	1097.46	715.34	501.70	11.63	595.76	33.08	0.00	21.46
1938	0.36	740.82	491.14	499.59	13.36	241.23	24.83	4.69	6.42
1939	4.92	536.02	375.63	490.47	17.93	45.55	24.83	7.43	-5.45
1940	67.51	457.47	363.86	418.28	27.53	39.19	24.83	0.00	-70.21
1941	134.28	387.51	251.11	343.25	35.80	44.26	24.83	0.71	-145.96
1942	2.84	509.58	329.18	503.57	6.91	6.02	24.83	2.96	12.11
1943	1.93	809.55	529.64	499.01	12.38	310.53	26.20	0.00	11.89
1944	10.70	503.56	324.85	494.86	7.76	8.70	24.83	1.80	4.58
1945	1.07	783.58	523.96	494.21	18.04	289.36	24.83	5.34	0.39
1946	0.40	610.37	407.25	501.85	11.07	108.52	24.83	0.00	13.37
1947	4.80	797.71	512.97	500.25	8.27	297.46	24.83	0.00	11.77
1948	0.00	787.17	489.31	506.90	6.43	280.28	25.14	0.00	18.71
1949	0.41	764.53	535.07	495.16	17.75	269.37	24.83	5.55	1.12
1950	0.26	1021.08	621.33	504.66	8.40	516.42	26.00	0.00	17.34
1951	0.76	689.28	447.50	502.05	10.51	187.23	24.83	0.00	13.56
1952	0.00	716.29	506.86	495.97	17.36	220.32	26.00	7.43	1.22
1953	0.00	756.84	511.96	499.83	13.49	257.01	26.29	0.00	12.80
1954	4.89	647.19	425.04	498.57	9.86	148.61	24.83	0.00	10.09
1955	0.35	1124.36	711.12	508.08	4.89	616.28	26.00	0.00	20.76
1956	0.00	905.30	595.63	499.83	13.49	405.48	26.00	0.00	12.51
1957	1.22	588.82	422.00	494.39	17.71	94.43	24.83	6.37	-0.47
1958	4.24	603.87	436.02	491.03	18.05	112.84	24.83	2.61	-0.07
1959	2.00	830.98	524.63	505.90	5.42	325.08	24.83	0.00	17.41
1960	0.12	903.52	632.17	495.62	17.59	407.90	26.00	1.16	7.14
1961	0.91	601.65	416.94	495.91	16.50	105.74	24.83	0.00	7.42
1962	1.58	848.82	550.02	505.95	5.80	342.87	24.83	0.00	17.46
1963	1.12	769.69	500.13	494.92	17.29	274.77	24.83	0.00	6.43
1964	0.00	755.81	535.91	495.97	17.36	259.85	26.00	3.14	5.50
1965	47.59	453.23	339.64	439.92	25.81	13.31	24.83	1.77	-50.34
1966	3.87	647.46	432.42	504.96	4.49	142.50	24.83	0.00	16.48
1967	4.07	524.84	357.47	494.41	14.85	30.43	24.83	0.00	5.92
1968	2.71	606.85	368.93	501.88	8.74	104.97	24.83	0.00	13.39
1969	0.49	885.88	582.18	506.04	6.79	379.83	26.00	0.00	18.72
1970	5.39	556.29	360.61	503.65	4.28	52.64	24.83	0.26	14.90

Table 15.1b. Volume Calculations for 28 March through 31 October, Foster with Green Peter, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Shortage	Total Inflow Passed	Inflow From GPR Releases	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	0.31	903.26	568.68	511.62	1.40	391.64	26.00	0.00	24.30
1972	0.55	735.46	508.12	494.95	17.83	240.51	24.83	5.85	0.62
1973	69.39	438.02	330.62	420.88	23.05	17.14	24.83	0.00	-67.61
1974	0.01	887.59	626.29	495.96	17.36	391.63	26.26	6.38	2.52
1975	1.60	706.65	471.36	500.19	11.53	206.45	25.30	0.00	12.17
1976	2.40	689.43	504.11	492.55	18.37	196.88	24.83	7.43	-3.36
1977	1.15	610.55	391.08	498.25	13.92	112.30	26.00	0.00	10.92
1978	2.58	504.89	331.42	493.09	17.65	11.81	24.83	7.43	-2.83
1979	3.31	659.31	397.42	509.06	0.95	150.25	24.83	0.90	19.68
1980	3.37	545.75	385.41	491.90	18.05	53.85	24.83	3.14	0.27
1981	1.87	694.44	416.86	505.05	6.40	189.39	27.17	0.00	18.90
1982	1.29	644.41	409.21	499.31	12.73	145.10	24.83	0.00	10.82
1983	1.01	663.31	432.67	500.21	12.10	163.10	26.00	0.00	12.89
1984	0.00	931.65	585.37	502.46	10.86	429.19	35.89	0.00	25.03
1985	2.00	705.21	467.88	498.39	12.93	206.82	26.00	0.00	11.07
1986	1.64	500.74	349.26	494.21	17.48	6.54	24.83	3.14	2.58
1987	100.53	395.92	329.43	385.26	27.53	10.66	24.83	0.26	-103.49
1988	1.52	711.13	483.21	494.14	17.67	216.99	26.00	2.07	4.75
1989	5.26	624.11	441.34	489.22	18.84	134.89	24.83	5.57	-4.84
1990	3.17	729.91	480.42	493.53	16.63	236.38	26.00	0.00	6.21
1991	0.32	653.84	448.61	495.64	17.36	158.20	24.83	2.72	4.44
1992	82.57	428.93	321.76	404.19	26.56	24.73	24.83	0.00	-84.29
1993	0.09	928.51	609.82	495.88	17.36	432.64	26.00	5.53	3.03
1994	15.54	556.05	343.20	488.98	8.80	67.07	24.83	0.40	0.09
1995	2.87	644.15	399.31	499.59	10.86	144.56	24.83	0.00	11.10
1996	0.11	752.54	472.59	501.61	11.61	250.94	24.83	0.00	13.12
1997	7.62	687.31	432.54	497.07	8.64	190.25	24.83	0.00	8.58
1998	0.21	528.72	375.90	495.72	17.39	33.00	26.00	4.63	3.77
1999	0.10	750.19	520.06	495.83	17.40	254.36	26.00	5.85	2.66
2000	2.38	607.51	436.54	493.32	17.63	114.19	26.00	7.43	-1.43
2001	32.77	478.58	326.86	461.64	18.91	16.94	24.83	0.00	-26.85
2002	2.68	699.52	498.69	492.38	18.25	207.13	24.83	7.43	-3.53
2003	13.46	649.49	424.30	493.06	6.79	156.42	24.83	7.23	-2.66
2004	5.97	599.66	372.75	498.71	8.64	100.95	26.00	0.00	11.39
2005	0.92	584.11	366.29	495.05	17.36	89.06	26.00	0.51	7.22
2006	3.21	563.23	382.34	490.85	19.26	72.38	26.00	2.11	1.42
2007	15.57	546.51	315.24	491.41	6.34	55.10	24.83	0.00	2.93



Graphed values are chronological (1929-2007)



Graphed values are sorted by Stored water used for BiOp (need always same)

Figure 15.1. Water volume totals for Foster 1929-2007, in chronological order (on left), and sorted by total stored water released for the BiOp, which is the Black value. White and Blue volumes include flows from Green Peter outflows and from the unregulated South Santiam River inflows. Note the BiOp Need is constant (black + white + red).

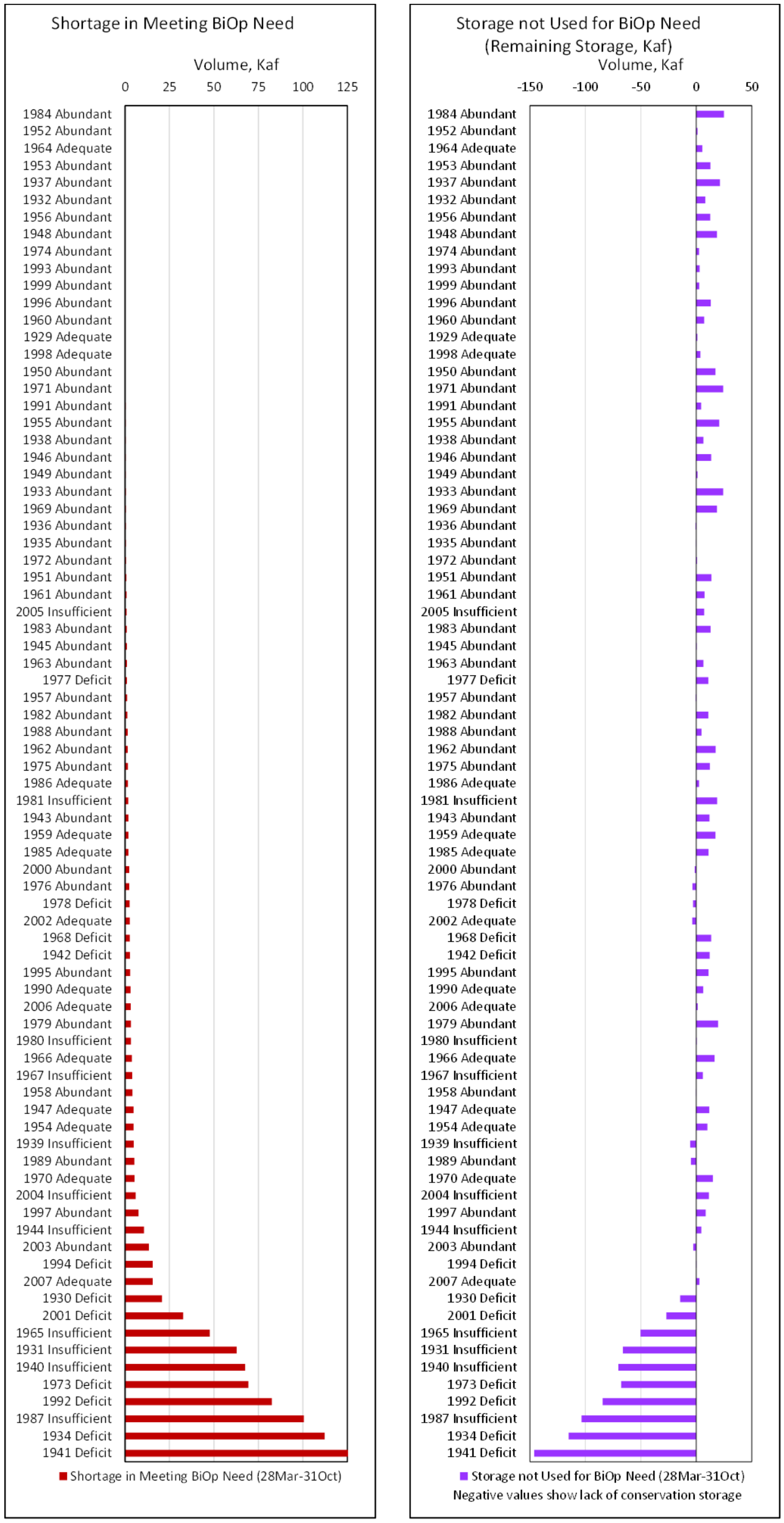
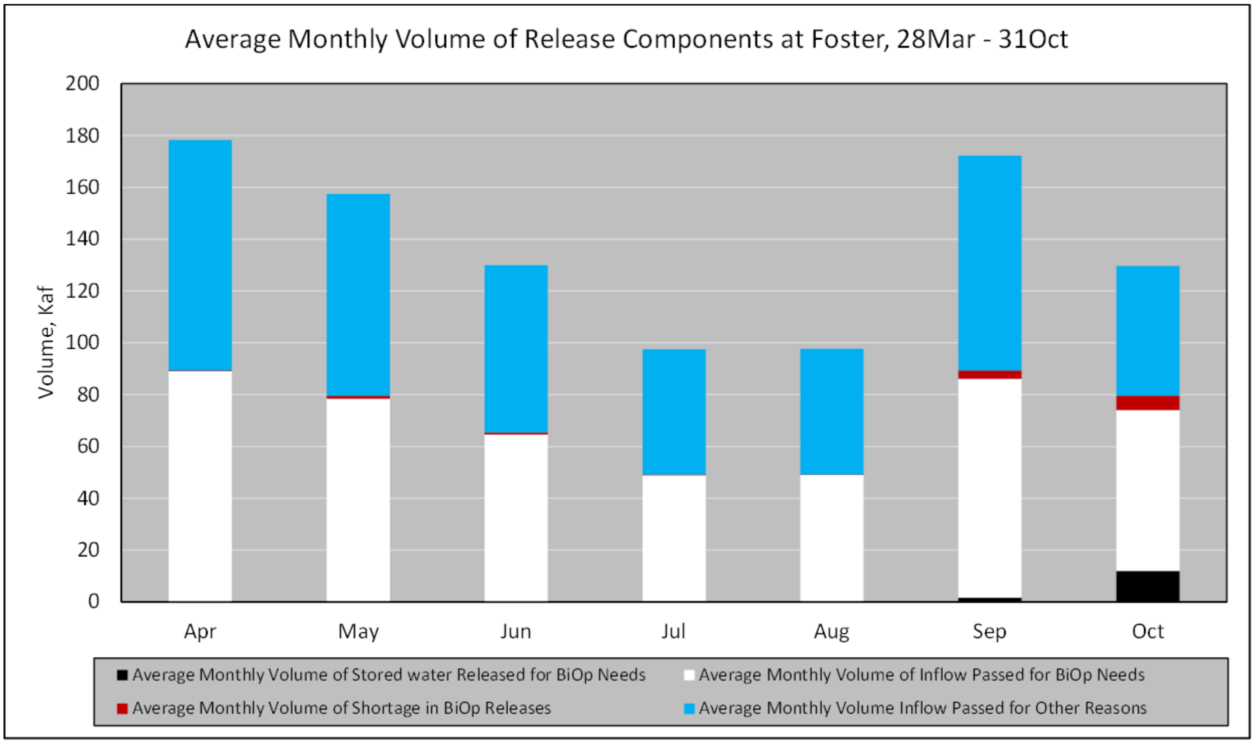


Figure 15.2. Water Volume totals for Foster 1929-2007 sorted by shortage, with shortage volume on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	11.90	89.26	79.54	65.45	49.19	49.19	89.26	79.54
Stored Water Released for BiOp Needs	0.00	0.00	0.26	0.05	0.31	0.19	1.65	11.96
Inflow Passed for BiOp Needs	11.90	89.01	78.19	64.62	48.60	48.74	84.40	62.08
Shortage in meeting BiOp Needs	0.00	0.25	1.09	0.78	0.28	0.26	3.21	5.50
Inflow Passed Other Reasons	11.90	89.01	77.93	64.57	48.29	48.54	82.95	50.18

Figure 15.3. Water volume average monthly totals for release components for Foster 1929-2007. Black is the stored water released for the BiOp target minimums, white is the inflow passed to meet the BiOp target minimums, red is the shortage in releases for the supplemental flows, and blue is the inflow passed for other reasons. White and Blue volumes include flows from Green Peter outflows and from the unregulated South Santiam River inflows.

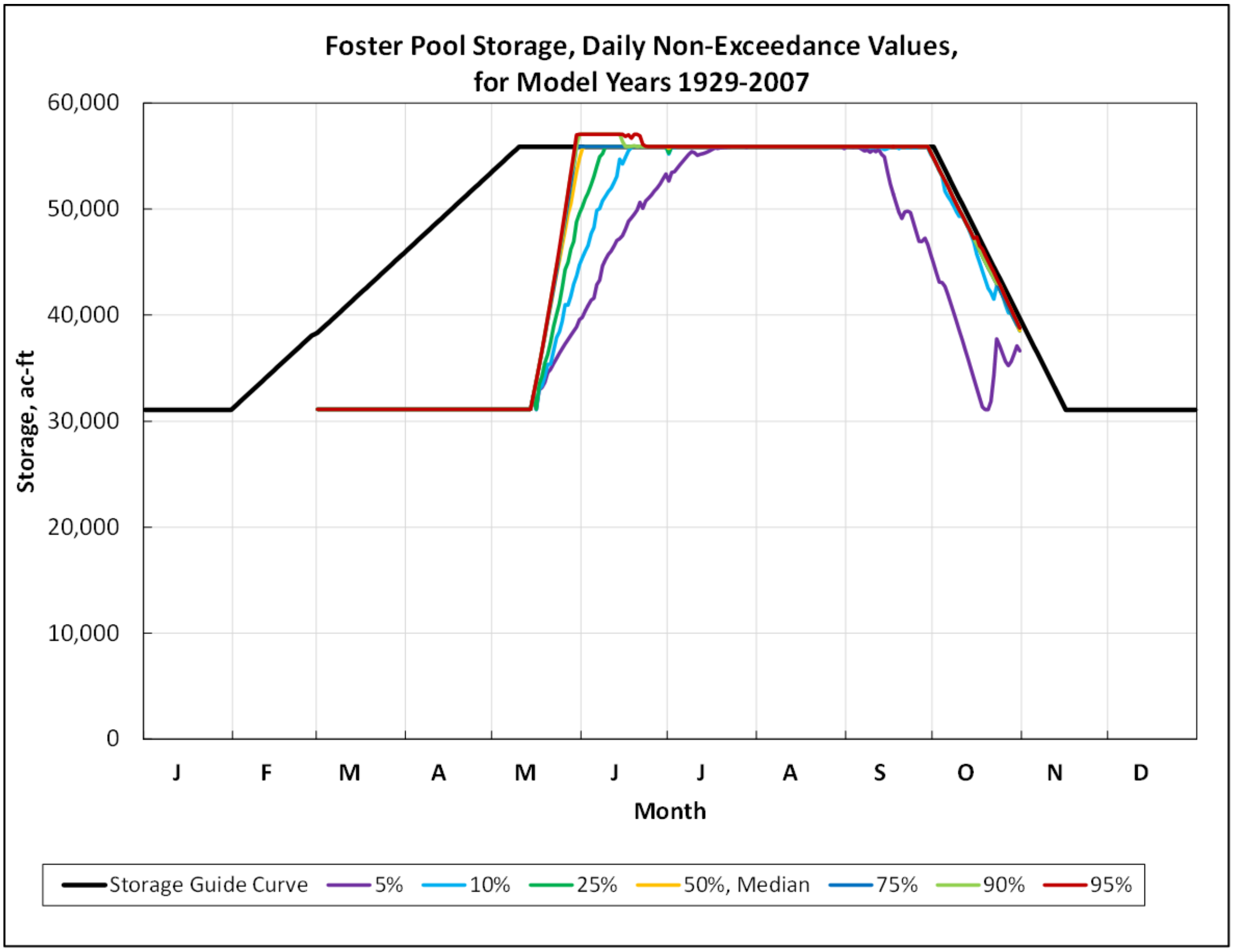


Figure 15.4. Non-exceedance storage values for Foster 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years. (Note Foster operations currently delay refill from the standard rule curve for fish weir operations to pass juveniles, where spill is required during a spring window with a lower pool level to ensure fish survival.)

Table 15.2. Component Volume Calculations for 28 March through 31 October, Foster Only, 1929 through 1970.

Year	Volumes for 28 March-31 October, KAF				Year	Volumes for 28 March-31 October, KAF			
	Stored Water For BiOp	Local Inflow Passed For BiOp	Shortage To Meet BiOp Flows	Local Inflow Passed Other Reasons		Stored Water For BiOp	Local Inflow Passed For BiOp	Shortage To Meet BiOp Flows	Local Inflow Passed Other Reasons
1929	17.36	42.79	0.13	203.87	**1971**	1.40	51.43	0.31	271.21
1930	10.56	103.19	20.81	8.05	**1972**	17.83	64.61	0.55	167.22
1931	26.05	52.53	62.75	113.67	**1973**	23.05	89.08	69.39	17.14
1932	17.01	52.00	0.00	222.81	**1974**	17.36	49.75	0.01	229.53
1933	10.33	48.88	0.47	340.15	**1975**	11.53	114.60	1.60	125.49
1934	27.09	79.58	112.27	38.00	**1976**	18.37	60.62	2.40	145.56
1935	17.61	73.90	0.52	101.64	**1977**	13.92	163.23	1.15	74.60
1936	17.60	90.54	0.52	97.51	**1978**	17.65	162.03	2.58	11.40
1937	11.63	46.47	0.00	343.94	**1979**	0.95	67.99	3.31	117.63
1938	13.36	59.54	0.36	164.89	**1980**	18.05	110.90	3.37	49.02
1939	17.93	105.04	4.92	44.14	**1981**	6.40	134.68	1.87	141.07
1940	27.53	61.02	67.51	31.18	**1982**	12.73	128.52	1.29	112.55
1941	35.80	71.16	134.28	44.26	**1983**	12.10	134.76	1.01	106.84
1942	6.91	134.31	2.84	6.02	**1984**	10.86	75.24	0.00	276.91
1943	12.38	72.11	1.93	212.80	**1985**	12.93	95.59	2.00	156.11
1944	7.76	123.52	10.70	8.52	**1986**	17.48	146.32	1.64	6.49
1945	18.04	53.50	1.07	194.30	**1987**	27.53	63.03	100.53	10.66
1946	11.07	112.49	0.40	94.95	**1988**	17.67	84.56	1.52	153.76
1947	8.27	99.26	4.80	187.00	**1989**	18.84	90.84	5.26	96.74
1948	6.43	81.13	0.00	215.12	**1990**	16.63	108.87	3.17	147.41
1949	17.75	64.16	0.41	177.52	**1991**	17.36	104.18	0.32	114.74
1950	8.40	58.46	0.26	345.42	**1992**	26.56	84.34	82.57	24.73
1951	10.51	96.58	0.76	140.73	**1993**	17.36	52.74	0.09	283.90
1952	17.36	68.76	0.00	158.62	**1994**	8.80	96.73	15.54	52.50
1953	13.49	85.14	0.00	171.44	**1995**	10.86	128.56	2.87	118.32
1954	9.86	113.78	4.89	114.87	**1996**	11.61	131.31	0.11	149.37
1955	4.89	40.42	0.35	369.40	**1997**	8.64	113.65	7.62	137.74
1956	13.49	50.26	0.00	265.72	**1998**	17.39	146.38	0.21	24.39
1957	17.71	101.29	1.22	67.59	**1999**	17.40	76.78	0.10	169.67
1958	18.05	113.88	4.24	59.65	**2000**	17.63	111.18	2.38	69.57
1959	5.42	89.10	2.00	216.17	**2001**	18.91	104.76	32.77	16.88
1960	17.59	59.52	0.12	229.87	**2002**	18.25	81.89	2.68	116.24
1961	16.50	104.31	0.91	84.39	**2003**	6.79	46.07	13.46	133.32
1962	5.80	62.59	1.58	232.80	**2004**	8.64	147.12	5.97	86.30
1963	17.29	93.89	1.12	185.33	**2005**	17.36	196.31	0.92	79.06
1964	17.36	74.29	0.00	163.57	**2006**	19.26	117.90	3.21	60.67
1965	25.81	90.27	47.59	12.96	**2007**	6.34	90.68	15.57	55.10
1966	4.49	63.38	3.87	99.31					
1967	14.85	141.86	4.07	21.54					
1968	8.74	157.88	2.71	80.12					
1969	6.79	66.82	0.49	249.56					
1970	4.28	99.92	5.39	43.40					

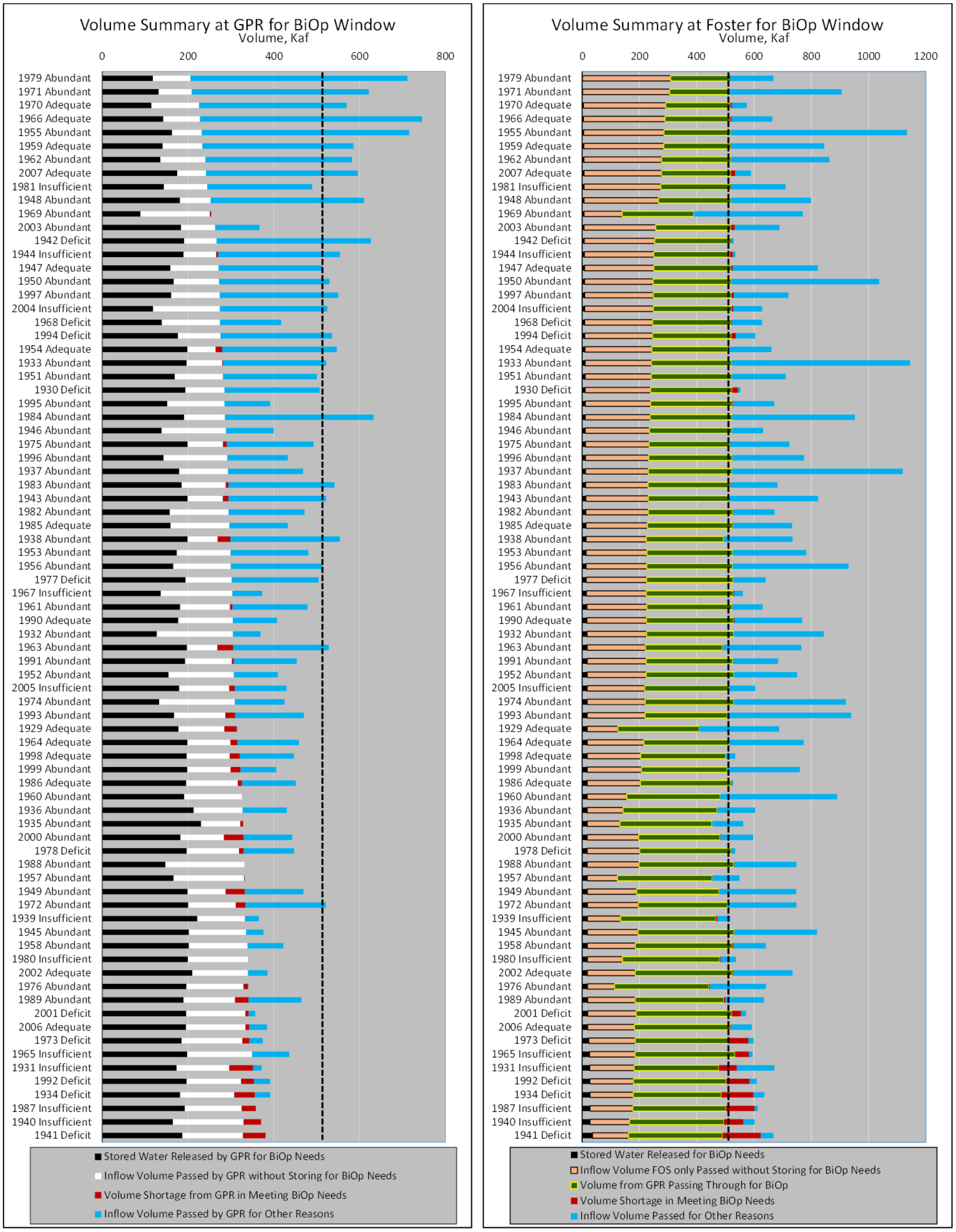
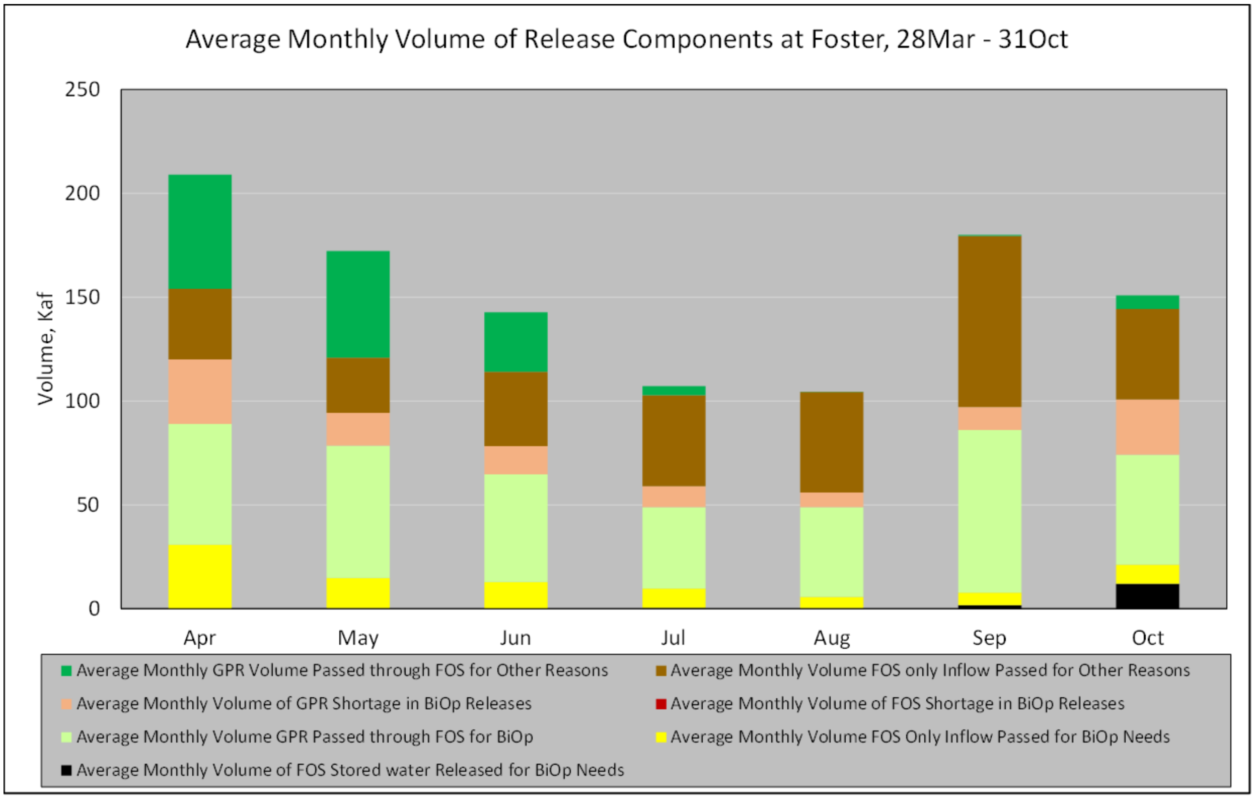


Figure 15.5. Water volume totals for Green Peter (left) and Foster (right) 1929-2007, both sorted by BiOp Need at Green Peter. Graph at left same as Figure 14.1 with the addition of the dotted line showing the volume needed for Foster minimums. Right graph breaks the white bars of Figure 15.1 for Foster into the water that came from Green Peter specifically to meet the minimum targets (olive green outlined in yellow) and the inflow passed from the unregulated South Santiam to meet the targets (light orange). Dashed line indicates volume needed from Foster in both graphs.



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	11.90	89.26	79.54	65.45	49.19	50.25	89.34	79.55
FOS Stored Water Released for BiOp Needs	0.00	0.00	0.26	0.05	0.31	0.19	1.65	11.96
Inflow Passed for BiOp Needs, GPR share	7.35	56.66	57.43	38.62	16.99	8.94	10.93	21.17
Inflow Passed for BiOp Needs, FOS share	4.22	30.75	14.45	12.70	9.38	5.50	6.10	9.14
Shortage in meeting BiOp Need, FOS share	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shortage in meeting BiOp Need, GPR share	4.22	31.00	15.80	13.53	9.97	7.02	11.04	26.61
Inflow Passed Other Reasons, GPR share	7.14	55.06	51.36	28.71	4.45	0.12	0.50	6.59
Inflow Passed Other Reasons, FOS share	4.76	33.95	26.57	35.86	43.83	48.42	82.45	43.59

Figure 15.6. Water volume average monthly totals for release components for Foster 1929-2007, with Green Peter's contributions broken out separately. Black is the Foster stored water released for the BiOp target minimums, the yellow plus light green equals the white from Figure 15.3, with light green passed through from Green Peter and yellow the inflow from the South Santiam passed to meet the BiOp target minimums. Red is the Foster share of the shortage in releases for the supplemental flows (and on average each month, there is no Foster share of shortage), orange is the Green Peter share of the shortage, and brown plus dark green equals the bright blue from Figure 15.3, with dark green the Green Peter share and brown the South Santiam share of inflow passed for other reasons.

16 Detroit Water Volume Summary, 28Mar-31Oct, 1929-2007.

The water volume calculation Basic Methodology detailed in Section 5 was used on the Baseline simulation results for 1929 through 2007 for Detroit, where the ResSim operation set for the project uses minimum release rules at Detroit to meet BiOp targets. The water volume component calculations for Detroit follow the method used for Fern Ridge in Section 13, since that dam also has BiOp target rules as project minimum flow releases.

Detroit reservoir releases supplement flows at Salem by meeting high project minimum release values. The minimum releases are slightly reduced in the fall for years when the pool is much lower than usual, but otherwise are constant every year. The minimum releases required are:

01 Jan to 31 Jan: 1200 cfs minimum flow,
01 Feb to 15 Mar: 1000 cfs minimum flow,
16 Mar to 31 May: 1500 cfs minimum flow,
01 Jun to 14 Jul: 1200 cfs minimum flow,
15 Jul to 31 Aug: 1000 cfs minimum flow,
01 Sep to 15 Oct: 1500 cfs minimum flow, 1200 cfs minimum when pool is low,
16 Oct to 31 Dec: 1200 cfs minimum flow.

The two rules used in the Detroit operation set to meet these targets are described in Section 4 and shown in Figure 4.4. These rules are specific to Detroit dam. The time series records used for the Detroit calculations are:

//DETROIT-POOL/FLOW-IN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT-POOL/FLOW-OUT/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT-POOL/STOR/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT-POOL/ELEV/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT/ZONEID/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT-BETTER DET MIN CON ZONE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/
//DETROIT-DET BETTER BUFFER BASELINE/FLOW-MIN/01JAN1928 - 01JAN2008/1DAY/BETBASE---0/

Water volume component calculations for Detroit are tabulated in Table 16.1 (split into Table 16.1a for 1929 through 1970 and Table 16.1b for 1971 through 2007) and graphed in Figure 16.1. Note that the BiOp Need is usually a constant value, since the need is calculated by the project minimum releases which vary only in Deficit water years. The shortages and the additional stored water released during drafting that is not for BiOp Need is graphed in Figure 16.2, sorted by the shortage volumes, and the average monthly water volume components are graphed in Figure 16.3. The Detroit storage non-exceedance graph is shown in Figure 16.4. Refer to Section 6 for Blue River to see full descriptions of these tables and graphs.

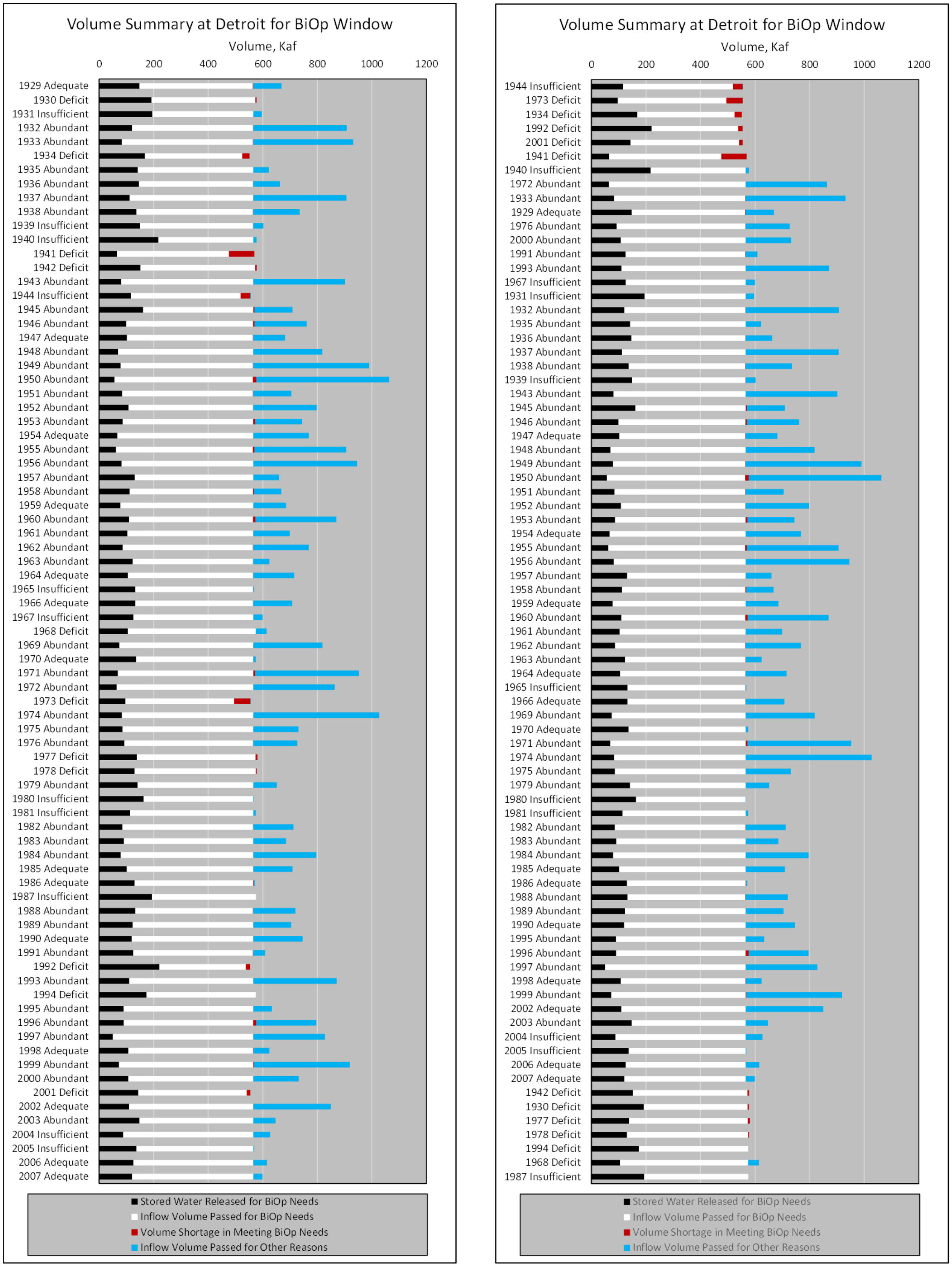
Special Note: The minimum releases from Detroit include irrigation releases for May through September (see the "Willamette Basin Review, ResSim Baseline Model Documentation Report"), which are included in the BiOp Need calculations in this section. Section 17, which totals the results for all storage projects in the basin, will then have a calculation that removes irrigation releases from both the BiOp Need total calculations and the stored water used for BiOp total calculations. Refer to Section 17 for more details.

Table 16.1a. Volume Calculations for 28 March through 31 October, Detroit, 1929 through 1970. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/29 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1929	565.77	1.99	517.86	415.28	148.50	102.58	287.70	45.13	92.08
1930	572.75	4.80	380.26	380.26	192.49	0.00	203.48	16.93	-10.74
1931	565.88	0.00	400.99	370.60	195.29	30.39	260.84	7.04	58.51
1932	565.88	1.52	784.66	443.08	121.29	341.58	287.92	0.09	165.03
1933	565.74	1.50	845.78	480.49	83.75	365.29	287.92	17.58	185.09
1934	551.31	26.50	356.48	356.48	168.32	0.00	167.91	0.11	-27.03
1935	565.88	0.00	479.64	423.55	142.33	56.09	287.70	20.08	125.29
1936	565.88	1.43	514.52	417.82	146.63	96.70	287.82	42.82	96.94
1937	565.88	0.67	793.66	453.16	112.06	340.50	287.92	6.26	168.94
1938	565.88	1.65	596.23	426.93	137.30	169.30	287.70	6.52	142.23
1939	565.88	1.07	451.33	415.30	149.51	36.03	287.70	39.75	97.36
1940	565.59	0.00	360.45	348.45	217.14	12.00	250.19	2.50	30.55
1941	565.54	92.78	410.94	410.94	65.31	0.00	43.89	0.79	-115.00
1942	572.13	5.56	420.66	420.66	151.47	0.00	183.14	0.24	25.87
1943	565.88	0.65	818.98	483.71	81.52	335.27	287.70	4.12	201.41
1944	542.68	35.76	404.30	402.67	116.11	1.64	129.52	3.83	-26.18
1945	565.88	4.76	542.63	403.67	161.81	138.95	287.92	7.50	113.85
1946	565.88	6.03	655.30	465.07	99.51	190.22	287.70	1.21	180.95
1947	565.88	1.71	576.94	461.54	102.64	115.40	287.70	0.00	183.35
1948	565.88	0.55	747.55	495.50	69.84	252.05	287.92	1.39	216.15
1949	565.88	1.53	908.97	485.04	79.31	423.93	288.07	10.89	196.35
1950	565.88	14.26	992.01	506.63	56.72	485.39	287.98	0.00	216.99
1951	565.88	1.60	618.10	479.55	84.74	138.55	287.70	0.28	201.08
1952	565.88	1.00	687.91	456.29	108.60	231.63	287.92	35.42	142.90
1953	565.88	7.95	648.72	478.16	86.89	170.56	287.92	9.73	183.35
1954	565.88	0.75	699.99	498.01	67.12	201.99	287.70	8.10	211.72
1955	565.88	6.65	836.64	501.06	62.28	335.58	287.92	0.00	218.99
1956	565.88	0.00	863.30	483.55	82.34	379.75	287.92	0.19	205.39
1957	565.88	0.00	528.72	434.64	131.24	94.08	287.70	13.37	143.09
1958	565.88	3.65	552.11	452.77	111.84	99.33	287.70	3.01	169.20
1959	565.88	0.00	607.01	487.86	78.03	119.15	287.70	7.98	201.70
1960	565.88	9.07	750.26	454.43	109.88	295.83	287.92	5.39	163.58
1961	565.88	0.73	594.54	461.20	103.96	133.34	287.70	2.55	180.46
1962	565.88	1.81	679.68	477.23	86.84	202.45	287.92	5.49	193.77
1963	565.88	1.13	499.38	441.19	123.57	58.19	287.70	1.40	161.60
1964	565.88	1.40	607.55	458.61	105.87	148.94	287.92	17.65	163.00
1965	565.88	0.97	434.34	432.28	132.63	2.06	285.99	7.06	145.33
1966	565.88	1.39	572.77	431.62	132.88	141.15	287.92	9.11	144.54
1967	565.87	0.00	473.02	439.61	126.26	33.41	230.26	2.86	101.15
1968	574.80	0.00	509.13	469.83	104.97	39.30	227.89	0.00	122.92
1969	565.88	0.18	743.40	490.98	74.72	252.42	287.92	5.32	207.70
1970	565.88	0.79	437.59	428.98	136.11	8.61	279.18	3.61	138.66

Table 16.1b. Volume Calculations for 28 March through 31 October, Detroit, 1971 through 2007. (Remaining Storage in last column is max Conservation zone storage – stored water used for BiOp through 31 Oct – shortage – stored water used after 31 Oct to meet min flows. Negative value in last column shows lack of conservation storage. Note 11/15 last day of conservation storage.)

Year	Volumes Computed for 28 March through 31 October, KAF						Reservoir Storage Information, KAF		
	BiOp Need	BiOp Shortage	Inflow Passed	Inflow Passed For BiOp	Stored Water For BiOp	Inflow Passed Other Reasons	Maximum Conservation Storage for This Year	Stored Water Used After 10/31 For Min Flow	Remaining Storage (if<0 below Min Con)
1971	565.88	6.93	876.33	496.71	69.17	379.62	287.92	6.93	211.81
1972	565.73	0.18	797.79	500.58	64.97	297.21	287.92	0.18	217.17
1973	551.01	59.88	399.40	398.30	96.92	1.10	94.89	59.88	-61.91
1974	565.88	0.00	943.05	482.13	83.75	460.92	287.92	0.00	190.49
1975	565.88	0.33	643.32	478.93	86.62	164.39	287.92	0.33	200.96
1976	565.81	1.07	632.39	471.71	93.03	160.68	288.83	1.07	172.96
1977	573.55	6.93	435.28	435.28	138.27	0.00	170.95	6.93	25.64
1978	574.60	3.58	444.21	444.21	130.38	0.00	150.72	3.58	-7.26
1979	565.88	0.00	509.47	424.15	141.73	85.32	287.92	0.00	138.34
1980	565.88	0.00	403.49	401.89	163.99	1.59	233.44	0.00	59.69
1981	565.88	0.00	460.85	452.11	113.77	8.73	279.54	0.00	161.55
1982	565.88	1.17	625.21	478.94	85.77	146.26	287.70	1.17	199.88
1983	565.88	0.36	593.83	474.30	91.23	119.53	287.70	0.36	194.62
1984	565.88	0.01	715.78	486.13	79.74	229.64	287.92	0.01	208.17
1985	565.88	0.89	606.29	463.30	101.70	143.00	287.70	0.89	183.98
1986	565.88	1.74	438.96	435.20	130.69	3.76	269.97	1.74	134.67
1987	575.01	0.00	381.62	381.62	193.39	0.00	234.67	0.00	12.00
1988	565.88	1.58	585.03	431.51	132.79	153.51	287.70	1.58	151.98
1989	565.88	0.18	580.87	442.65	123.05	138.21	287.70	0.18	159.32
1990	565.88	0.73	625.08	445.19	119.96	179.89	287.70	0.73	167.01
1991	565.85	1.70	480.85	438.43	125.73	42.42	287.70	1.70	155.61
1992	554.16	16.33	316.79	316.79	221.04	0.00	213.68	16.33	-23.98
1993	565.87	0.64	759.87	454.80	110.42	305.07	287.92	0.64	141.49
1994	574.70	0.00	401.09	401.09	173.61	0.00	213.88	0.00	40.26
1995	565.88	0.17	542.78	475.43	90.28	67.35	287.70	0.17	194.61
1996	565.88	11.17	693.80	474.86	90.56	218.94	287.92	11.17	186.19
1997	565.88	0.94	776.47	514.58	50.37	261.89	287.70	0.94	236.39
1998	565.88	1.55	515.02	457.42	107.48	57.60	287.70	1.55	171.66
1999	565.88	2.38	842.69	492.54	73.35	350.15	287.92	2.38	210.13
2000	565.84	0.70	623.30	457.56	107.58	165.75	287.92	0.70	163.03
2001	554.45	13.04	397.26	397.26	144.14	0.00	146.90	13.04	-17.24
2002	565.88	0.13	738.79	455.51	110.24	283.28	287.95	0.13	159.36
2003	565.88	0.00	498.11	417.32	148.57	80.80	287.70	0.00	124.97
2004	565.88	0.00	538.77	477.28	88.60	61.48	287.70	0.00	195.14
2005	565.88	0.00	431.01	428.72	137.16	2.29	228.91	0.00	91.74
2006	565.88	0.93	488.06	439.02	125.93	49.04	287.70	0.93	159.02
2007	565.88	0.00	477.76	444.48	121.41	33.29	274.16	0.00	146.64



Graphed values are chronological (1929-2007) **Graphed values are sorted by BiOp Need (Black + White + Red)**

Figure 16.1. Water volume totals for Detroit, 1929-2007, in chronological order (on left), and sorted by total BiOp Need (on right), which is the Black + White + Red value.

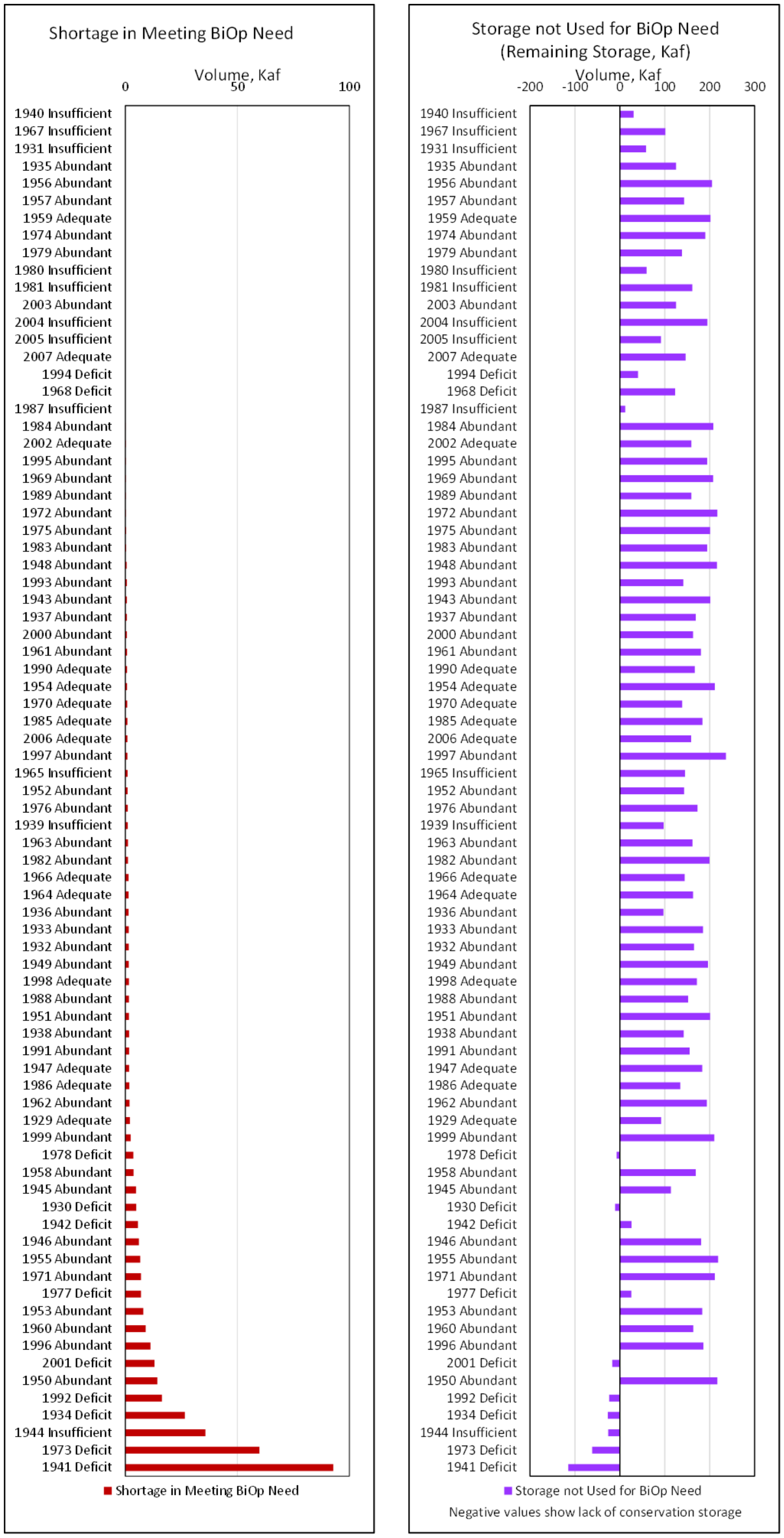
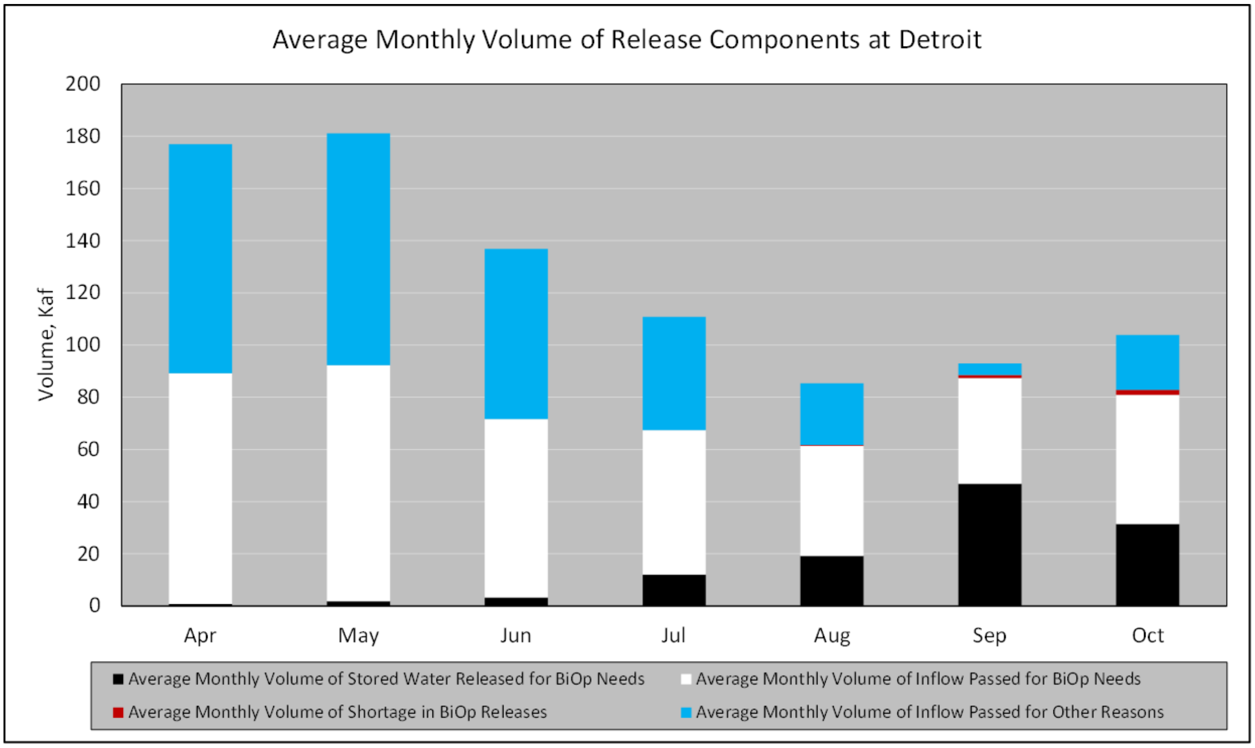


Figure 16.2. Water Volume totals for Detroit 1929-2007 sorted by total BiOp Need and then by shortage, with shortage volume on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	11.90	89.26	92.33	71.60	67.37	61.75	88.59	82.83
Stored Water Released for BiOp Needs	0.20	0.77	1.80	3.21	12.01	19.12	46.84	31.45
Inflow Passed for BiOp Needs	11.70	88.49	90.53	68.40	55.36	42.35	40.49	49.43
Shortage in meeting BiOp Needs	0.00	0.00	0.00	0.00	0.00	0.27	1.26	1.94
Inflow Passed Other Reasons	11.50	87.72	88.73	65.19	43.43	23.56	4.43	21.06

Figure 16.3. Water volume average monthly totals for release components for Detroit 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

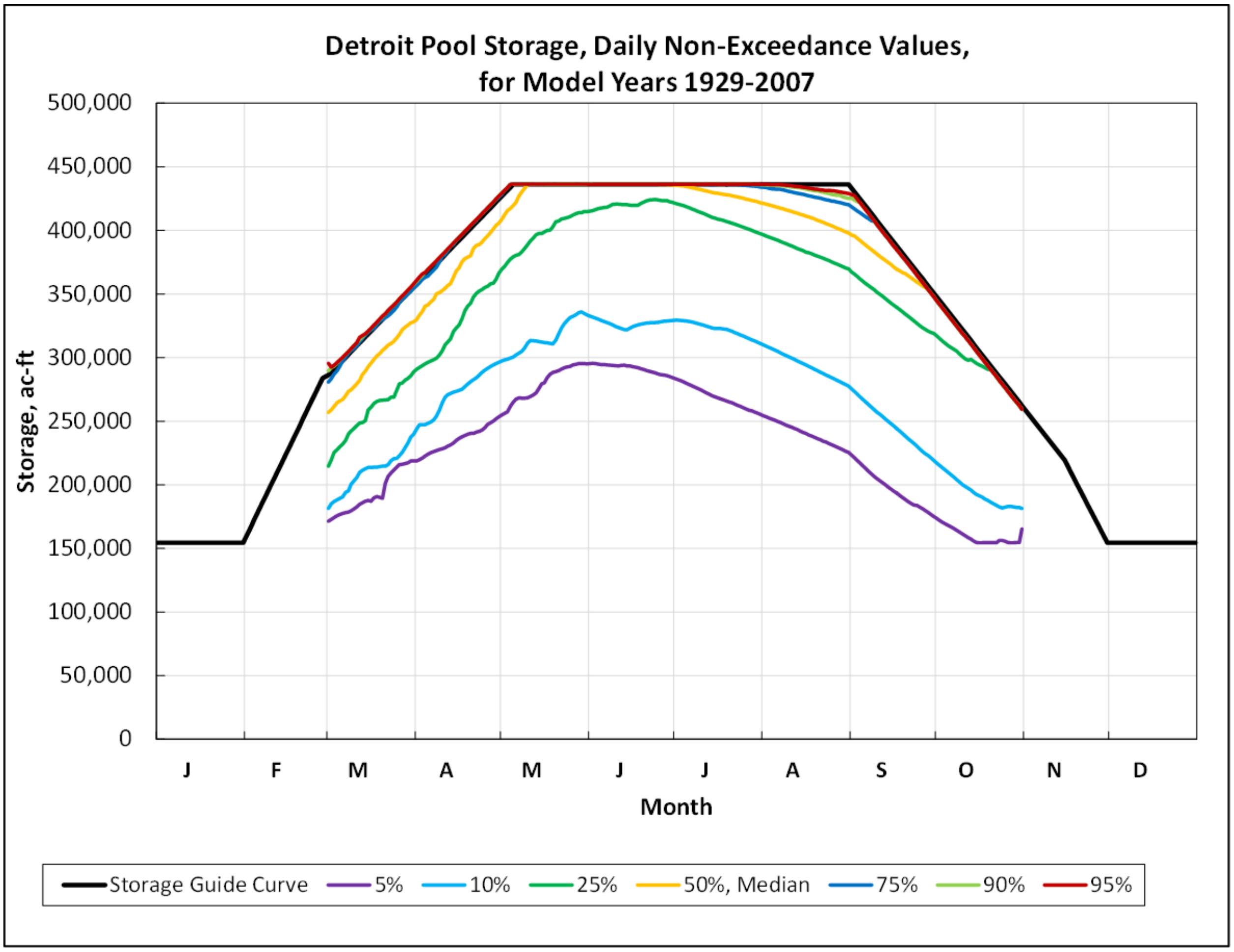


Figure 16.4. Non-exceedance storage values for Detroit 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

17 Willamette Basin Total BiOp Flows, 28Mar-31Oct, 1929-2007.

This section pulls together all the separate project information presented in the previous sections. Each of the individual project sections should be used to determine the specifics of the water volume component calculations presented by project, but the basin total information is needed as well.

This section will present the following information on total water volumes for the BiOp window, defined as 28 March through 31 October. In particular, note that the BiOp Need and the stored releases for BiOp Need have a 95 Kaf adjustment applied, which is explained below. No adjustments are required for the passed-inflow calculations, shortages, or remaining storage values.

- Total BiOp Need – the amount of water passing through Corps dams in the Willamette Basin that is required to meet BiOp minimum tributary flows and to supplement flows at Albany and Salem on the mainstem to meet the BiOp minimum flow targets. This calculation implicitly includes 95 Kaf for irrigation contracts, in part because the 95 Kaf does not have assigned components at any particular reservoir. Releases at two projects (Fern Ridge and Detroit, as noted in Sections 13 and 16) had irrigation volumes included in their minimum release rules, which were summed into the BiOp Need calculations at FRN and DET, but elsewhere the irrigation contract volumes were not specified in any reservoir releases. This is discussed in more detail below, including the use of 1929 as an example.
- Total Shortage in meeting BiOp Need – the amount of water that the dams were not able to release to meet the BiOp Need.
- Total Inflow Volume Passed to Meet BiOp Need – the total amount of water passed through the dams without being stored specifically to meet BiOp Need.
- Total Volume of Stored Water Released to Meet BiOp Need – the total amount of water released by the Willamette Basin dams specifically to Meet BiOp Need. This calculation is based on the sum of all the individual project stored water releases to meet BiOp Need, and this calculation also implicitly includes stored water releases to cover 95 Kaf of irrigation contracts. The stored water releases are totaled from the individual project data and then the 95 Kaf is subtracted to obtain the BiOp only component. An example year using 1929 is provided below to provide more detail on the 95 Kaf of irrigation contracts.
- Total Inflow Volume Passed for Other Reasons – the total amount of water passed through the dams for reasons other than meeting BiOp Need. This most often occurs when the pool is above the rule curve, but could occasionally occur for other reasons.
- Total Volume of water remaining in storage – this is the total storage volume released by the basin dams during the fall drafting that was released to follow rule curves after accounting for the volume needed to meet BiOp Need.

➢ ***Special note on the 95 Kaf adjustment for BiOp Need and stored water releases for Need***. The implicit inclusion of 95 Kaf for stored water irrigation contracts in the BiOp Need calculations in the individual project computations in Sections 6 through 16 is because of two reasons: first, current irrigation depletions have already been accounted for in the flow dataset, and second, most of the irrigation contracts are satisfied by releasing for minimum tributary targets. In the report "Willamette Basin Review – Flow Dataset Used for ResSim Analysis", Table 5.2 in that report showed that 278 Kaf of irrigation in the whole Willamette Basin has been included in the flow dataset, and Table 5.3 in that report showed that 80 Kaf of the total 278 Kaf was from BOR contracts on USACE storage reservoirs in 2007. The remaining 198 Kaf of irrigation (278 – 80 Kaf) was satisfied by sources other than stored water. The 95 Kaf (rather than 80 Kaf) is used as the adjustment factor to the BiOp Need and stored water used to meet BiOp Need calculations because current reservoir operations can support this contract volume without changing minimum releases (Willamette Project Supplemental Biological Assessment, page 3-166, and RPA 3 of the Reasonable and Prudent Alternative of the NMFS BiOp, page 9-26 to 9-27). Although 198 Kaf of agricultural irrigation is from non-stored water, it is important to understand that any reduction in instream flows that causes mainstem flows at Albany or Salem to be lower than BiOp minimum targets must be supplemented by stored water releases.

As an example for the adjustment using the 95 Kaf, the totals from all eleven storage projects for 1929 (see Tables 17.1a-d) are:

From Tables in previous sections:

Total Need calculated	=	2374 Kaf
Total shortage in meeting need	=	70 Kaf
Total Inflow Passed to meet BiOp Need	=	1534 Kaf
Total Stored Water Passed to meet BiOp Need	=	998 Kaf
Total Inflow Passed for non-BiOp reasons	=	625 Kaf

Current stored water contract adjustments to the calculations above:

Adjusted BiOp Need	=	2374 – 95	=	2279 Kaf
Adjusted Stored Water for BiOp Need	=	998 – 95	=	903 Kaf

In addition to the data outlined above, this section also includes a number of tables and figures that show results in a variety of ways to fully characterize what water is used for, where water volume is short, where water volume has remaining quantities, and how water year type factors into these results.

The total water volumes defined above are listed in Table 17.1 below (split into Table 17.1a for 1929 through 1970 and Table 17.1b for 1971 through 2007 for BiOp Need and stored water volumes and Table 17.1c for 1929 through 1970 and Table 17.1d for 1971 through 2007 for shortages, inflow volume totals, and remaining storage values, and Table 17.1e for all years with demand for stored water, which is the sum of the adjusted storage released for BiOp Need and the volume shortage) and graphed in Figure 17.1. The total shortage and the total volume of water remaining in storage is graphed in Figure 17.2, sorted by the shortage volumes. Figure 17.3 illustrates that there is some flexibility in real time water management to cover modeled shortages, with a more detailed discussion of this graph provided later in this section. The average monthly water volume components for the basin totals are graphed in

Figure 17.4. The total basin conservation storage non-exceedance graph is shown in Figure 17.5. Figure 17.6 shows the maximum refill level and its associated date for each year modeled – this graph in particular highlights the result that for many years, the projects do not completely refill, with refill less likely the drier the year. Figures 17.1 and 17.6 together illustrate an important concept about stored water releases for BiOp Needs – the driest years, which have the highest need for supplemental water, also have the lowest refill levels, so the amount of stored water released to meet BiOp Need can be a very high percentage of the stored water available.

The volume totals defined above are obtained from the project specific Sections 6 through 16. The basin total values are obtained from the project tables presented in each section, although the basin totals are handled differently for dams in series with another project, specifically for Green Peter / Foster and Hills Creek / Lookout Point for certain volume totals. Dams in series require special care to make sure that no water volumes are counted twice. These particulars are discussed below.

Section 12 for Lookout Point detailed how the BiOp Need evaluated at Lookout Point included the BiOp Need evaluated at Hills Creek. This means that the system total should use the BiOp Need computed at Lookout Point that includes Hills Creek values. Section 15 for Foster detailed how the total BiOp Need downstream of Foster was determined by sum of the water volume needed just downstream of Foster. This means that the system total BiOp Need is calculated as in the following example:

Blue River Need	Section 6	Table 6.1a, 1929	=	75.50 Kaf
Cougar Need	Section 7	Table 7.1a, 1929	=	203.12 Kaf
Dorena Need	Section 8	Table 8.1a, 1929	=	79.21 Kaf
Cottage Grove Need	Section 9	Table 9.1a, 1929	=	34.95 Kaf
Fall Creek Need	Section 10	Table 10.1a, 1929	=	153.28 Kaf
Lookout Point + Hills Creek Need	Section 12	Table 12.1a, 1929	=	716.71 Kaf
Fern Ridge Need	Section 13	Table 13.1a, 1929	=	32.56 Kaf
Foster Total Need	Section 15	Section 15 text	=	513.32 Kaf
Detroit Need	Section 16	Table 16.1a, 1929	=	565.77 Kaf
Willamette Basin Total Need	**Section 17**	**Table 17.1a, 1929**	**=**	**2374.41 Kaf**
Adjusted Basin Total BiOp Need	**Section 17**	**Table 17.1a, 1929**	**=**	**2279.41 Kaf**

Section 12 for Lookout Point detailed the total shortage for the LOP/HCR system (Table 12.1) versus the estimated LOP only shortage in Table 12.2. The combined system shortage value will be used for calculating the basin total shortage. Section 15 for Foster detailed how the shortage at Foster was determined separately from the shortage at Green Peter since the two operation sets used different rules. (HCR and LOP used the same downstream minimum flow rules for Albany and Salem, while Green Peter used a downstream minimum rule at Foster outflow and Foster used a minimum release rule.) This means that the system total shortage in meeting BiOp Need is calculated as in the following example:

Blue River Shortage	Section 6	Table 6.1a, 1929	=	0.00 Kaf
Cougar Shortage	Section 7	Table 7.1a, 1929	=	0.39 Kaf
Dorena Shortage	Section 8	Table 8.1a, 1929	=	0.00 Kaf
Cottage Grove Shortage	Section 9	Table 9.1a, 1929	=	0.10 Kaf

Fall Creek Shortage	Section 10	Table 10.1a, 1929	=	5.61 Kaf
Lookout Point + Hills Creek Shortage	Section 12	Table 12.1a, 1929	=	0.34 Kaf
Fern Ridge Shortage	Section 13	Table 13.1a, 1929	=	0.00 Kaf
Green Peter Shortage	Section 14	Table 14.1a, 1929	=	61.53 Kaf
Foster only Shortage	Section 15	Table 15.1a, 1929	=	0.13 Kaf
Detroit Shortage	Section 16	Table 16.1a, 1929	=	1.99 Kaf
Willamette Basin Total Shortage	**Section 17**	**Table 17.1c, 1929**	**=**	**70.09 Kaf**

The total volume of inflow passed for BiOp Need and the total amount of inflow passed for other reasons follows the same type of summation methodology used for the shortage calculation, where the Lookout Point data (including Hills Creek) from Table 12.1 are used, the Green Peter values from Table 14.1 are used, and the Foster only values from Table 15.2 are used.

The basin totals for stored water released to meet BiOp Need are obtained from the project tables in each project section, as are the values for the additional stored water released during the fall drafting season that were not released for BiOp Needs.

An example summation for the values in Table 17.1 is as follows for model year 1929, "Stored Water Released for BiOp":

Blue River Stored Water for Need	Section 6	Table 6.1a, 1929	=	40.02 Kaf
Cougar Stored Water for Need	Section 7	Table 7.1a, 1929	=	61.74 Kaf
Dorena Stored Water for Need	Section 8	Table 8.1a, 1929	=	28.47 Kaf
Cottage Grove Stored Water for Need	Section 9	Table 9.1a, 1929	=	13.58 Kaf
Fall Creek Stored Water for Need	Section 10	Table 10.1a, 1929	=	107.72 Kaf
Hills Creek Stored Water for Need	Section 11	Table 11.1a, 1929	=	99.11 Kaf
Lookout Point Stored Water for Need	Section 12	Table 12.1a, 1929	=	189.34 Kaf
Fern Ridge Stored Water for Need	Section 13	Table 13.1a, 1929	=	17.48 Kaf
Green Peter Stored Water for Need	Section 14	Table 14.1a, 1929	=	196.09 Kaf
Foster Stored Water for Need	Section 15	Table 15.1a, 1929	=	17.36 Kaf
Detroit Stored Water for Need	Section 16	Table 16.1a, 1929	=	148.50 Kaf
Willamette Basin Total Stored Water for Need	**Section 17**	**Table 17.1a, 1929**	**=**	**997.82 Kaf**
Adjusted Basin Total Stored Water for BiOp	**Section 17**	**Table 17.1a, 1929**	**=**	**902.82 Kaf**

Figure 17.1 is side-by-side bar graphs of the water volume component results for the Basin total. The graph on the left presents model years in chronological order, while those on the right have the data sorted by the total basin (adjusted) BiOp Need. The two figures also have a dashed black vertical line at 1600 Kaf, which represents the total maximum conservation storage in the basin projects of about 1.6 Maf. ***Note that in all years, the volume of water that the projects release in order to meet BiOp Needs (stored water and passed inflow for meeting BiOp Needs, black + white bars) is always greater than the maximum conservation storage of the system. This means the reservoir storage alone will never be enough to meet BiOp Needs.***

All years have at least some calculated shortage in meeting BiOp Needs, which are the red bars in Figure 17.1 and in the sorted data shown in Figure 17.2 on the left. Figure 17.2 also has a graph of the remaining storage shown on the right, with the same sorting as the shortages calculated in the left side graph. In real-time water management, the minimum flow targets are met more frequently than is indicated by the shortage calculations shown here, and the high values of remaining storage shown in the right graph of Figure 17.2 indicate that real-time water management had stored water available to release to cover some shortages. Since the ResSim model does not operate to look ahead to predicted storage levels or forecasted streamflows, there are times that supplemental flows are not released in the simulation *when they would have been* in real-time water management. This means that some shortages shown in Figure 17.2 are artifacts of ResSim and not of water management, and it can be assumed that in some years, real-time water management would have provided more supplemental flows than ResSim did.

The remaining storage (shown in purple in Figure 17.2) minus the shortage (shown in red in Figure 17.2) is plotted in Figure 17.3, which provides a measure of the flexibility of real time water management to have utilized forecasts and planning to supplement flows to meet BiOp targets and reduce the number of years with shortages. Positive values in Figure 17.3 mean that there was enough stored water available to have covered the modeled shortages, while negative values mean that was not enough stored water available to have prevented all shortages, even with real time water management flexibility. Note that 23 of the 79 full calendar years in the POR would have still had some shortage, even with the benefit of real time water management flexibility.

Referring back to Figure 17.1, all years also have at least a little inflow passed for other reasons, even when the shortage is large. This is because the bars are totals for each model year, and the totals are sums of daily values - there may be a shortage on one day but excess on another day, and values for each year are summed through the whole BiOp window.

The values of the remaining storage water volumes (last data columns of Tables 17.1 c and d) are plotted by two different sorting methods in Figure 17.7. The upper graph shows the volume of water remaining in storage when sorted by high to low values of the adjusted storage required to meet BiOp Need. The lower graph sorts the volume of water remaining in storage values themselves from low to high, and shows arrows for three non-exceedance percentile lines are drawn on the graph. These are for 20%, 50%, and 80% non-exceedance percentages. Note that non-exceedance percentiles are the opposite of reliability – the 20% non-exceedance remaining storage means that amount of stored water is remaining that may be available for other purposes 80% of the time. The 80% non-exceedance value of remaining stored water is only available 20% of the time.

The values of the adjusted stored water released to meet BiOp Need (last data columns in Tables 17.1a and b) are plotted in Figure 17.8, sorted from low to high. The graph also includes some non-exceedance percentile marks (the vertical green lines) and the associated storage value for each percentile.

Water Year Type is a good predictor of storage availability – lower water years rarely have stored water available at the end of the season and higher water years generally have remaining storage which could have been released for other purposes:

> ***Abundant*** *Water Years are 54% of the period of record analyzed, the reservoirs refill or nearly refill, and there is generally little shortage in meeting the BiOp needs in the*

ResSim model. Any shortages shown in the Baseline model would likely not be present with real-time reservoir regulation (most Abundant years have positive values in Figure 17.3). There is storage remaining at the end of the season in nearly all years. The BiOp needs were met by a combination of passing inflows and stored water releases, with the majority of the need met by passing inflows.

***Adequate** Water Years are 18% of the period of record analyzed, the reservoirs are short of refill, and there are generally some shortages in meeting the BiOp needs in the ResSim model. There is often storage remaining at the end of the season. Some of the shortages shown in the Baseline model would not be present with real-time reservoir regulation (most Adequate years have positive values in Figure 17.3). The BiOp needs were met by a combination of passing inflows and stored water releases, with a lot of the need met by passing inflows.*

***Insufficient** Waters Year are 14% of the period of record analyzed, reservoir refill is low, and there are shortages in meeting the BiOp needs in the ResSim model. There is little storage remaining at the end of the season. The shortages in meeting BiOp needs might be reduced but still present in real-time reservoir regulation, which would reduce the amount of remaining storage available in real-time as well (most Insufficient years have negative values in Figure 17.3). The BiOp needs were met by a combination of passing inflows and stored water releases, with more dependency on the stored water component than in the higher water years.*

***Deficit** Water Years are 14% of the period of record analyzed, the reservoirs are very short of refill (even with lower mainstem BiOp targets), and the shortages in meeting the BiOp needs are high in the ResSim model. There is no storage remaining at the end of the season. Real-time reservoir regulation might have a different shaping of the regulated flows than the Baseline model results, but Deficit years do not have enough water to meet the Needs all season (all Deficit years have negative values in Figure 17.3). The BiOp needs were met by a combination of passing inflows and stored water releases, with even more dependency on the stored water component than in the Insufficient water years.*

Summary of Stored Water Volume used to meet BiOp Needs. The amount of stored water released to meet BiOp Needs decreases as reservoir inflows increase. This results in an inverse relationship between the amount of stored water remaining at the end of the season and the amount of stored water used to meet BiOp Needs. In low water years, the reservoir refill level is low and there is not enough stored water to meet the need. In higher water years, the reservoirs are likely to refill and there is some storage remaining at the end of the season. In all years, a significant amount of inflow is passed (released from the reservoirs without first storing it) to meet the BiOp Needs. The amount of storage remaining at the end of the season is inversely related to its reliability – the higher the reliability sought, the less storage can be assured.

Table 17.1a. Volume Calculations for 28 March through 31 October, Willamette Basin Totals, Model Years 1929 through 1970, BiOp Need and Stored Water to meet BiOp Need.

Year	Volumes Computed for 28 March through 31 October, in KAF			
	Need Total From Tables in Sections 6 -16 From Individual Project Results	**Adjusted BiOp Need (Removes 95 Kaf To Account for Irrigation Storage Contracts)**	**Total Volume of Stored Water Released for Need Sections 6-16**	**Adjusted Stored Water Volume (less 95 Kaf) To Meet BiOp Need**
1929	2374.41	2279.41	997.82	902.82
1930	2484.35	2389.35	1047.24	952.24
1931	2632.02	2537.02	1177.91	1082.91
1932	2220.40	2125.40	780.99	685.99
1933	2176.42	2081.42	634.34	539.34
1934	2600.60	2505.60	939.96	844.96
1935	2387.89	2292.89	951.27	856.27
1936	2446.13	2351.13	911.47	816.47
1937	2180.09	2085.09	676.87	581.87
1938	2481.78	2386.78	1008.57	913.57
1939	2848.21	2753.21	1158.61	1063.61
1940	2827.66	2732.66	1268.79	1173.79
1941	2634.23	2539.23	564.82	469.82
1942	2452.14	2357.14	965.79	870.79
1943	2283.61	2188.61	675.96	580.96
1944	2487.04	2392.04	1079.57	984.57
1945	2331.86	2236.86	958.53	863.53
1946	2640.73	2545.73	937.01	842.01
1947	2504.88	2409.88	884.06	789.06
1948	2199.26	2104.26	635.59	540.59
1949	2403.79	2308.79	818.77	723.77
1950	2171.97	2076.97	578.55	483.55
1951	2563.33	2468.33	965.22	870.22
1952	2549.61	2454.61	967.25	872.25
1953	2284.42	2189.42	700.43	605.43
1954	2527.36	2432.36	817.46	722.46
1955	2247.75	2152.75	660.07	565.07
1956	2164.76	2069.76	650.10	555.10
1957	2474.12	2379.12	1007.80	912.80
1958	2604.39	2509.39	1027.62	932.62
1959	2489.81	2394.81	804.49	709.49
1960	2282.27	2187.27	851.12	756.12
1961	2403.98	2308.98	876.30	781.30
1962	2278.85	2183.85	751.30	656.30
1963	2399.81	2304.81	902.94	807.94
1964	2457.86	2362.86	835.41	740.41
1965	2645.13	2550.13	1096.84	1001.84
1966	2774.37	2679.37	1260.57	1165.57
1967	2460.32	2365.32	965.72	870.72
1968	2443.87	2348.87	828.23	733.23
1969	2297.76	2202.76	719.27	624.27
1970	2739.17	2644.17	1236.15	1141.15

Table 17.1b. Volume Calculations for 28 March through 31 October, Willamette Basin Totals, Model Years 1971 through 2007, BiOp Need and Stored Water to meet BiOp Need.

Year	Volumes Computed for 28 March through 31 October, in KAF			
	Need Total From Tables in Sections 6 -16 From Individual Project Results	**Adjusted BiOp Need (Removes 95 Kaf To Account for Irrigation Storage Contracts)**	**Total Volume of Stored Water Released for Need Sections 6-16**	**Adjusted Stored Water Volume (less 95 Kaf) To Meet BiOp Need**
1971	2261.48	2166.48	683.86	588.86
1972	2191.66	2096.66	763.27	668.27
1973	2570.71	2475.71	959.76	864.76
1974	2381.47	2286.47	900.70	805.70
1975	2541.29	2446.29	877.11	782.11
1976	2382.09	2287.09	828.35	733.35
1977	2386.51	2291.51	851.72	756.72
1978	2334.12	2239.12	803.80	708.80
1979	2608.66	2513.66	1165.85	1070.85
1980	2574.20	2479.20	1151.65	1056.65
1981	2454.72	2359.72	923.91	828.91
1982	2505.42	2410.42	882.65	787.65
1983	2452.54	2357.54	808.49	713.49
1984	2296.94	2201.94	711.67	616.67
1985	2604.20	2509.20	1027.23	932.23
1986	2709.15	2614.15	1146.11	1051.11
1987	2700.40	2605.40	1143.46	1048.46
1988	2459.55	2364.55	1037.29	942.29
1989	2658.46	2563.46	1114.32	1019.32
1990	2812.45	2717.45	1179.90	1084.90
1991	2481.66	2386.66	997.51	902.51
1992	2550.72	2455.72	1109.45	1014.45
1993	2258.79	2163.79	760.04	665.04
1994	2575.35	2480.35	1067.32	972.32
1995	2665.60	2570.60	945.88	850.88
1996	2429.83	2334.83	892.17	797.17
1997	2287.32	2192.32	679.66	584.66
1998	2666.93	2571.93	1022.71	927.71
1999	2480.95	2385.95	811.84	716.84
2000	2480.99	2385.99	914.39	819.39
2001	2733.45	2638.45	1063.13	968.13
2002	2749.07	2654.07	1101.77	1006.77
2003	2740.14	2645.14	1299.31	1204.31
2004	2656.41	2561.41	930.23	835.23
2005	2473.45	2378.45	1008.10	913.10
2006	2595.99	2500.99	1154.74	1059.74
2007	3007.86	2912.86	1274.59	1179.59

Table 17.1c. Volume Calculations for 28 March through 31 October, Willamette Basin Totals, Model Years 1929 through 1970, shortages, inflows, and remaining storage.

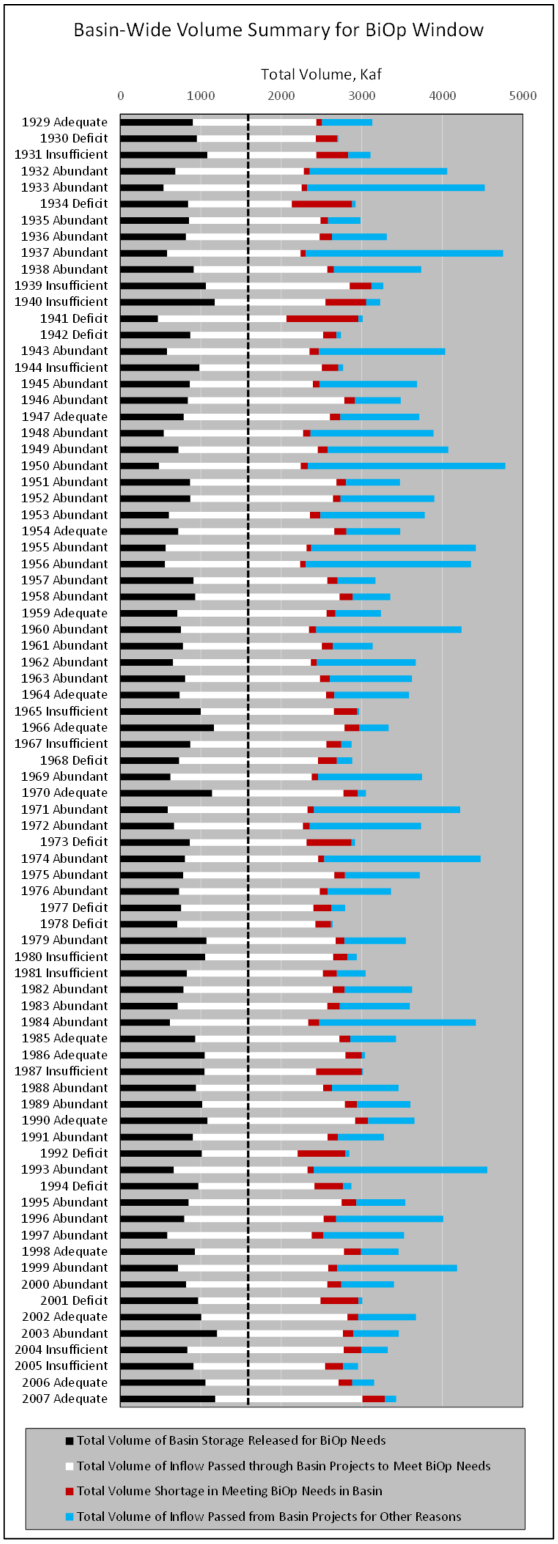
Year	Volumes Computed for 28 March through 31 October, in KAF			Volumes in KAF
	Total Release Volume Shortage To Meet the BiOp Need	Total Volume of Reservoir Inflows Passed for BiOp Need	Total Reservoir Inflows Passes For Other Reasons	Remaining Total Basin Storage (A negative value shows a lack of Conservation storage in the system to meet the Needs)
1929	70.09	1533.78	625.36	482.25
1930	269.37	1476.05	10.99	-381.46
1931	393.78	1353.86	277.74	-282.64
1932	72.32	1595.80	1706.92	727.40
1933	65.09	1715.21	2207.89	877.16
1934	749.26	1285.53	42.73	-768.57
1935	94.37	1631.42	401.94	603.01
1936	152.58	1660.68	681.16	444.45
1937	62.80	1659.10	2450.93	858.12
1938	83.36	1658.32	1083.83	522.47
1939	269.37	1786.68	148.91	-17.76
1940	507.48	1376.03	171.38	-443.48
1941	893.81	1595.38	51.87	-980.34
1942	167.65	1648.70	54.60	97.70
1943	116.27	1771.34	1567.38	807.86
1944	204.79	1519.57	58.86	-93.62
1945	82.19	1529.18	1211.30	544.36
1946	132.56	1941.47	567.72	599.02
1947	128.37	1815.80	981.45	580.64
1948	91.88	1731.35	1528.12	885.86
1949	121.87	1729.85	1499.78	726.99
1950	85.37	1759.35	2455.18	984.25
1951	118.49	1815.87	671.13	548.33
1952	93.12	1770.28	1163.92	586.27
1953	129.91	1750.22	1295.69	704.90
1954	148.81	1936.59	670.45	629.65
1955	55.33	1750.90	2045.11	987.76
1956	68.78	1680.07	2053.51	840.29
1957	127.75	1659.89	469.29	485.21
1958	165.11	1791.36	465.17	437.92
1959	110.51	1852.94	566.31	544.34
1960	90.14	1587.92	1805.15	716.14
1961	133.29	1723.63	498.67	684.81
1962	75.98	1710.31	1227.36	871.70
1963	119.29	1674.16	1020.85	659.86
1964	101.60	1815.62	929.71	598.86
1965	290.75	1652.94	21.74	-96.74
1966	186.94	1619.94	361.27	32.92
1967	183.49	1690.93	128.15	292.01
1968	232.62	1723.88	191.28	159.86
1969	77.31	1755.74	1290.49	813.09
1970	179.02	1631.33	99.75	-2.00

Table 17.1d. Volume Calculations for 28 March through 31 October, Willamette Basin Totals, Model Years 1971 through 2007, shortages, inflows, and remaining storage.

Year	Volumes Computed for 28 March through 31 October, in KAF			Volumes in KAF
	Total Release Volume Shortage To Meet the BiOp Need	Total Volume of Reservoir Inflows Passed for BiOp Need	Total Reservoir Inflows Passes For Other Reasons	Remaining Total Basin Storage (A negative value shows a lack of Conservation storage in the system to meet the Needs)
1971	80.25	1737.84	1815.43	969.09
1972	85.27	1601.11	1382.28	764.81
1973	558.61	1450.01	43.34	-598.54
1974	75.36	1653.20	1940.36	699.48
1975	131.51	1876.51	931.57	644.99
1976	95.46	1745.29	789.13	610.28
1977	223.99	1643.34	169.00	-14.91
1978	193.40	1714.95	20.84	45.78
1979	110.20	1604.58	762.75	314.92
1980	177.11	1587.45	118.00	63.80
1981	171.51	1689.77	357.93	514.14
1982	150.33	1849.56	838.22	651.57
1983	155.61	1858.73	868.70	637.52
1984	138.23	1718.21	1942.36	882.65
1985	135.10	1789.65	568.78	498.92
1986	204.60	1747.34	37.80	153.91
1987	568.53	1385.40	13.45	-615.75
1988	108.34	1578.53	827.26	470.93
1989	150.59	1772.19	662.95	409.76
1990	162.00	1832.08	576.48	222.29
1991	130.21	1672.10	569.08	507.90
1992	591.85	1190.55	47.76	-654.55
1993	73.83	1662.64	2157.47	669.24
1994	353.93	1441.77	101.46	-287.70
1995	185.24	1898.33	606.82	403.73
1996	155.76	1728.89	1328.99	645.34
1997	141.45	1794.33	1004.65	913.34
1998	210.68	1851.74	467.37	386.32
1999	109.96	1867.43	1489.36	710.10
2000	172.18	1752.89	655.45	517.12
2001	471.37	1520.73	46.15	-473.35
2002	134.85	1815.99	714.33	228.25
2003	128.56	1561.83	564.81	87.42
2004	218.70	1939.59	328.13	443.54
2005	221.71	1633.09	185.52	267.74
2006	169.72	1652.02	274.06	329.14
2007	278.83	1829.78	138.19	-33.05

Table 17.1e. Volume Calculations for 28 March through 31 October, Willamette Basin Totals, Model Years 1929 through 2007, Adjusted Stored Water to meet BiOp Need (from 17.1 a,b), Shortage Volume (from 17.1c,d), and Demand for Storage (sum of the two values).

Year	Volumes for 28 March - 31 October, KAF			Year	Volumes for 28 March - 31 October, KAF		
	Adjusted Stored Water Volume To Meet BiOp Need	Total Release Volume Shortage To Meet the BiOp Need	Total Demand for Stored Water (Sum of both Columns)		Adjusted Stored Water Volume To Meet BiOp Need	Total Release Volume Shortage To Meet the BiOp Need	Total Demand for Stored Water (Sum of both Columns)
1929	902.82	70.09	972.91	**1971**	588.86	80.25	669.11
1930	952.24	269.37	1221.61	**1972**	668.27	85.27	753.54
1931	1082.91	393.78	1476.69	**1973**	864.76	558.61	1423.37
1932	685.99	72.32	758.31	**1974**	805.70	75.36	881.06
1933	539.34	65.09	604.43	**1975**	782.11	131.51	913.62
1934	844.96	749.26	1594.23	**1976**	733.35	95.46	828.81
1935	856.27	94.37	950.64	**1977**	756.72	223.99	980.71
1936	816.47	152.58	969.05	**1978**	708.80	193.40	902.20
1937	581.87	62.80	644.67	**1979**	1070.85	110.20	1181.05
1938	913.57	83.36	996.93	**1980**	1056.65	177.11	1233.76
1939	1063.61	269.37	1332.98	**1981**	828.91	171.51	1000.42
1940	1173.79	507.48	1681.27	**1982**	787.65	150.33	937.98
1941	469.82	893.81	1363.63	**1983**	713.49	155.61	869.10
1942	870.79	167.65	1038.44	**1984**	616.67	138.23	754.90
1943	580.96	116.27	697.22	**1985**	932.23	135.10	1067.34
1944	984.57	204.79	1189.36	**1986**	1051.11	204.60	1255.71
1945	863.53	82.19	945.72	**1987**	1048.46	568.53	1616.99
1946	842.01	132.56	974.57	**1988**	942.29	108.34	1050.63
1947	789.06	128.37	917.43	**1989**	1019.32	150.59	1169.91
1948	540.59	91.88	632.46	**1990**	1084.90	162.00	1246.90
1949	723.77	121.87	845.64	**1991**	902.51	130.21	1032.71
1950	483.55	85.37	568.92	**1992**	1014.45	591.85	1606.29
1951	870.22	118.49	988.71	**1993**	665.04	73.83	738.87
1952	872.25	93.12	965.37	**1994**	972.32	353.93	1326.25
1953	605.43	129.91	735.34	**1995**	850.88	185.24	1036.13
1954	722.46	148.81	871.27	**1996**	797.17	155.76	952.92
1955	565.07	55.33	620.40	**1997**	584.66	141.45	726.11
1956	555.10	68.78	623.88	**1998**	927.71	210.68	1138.38
1957	912.80	127.75	1040.56	**1999**	716.84	109.96	826.81
1958	932.62	165.11	1097.73	**2000**	819.39	172.18	991.57
1959	709.49	110.51	820.00	**2001**	968.13	471.37	1439.50
1960	756.12	90.14	846.26	**2002**	1006.77	134.85	1141.62
1961	781.30	133.29	914.60	**2003**	1204.31	128.56	1332.87
1962	656.30	75.98	732.28	**2004**	835.23	218.70	1053.93
1963	807.94	119.29	927.23	**2005**	913.10	221.71	1134.81
1964	740.41	101.60	842.01	**2006**	1059.74	169.72	1229.45
1965	1001.84	290.75	1292.58	**2007**	1179.59	278.83	1458.42
1966	1165.57	186.94	1352.51				
1967	870.72	183.49	1054.21				
1968	733.23	232.62	965.85				
1969	624.27	77.31	701.58				
1970	1141.15	179.02	1320.17				



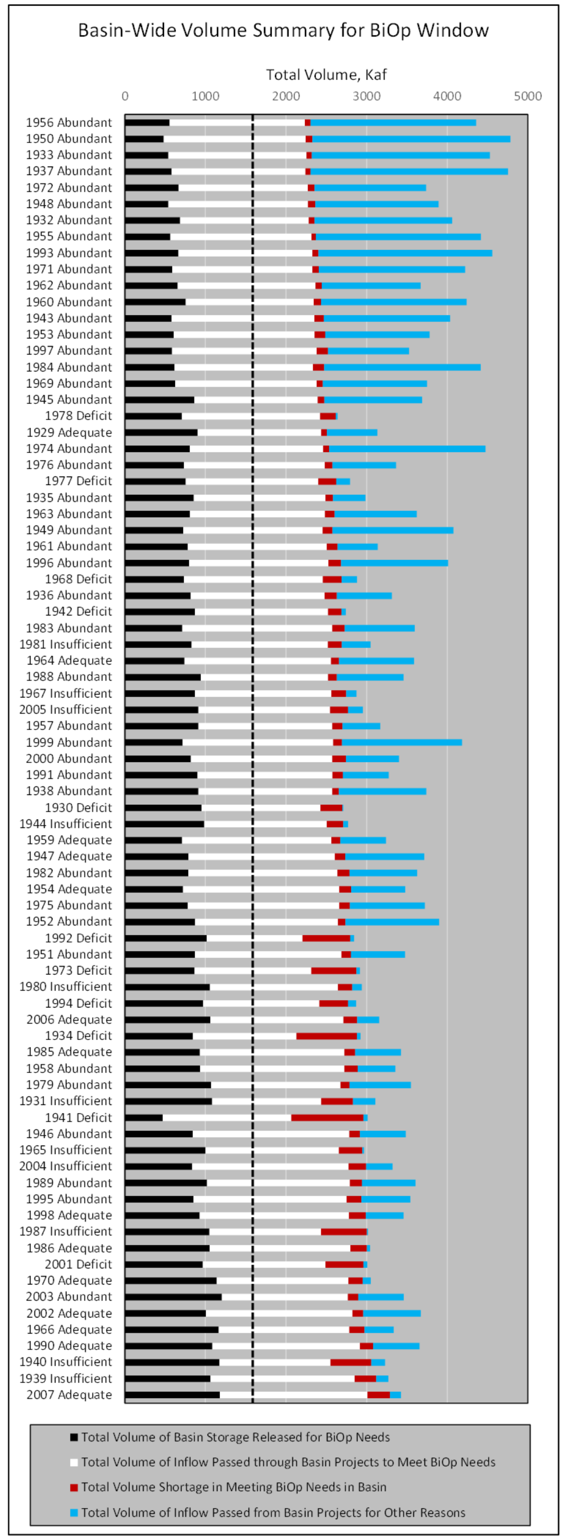


Figure 17.1. Water volume totals for the Willamette Basin projects, 1929-2007, in chronological order (on left), and sorted by total BiOp Need, which is the Black + White + Red. Dashed vertical line illustrates the combined conservation storage in the basin of about 1.6 Maf.

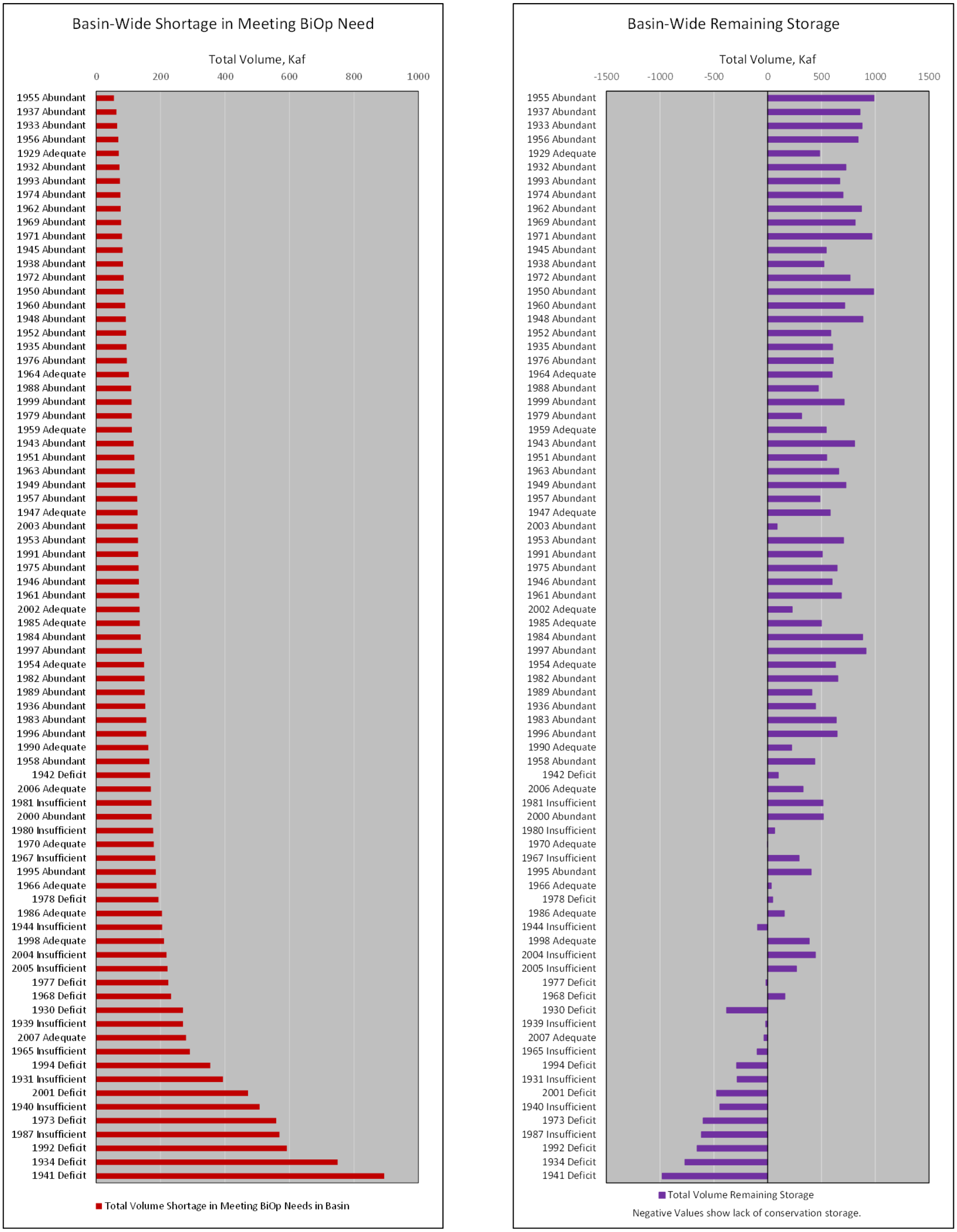
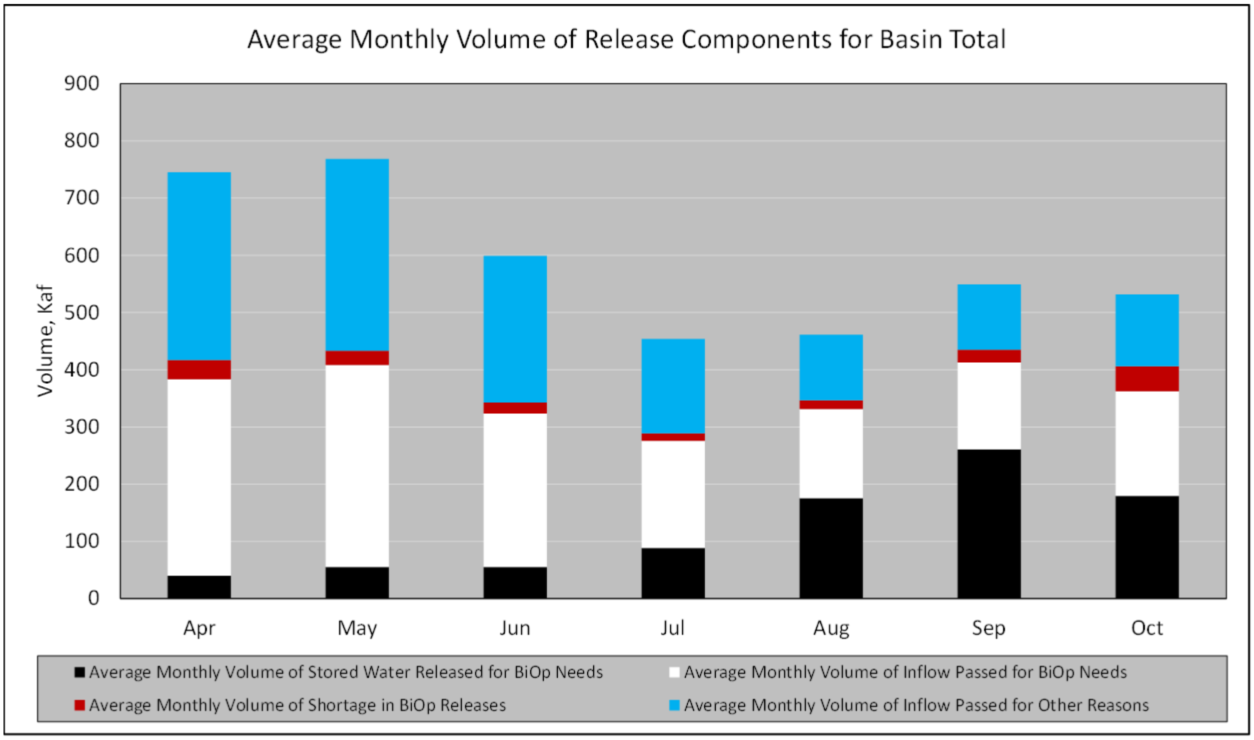


Figure 17.2. Water Volume totals for the Willamette Basin, 1929-2007, sorted by total volume shortage, with shortage on left (red) and remaining storage volume released not for BiOp Needs on right (purple). (Negative remaining indicates a shortage in conservation storage.)

Figure 17.3. Remaining storage (purple) minus shortage (red), shown in bright teal, 1929-2007, sorted by total volume shortage, indicating that real time water management had more flexibility to meet minimum flow targets than modeled by ResSim. Positive values mean stored water was available in real time to supplement flow shortages, while negative values mean that there was not enough stored water to cover the shortage. Note 23 years in the POR would still have had some shortage.



Average Monthly Volumes, KAF	28-31Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
BiOp Need	42.46	379.74	408.00	322.32	268.90	312.46	397.74	356.73
Stored Water Released for BiOp Needs	2.28	39.60	55.22	54.91	88.80	175.37	260.54	179.65
Inflow Passed for BiOp Needs	40.36	344.01	353.11	268.74	186.68	155.97	151.97	182.95
Shortage in meeting BiOp Needs	4.38	33.29	24.73	19.18	13.30	15.26	22.41	43.73
Inflow Passed Other Reasons	39.84	328.62	335.65	256.19	164.77	114.79	114.33	125.73

Figure 17.4. Water volume average monthly totals for release components for all Willamette Basin dams, 1929-2007. Black is the stored water released for the mainstem BiOp target minimums, white is the inflow passed to meet the mainstem BiOp target minimums, red is the shortage in releases for the mainstem supplemental flows, and blue is the inflow passed for other reasons.

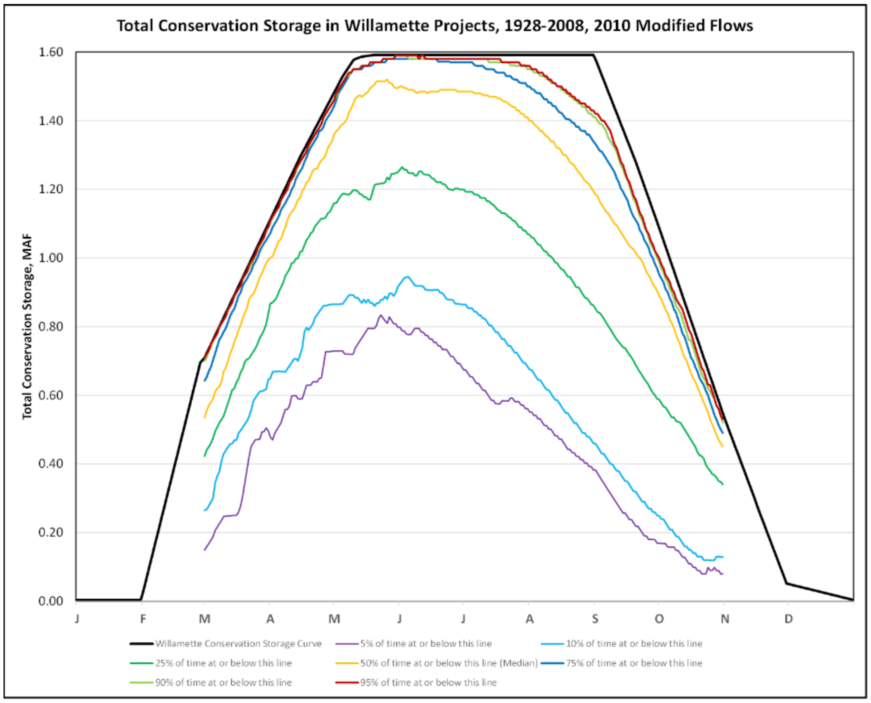


Figure 17.5. Non-exceedance conservation storage values for the total system storage, 1929-2007. Non-exceedance values are computed for every day of the year, and percentiles are computed separately for each day of the year. The lines represent constant percentile values, not specific years.

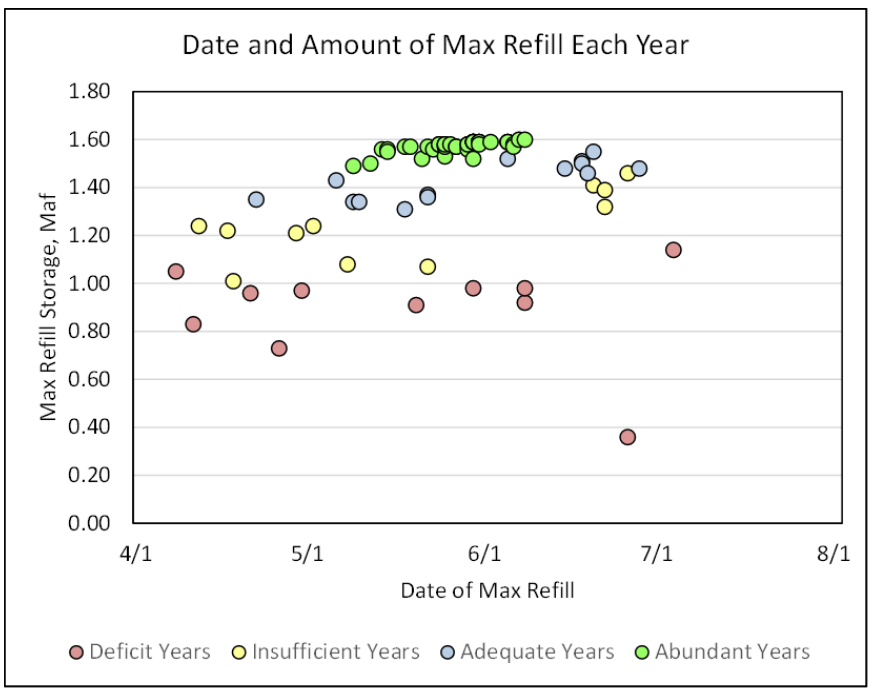
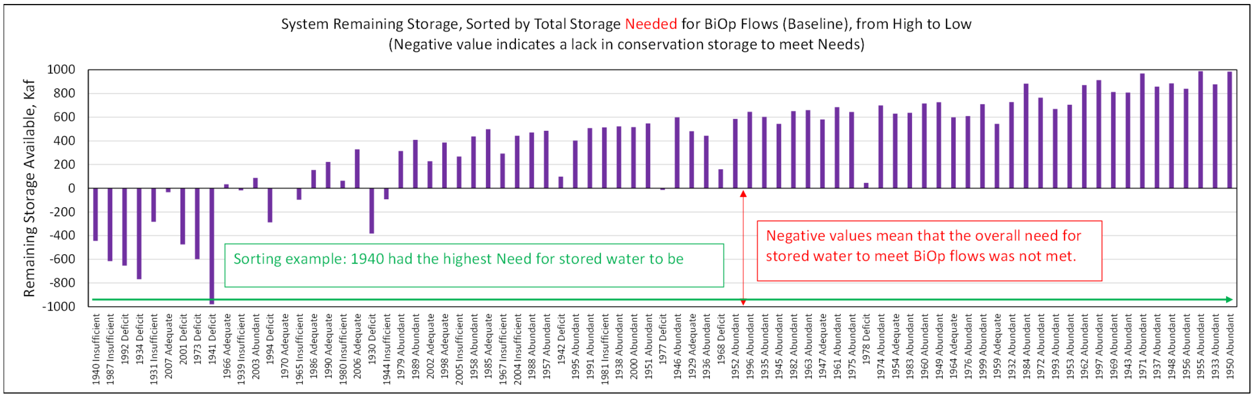


Figure 17.6. Maximum conservation season storage and date it occurs for each year in the modeled dataset. Data is plotted by water year type as well.



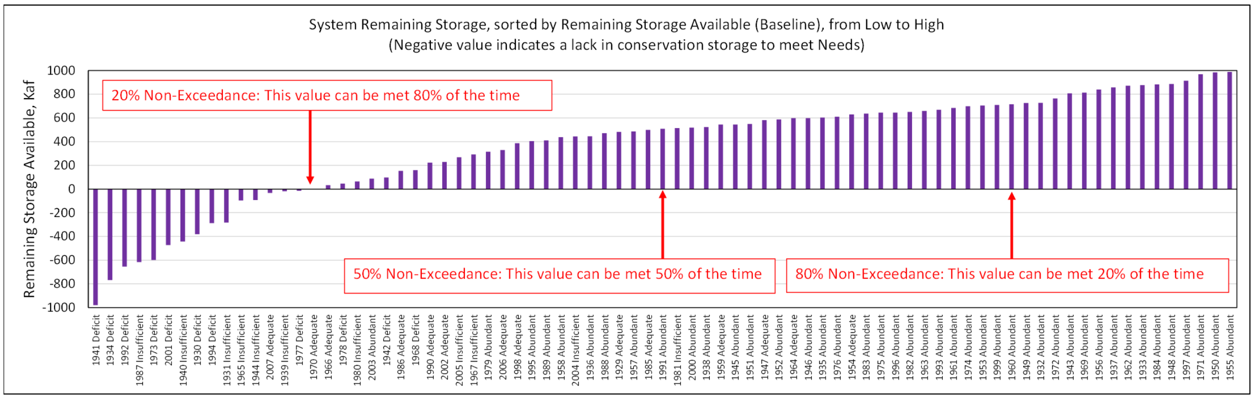


Figure 17.7. Remaining storage for the basin total, with volumes shown in Kaf, shown two ways. (Same data in both graphs, just sorted differently. Data is from the last columns in Tables 17.1c and d, but sorted differently than in the tables.)

Upper graph has the results sorted by total BiOp Need in the basin, from high to low, with the year on the far left having the highest need and the year on the right the lowest need.

Lower graph has results sorted by remaining storage low to high values. Lower graph also shows non-exceedance percentiles of 20%, 50%, and 80% with arrows. Note these percentiles are for the storage volume available OR LESS for each % shown. Note both graphs show negative storage (indicating lack of conservation storage) common for deficit and insufficient water years.

20% non-exceedance = remaining storage with 80% reliability
80% non-exceedance = remaining storage with 20% reliability

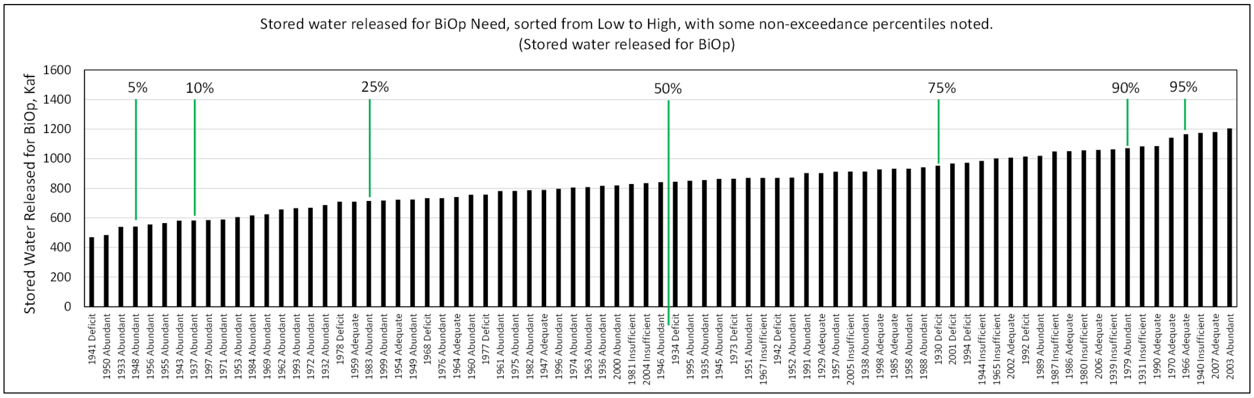


Figure 17.8. Total storage released to meet BiOp Needs, with volumes shown in Kaf. (Data is from the last columns in Tables 17.1a and b, sorted from low to high values.)

Graph also shows non-exceedance percentiles of 5%, 10%, 25%, 50%, 75%, 90%, and 95% with vertical green lines. Note these percentiles are for the storage volume released OR LESS for each percentile shown.

5% non-exceedance = 541 Kaf or less is used 5% of the time
10% non-exceedance = 589 Kaf or less is used 10% of the time
25% non-exceedance = 713 Kaf or less is used 25% of the time
50% non-exceedance = 839 Kaf or less is used 50% of the time
75% non-exceedance = 952 Kaf or less is used 75% of the time
90% non-exceedance = 1064 Kaf or less is used 90% of the time
95% non-exceedance = 1141 Kaf or less is used 95% of the time

18 References.

Bonneville Power Administration (BPA). 2011. 2010 Level Modified Streamflow, 1928-2008. DOE/BP-4352.

NOAA Fisheries. 2008. Endangered Species Act Section 7(a)(2) Consultation, Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Consultation on the Willamette River Basin Flood Control Project. Log Number F/NWR/2000/02117. Northwest Region, Seattle, WA. (From NMFS office.)

U.S. Army Corps of Engineers. 2017. Appendix E – ResSim Analysis for 2008 Baseline Flow Dataset, part of the Willamette Basin Review Feasibility Study, Integrated Feasibility Report and Environmental Assessment.

U.S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation. 2007. Supplemental Biological Assessment of the Effects of the Willamette River Basin Flood Control Project on Species Listed under the Endangered Species Act. Portland, OR.

U.S. Fish and Wildlife Service (USFWS). 2008. Endangered Species Act Section 7 Consultation, Biological Opinion on the Continued Operation and Maintenance of the Willamette River Basin Project and Effects to Oregon Chub, Bull Trout, and Bull Trout Critical Habitat Designated Under the Endangered Species Act. File Number 8330.F0224(07). Tails Number 13420-2007-F-0024. Oregon Fish and Wildlife Office, Portland, OR.

19 Appendix.

A large number of Excel files were used to make the calculations presented in this report. The following sections outline the spreadsheet names, their worksheet names, what general type of information is available on each worksheet or where that data came from, and the relevant figure in the report that is on that worksheet or the table that includes data from that worksheet.

19.1 Blue River Spreadsheets

The spreadsheet used to obtain the Blue River contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.1a. BiOp Volume Computation Excel File Reference Information for Blue River.

Excel File Name:	**All BLU BiOp_Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
Flow Chart	Figure 5.9		
BLUE RIVER-POOL-STOR			simulation.dss file from Baseline run
BLUE RIVER-POOL-ELEV			simulation.dss file from Baseline run
BLUE RIVER-ZONEID			simulation.dss file from Baseline run
BLU-DAM-MIN FLOW			simulation.dss file from Baseline run
BLU-MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
BLU-MIN FLOW – AT SALEM			simulation.dss file from Baseline run
BLUE RIVER-POOL-FLOW-IN			simulation.dss file from Baseline run
BLUE RIVER-POOL-FLOW-OUT			simulation.dss file from Baseline run
BLU-MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
BLU-MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 6.1 (left) and Figure 5.10	Table 6.1	Values read from other sheets and calculated
Sorted Project Summary	Figure 6.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 6.2		Values read from other sheets
BiOp-Need-Monthly	Figure 6.3		Values read from other sheets and calculated
Project Summary 1929 flow			Values read from other sheets
Project Summary 1929 volume	Figure 5.5		Calculated values
Project Summary 1934 flow			Values read from other sheets
Project Summary 1934 volume	Figure 5.8		Calculated values

The spreadsheet used to obtain the basic methodology information from Blue River for 1929 is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.1b. BiOp Volume Computation Excel File Reference Information for Basic Methodology.

Excel File Name:	**BLU BiOp flow breakdown- Baseline-14April2017.xlsx**		
Worksheet Name (Relevant sheets only)	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Index_Sheet			Imported data sheets through macro
BLUE RIVER-ZONEID			simulation.dss file from Baseline run
ALB-Min-Rule			simulation.dss file from Baseline run
SLM-Min-Rule			simulation.dss file from Baseline run
Flow-In			simulation.dss file from Baseline run
Flow-Out			simulation.dss file from Baseline run
Out-In			Calculated values
flow type			simulation.dss file from Table 5.1 run
Characterized flowout			Calculated values
water used to meet BiOp			Calculated values
Stored water used for BiOp			Calculated values
Graph-Adequ	Figure 5.2, 5.3, and Figure 5.4		Graphs
Graph-Deficit	Figure 5.7		Graphs

19.2 Cougar Spreadsheet

The spreadsheet used to obtain the Cougar contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.2. BiOp Volume Computation Excel File Reference Information for Cougar.

Excel File Name:	**All CGR BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
COUGAR-POOL-STOR			simulation.dss file from Baseline run
COUGAR-ZONEID			simulation.dss file from Baseline run
CGR-DAM-MIN FLOW			simulation.dss file from Baseline run
CGR-MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
CGR-MIN FLOW – AT SALEM			simulation.dss file from Baseline run
COUGAR-POOL-FLOW-IN			simulation.dss file from Baseline run
COUGAR-POOL-FLOW-OUT			simulation.dss file from Baseline run
CGR-MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
CGR-MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 7.1 (left)	Table 7.1	Values read from other sheets and calculated
Sorted Project Summary	Figure 7.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 7.2		Values read from other sheets
BiOp-Need-Monthly	Figure 7.3		Values read from other sheets and calculated

19.3 Dorena Spreadsheet

The spreadsheet used to obtain the Dorena contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.3. BiOp Volume Computation Excel File Reference Information for Dorena.

Excel File Name:	**All DOR BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
DORENA-POOL-STOR			simulation.dss file from Baseline run
DORENA-ZONEID			simulation.dss file from Baseline run
DOR-DAM-MIN FLOW			simulation.dss file from Baseline run
DOR-MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
DOR-MIN FLOW – AT SALEM			simulation.dss file from Baseline run
DORENA-POOL-FLOW-IN			simulation.dss file from Baseline run
DORENA-POOL-FLOW-OUT			simulation.dss file from Baseline run
DOR-MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
DOR-MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 8.1 (left)	Table 8.1	Values read from other sheets and calculated
Project Summary sorted	Figure 8.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 8.2		Values read from other sheets
BiOp-Need-Monthly	Figure 8.3		Values read from other sheets and calculated

19.4 Cottage Grove Spreadsheet

The spreadsheet used to obtain the Cottage Grove contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.4. BiOp Volume Computation Excel File Reference Information for Cottage Grove.

Excel File Name:	**All COT BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
COTTAGE GROVE-POOL-STOR			simulation.dss file from Baseline run
COTTAGE GROVE-ZONEID			simulation.dss file from Baseline run
COT-DAM-MIN FLOW			simulation.dss file from Baseline run
COT-MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
COT-MIN FLOW – AT SALEM			simulation.dss file from Baseline run
COTTAGE GROVE-POOL-FLOW-IN			simulation.dss file from Baseline run
COTTAGE GROVE-POOL-FLOW-OUT			simulation.dss file from Baseline run
COT-MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
COT-MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 9.1 (left)	Table 9.1	Values read from other sheets and calculated
Project Summary sorted	Figure 9.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 9.2		Values read from other sheets
BiOp-Need-Monthly	Figure 9.3		Values read from other sheets and calculated

19.5 Fall Creek Spreadsheet

The spreadsheet used to obtain the Fall Creek contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.5. BiOp Volume Computation Excel File Reference Information for Fall Creek.

Excel File Name:	**All FAL BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
FALL CREEK-POOL-STOR			simulation.dss file from Baseline run
FALL CREEK -ZONEID			simulation.dss file from Baseline run
FAL-DAM-MIN FLOW			simulation.dss file from Baseline run
FAL -MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
FAL -MIN FLOW – AT SALEM			simulation.dss file from Baseline run
FALL CREEK -POOL-FLOW-IN			simulation.dss file from Baseline run
FALL CREEK -POOL-FLOW-OUT			simulation.dss file from Baseline run
FAL -MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
FAL -MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 10.1 (left)	Table 10.1	Values read from other sheets and calculated
Project Summary sorted	Figure 10.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 10.2		Values read from other sheets
BiOp-Need-Monthly	Figure 10.3		Values read from other sheets and calculated

19.6 Hills Creek Spreadsheet

The spreadsheet used to obtain the Hills Creek contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.6. BiOp Volume Computation Excel File Reference Information for Hills Creek.

Excel File Name:	**All HCR BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
HILLS CREEK-POOL-STOR			simulation.dss file from Baseline run
HILLS CREEK -ZONEID			simulation.dss file from Baseline run
HCR-DAM-MIN FLOW			simulation.dss file from Baseline run
HCR -MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
HCR -MIN FLOW – AT SALEM			simulation.dss file from Baseline run
HILLS CREEK -POOL-FLOW-IN			simulation.dss file from Baseline run
HILLS CREEK -POOL-FLOW-OUT			simulation.dss file from Baseline run
HCR -MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
HCR -MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 11.1 (left)	Table 11.1	Values read from other sheets and calculated
Project Summary sorted	Figure 11.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 11.2		Values read from other sheets
BiOp-Need-Monthly	Figure 11.3		Values read from other sheets and calculated

19.7 Lookout Point Spreadsheet

The spreadsheet used to obtain the Lookout Point contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.7. BiOp Volume Computation Excel File Reference Information for Lookout Point.

Excel File Name:	**All LOP including HCR BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
LOOKOUT POINT-POOL-STOR			simulation.dss file from Baseline run
LOOKOUT POINT -ZONEID			simulation.dss file from Baseline run
LOP-DAM-MIN FLOW			simulation.dss file from Baseline run
LOP -MIN FLOW – AT ALBANY			simulation.dss file from Baseline run
LOP -MIN FLOW – AT SALEM			simulation.dss file from Baseline run
LOOKOUT POINT -POOL-FLOW-IN			simulation.dss file from Baseline run
LOOKOUT POINT -POOL-FLOW-OUT			simulation.dss file from Baseline run
LOP -MIN ALBANY EXTENDED			simulation.dss file from Table 5.1 run
LOP -MIN SALEM EXTENDED			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp Shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 12.1 (left) and Figure 12.5	Table 12.1 and Figure 12.8 (left side)	Values read from other sheets and calculated Some values pasted from HCR spreadsheet And pasted here.
Project Summary sorted	Figure 12.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 12.2		Values read from other sheets
BiOp-Need-Monthly	Figure 12.3		Values read from other sheets and calculated
HCR Project Summary			Pasted values from HCR spreadsheet
LOP only Project Summary	Figure 11.3, Figure 12.8 (right) and Figure 12.9	Table 12.2 and Table 12.4	Values read from other sheets and calculated

19.8 Fern Ridge Spreadsheet

The spreadsheet used to obtain the Fern Ridge contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.8. BiOp Volume Computation Excel File Reference Information for Fern Ridge.

Excel File Name:	**All FRN BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
FERN RIDGE-POOL-STOR			simulation.dss file from Baseline run
FERN RIDGE -ZONEID			simulation.dss file from Baseline run
FERN RIDGE-DAM-MIN FLOW-FLOW-MI			simulation.dss file from Baseline run
FERN RIDGE -POOL-FLOW-IN			simulation.dss file from Baseline run
FERN RIDGE -POOL-FLOW-OUT			simulation.dss file from Baseline run
StoredReleases			Calculated values
FRN BiOp-Need			Calculated values
FRN BiOp shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet biop			Calculated values
Stored Meet BiOp			Calculated values
Project Summary	Figure 13.1 (left)	Table 13.1	Values read from other sheets and calculated
Project Summary sorted	Figure 13.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 13.2		Values read from other sheets
BiOp-Need-Monthly	Figure 13.3		Values read from other sheets and calculated

19.9 Green Peter Spreadsheet

The spreadsheet used to obtain the Green Peter contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.9. BiOp Volume Computation Excel File Reference Information for Green Peter.

Excel File Name:	**All GPR BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
GREEN PETER-POOL-STOR			simulation.dss file from Baseline run
GREEN PETER -ZONEID			simulation.dss file from Baseline run
GPR-DAM-MIN FLOW			simulation.dss file from Baseline run
GPR-MIN FROM FOS			simulation.dss file from Baseline run
GPR-VARIABLE MIN FOS			simulation.dss file from Baseline run
GREEN PETER -POOL-FLOW-IN			simulation.dss file from Baseline run
GREEN PETER -POOL-FLOW-OUT			simulation.dss file from Baseline run
GPR-MIN FOS EXT			simulation.dss file from Table 5.1 run
GPR-VARIABLE MIN FOS EXT			simulation.dss file from Table 5.1 run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary BiOp Window	Figure 14.1 (left)	Table 14.1	Values read from other sheets and calculated
Project Summary sorted BiOp Win	Figure 14.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 14.2		Values read from other sheets
BiOp-Need-Monthly-A-O	Figure 14.3		Values read from other sheets and calculated for April through October only (BiOp window)
BiOp-Need-Monthly-F-D	Figure 11.3		Values read from other sheets and calculated for February through December, not presented in report
Project Summary BiOp Feb-Dec			Values read from other sheets and calculated but not presented in report

19.10 Foster Spreadsheet

The spreadsheet used to obtain the Foster contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.10a. BiOp Volume Computation Excel File Reference Information for Foster.

Excel File Name:	**All FOS BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Summary			Lists dss time series records
FOSTER-POOL-STOR			simulation.dss file from Baseline run
FOSTER -ZONEID			simulation.dss file from Baseline run
FOS-NEW MIN FLOW-MIN			simulation.dss file from Baseline run
FOSTER -POOL-FLOW-IN			simulation.dss file from Baseline run
FOSTER -POOL-FLOW-OUT			simulation.dss file from Baseline run
GREEN PETER -POOL-FLOW-OUT			simulation.dss file from Baseline run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary			Values read from other sheets and calculated
Project Summary BiOp Window	Figure 15.1 (left)	Table 15.1	Values read from other sheets and calculated
Project Summary BiOp Win sort	Figure 15.1 (right) and Figure 15.5		Values pasted from other sheets and sorted
shortage and remaining	Figure 15.2		Values read from other sheets
BiOp-Need-Monthly-A-O	Figure 15.3		Values read from other sheets and calculated for April through October only (BiOp window)
BiOp-Need-Monthly-F-D	Figure 15.6		Values read from other sheets and calculated for February through December, not presented in report

Table 19.10b. BiOp Volume Computation Excel File Reference Information for additional Foster data.

Excel File Name:	**Sum of all stored water used BiOp with min tribs– Baseline-14April2017.xlsx**		
Worksheet Name (Relevant sheets only)	**Report Figure Reference**	**Report Table Reference**	**Data Source**
GPR		Table 15.1	Values from GPR spreadsheet with total flow into Foster computed here
FOS use FOS only		Table 15.2	Values from FOS spreadsheet with estimates for removal of GPR flows here

19.11 Detroit Spreadsheet

The spreadsheet used to obtain the Detroit contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.11. BiOp Volume Computation Excel File Reference Information for Detroit.

Excel File Name:	**All DET BiOp_ Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
DETROIT-POOL-STOR			simulation.dss file from Baseline run
DETROIT -ZONEID			simulation.dss file from Baseline run
DET-DAM-FLOW-MIN			simulation.dss file from Baseline run
DET-LOWER MINS-FLOW-MIN			simulation.dss file from Baseline run
DETROIT -POOL-FLOW-IN			simulation.dss file from Baseline run
DETROIT -POOL-FLOW-OUT			simulation.dss file from Baseline run
NORTH SANTIAM DIVERSION-FLOW			simulation.dss file from Baseline run
StoredReleases			Calculated values
BiOp-Need			Calculated values
BiOp shortage			Calculated values
Passed Inflow			Calculated values
Passed Inflow meet BiOp			Calculated values
Stored meet BiOp			Calculated values
Project Summary	Figure 16.1 (left)	Table 16.1	Values read from other sheets and calculated
Project Summary sorted	Figure 16.1 (right)		Values pasted from other sheets and sorted
shortage and remaining	Figure 16.2		Values read from other sheets
BiOp-Need-Monthly	Figure 16.3		Values read from other sheets and calculated

19.12 Willamette Basin Totals Spreadsheets

The spreadsheet used to obtain the full Willamette Basin contribution to the BiOp flows is listed in the table below, along with the names of each of the worksheets in the file. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.12a. BiOp Volume Computation Excel File Reference Information for Willamette Basin Totals.

Excel File Name:	**Sum of all stored water used BiOp with min tribs- Baseline-14April2017.xlsx**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
BLU			Values from Blue River Spreadsheet, Project Summary worksheet
CGR			Values from Cougar Spreadsheet, Project Summary worksheet
DOR			Values from Dorena Spreadsheet, Project Summary worksheet
COT			Values from Cottage Grove Spreadsheet, Project Summary worksheet
FAL			Values from Fall Creek Spreadsheet, Project Summary worksheet
HCR			Values from Hills Creek Spreadsheet, Project Summary worksheet
LOP with HCR			Values from Lookout Point Spreadsheet and HCR data, Project Summary worksheet, includes calculations to get LOP only data
FRN			Values from Fern Ridge Spreadsheet, Project Summary worksheet
GPR			Values from Green Peter Spreadsheet, Project Summary BiOp Window worksheet
FOS use FOS only			Values from Foster Spreadsheet, Project Summary BiOp Window worksheet, with calculations to get FOS only estimated data
DET			Values from Detroit Spreadsheet, Project Summary worksheet
Component Totals	Figure 17.1 (left) and Figure 17.3	Table 17.1	Values read from other sheets and calculated
Component Totals sorted	Figure 17.1 (right) and Figure 17.2		Values pasted from other sheets and sorted
WY list			Same data as Table 3.1
VolumeNeededSLM5M			Data from Salem flow spreadsheet

19.13 Storage Data Spreadsheets

The spreadsheet used to obtain any of the storage information at the projects and for the basin total is listed below. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.13. Storage Value Excel File Reference Information for all Projects and Basin Total.

Excel File Name:	**Storage Charts_ Baseline-14April2017.xlsm**		
Worksheet Name	**Report Figure Reference**	**Report Table Reference**	**Data Source**
Index_Sheet			List and hyperlinks to project data sheets
BLUE RIVER-POOL-STOR			simulation.dss file from Baseline run
COTTAGE GROVE-POOL-STOR			simulation.dss file from Baseline run
COUGAR-POOL-STOR			simulation.dss file from Baseline run
DETROIT-POOL-STOR			simulation.dss file from Baseline run
DORENA-POOL-STOR			simulation.dss file from Baseline run
FALL CREEK-POOL-STOR			simulation.dss file from Baseline run
FERN RIDGE-POOL-STOR			simulation.dss file from Baseline run
FOSTER-POOL-STOR			simulation.dss file from Baseline run
GREEN PETER-POOL-STOR			simulation.dss file from Baseline run
HILLS CREEK-POOL-STOR			simulation.dss file from Baseline run
LOOKOUT POINT-POOL-STOR			simulation.dss file from Baseline run
TotalStorage			Values calculated for basin total
BLU	Figure 5.9 and Figure 6.4		Graphed Data
CGR	Figure 7.4		Graphed Data
COT	Figure 9.4		Graphed Data
DET	Figure 16.4		Graphed Data
DOR	Figure 8.4		Graphed Data
FAL	Figure 10.4		Graphed Data
FRN	Figure 13.4		Graphed Data
FOS	Figure 15.4		Graphed Data
GPR	Figure 14.4		Graphed Data
HCR	Figure 11.4		Graphed Data
LOP	Figure 12.4		Graphed Data
storage summary			Graphed Data
Total Graph	Figure 17.4		Graphed Data
Total Table			Values read from each project sheet
Title_Page			Data from macro run for file name
refill summary	Figure 17.5		Hand pasted and sorted by WY type

Table 19.13b. Additional Willamette Basin Total data.

Excel File Name:	**new look at stored water use-hand paste Baseline-14April2017.xlsx**		
Worksheet Name (Relevant sheets only)	**Report Figure Reference**	**Report Table Reference**	**Data Source**
sorted system totals sorted system by remains Graphs	Figure 17.6		Hand paste data from the “Sum of all stored water used BiOp with min tribs-Baseline-14April2017” file and sort differently than before.
Stored water sorted lo-hii Graphs stored water	Figure 17.7		Hand paste data from the “Sum of all stored water used BiOp with min tribs-Baseline-14April2017” file and sort differently than before.

19.14 Flow at Salem Spreadsheets

The spreadsheet used to obtain regulated flow data at Salem for the Baseline. Figures and tables in the report that use data from these worksheets are defined and listed in the table below as well.

Table 19.14a. Salem Regulated Flow Data Excel File Reference Information.

Excel File Name:	**Exceedance_Graph_Salem_ Baseline-14April2017.xlsm**		
Worksheet Name (Relevant sheets only)	**Report Figure Reference**	**Report Table Reference**	**Data Source**
WILLAMETTE_AT SALEM-FLOW Willamette @ Salem	Figure 2.3		simulation.dss file from Baseline run Graphed data from Salem flow sheet

Table 19.14b. Salem Unregulated Flow Data Excel File Reference Information.

Excel File Name:	**Exceedance_Graph_SLM5M.xls**		
Worksheet Name (Relevant sheets only)	**Report Figure Reference**	**Report Table Reference**	**Data Source**
WILLAMETTE_AT SALEM-FLOW Willamette @ Salem	Figure 2.2		simulation.dss file from total flow at Salem time series record from 2010 Modified flows Graphed data from Salem flow sheet